Oakland Airport Connector Options Analysis

Oakland, California

Final Report

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TransForm works to create world-class public transportation and walkable communities in the Bay Area and beyond. We build diverse coalitions, influence policy, and develop innovative programs to improve the lives of all people and protect the environment. Based in Oakland with offices in Sacramento and San Jose, TransForm is now California's largest non-profit promoting smarter and more efficient transportation and land use strategies.

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Kittelson & Associates, Inc. (KAI) has conducted transit corridor studies for agencies throughout the United States and is a nationally recognized leader in bus rapid transit, transit signal priority, and transit quality-of-service assessment. KAI also has expertise in evaluating transit markets and needs, and assessing transit-oriented development patterns around transit stations. The firm authored both editions of the Transportation Research Board's *Transit Capacity and Quality of Service Manual*, which offers guidance on evaluating bus and rail operations. In addition, KAI has authored other national transit guidebooks, including the *BRT Practitioner's Guide* and *A Guidebook for Developing a Transit Performance Measurement System*. KAI staff members are a reliable resource for transit operations analysis, planning, design, and research services, as well as traffic planning and transportation engineering services in support of transit projects.

Founded in 1985, KAI's staff is located internationally with offices in Anchorage, Alaska; Baltimore, Maryland; Bend and Portland, Oregon; Boise, Idaho; Fort Lauderdale and Orlando, Florida; Reston, Virginia; Tucson, Arizona; and a wholly-owned subsidiary in Brisbane, Australia.

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Section 1
Executive Summary

Executive Summary

PROJECT PURPOSE

This report providers an updated and expanded analysis of options for the Oakland Airport Connector. The options studied consist of No Action (retain existing AirBART service), Rapid Bus, Full Bus Rapid Transit (BRT), and Automated Guideway Transit (AGT). The Rapid Bus and Full BRT configurations analyzed in this report have not been studied previously and incorporate information about BRT service that was not available at the time the Final Environmental Impact Report/Final Environment Impact Statement (FEIR/FEIS) for the Oakland Airport Connector was completed in 2002. In addition, the report updates information for the No Action and AGT options based on the most up-to-date data available.

The intent of this report is to inform current discussions on the Oakland Airport Connector through a valid comparison of the four key modal options. Subsequent to the certification of the FEIR/FEIS, there has been a considerable drop in airline passenger volumes at Oakland International Airport, the shift of some flights to San Francisco International Airport, a significant reduction in projections of future airline passenger volumes at the airport, and other factors. This report uses BART's most recent passenger volume forecasts for 2013 (assumed year of project opening) and 2030, and also looks at ridership under conditions when the airport has reached the maximum number of annual passengers it can serve (approximately 30 million annual passengers).

The report also uses the most up-to-date information on road conditions and analysis using BART's selected AGT option. Compared to the AGT option in the 2002 FEIR/FEIS, the AGT Project selected by BART has a top speed of 31 MPH instead of 45 MPH, has longer walk distances, and does not include the two intermediate stops.

OVERVIEW OF NEW ALTERNATIVES

According to the *Bus Rapid Transit Practitioner's Guide* published by the Transportation Research Board, BRT is "a flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity." BRT can incorporate various combinations of the following features:

- Running ways (operations in mixed traffic, bus lanes, grade-separated busways);
- High-quality stations with passenger amenities;
- Distinctive vehicles;
- Efficient fare collection;
- Technology that provides passenger information, interacts with traffic signal systems, and so on;
- Frequent, all-day service; and
- Distinctive system identity.

The "Quality Bus" option analyzed in the 2002 FEIR/FEIS included the following BRT components:

- Integration with BART's ticketing system (i.e., off-board fare payment);
- Bus boarding and alighting through all doors (speeding up the time to load and unload passengers);
- Dedicated bus stop at the Coliseum/Oakland Airport BART station in proximity to a new station entrance, providing quick bus access to and from Hegenberger Road;
- Low-floor, articulated buses equipped with luggage racks;
- Four-minute headways between buses, with service hours identical to the BART system;
- Signal priority at signalized intersections (holding a green signal a few seconds longer when needed to allow buses to get through an intersection, and returning to green a few seconds earlier if a bus is already stopped at the intersection); and
- An exclusive bus lane at the airport terminal, leading to the airport bus stop.

This report studies two additional options that reflect two variations of true BRT service that are designed to address the deficiencies that the FEIR/FEIS identified with the Quality Bus option.

The first option, **Rapid Bus**, is designed as a relatively low-cost form of BRT that could be implemented relatively quickly, as it does not require major physical changes to existing streets, other than signing and striping changes and changes to traffic signal equipment. Rapid Bus includes all of the features of the Quality Bus option listed above, plus the following:

- Curbside bus lanes along Hegenberger Road and Airport Access Road that would also be open to use by right-turning traffic;
- Queue jump signal phasing at the ends of bus lanes, to give buses a head start on other traffic traveling in the same direction;
- Direct access to the fare-paid area of the Coliseum BART station; and
- A secure, climate-controlled waiting area at the Coliseum BART station, with monitors displaying the time of the next bus departure to the airport.

The second option, **Full BRT,** is designed as a more-extensive BRT option that provides additional travel time and reliability improvements compared to the Rapid Bus option, at an additional cost. Full BRT includes all of the features of the Quality Bus option listed above, plus the following:

- Bus lanes in the median of Hegenberger Road for use exclusively by Oakland Airport Connector buses;
- A curbside bus lane on Airport Access Road that could also be used by right-turning traffic;
- A flyover that would bridge the Hegenberger Road/South Coliseum Way intersection, allowing buses and Hegenberger through traffic to avoid traffic signal delays at all times, and avoid special event traffic delays during Coliseum events.

Any number of other options could conceivably be developed from mixtures of these two options; however, Rapid Bus and Full BRT represent reasonable ends of the BRT spectrum in terms of service attributes and costs.

COMPARISON OF FOUR ALTERNATIVES

- **AirBART:** AirBART provides a low operating cost connection from the Coliseum BART station to the Oakland Airport. However, it does not meet comparison criteria requirements related to frequency, reliability, capacity, supporting the OIA Master Plan, and flexibility to serve intermediate stops, providing access to the local community which includes significant populations of minority and low-income residents. This indicates that AirBART is not a viable long term solution, and supports the need for an alternative mode of operation.
- **Rapid Bus:** This option provides a significant improvement over the existing AirBART service, with more frequent, faster service that could be implemented by 2012. Overall travel times are equal to AGT in 2013, as this option provides shorter transfer and walk times, despite having a longer in-vehicle trip between BART and the airport. In 2030, Rapid Bus loses its advantage and is 1.6 minutes slower than AGT. It is slower than Full BRT in 2013 and in 2030. Of the three new alternatives, Rapid Bus is the most cost-effective option at $6.83 per new ride, based on the Federal Transit Administration's (FTA) New Starts cost-effectiveness criterion. Because it uses a curb-side dedicated lane, Rapid Bus is the most flexible in adding stops to support local economic development plans and serve the local community. However, Rapid Bus does not meet the reliability criterion, has a slightly higher operating subsidy per ride than Full BRT ($2.33 for Rapid Bus compared to $1.95 for Full BRT), and attracts fewer rides than either Full BRT or AGT at a $3 fare. Rapid Bus has higher estimated ridership than AGT, however, with a $6 fare for AGT.
- **Full BRT:** Full BRT provides significant improvements over Rapid Bus, with more reliable service, requiring only a 4-minute buffer for reliability under normal operating conditions. Like AGT, Full BRT is not affected by events at the Coliseum, due to the construction of a flyover bridge on Hegenberger at South Coliseum Way. Full BRT has lower walk times than AGT at both the Coliseum BART station and the Oakland Airport terminal which results in an overall faster total trip time compared to AGT. Due to these operational improvements and the shorter walk time from the station to the Oakland Airport terminal, Full BRT has ridership comparable to AGT in 2013 and 2030, using a $3 fare. Using the current planning assumption of a $6 fare for AGT, Full BRT has approximately 13% higher ridership than the AGT option. Assuming a $3 fare, the Full BRT cost-effectiveness measure of $15.86 per new ride is significantly lower than for the AGT (see discussion below). Through the flexibility to have two local stops, this option provides more support to economic development plans and local communities. Full BRT also has the lowest operating cost per ride, and therefore the lowest subsidy per ride required, at $1.95. Overall, this option at least minimally meets all comparison criteria.
- **AGT:** Due to the separated guideway, AGT is the strongest of all options in terms of reliability. As a result of the level of construction required, AGT would be operational in

2014, compared to 2012 for Rapid Bus and 2013 for Full BRT. Ridership is comparable to Full BRT with a $3 fare, and approximately 13% lower than Full BRT when using a fare of $6 for AGT. The operating cost per ride is the highest of all options, which leads to a subsidy per ride of $10.76 at a $3 fare and $9.85 with a $6 fare. Using 2002 FEIR/FEIS capital cost of $204 million, the cost-efficiency rating for AFT is $37.97 cost per incremental ride with a $3 fare and $53.74 with a $6 fare. Estimating the annual capital costs for the current $459 million project increases the cost-effectiveness measure to $68.17 per incremental ride if the fare is $3, and $102.74 per incremental ride if the fare is $6. The station at the airport will displace airport parking, while all other options have very minimal impact on parking or potential future development at the airport. AGT has the least amount of flexibility in additional stations. One optional station is possible at Doolittle, in conjunction with the maintenance facility, but no additional stations are feasible without a significant redesign of the system. As a result, the AGT minimally meets the evaluation criteria for flexibility to serve intermediate stops and improve access for the local community, and support economic development plans.

- **Summary Tables:** A summary of the comparison criteria for the four options is provided in the two tables on the following pages. The Comparison Criteria Matrix is based upon the measures from the 2002 FEIR/FEIS. The Additional Evaluation Criteria are new criteria added for this project. The comparison criteria are explained in detail in Section 5 of the report.

CONCLUSION

The overall best option, based on the comparison criteria, is Full BRT. It has a higher level of ridership than AGT when assuming the planned fares of $3 for Full BRT and $6 for AGT, a lower subsidy per ride and significantly lower cost per incremental ride. Total travel time is faster than AGT, including walk and in-vehicle time. While travelers would need to consider budgeting an extra 4 minutes for their trip in case of longer-than-normal travel times due to lower reliability on Full BRT, this time is likely inconsequential in comparison to total transit travel time and buffer time required for airport security and other flight considerations. Like AGT, the Full BRT option would not be affected by events at the Coliseum. The Full BRT option is more flexible than AGT in its ability to serve intermediate stations that can support economic development and provide improved service to the local community which includes a large population of low-income and minority riders.

It is possible to have a phased implementation of Full BRT so that transit signal priority and fare payment improvements occur relatively quickly, allowing some of the benefits to occur during construction of the Full BRT system.

Comparison Criteria Matrix

Original Criteria	AirBART	Rapid Bus	Full BRT	AGT
1. Provide reliable scheduled service between BART and OIA. (minutes)	Buffer: 15 Events: 3	Buffer: 8 Events: 3	Buffer: 4 Events: 0	Buffer: 0 Events: 0
2. Provide on-time performance equal to BART.	Does not meet	Does not meet	Meets	Meets or exceeds
3. Accommodate a minimum of 700 passengers per hour per direction.	250 passengers Does not meet	900 passengers Meets	900 passengers Meets	1,950 passengers Meets
4. Ensure that transit vehicles arrive at least every six minutes.	10 minutes Does not meet	4 minutes Meets	4-minutes Meets	4.6-minutes Meets
5. Ensure that the maximum wait time is no greater than six minutes.	Does not meet	Meets	Meets	Meets
6. Complete trips between OIA and the Coliseum BART Station at least as quickly as motorists during off-peak weekday traffic. (minutes)	2013: 13.0 2030: 14.6 Meets/Meets	2013: 10.6 2030: 12.2 Meets/Meets	2013: 9.6 2030: 10.1 Meets/Meets	2013: 8.2 2030: 8.2 Meets/Meets
7. Allow capacity adjustments throughout the day.	Meets	Meets	Meets	Meets
8. Provide flexibility to expand and upgrade the system to accommodate increased ridership.	Does not meet	Meets	Meets	Meets
9. Provide flexibility to serve intermediate stops.	Does not meet	Meets	Meets	Minimally meets
10. Minimize significant negative environmental effects.	No change from FEIR/FEIS	Improved over FEIR/FEIS	Improved over FEIR/FEIS	No change from FEIR/FEIS
11. Be constructed and operated within reasonable costs. (Cost per incremental ride [1])	Not Applicable	$3 fare: $6.83 Meets	$3 fare: $15.86 Meets	$3 fare: $68.17 $6 fare: $102.74 Does not meet
12. Avoid substantial impacts to sensitive residential, public, and commercial land uses.	No Change from FEIR/FEIS	Hybrid vehicles Improved over FEIR/FEIS	Hybrid vehicles Improved over FEIR/FEIS	No Change from FEIR/FEIS
13. Minimize the amount of private property needed for rights of way.	No acquisition required	No acquisition required	No acquisition required	Acquisition Does not meet
14. Minimize the extent of displacement (e.g., businesses or parking).	No displacement	Minimal parking displacement	Minimal parking displacement	Displacement required
15. Avoid constraining known development plans.	Minimally meets	Meets	Minimally meets	Minimally meets
16. Avoid creating odd-shaped land areas with limited development potential.	No acquisition required Meets	No acquisition required Meets	No acquisition required Meets	None created Meets
17. Support increased transit service for targeted redevelopment and revitalization areas to facilitate economic growth.	Does not meet	Meets	Meets	Minimally meets
18. Conform to/support the Airport Development Program.	Meets 2 of 4 elements	Meets 3 of 4 elements	Meets 3 of 4 elements	Meets 3 of 4 elements

[1] *AGT incremental costs assume that capital cost details for the current project ($459 million) are proportionate to the costs provided in the 2002 FEIR/FEIS (capital costs of $204 million). The cost per incremental ride calculated with the 2002 FEIR/FEIS data is $37.97 with a $3 fare and $53.74 with a $6 fare for AGT.*

Additional Comparison Criteria

Additional Criteria	AirBART	Rapid Bus	Full BRT	AGT
A. Ridership on Connector (average daily rides) $3 Fare:	2013: 2,100 2030: 3,440 – 4,460	2013: 2,890 2030: 4,580 – 6,160	2013: 3,080 2030: 5,110 – 6,610	2013: 3,070 2030: 5,100 – 6,610
$6 AGT fare:				2013: 2,685 2030: 4,465-5,785
B. Total walk time: From BART to the Connector, from the OIA to the Connector (minutes)	4.1 min	4.3 min	4.3 min	6.6 min
C. Job creation: permanent jobs required	23 jobs	46 jobs	46 jobs	27 jobs
D. Construction time: how soon could service begin	2010	2012	2013	2014
E. Improving access to transit for local community	No local stops Does not meet	Local stops are feasible Meets	Local stops are feasible Meets	One local stop is feasible Does not meet
F. Operating subsidy per ride	$3 fare: $1.29	$3 fare: $2.33	$3 fare: $1.95	$3 fare: $10.76 $6 fare: $9.85

Section 2
Project Overview

Project Overview

PROJECT PURPOSE

This report providers an updated and expanded analysis of options for the Oakland Airport Connector. The options studied consist of No Build, Rapid Bus, Full Bus Rapid Transit (BRT), and Automated Guideway Transit (AGT). The Rapid Bus and Full BRT options have not been studied previously and incorporate information about BRT service that was not available at the time the Final Environmental Impact Report/Final Environment Impact Statement (FEIR/FEIS) for the Oakland Airport Connector was completed in 2002. In addition, the report updates information for the No Build and AGT options based on the most up-to-date data available.

The intent of this project is to inform current discussions on the Oakland Airport Connector through a valid comparison of the four key modal options. Since the certification of the FEIR and the selection of the preferred alternative by the BART Board of Directors in 2002, rising costs and changes to the configuration of the preferred option, improvements to the road corridor, and reductions in airport passenger projections have significantly reduced the potential benefits and increased the costs associated with BART's preferred alternative relative to other options. Changes to the AGT option have included the removal of intermediate stations, lowering the minimum acceptable top speed from 45 mph down to 27 mph, a potential increase in fares to as much as twice the current AirBART fare, and locating both the Coliseum BART and airport AGT stations farther away than originally planned. BART updated its ridership projections for the No Action and AGT options, but not the Quality Bus option, in 2005, 2007, and 2009 (References ***1***, ***2***, ***3***), incorporating some of the changes to the preferred AGT Alternative, along with updated airport passenger projections.

BACKGROUND ON THE OAKLAND AIRPORT CONNECTOR

The Oakland Airport Connector is a planned 3.2-mile public transit link between the Bay Area Rapid Transit (BART) Coliseum/Oakland Airport station and the Oakland International Airport that would replace existing AirBART bus service. This link has been discussed and studied since the early 1970s. It has been identified as a regional priority for over ten years and was brought before Alameda County voters as one project in package of improvements for a transportation sales tax initiative in November 2000 under Measure B. The project was estimated to cost $130 million at that time. The BART Board of Directors certified its FEIR/FEIS for the project in 2002. The FEIR/FEIS analyzed three alternatives:

- No Action, continuing the existing AirBART service;
- Quality Bus, an option that improved the connection between BART and bus at the Coliseum BART station and provided signal priority for buses on Hegenberger Road; and
- Automated Guideway Transit (AGT), an automated, completely grade-separated link between BART and the airport.

While the Quality Bus option was assessed as the most cost-effective option in terms of cost per new ride, AGT was selected as the preferred alternative because it:

- Allowed for improved on-time performance and reliability;
- Provided a quicker travel time than the other options and driving;
- Produced the highest ridership for the link and the greatest increase in BART ridership; and
- Assisted economic development on Hegenberger, consistent with Oakland General Plan goals and BART expansion policies, through the provision of intermediate stations.

The March 2002 FEIR/FEIS showed capital costs of $204 million for the AGT alternative.

In December 2009, BART selected the Flatiron/Parsons Joint Venture to design and construct the OAC project at a total cost of $492 million, including $34 million that BART had already spent on the project. In February 2010, after investigation of a formal complaint filed by Public Advocates, on behalf of TransForm, Urban Habitat Program, and Genesis, the FTA found the project to be non-compliant with their requirements related to Title VI of the Civil Rights Act, causing FTA to revoke the $70.0 million ARRA grant.

A revised funding plan was brought to the BART Board of Directors meeting in July 2010. The project was reduced to $484 million (after an $8 million reduction in contingency) with contributions from the following agencies and funding programs (***4***):

- Federal Transit Administration (FTA) Small Starts Grant: $25.0 million
- State Transportation Improvement Program (STIP): $20.7 million
- MTC/State Local Partnership Program: $20.0 million
- MTC/PTMISEA (Proposition 1B): $12.8 million
- RTIP Funding Exchange (CMIA and SHOPP): $20.0 million
- High-Speed Passenger Train Bond: $5.4 million
- Alameda County Measure B ½ cent sales tax: $89.1 million
- Port of Oakland Passenger Facility Charges: $29.3 million
- MTC Regional Measure 1 & 2 Bridge Tolls: $146.2 million
- BART SFO Reserve Account: $10.0 million
- Debt draws: $105.7 million

The BART Board adopted the funding plan, and made award of the contract contingent on securing the FTA Small Starts grant, State STIP funds, and Port of Oakland Passenger Facility Charges.

DIFFERENCES FROM PREVIOUS STUDIES

Although an improved "Quality Bus" option was analyzed by the FEIR/FEIS, none of the major planning studies to date have addressed true Bus Rapid Transit (BRT). This can be attributed at least in part to a lack of information on this mode. Although freeway- and busway-based express

bus systems have existed in North America since the 1970s and BRT systems have been developed in other parts of the world, it has only been in the last decade that numerous surface-running BRT routes and systems have been developed in North America, spurred in part in the U.S. by increased federal funding assistance. Since the FEIR/FEIS was produced in 2002, several major federally funded studies of the characteristics, benefits, and costs of BRT have been produced, including two editions of *Characteristics of Bus Rapid Transit* (***8***, ***9***), and the *Bus Rapid Transit Practitioner's Guide* (***10***). These reports provide up-to-date information on BRT, based on the experiences of numerous BRT routes and systems around the U.S. and Canada, and have been used as source documents for estimating the ridership, travel time, and reliability characteristics of the two BRT options studied in this report.

Bus Rapid Transit has been described as:

> "A flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity. This definition highlights BRT's flexibility and the fact that it encompasses a wide variety of applications, each one tailored to a particular set of travel markets and physical environments. BRT's flexibility derives from the fact that BRT vehicles (e.g., buses, specialized BRT vehicles) can travel anywhere there is pavement and the fact that BRT's basic service unit, a single vehicle, is relatively small compared to train-based rapid transit modes. A given BRT corridor application might encompass route segments where vehicles operate both in mixed traffic and on a dedicated, fully grade-separated transitway with major stations. BRT is an integrated system that is [designed] to improve the speed, reliability, and identity of bus transit." (***9***)

Bus Rapid Transit can include many different combinations of components, including: (***10***)

- Running ways (mixed traffic, bus lanes, grade-separated busways);
- High-quality stations with passenger amenities;
- Distinctive vehicles;
- Efficient fare collection;
- Technological features that provide passenger information, interact with traffic signal systems, etc.;
- Frequent, all-day service; and
- Distinctive system identity.

The "Quality Bus" option analyzed in the FEIR/FEIS (***11***) included the following BRT components:

- Integration with BART's ticketing system (i.e., off-board fare payment);
- Bus boarding and alighting through all doors (speeding up the time to load and unload passengers);
- Dedicated bus stop at BART in proximity to a new station entrance, providing quick bus access to and from Hegenberger Road;
- Low-floor, articulated buses equipped with luggage racks;
- Four-minute headways between buses, with service hours identical to the BART system;

- Signal priority at signalized intersections (holding a green signal a few seconds longer when needed to allow buses to get through an intersection, and returning to green a few seconds earlier if a bus is already stopped at the intersection); and
- An exclusive bus lane at the airport terminal, leading to the airport bus stop.

BART's 2002 FEIR/FEIS determined that the Quality Bus option would be slower than the AGT option when total trip times were compared, that it would be subject to increased travel times in the future as traffic congestion increased, that it would be more subject to variability in travel times under normal operations, and that it could be slowed down considerably by special event traffic from the Coliseum, although it also noted possible ways for addressing potential special event delays.

This report studies two additional options that reflect two variations of BRT service that are designed to address the deficiencies that the FEIR/FEIS identified with the Quality Bus option.

The first option, Rapid Bus, is designed as a relatively low-cost BRT route that could be implemented relatively quickly, as it does not require major physical changes to existing streets, other than signing and striping changes and changes to traffic signal equipment. The component with the longest construction time would be the construction of the Rapid Bus stop at the Coliseum BART station. Rapid Bus includes all of the features of the Quality Bus option listed above, plus the following additional features:

- Exclusive bus lanes along Hegenberger Road and Airport Access Road (mostly curbside) that could also be used by right-turning traffic;
- Queue jump signal phasing at the ends of bus lanes, to give buses a head start on other traffic traveling in the same direction;
- Direct access to the fare-paid area of the Coliseum BART station, through the use of platform screen doors to control access between buses and the station;
- A secure, climate-controlled waiting area at the Coliseum BART station, with monitors displaying the time of the next bus departure to the airport: and
- Raised stops to provide level boarding platforms at all stops/stations.

The second option, Full BRT, is designed as a more-extensive BRT option that provides additional travel time and reliability improvements compared to the Rapid Bus option, at an additional cost. Full BRT includes all of the features of the Quality Bus option listed above, plus the following additional features:

- Bus lanes in the median of Hegenberger Road for use exclusively by Oakland Airport Connector buses;
- A curbside bus lane on Airport Access Road that could also be used by right-turning traffic;
- A flyover that would bridge the Hegenberger Road/South Coliseum Way intersection, allowing buses and Hegenberger through traffic to avoid traffic signal delays at all times, and avoid special event traffic delays during Coliseum events;

- Queue jump signal phasing at the ends of bus lanes, to give buses a head start on other traffic traveling in the same direction;
- Direct access to the fare-paid area of the Coliseum BART station, through the use of platform screen doors to control access between buses and the station;
- A secure, climate-controlled waiting area at the Coliseum BART station, with monitors displaying the time of the next bus departure to the airport; and
- Raised stops to provide level boarding platforms at all stops/stations.

Any number of other options could conceivably be developed from mixtures of these two options; however, Rapid Bus and Full BRT represent reasonable ends of the BRT spectrum in terms of service attributes and costs.

Since the time the FEIR/FEIS was developed, other changes have occurred. One significant change is the opening of an improved connection from I-880 to the airport via 98th Avenue, including the elimination of several traffic signals on airport property and the widening of Airport Drive both leading to and at the airport terminal. While these reconfigurations were included in traffic analysis in the FEIR/FEIS, the improvements have provided a significantly greater benefit than originally assumed by providing an alternative access route to Hegenberger Road. Combined with changes on Airport property that were not included in the FEIR/FEIS study, these projects have greatly eased traffic congestion on airport property. This report accounts for these improvements by using current traffic volumes on Hegenberger Road as a starting point for its traffic analysis, and then increasing volumes in the future based on the latest airport passenger forecast ranges that BART is using for the Oakland Airport Connector project and other background traffic growth unrelated to the airport.

The other significant change is a considerable drop in passenger volumes at the airport, resulting from the current downturn in the economy, the movement of some flights to San Francisco International Airport, and other factors. To allow apples-to-apples comparisons, this report uses BART's most recent passenger volume forecasts for both 2013 (assumed year of project opening) and 2030, but also includes sensitivity analyses that address other assumptions, including looking at ridership under conditions when the Oakland Airport has reached the maximum number of annual passengers it can serve (approximately 30 million annual passengers).

REPORT SCOPE

Because the No Action and AGT options have already been described in detail in the FEIR/FEIS and follow-up reports, this report focuses on presenting the analysis related to the two new options, Rapid Bus and Full BRT. Section 3 summarizes the characteristics of the four options, with most of the detail focused on the Rapid Bus and Full BRT options. Section 4 presents the analysis of the ridership, travel time, reliability, cost, job creation, and other attributes of the Rapid Bus and Full BRT options, including details of the methodologies used. Section 5 presents the evaluation criteria used in the FEIR/FEIS to evaluate the different options, and compares the four options based on these criteria (using the most recent information available), along with additional comparison criteria developed for this project. Finally, Section 6 summarizes the results and presents the report's

conclusions. Appendices to the report present the traffic analysis results and present concepts for the Rapid Bus and Full BRT routes and stations.

For ease of comparison, the base analysis presents each option as a non-stop route between BART and the airport, and assumes that each option has the same fare as the current AirBART service. Section 4 then supplements this analysis with additional analyses relating fare levels and their potential impact on ridership; operating subsidies; the feasibility, cost, and ridership implications of intermediate stations; flexibility to serve a future third terminal at the airport; and the ability to serve the local community providing improved access to BART.

This analysis has been conducted at a planning level, sufficient to allow a fair comparison to be made of the four options, including the determination of the feasibility and order-of-magnitude costs of each option. However, it is not intended to substitute for a full preliminary engineering assessment of the Rapid Bus and Full BRT options.

Section 3
Descriptions of the Options

Descriptions of the Options

Four options are assessed by this report. The No Action (AirBART) and locally preferred (Automated Guideway Transit) options have been included from the March 2002 FEIR/FEIS (***11***). The study includes two new options: Rapid Bus and Full Bus Rapid Transit (BRT). Detailed conceptual street cross-sections are provided in Appendix B.

NO ACTION (RETAIN AIRBART)

This option retains the existing AirBART service. AirBART operates approximately every 10 minutes during peak periods and travels non-stop between a stop on the third curb between Terminals 1 and 2 at the Oakland Airport and a stop adjacent to the main entrance to the Coliseum/Oakland Airport BART station. Passengers pay an exact cash fare, can insert a pre-purchased $3 BART ticket into the farebox as payment, or can purchase a ticket at new AirBART ticket machines at the Airport. AirBART uses 40-foot low-floor buses providing 32 seats and luggage racks. Passengers must board through the front door to pay their fare, but may exit through either the front or rear doors. Figure 1 depicts the existing AirBART service at the Coliseum BART station.

Figure 2 shows the AirBART route. Leaving the Coliseum BART bus stop, the bus travels to the airport via San Leandro Street, 66th Avenue, Oakport Street, Edgewater Drive, Hegenberger Road, and Airport Drive. An optional route is also used at the discretion of AirBART, depending on traffic conditions, that uses 69th Avenue, Snell Street, 75th Avenue, and San Leandro Street to travel around the BART station to access Hegenberger Road. The optional route crosses the Union Pacific railroad tracks twice in the process; however, as of 2003, only one freight train a day used the tracks (***12***). Returning to BART, the bus travels via Airport Drive, Airport Access Road, Hegenberger Road, and San Leandro Street. The bus travels in mixed traffic the entire way, meaning that the bus is fully exposed to any traffic congestion that may exist along the way, including special event traffic at the Coliseum.

Figure 1 Existing AirBART at Coliseum BART Station

Figure 2 AirBART Route and Features

AUTOMATED GUIDEWAY TRANSIT (AGT)

This option represents BART's current preferred alternative for the Oakland Airport Connector. Under this option, automated vehicles would operate along a mostly elevated guideway between the Coliseum BART station and the airport. The AGT station serving the Coliseum BART station would be located on the west side of San Leandro Street, immediately north of the Hegenberger Expressway overpass, and would be connected to the existing BART train platform via an elevated walkway and escalators and elevators leading to the south end of the train platform. At the airport, the AGT station would be located in a portion of the hourly parking lot across from the entrance to Terminal 1. Passengers going to the airport would take an escalator or elevator from the AGT platform to ground level and then use the existing signalized crosswalks to cross the terminal roadway to access Terminal 1 and sidewalks leading to Terminal 2. A maintenance facility would be located on a site to the southwest of the Hegenberger Road/Airport Access Road intersection, which could be converted into an optional Doolittle station (***13***).

Fare payment would be integrated with the rest of the BART system, meaning that passengers could use BART fare media for their entire trip and would only need to pay once during their trip to or from the airport. Passengers traveling from the airport would purchase their BART ticket upon arrival at the AGT platform at the Coliseum BART station and would proceed through faregates leading to the elevated walkway connecting to the BART train platforms. Although the fare has not yet been set, recent planning documents have included a potential fare of $6 (***3, 5, 6***). If a future station were built at Doolittle, passengers traveling between the airport and the Doolittle station would not pay a fare; passengers traveling between other points in the BART system and the Doolittle station would pay the same fare as those traveling to the airport.

Figure 3 shows the proposed route. Leaving the Coliseum BART station, cable-propelled vehicles would travel in an elevated guideway in the median of Hegenberger Road as far as Pardee Drive. The elevated guideway would then continue parallel to and west of Airport Access Road, passing through the optional Doolittle station. The guideway would then fly over Airport Access Road and Doolittle Drive before coming down to grade along the south side of Airport Drive. Once past Ron Cowan Parkway, the guideway would elevate again and would fly over the terminal loop road and cross above the daily parking lot before entering the airport station (***13***). Figure 4 shows the existing Coliseum BART station and Hegenberger overpass. Figure 5 provides a photo-simulation of how the station might look with the AGT station and walkway from BART.

AGT trains would initially consist of 3 cars, and could be expanded to 4 cars at a later date if demand warranted. Each car would have one door on each side and the train interior would be open, allowing passengers to freely move throughout the train. Based on illustrations of the proposed vehicles, a 4-car train is estimated to provide 32 seats along the sides of the train, along with 4 seating positions at each end of the train. At a station, passengers would board and alight on the same side of the train, using all 3 or 4 doors.

Figure 3 AGT Route and Features

Figure 4 Existing Coliseum BART Station and Hegenberger overpass

Figure 5 Coliseum BART Station and Hegenberger overpass with AGT[1] walkway and station

[1] Photo-simulations created for TransForm based on BART website: http://www.bart.gov/about/projects/oac/

RAPID BUS

The Rapid Bus option is designed to address BART's objectives for the Oakland Airport Connector at a substantially lower cost than AGT. This option is based on the concept of street-running bus rapid transit using a combination of semi-exclusive bus lanes and bus signal priority to provide faster, more reliable service than the current AirBART service. Similar types of service are currently provided in Las Vegas, Phoenix, and Honolulu (*9*). AC Transit's San Pablo Avenue 72R Rapid line and VTA's 522 Rapid line from San Jose to Palo Alto are now using some of these features, such as special queue jump lanes at busy intersections, but lack the bus lane component that is being proposed in this analysis. Service quality would be improved over AirBART in a number of respects—running way, stations, fare integration, and vehicle—as described below.

Running Way

Portions of the route operating on Hegenberger Road that could experience traffic congestion would be operated in curbside bus lanes. General vehicle traffic would be allowed into or across the bus lane to make a right turn at the next driveway or intersection, but buses would otherwise be free to travel in a lane unobstructed by other vehicles. At intersections at the end of a bus lane, buses would receive a green signal prior to other through vehicles, thus allowing buses to jump the queue and proceed along their route (and change lanes, if necessary) ahead of other traffic. Signal priority at traffic signals would hold a green signal a few seconds longer, if needed, to allow a Rapid Bus to make it through the intersection, or would return the signal to green a few seconds earlier, if a bus was stopped at the intersection.

The assumed route is shown in Figure 6. Similar to the "Quality Bus" alternative in the 2002 Final EIR/EIS for the Oakland Airport Connector, buses would stop in a new bus lane between San Leandro Street and the BART tracks to the south of the existing BART station. A special traffic signal phase would be provided at the bus lane exit that would allow buses to cross San Leandro Street and access the on-ramp to Hegenberger Expressway. Once on Hegenberger, buses would use a curbside exclusive bus lane as far as South Coliseum Drive, and would then merge left one lane prior to the I-880 interchange. After the point where a general traffic lane is added on the left side of Hegenberger Road, a bus lane would be developed in the second lane from the right, with the right lane being reserved for traffic bound for Edgewater Drive. The bus lane would continue across Edgewater Drive, at which point right-turning traffic would be allowed to use the lane. The lane would continue to Doolittle Drive, where a queue jump phase would be provided, when necessary, to give buses a head start across the intersection. Buses would continue in general traffic on Airport Drive to the airport terminal, where they would serve a stop on the third curb between Terminals 1 and 2.

Returning from the airport, buses would operate in general traffic on Airport Drive, and would exit onto Airport Access Road. They would then operate in a semi-exclusive bus lane (right turns allowed) on Airport Access Road to Hegenberger Road, and continuing in a semi-exclusive bus lane on Hegenberger to Edgewater Drive. At Edgewater Drive, a queue jump phase would be provided, when necessary, to give buses a head start across the intersection. The semi-exclusive bus lane would resume past the I-880 interchange in the right lane and would continue to the exit to San Leandro Street. At the traffic signal at San Leandro Street, buses would turn into a bus lane and proceed to the bus stop.

The bus lanes could be developed within the existing street right-of-way and no driveway or median closures would be required. Conceptual street cross-sections are provided in Appendix B.

Figure 6 Rapid Bus Route and Features

Stations

The station at the Coliseum BART station would be constructed in the space beneath, and immediately adjacent to the BART tracks south of the existing BART train platform. Passengers arriving on BART trains would walk to the south end of the train platform, where they would take an escalator, stair, or elevator down to the ground level into a waiting area constructed underneath the southbound BART tracks. The waiting area would be enclosed and climate-controlled. When a bus was ready to load passengers, platform screen doors would open to allow access to the bus doors. A minimal gap would exist between the platform and the bus (as in the BRT systems in Eugene, Cleveland, and Las Vegas), which could be bridged if necessary by a ramp extending from the bus. Passengers would remain within the BART fare-paid area at all times. Passengers arriving at the station by Rapid Bus would be dropped off at a separate enclosed unloading area closer to 75th Avenue, which would lead to a choice of escalator, stair, or elevator up to the BART train platform level. A layover position for buses would be provided between the departure and arrival platforms. Figure 7 and Figure 9 show the existing Coliseum BART station at San Leandro. Figure 8 and Figure 10 provide examples of how the Rapid Bus and Full BRT stations would be integrated into the existing right-of-way.

The station at the airport would be constructed on the third curb of the terminal roadway between Terminals 1 and 2, with the sidewalk widened into the first lane of the three-lane bus roadway to provide additional waiting area for passengers. As was the case at the Coliseum BART station, separate enclosed loading and unloading positions would be provided, and access to and from these areas would be controlled by faregates and platform screen doors. Ticket vending and addfare machines would also be provided, along with an optional station agent booth.

The Oakland Airport Master Plan identifies a potential future Terminal 3, which would be located west of Terminal 1 and become the first terminal reached upon entering the terminal area. An optional station serving a future Terminal 3 could be constructed near the terminal entrance if needed. Optional intermediate stations could also be provided along Hegenberger Road at Pardee Drive and Edgewater Drive, by extending the sidewalk into the parking lane. These stations would provide equipment for vending and processing BART tickets and smart cards, but would not necessarily have to be fully enclosed, as fare control also occurs when passengers exit the BART system. If a fare-paid area was desired, different equipment than a standard BART faregate might need to be used, due to sidewalk space limitations.

Figure 7 Existing Coliseum BART Station on San Leandro

Figure 8 Coliseum BART Station on San Leandro with Rapid Bus or Full BRT

Figure 9 Existing Coliseum BART Station on San Leandro

Figure 10 Rapid Bus at Coliseum BART station with exclusive boarding area for riders

Fare Integration

Passengers would use standard BART fare media and would process their ticket or smart card at the airport (or intermediate station, if incorporated into the route). Because passengers would remain in the fare-paid area at the Coliseum BART station, the transfer would occur similarly to transfers between routes elsewhere in the BART system.

Vehicles

The assumed vehicle is the same as that assumed for the FEIR/FEIS Quality Bus option, namely a 60-foot articulated bus equipped with luggage racks and 47 seats. The vehicle would have three doors on the right side of the bus. Figure 11 shows the type of special vehicle that is used for Rapid Bus or BRT service.

Figure 11 Examples of Special Rapid/BRT vehicles in Las Vegas with all door, level boarding

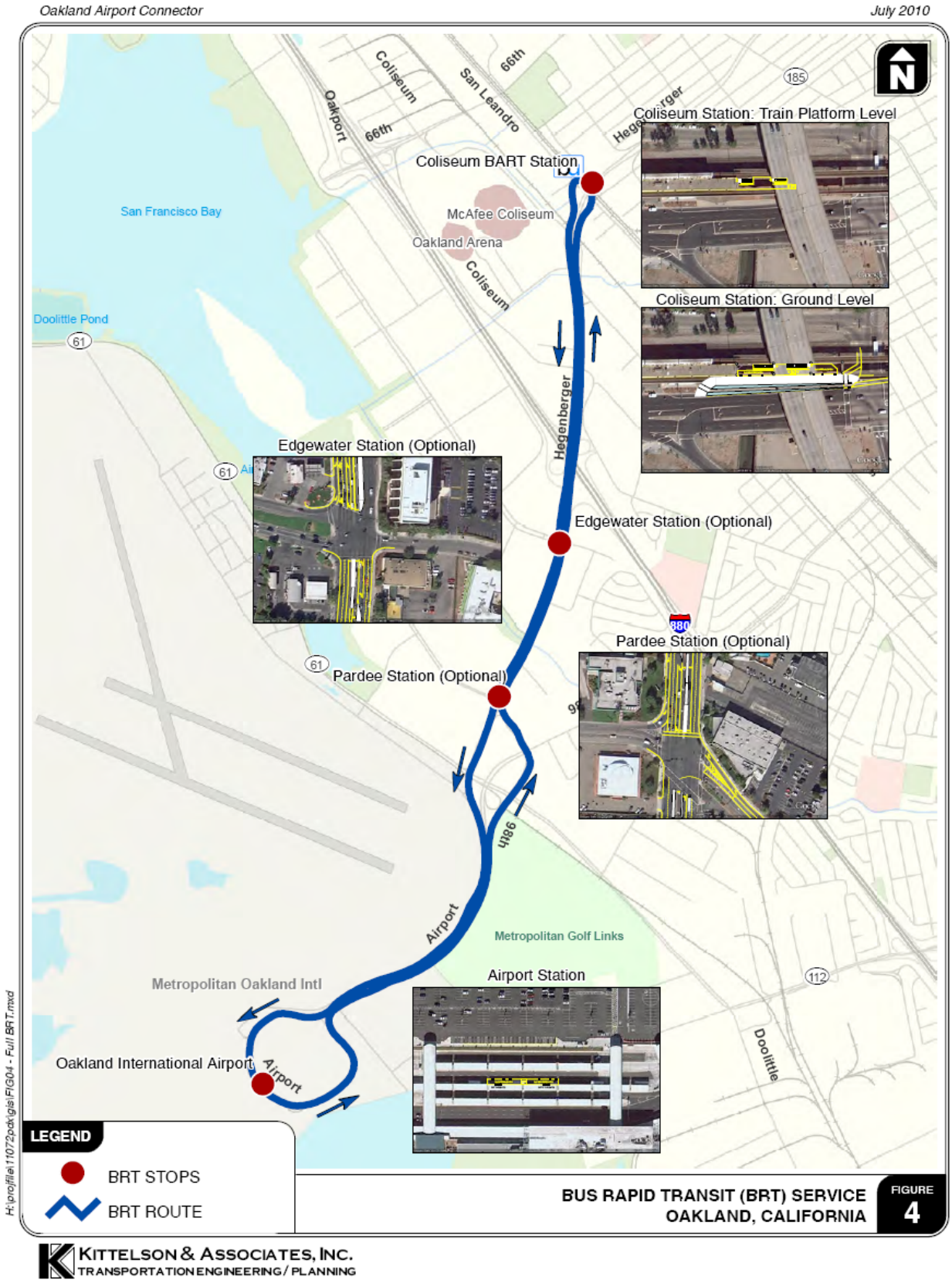
FULL BRT

The Full BRT option is designed to provide a greater degree of exclusive right-of-way (and thus better speeds and reliability) than the Rapid Bus option, while keeping overall costs substantially below that of AGT. This alternative provides bus rapid transit running in the street median to provide greater insulation from traffic effects, plus a grade-separated section at the south entrance to the Coliseum. Similar types of service are currently operated in Cleveland and Eugene. As was the case with Rapid Bus, service quality would be improved in a number of respects—running way, stations, fare integration, and vehicle.

Running Way

Buses would operate in the median of Hegenberger Road for most of its length between BART and the airport. Turns across the median would only be allowed at traffic signals, meaning that some left turns in the corridor would be converted into a right turn and a U-turn (or vice versa). A semi-exclusive (right turns allowed) curbside bus lane would be provided along Airport Access Road for buses traveling from the airport to BART. Between I-880 and Baldwin Street, four lanes for buses and through Hegenberger traffic would be elevated, flying over the Hegenberger Road/South Coliseum Way intersection to avoid potential traffic delays, particularly before and after Coliseum events. Traffic signal pre-emption for buses would be provided at the traffic signal serving a driveway northeast of Baldwin Street, to allow buses to enter and exit the median bus lanes without delay. Traffic signal priority would be provided at other signalized intersections. The assumed route is shown in Figure 12.

Figure 12 Full BRT Route and Features



The bus lanes could be developed within the existing street right-of-way, although the landscaping in Hegenberger Road between Edgewater Drive and Doolittle Drive would need to be replaced as part of the construction of the median bus lanes. Conceptual street cross-sections are provided in Appendix B.

Stations

Stations at BART and the airport would be the same as described for the Rapid Bus option, including the option to provide a station at a future Terminal 3. Figure 13 and demonstrates how a BRT station is connected to a station using a walkway. Figure 14 provides a view of the level boarding feature. The vehicle will line up with the glass doors at the station, providing fast easy access for passengers, luggage, strollers and mobility devices.

Figure 13 Walkway and level boarding area for South Africa airport BRT

Figure 14 Level boarding with station gates, South Africa airport BRT

Optional intermediate stations could also be provided along Hegenberger Road at Pardee Drive and Edgewater Drive in the median of Hegenberger Road, accessed from the crosswalks at the adjacent intersections. These stations would provide equipment for vending and processing BART tickets and smart cards, but would not necessarily have to be fully enclosed, as fare control also occurs when passengers exit the BART system. If a fare-paid area was desired, different equipment than a standard BART faregate might need to be used, due to space limitations. A rendering of an intermediate station under the Full BRT option is shown in Figure 15.

Figure 15 Median stations would serve development along the Hegenberger corridor

Fare Integration

Passengers would use standard BART fare media and would process their ticket or smart card at the airport (or intermediate station, if incorporated into the route). Because passengers would remain in the fare-paid area at the Coliseum BART station, the transfer would occur similarly to transfers between rail lines elsewhere in the BART system. Different fares could be charged to different stations along the route, if desired (for example, a premium fare for trips to the airport, similar to the premium fare that BART charges to San Francisco International Airport).

Vehicles

The assumed vehicle is the same as that assumed for the FEIR/FEIS Quality Bus option, namely a 60-foot articulated bus equipped with luggage racks and 47 seats. The vehicle would have three doors on the right side of the bus. If intermediate stations were to be provided in the median of Hegenberger Road, the vehicle would also have two doors on the left side of the bus and would be equipped with 43 seats. Figure 16 provides a rendering of a specialized bus on operating in the median bus lane on Hegenberger Road.

Figure 16 BRT route would offer rail-like experience, with special high quality vehicles

Section 4
Analysis of the Options

Analysis of the Options

INTRODUCTION

This section presents the methodology and calculation used to assess the operating characteristics and costs for each of the options under base conditions (i.e., assuming the current AirBART fare and without any optional stations). After base conditions have been analyzed, further analysis is presented of the implications of different fare levels and the addition of optional stations.

WALK DISTANCES

Walk distances are based on the horizontal path used by passengers, as measured using Google Earth, not including the length of any escalators used (the time spent on escalators is accounted for separately in a subsequent step). The height of vertical circulation (escalator/stair/elevator) elements at the Coliseum BART station is estimated from FEIR/FEIS information (***11***), the height of the AGT station at Coliseum BART relative to the train platform comes from the Flatiron/Parsons/ Doppelmayr Executive Summary (***13***), and the height of the AGT station at the airport is estimated from an illustration in the Flatiron/Parsons/Doppelmayr Executive Summary (***13***). Table 1 summarizes the walk distances for each option.

Table 1 Walk Distances (feet)

	AirBART	Rapid Bus	Full BRT	AGT
Walk: BART	225	270	270	435
Vertical circulation: BART	35	35	35	20
Walk: Airport Terminal 1	620	540	540	365
Walk: Airport Terminal 2	285	365	365	975
Walk: Future Terminal 3	265	265	265	725[1]
Vertical circulation: airport	0	0	0	35

[1] *Assumes an elevated walkway between the AGT station and the future terminal.*

Table 1 shows that AGT provides the shortest walk distance to Terminal 1, but the longest walk distance to Terminal 2, a future Terminal 3, and to the Coliseum BART station.

IN-VEHICLE TIME

Base one-way in-vehicle time (prior to accounting for speed improvements due to transit priority measures) was determined as follows:

- **AirBART:** Based on a minimum 7.3-mile round trip, and the average speed of 16.8 mph from the FEIR/FEIS (***11***).
- **Rapid Bus and Full BRT:** Based on a 6.8-mile round trip and the AirBART average speed.
- **AGT:** Based on the Flatiron/Parsons/Doppelmayr Executive Summary (***13***).

Travel time savings due to bus lanes (both curbside and median) were assumed to be 0.5 minutes per mile of bus lane, based on information in the *BRT Practioner's Handbook* (***10***). Travel time savings due to bus signal priority was estimated at 5%, which is the low end of the range given in the *BRT Practioner's Handbook* (***10***), as the portion of the route on airport property has no traffic signals. Travel time savings for Full BRT resulting from the flyover were determined from the traffic analysis presented in Appendix A. Table 2 presents the travel time results for the year 2013.

Table 2 2013 One-Way In-vehicle Time (minutes)

	AirBART	Rapid Bus	Full BRT	AGT
Average base in-vehicle time	13.0	11.8	11.8	8.2
Exclusive bus lane time savings	0.0	-0.6	-0.9	0.0
Bus signal priority time savings	0.0	-0.6	-0.6	0.0
Flyover time savings	0.0	0.0	-0.7	0.0
2013 average in-vehicle time	13.0	10.6	9.6	8.2

Table 2 shows that AGT provides the fastest in-vehicle time in 2013, about 1.4 minutes faster than Full BRT and about 2.4 minutes faster than Rapid Bus.

One-way in-vehicle time in 2030 was estimated for the bus options by adding the change in delay for bus movements at key signalized intersections (estimated from the traffic analysis in Appendix A) to the 2013 in-vehicle time. AGT travel time remains the same, as it has no traffic signal interference to deal with. Table 3 presents the travel time results for the year 2030.

Table 3 2030 One-Way In-vehicle Time (minutes)

	AirBART	Rapid Bus	Full BRT	AGT
2013 average in-vehicle time	13.0	10.6	9.6	8.2
Delay from traffic growth	1.6	1.6	0.5	0.0
2030 average in-vehicle time	14.6	12.2	10.1	8.2

Table 3 shows that AGT also provides the fastest in-vehicle time in 2030, about 1.9 minutes faster than Full BRT and about 4.0 minutes faster than Rapid Bus. Most of the increase in travel time occurs due to congestion at the South Coliseum Way/Hegenberger Road intersection, but the flyover included as part of the Full BRT option allows buses (and through traffic) to avoid that delay.

TRANSIT TRAVEL TIME

Transit travel time reflects the average amount of time persons would spend on the BART system from the time they entered a BART station to the time they arrived at an airport terminal. This time includes the following:

- Average in-vehicle travel time on a BART train from the point of origin to the Coliseum BART station (determined from data supplied by BART),

- Walk time from the middle of the BART train platform to the middle of the Oakland Airport Connector platform (including time on escalators),
- Average wait time for the next Connector departure to the airport (assumed to be half the headway),
- Average one-way in-vehicle time on the Connector (from the previous step),
- Average time to deboard from the Connector, and
- Average walk time from the middle of the Oakland Airport Connector platform at the airport to a terminal entrance (including time on escalators and an assumed average 30-second delay at the crosswalks across the terminal roadway, estimated from field measurements).

Walk time was estimated using a walking speed of 4 feet per second, escalator speed of 100 feet per minute, walk distances from a previous step, and typical escalator dimensions. Boarding time is incorporated into the average wait time for the next Connector departure, as it is assumed the next vehicle will arrive at a station shortly after the previous one departs. Deboarding time assumes 2 seconds per person per door on AGT, 5 seconds per person per door on buses (assuming congestion around the bus luggage racks), 2 doors per vehicle for AirBART, 3 doors per vehicle for the other options, and 25 persons per vehicle.

Table 4 gives the transit travel time results.

Table 4 Transit Travel Time (minutes)

	AirBART	Rapid Bus	Full BRT	AGT
Walk time: Coliseum BART station	1.7	1.9	1.9	2.5
Average wait time for Connector	5.0	2.0	2.0	2.3
Average Connector in-vehicle time (2013)	13.0	10.6	9.6	8.2
Average deboarding time	0.4	0.3	0.3	0.1
Walk time: Airport Terminal 1	*3.1*	*2.8*	*2.8*	*2.8*
Walk time: Airport Terminal 2	*1.7*	*2.0*	*2.0*	*5.3*
Average walk time at airport	2.4	2.4	2.4	4.1
Subtotal: Total Connector Time	*22.5*	*17.2*	*16.2*	*17.2*
Average BART in-vehicle time	21.5	21.5	21.5	21.5
Total transit travel time (2013)	44.0	38.7	37.9	38.7
Total transit travel time (2030)	45.6	40.3	38.4	38.7

Table 4 shows that Rapid Bus and AGT have the same overall transit travel times in 2013 and that Full BRT is faster than either of these by 1.0 minute. AGT's superior in-vehicle travel time and deboarding time is offset by the longer walking distances required at both ends of the AGT trip, particularly to Terminal 2. In 2030, Full BRT is faster than AGT by 0.3 minutes, while AGT is faster than Rapid Bus by 1.6 minutes.

RELIABILITY

From a passenger's point-of-view, particularly when traveling to the airport, reliability can be measured in terms of the extra time passengers should allow to be reasonably certain of arriving at their destination by their desired time (e.g., final check-in time). The more reliable the service, the less time passengers need to budget for unscheduled events. *Buffer time* measures the extra time a person should budget in order to arrive at a destination by the desired time 95% of the time. In an airport context, the connector buffer time is only a portion of the total buffer time needed for the trip, as passengers would also need to budget extra time for their initial BART ride and to account for unexpectedly long lines at check-in counters and/or security.

The FEIR/FEIS (***11***) identifies four sources of unreliability in the existing AirBART service: traffic congestion at peak travel times during the day ("rush hour"); traffic congestion during peak travel periods at the airport (e.g. holidays); traffic congestion due to special events at the Coliseum; and variable travel times due to traffic signal delays, differences in passenger loads from trip to trip, etc.

The Oakland Airport Master Plan (***14***) states that "the current roadway system, which is under construction in the loop area until 2008, is expected to accommodate passenger demand increases anticipated due to the expansion and renovation of Terminal 2." The Master Plan goes on to identify additional access and roadway improvements that could be considered if further airport expansion occurred; these improvements would be expected to maintain good traffic operations within the airport property if the airport were to expand. Therefore, reliability issues due to airport peak travel have been removed as an issue, and only the other three now need to be considered.

Other potential sources of delay that impact reliability are emergency situations and mechanical breakdowns. Bus systems can be flexible, adding another vehicle, driving around a stalled vehicle, or even selecting an alternate route. Unlike bus systems, emergency situations and mechanical breakdowns on the AGT system remove half or even the entire system from service rather than the just the affected vehicle. Because these situations are very infrequent, they have not been included in this analysis.

Buffer time was estimated for each option as follows:

- **AirBART:** According to the FEIR/FEIS (***11***), normal AirBART travel times range from 15–30 minutes. We therefore assume a 15-minute buffer time for AirBART (i.e., 15 minutes extra time above the 15-minute scheduled time). It is not known whether the 30-minute trips occurred during special events or not, and the FEIR/FEIS data were developed prior to the opening of the improved 98th Avenue connection to the airport; therefore, the 15-minute buffer time estimate is considered to be conservative. During Coliseum special events, AirBART could be diverted via 98th Avenue, which adds 0.9 miles to the trip, or about 3 minutes of travel time at the AirBART speed of 16.8 mph given in the FEIR/FEIS. In the future, AirBART would be subject to greater travel time variability as traffic congestion increased.
- **Rapid Bus:** Rapid Bus would operate in curbside bus lanes on Hegenberger Road and would be provided with traffic signal priority at signalized intersections. According to data in the *BRT Practitioner's Guide* (***10***), curbside bus lanes reduce travel time variability by an average of 20%, while bus signal priority reduces travel time variability by about 35%.

Applying these travel time variability reductions to the AirBART buffer time, it is estimated that the buffer time for Rapid Bus would be 8 minutes. During Coliseum special events, Rapid Bus could be diverted via 98th Avenue, which adds 0.9 miles to the trip, or about 3 minutes of travel time at the current scheduled AirBART speed of 16.8 mph. If additional stops were provided on Hegenberger Road, Rapid Bus would not be able to divert via 98th Avenue and other means would be required to address unreliability due to Coliseum traffic. The FEIR/FEIS identifies traffic control measures such as those used to facilitate bus and light rail travel to and from Pacific Bell (now AT&T) Park in San Francisco as feasible ways to ensure that buses are given priority (***11***). Given the presence of a bus lane that buses could use to jump the queue as right turns into the Coliseum were being served, the additional delay getting through the Hegenberger Road/South Coliseum Way intersection would not be expected to be more than 3 minutes, and could be less, depending on the form of traffic control used. In the future, the bus lanes would help protect Rapid Bus from increased travel time variability, as buses would be able to bypass congestion in the general traffic lanes.

- **Full BRT:** Full BRT would operate in median bus lanes on Hegenberger Road, would be provided with traffic signal priority at signalized intersections, and would have a flyover at South Coliseum Way that would avoid the traffic signal (and any special event traffic) at the intersection. According to data in the *BRT Practitioner's Guide* (***10***), median bus lanes reduce travel time variability by an average of 57%, while bus signal priority reduces travel time variability by about 35%. Applying these travel time variability reductions to the AirBART buffer time, it is estimated that the buffer time for Full BRT would be 4 minutes. The flyover would allow buses to avoid any special event traffic (assuming normal traffic signal operation at the Hegenberger Road/I-880 Southbound Off-ramp intersection); thus, the special event buffer time for Full BRT would be expected to be 0 minutes. In the future, the bus lanes would help protect Full BRT from increased traffic congestion, as buses would be able to bypass the congestion.
- **AGT:** AGT vehicles would operate in a complete grade-separated guideway and would not experience any traffic interference. According to data from the Flatiron/Parsons/ Doppelmayr Executive Summary, similar systems achieve 99%+ system reliability in terms of time in operation. Therefore, the buffer time for AGT is assumed to be 0 minutes in both the opening year and the long-term future.

Table 5 summarizes these results.

Table 5 Buffer Time and Special Event Delay (minutes)

	AirBART	Rapid Bus	Full BRT	AGT
Buffer time	15	8	4	0
Special event delay	3	3	0	0

Table 5 shows that under the AGT option, passengers would not need to budget any extra time due to unreliability. Passengers should budget 4 extra minutes to make sure of arriving at their destination on time 95% of the time with Full BRT, and up to 11 extra minutes with Rapid Bus.

Coming to the airport under any option, passengers would also want to budget extra time for the possibility of long check-in and security lines (the airport recommends arriving a minimum of 90 minutes prior to departure and many airlines recommend 2 hours). When coming to the airport, budgeting extra time essentially means catching the next earlier BART train (which depending on the origin BART station and time of day, could leave 15–20 minutes earlier), and passengers would need to consider whether the small possibility of being, for example, 4 minutes late would be sufficient to leave 15 minutes earlier, particularly given time allowances for delays at the airport. Traveling from the airport, randomness in flight arrival times in relation to the schedule, baggage delivery times, and Connector arrival times at BART relative to the arrival of a BART train to one's destination would make Connector travel time variability relatively unimportant.

RIDERSHIP

Ridership in the year of opening (2013) was forecast based on the following factors:

- Base AirBART ridership for 2010, from the latest BART ridership forecast for the Oakland Airport Connector (***3***);
- Airport passenger growth to 2013 (from 8.8 to 9.6 million annual passengers), assuming Connector ridership grows proportionately to airport passenger volume;
- Ridership growth due to frequency improvements relative to AirBART;
- Ridership growth due to travel time improvements relative to AirBART, based on the complete BART trip (including time on regular BART trains); and
- Ridership growth due to rapid transit image.

Elasticity factors given in the *BRT Practitioner's Guide* (***10***) and the *Traveler Response to Transportation System Changes* series of reports (***15***) can be used to estimate the change in ridership due to travel time and frequency improvements. For travel time, a midpoint arc elasticity of -0.4 was assumed (roughly stated, for every 1% reduction in travel time, ridership increases by 0.4%). For ridership, a midpoint arc elasticity of +0.2 for frequency was assumed, which roughly means for every 1% increase in frequency, ridership increases 0.2%. Because the existing AirBART service is already relatively frequent, a value toward the low end of the range of possible values was used.

Certain transit modes will attract riders that are not attracted to local bus service. This phenomenon has long been known for rail modes, and is often incorporated into long-range traffic forecasting models. A similar phenomenon has been documented for BRT, with full-featured BRT routes showing up to a 25% increase in ridership beyond what would be expected from frequency and travel time improvements (***10***). The *BRT Practitioner's Guide* (***10***) provides a method for estimating ridership growth due to the image of rapid transit, based on the number of BRT system features (e.g., type of running way, fare collection method, etc.) that are provided. This ridership growth is due to perceived comfort and reliability, branding, special vehicles, upgraded stations, ease of transfers, and other factors that generate additional ridership beyond that of a local bus with similar frequency and travel time characteristics. For Rapid Bus, 14% growth was used, while 22% growth was used for Full BRT. For AGT, 25% growth was assumed for this factor, based on a comparison of BART's latest near-term and long-term low forecasts (***3***) to ridership growth due to frequency and travel time improvements.

Estimated ridership for 2013, therefore, is the sum of anticipated AirBART ridership in 2013 (reflecting airport passenger growth) and the sum of the other factors listed above. Ridership forecasts for 2030 are generated by a similar process, using BART's low (15.9 million annual passengers) and high (20.6 million annual passengers) airport passenger forecasts, and reflecting any changes in travel time from 2013 to 2030. Note that in order to provide an apples-to-apples comparison of the alternatives, a $3 fare is assumed for all modes.

Table 6 through Table 8 provide ridership forecasts for 2013, 2030 (low forecast), and 2030 (high forecast) respectively. For ease of comparison, the full ridership effect of all of the factors listed above is assumed to take place immediately; in actuality, the effect would occur over time (BART's latest forecasts (***3***) assume 3 years).

Table 6 Year 2013 Daily Ridership

	AirBART	Rapid Bus	Full BRT	AGT
2010 base daily ridership	1,930	1,930	1,930	1,930
Airport passenger growth to 2013	170	170	170	170
Subtotal	*2,100*	*2,100*	*2,100*	*2,100*
Ridership growth due to travel time improvements	0	110	130	110
Ridership growth due to frequency improvements	0	390	390	330
Ridership growth due to rapid transit image	0	290	460	530
Estimated 2013 daily ridership	2,100	2,890	3,080	3,070

Table 7 Year 2030 Daily Ridership (Low Forecast)

	AirBART	Rapid Bus	Full BRT	AGT
2010 base daily ridership	1,930	1,930	1,930	1,930
Airport passenger growth to 2030	1,560	1,560	1,560	1,560
Subtotal	*3,490*	*3,490*	*3,490*	*3,490*
Ridership change due to travel time changes	-50	130	200	180
Ridership growth due to frequency improvements	0	650	650	560
Ridership growth due to rapid transit image	0	490	770	870
Estimated 2030 daily ridership	3,440	4,580	5,110	5,100

Table 8 Year 2030 Daily Ridership (High Forecast)

	AirBART	Rapid Bus	Full BRT	AGT
2010 base daily ridership	1,930	1,930	1,930	1,930
Airport passenger growth to 2030	2,590	2,590	2,590	2,590
Subtotal (low)	*4,520*	*4,520*	*4,520*	*4,520*
Ridership change due to travel time changes	-60	160	250	240
Ridership growth due to frequency improvements	0	850	850	720
Ridership growth due to rapid transit image	0	630	990	1,130
Estimated 2030 daily ridership	4,460	6,160	6,610	6,610

Table 6–Table 8 show that the Full BRT and AGT would generate approximately the same ridership in all analysis years, with ridership levels about 7% higher than the Rapid Bus option and about 48% higher than the AirBART option.

The above ridership estimates are based on a $3 fare for each alternative. Although the AGT fare has not yet been set, recent planning documents have included a potential fare of $6 (***3, 4, 6***). This analysis uses a fare elasticity of -0.2 consistent with the *Traveler Response to Transportation System Changes* series of reports (***15***) and *BART–Oakland Airport Connector Patronage Refinement Final Report*, April 24, 2007 (**2**). A fare elasticity of -0.2 indicates an approximate 0.2 percent decrease in transit ridership in response to each 1 percent fare increase. Adjusting for the loss of ridership due to the higher fare, 2013 ridership would be 2,685, and 2030 ridership would be between 4,465 (low estimate) to 5,785 (high estimate).

DIRECTIONAL HOURLY CAPACITY AND DEMAND

Providing sufficient capacity ensures that passengers can board the first vehicle that arrives (thus avoiding any delays and potential ridership loss due to overcrowding). Capacity can be measured in terms of *persons per hour* (seated and standing) or *seats per hour.* Buses are designed to have most persons seated, while AGT vehicles provide a relatively small number of seats compared to their overall person capacity, and most people stand when an AGT vehicle is fully loaded. Both measures are evaluated here.

For consistency with previous planning efforts, theoretical capacities are used—that is, the number of seats or passenger spaces per vehicle is multiplied by the number of departures per direction per hour. Theoretical capacities therefore assume that every seat/space is occupied on every trip. Given variations in passenger demands from one departure to the next (particularly at the Coliseum station, where passengers will arrive by the trainload rather than at random), practical capacities would be approximately 25% less. Practical capacities reflect the typical number of people that can be accommodated per hour without some passengers having to wait for the next Connector departure due to overcrowding of an individual vehicle.

Service frequencies for AirBART are based on current operation: 10-minute headways correspond to 6 departures per hour. The Rapid Bus and Full BRT options use the same assumption as the Quality Bus option in the FEIR/FEIS (***11***): 4-minute headways, corresponding to 15 departures per hour. Service frequencies for AGT are taken from the Flatiron/Parsons/Doppelmayr Executive Summary (***13***): 275-second headways, corresponding to 13 departures per hour. Seats and passenger spaces per vehicle are as described in Section 3 of this report.

Peak hour demand is based on data provided by the Port of Oakland, which shows that 12.1% of Friday daily passenger trips occurred during the busiest hour of the day during May and June 2010. Therefore, peak directional demand is calculated as (daily ridership) * (12.1%) * (50%), with the 50% factor representing an assumed 50/50 split between passengers going to and from the airport between 5 and 6 pm on a Friday.

Table 9 summarizes the capacity and demand analysis.

Table 9 Directional Hourly Capacity and Demand

	AirBART	Rapid Bus	Full BRT	AGT
Peak frequency (vehicles/hour)	6	15	15	13
Vehicle capacity (persons/vehicle)	42	60	60	150
Seated capacity (seats/vehicle)	32	47	47	40
Peak person capacity (persons/hour/dir)	250	900	900	1,950
Peak seated capacity (seats/hour/dir)	192	705	705	520
2013 peak demand (persons/h/dir)	125	175	185	185
2030 peak demand (low) (persons/h/dir)	210	275	310	310
2030 peak demand (high) (persons/h/dir)	270	375	400	400
Average persons/vehicle (2030 high)	45	25	27	31

Table 9 shows that all of the non-AirBART options provide sufficient capacity to meet the high demand forecasts through 2030, with the AGT option providing far more total person capacity than is required. The Rapid Bus and Full BRT options offer a higher seated capacity than AGT, though.

According to the Oakland Airport Master Plan (***14***), the airport will reach its capacity at or before 30 million annual passengers, or approximately 50% higher passenger volumes than used for the 2030 high forecast. The Master Plan indicates that expanding capacity would require adding a new runway, which the airport does not plan to do. All of the non-AirBART options would, therefore, accommodate the airport's maximum passenger levels, assuming no changes in mode split due to external factors (e.g., gasoline or parking prices). When considering practical capacities (25% lower than shown in Table 9), all of the non-AirBART options could still accommodate demand without short-term overcrowding occurring during typical Friday peak hours.

If additional capacity was required, additional Rapid Bus and Full BRT buses could be operated. The longest traffic signal cycle length in the corridor sets a practical limit on the minimum headway that could be operated without bus bunching occurring routinely, but decreasing the headway to 3 minutes, for example, would increase Rapid Bus and Full BRT capacity by 33%.

VEHICLE REQUIREMENTS

The number of vehicles required to operate service at a given headway depends on the *cycle time,* the time required to make a complete round trip, including allowances for late arrivals and driver break time. Cycle time was calculated as the sum of:

- Average dwell time (time for passenger boarding and deboarding, estimated using the same process as in the previous step);
- Round-trip running time (twice the average in-vehicle time from previous steps); and
- Recovery time (driver break time and allowance for late arrivals, assumed to be a minimum of 10% of the combined dwell and in-vehicle time, and rounded up to provide an integer number of vehicles in service).

Dividing the cycle time by the peak headway gives the maximum number of vehicles required in service. For the bus options, spare bus requirements were assumed to be 20% of the number of vehicles required in maximum service, rounded up. Table 10 summarizes the vehicle requirements for 2013; Table 11 summarizes the vehicle requirements for 2030.

Table 10 Year 2013 Vehicle Requirements

	AirBART	Rapid Bus	Full BRT	AGT
Average dwell time (min/stop)	2.1	1.4	1.4	0.95
Round-trip running time (min)	26.0	21.2	19.2	16.4
Recovery time (min)	9.8	4.0	6.0	0.0
Cycle time (min)	40.0	28.0	28.0	18.3
Peak headway (min)	10.0	4.0	4.0	4.6
2013 vehicles in maximum service	4	7	7	4
Spare vehicles	1	2	2	?

Table 11 Year 2030 Vehicle Requirements

	AirBART	Rapid Bus	Full BRT	AGT
Average dwell time (min/stop)	2.1	1.4	1.4	0.95
Round-trip running time (min)	29.2	24.4	20.2	16.4
Recovery time (min)	6.6	4.8	5.0	0.0
Cycle time (min)	40.0	32.0	28.0	18.3
Peak headway (min)	10.0	4.0	4.0	4.6
2030 vehicles in maximum service	4	8	7	4
Spare vehicles	1	2	2	?

OPERATING COSTS

Operating costs (including maintenance, insurance, fuel/electricity, and debt service costs) were estimated as follows:

- **AirBART:** AirBART service is contracted out through the Port of Oakland. Based on Port of Oakland data for 2007–2009, AirBART annual operating costs averaged $2.4 million per year. Assuming a 3% cost increase per year, 2013 annual costs would be approximately $2.7 million.
- **Rapid Bus and Full BRT:** Estimates were prepared assuming service was contracted to a private operator, consistent with existing AirBART service and the proposed AGT service. Contracted costs were based on four Bay Area operators with contracted service (Central Contra Costa, Western Contra Costa, Eastern Contra Costa, and Livermore/Amador Valley), which averaged $90 per revenue hour in 2008, or $104 per revenue hour when inflated to 2013 values. All capital improvements are assumed to be built without incurring debt (see section on Capital Costs). The annual costs for years 2013 and 2030 are shown in Table 12.

  Peak service was assumed to be operated between 7 a.m. and 10 p.m. every day, with reduced headways (every 7.5 minutes) for an additional 5.25 hours per day.
- **AGT:** As a Design/Build/Operate/Maintain project, AGT service would be contracted out. Costs of $4.9 million were taken from the Flatiron/Parsons/Doppelmayr Executive Summary (***13***). In addition, BART will incur annual costs of $1.65 million for electricity, insurance and finance fees, and an average of $6.37 million annually for debt service[1] (***6***). Total estimated annual BART operating costs are shown in Table 12.

Reserves for vehicle and other capital costs are not included in operating costs but are addressed in the following section on Capital Costs. Table 12 summarizes operating costs for each option.

Table 12 Annual Operating Costs (millions of 2013 dollars)

	AirBART	Rapid Bus	Full BRT	AGT
Year 2013	2.7	4.8	4.8	12.9
Year 2030	2.7	5.5	4.8	12.9

Table 12 shows that the AGT option would have significantly higher annual operating costs, primarily due to debt service on construction of the system. Contracted Rapid Bus would also have similar annual operating costs initially, but these costs would increase by 14% by 2030 (in constant dollars), because an extra bus will eventually need to be added to the route due to increased intersection delays. Not included for any of the options is the potential cost of a station agent to monitor the station and address customer questions with fare payment, routes, etc. Assuming three shifts, providing a station agent would cost approximately $400,000 per year in 2013 dollars.

[1] Assumes funding is received from Port of Oakland and debt service and financing fees through TIFIA over 35 years.

CAPITAL COSTS

Initial capital costs were estimated as follows and are summarized in Table 13:

- **AirBART:** No changes would be made to the existing service; therefore, no capital costs were assumed.
- **Rapid Bus and Full BRT:** Costs are assigned to the following categories: vehicles, guideway and intelligent transportation systems (e.g., traffic signal priority), stations, and intersection mitigation costs to maintain adequate traffic operations. No right-of-way purchase appears to be required for either option. A 50% contingency is added to the total to account for design costs, unknown costs, and unexpected cost increases. Cost data are obtained from the *BRT Practitioner's Guide* (***10***) and *Characteristics of Bus Rapid Transit,* 2009 edition (***9***). Vehicles are assumed to cost $800,000 each. Converting general purpose lanes to semi-exclusive bus lanes is assumed to cost $300,000 per lane mile ($3 million per lane mile in sections where more extensive reconstruction is required for the Rapid Bus option), constructing new median bus lanes is assumed to cost $10.2 million per lane mile, and a flyover is assumed to cost $30 million per lane mile. Technology costs are included in the per-lane-mile estimates. The BRT station at BART was assumed to cost $3 million, based on the cost of multi-level BRT stations in Brisbane, Australia and Ottawa, Canada, while the BRT station at the Airport was assumed to cost $1 million, based on the cost of a more elaborate, single-level BRT station than the existing AirBART station, including fare collection capabilities. As described in the traffic analysis in Appendix A, Rapid Bus requires modifying the traffic signal at the South Coliseum/Hegenberger intersection, accompanied by signing and striping changes, in order to maintain satisfactory traffic operations. Full BRT requires street widening into the Edgewater Drive median to create a third left-turn lane, and reconstruction of the South Coliseum/Hegenberger intersection associated with constructing the flyover.
- **AGT:** Vehicle, guideway, and station costs are taken from the BART Board of Directors meeting agenda where the construction contract was approved (***4***). Contingency and other costs (including financing and internal BART costs) are also taken from that agenda.

Table 13 Initial Capital Costs (millions of 2010 dollars)

	AirBART	Rapid Bus	Full BRT	AGT
Vehicles	0	7.2	7.2	361.0
Running way, ITS	0	2.3	67.0	
Stations	0	4.0	4.0	
Intersection operations mitigation	0	0.2	5.5	0.0
Subtotal	*0*	*13.7*	*83.7*	*361.0*
Contingency/Other	0	6.9	41.9	98.0
Total	0	20.6	125.6	459.0

Reserves for vehicle and other capital equipment replacement (e.g., AGT cables) are assumed to be $300,000 per year for AirBART, $670,000 per year for the Rapid Bus option and $600,000 per year for

the Full BRT option (all assuming a 12-year useful vehicle life), and $768,000 per year for the AGT option (*4*), all in 2010 dollars. Because capital equipment is budgeted separately from operating funds, they are shown here rather than as an element of operating costs.

FARE REVENUE AND OPERATING SUBSIDY PER RIDE

The fare for accessing the Oakland Airport is made up of two components: the cost to travel from the origin station to the Coliseum Station on the core BART system and the fare to connect from the Coliseum Station to the airport terminal. The average fare for trips on the BART core system traveling to the Coliseum Station was calculated as $3.05; the fare for trips from the Coliseum Station was calculated as $3.10. It is assumed that approximately the same number of trips travel to and from the airport resulting in an average fare for the portion of the trip on the core BART system of $3.075. AirBART currently charges a fare of $3.00 each way. The initial fare for all options was assumed to be $3.00 providing a common basis for calculating ridership.

In addition to the fare revenue directly generated from the connector service, a portion of the revenue generated from the core BART system as a result of new airport rides is allocated toward the costs of the connector service. The fare revenue from the core system is based on 25% of the new rides over and above the ridership generated by AirBART. Table 14 summarizes the added rides, additional fare revenue, and operating costs from Table 12, and calculates the operating cost per ride. Annual ridership estimates have been calculated using an annualization factor of 300 per the MTC Blueprint, as referenced in the spreadsheet "Input to the OAC Financial Model". The operating subsidy is calculated as total operating costs less total fare revenue. The subsidy can be covered through higher fares, or other operating revenues, and would be a policy decision.

Table 14 Fare Revenue and Operating Subsidy per Ride (2013)

	AirBART $3 Fare	Rapid Bus $3 Fare	Full BRT $3 Fare	AGT $3 Fare	AGT $6 Fare
Operating expense in 2013	$2,700,000	$4,800,000	$4,800,000	$12,900,000	$12,900,000
Average daily connector ridership	2,100	2,890	3,080	3,070	2,685
Annual Connector ridership	630,000	867,000	924,000	921,000	805,500
Operating cost per ride	$4.29	$5.54	$5.19	$14.01	$16.01
Annual fare revenue from Connector rides	$1,890,000	$2,601,000	$2,772,000	$2,763,000	$4,833,000
Incremental rides on core system	N/A	237,000	294,000	291,000	175,500
Incremental core system fare revenue	N/A	$182,200	$226,000	$223,700	$134,900
Annual fare revenue from Connector	$1,890,000	$2,783,200	$2,998,000	$2,986,700	$4,967,900
Annual subsidy	$810,000	$2,016,800	$1,802,000	$9,913,000	$7,932,000
Net operating subsidy per ride	$1.29	$2.33	$1.95	$10.76	$9.85

The subsidy per ride is a rough approximation of the additional fare required over the base fare ($3 for all alternatives) for the system to cover its costs through fares. As fares are increased, however, ridership decreases resulting in a higher cost per ride. This analysis did not calculate the

equilibrium point for fares to cover cost, but has provided this metric as an indication of the fare level needed should the operating conditions require it. Table 14 shows that the operating cost per ride is $4.29 fare for AirBART, resulting in a subsidy of $1.29 per ride. The Rapid Bus and Full BRT options have an operating cost of $5-$6 per ride, and an operating subsidy of approximately $2 per ride, due to the ability to attract new rides to the BART core system. The AGT option with a fare of $3 would require an operating subsidy of $10.76 per ride after adjusting for the additional rides on the core BART system. The lower ridership for AGT under the $6 fare scenario results in a higher operating cost per ride, of $16.01 in 2013. Due to the higher fare revenue generated, however, the operating subsidy per ride is lower, at $9.85.

COST-EFFECTIVENESS

The FTA New Starts criteria used for the FEIR/FEIS used a "cost-effectiveness index" that was a ratio of the incremental change in annualized costs to the incremental change in ridership. The FTA uses different evaluation criteria now, but for consistency with the FEIR/FEIS analysis, the cost-effectiveness index has been used here. The following process was used to calculate this index:

- **AirBART:** No initial capital costs were assumed. Reserves for capital equipment replacement (referred to in some documents as Capital Asset Replacement Program, or CARP) was taken from the text accompanying Table 13. Current operating costs were used (Table 12). Annual ridership was determined by multiplying the 2030 high forecast (Table 8) by an annualization factor of 300 per the MTC Blueprint. Fare revenue was based on an average of the 2013 and 2030 high ridership forecasts, and using a fare of $3.
- **Rapid Bus and Full BRT:** The FTA's Standard Cost Categories for Capital Projects spreadsheet (version 13) was used to estimate annualized capital costs, based on the cost categories shown in Table 13. Reserves for capital equipment replacement was taken from the accompanying text. Operating costs were taken from Table 12; Rapid Bus costs were based on an average of 2013 and 2030 costs. Annual ridership was determined by multiplying the 2030 high forecast (Table 8) by an annualization factor of 300 per the MTC Blueprint. Fare revenue was based on an average of the 2013 and 2030 high ridership forecasts, and using a fare of $3.
- **AGT:** Capital costs given in the 2002 FEIR/FEIS were used (***11***). Reserves for capital equipment replacement was taken from the text accompanying Table 13. The operating costs were given in Table 12. Annual ridership was determined by multiplying the 2030 high forecast (Table 8) by an annualization factor of 300 per the MTC Blueprint. Fare revenue was based on an average of the 2013 and 2030 high ridership forecasts, and using a fare of $3 and a fare of $6. The current project has changed considerably since the FEIR/FEIS, with a current project cost of $459 million (***4***). At the time of this report, detailed cost data were not available for the current project that would permit recalculating the annualized AGT capital cost for the current project. Instead, the annualized capital expenditures for the current AGT proposal were estimated based on the assumptions that: (1) the types of capital expenditures have remained proportionate between the 2002 FEIR/FEIS and the current AGT project; and (2) various capital costs have risen proportionately between 2002 and the current project estimate.

Table 15 FTA Cost-Effectiveness Index

	Rapid Bus $3 Fare	Full BRT $3 Fare	AGT $3 Fare (FEIR/FEIS 2002)	AGT $6 Fare (FEIR/FEIS 2002)	AGT $3 Fare (est. current)	AGT $6 Fare (est. current)
Net incremental annualized costs (millions)	$3.48	$10.23	$24.49	$21.36	$43.97	$40.84
Incremental annual ridership	510,000	645,000	645,000	397,500	645,000	397,500
Cost per incremental ride	$6.83	$15.86	$37.97	$53.74	$68.17	$102.74

Table 15 shows that Rapid Bus has the lowest cost per incremental ride at $6.83, and Full BRT is twice that figure, at $15.86. Using the 2002 FEIR/FEIS capital costs of $204 million, the incremental cost per passenger for AGT is $37.97 with a $3 fare, more than twice the figure for the Full BRT option. While the $6 fare for AGT lowers the net incremental annualized costs, the resulting lower ridership yields an incremental cost per ride of $53.74, which is more than three times the incremental cost per ride as for Full BRT. When the measure is recalculated using estimated annualized capital costs for the current project, the incremental cost per passenger increases to $68.17 with a $3 fare and $102.74 with the planning fare of $6.

JOB CREATION

The existing economic climate has placed a significant emphasis on job creation. The airport connection generates both short-term construction jobs as well as long-term jobs through service operations.

Temporary construction jobs can be estimated using the methodology developed by the President's Council of Economic Advisors (***17***) and used for the TIGER grant process. This method estimates one job-year per $92,000 of construction spending, which includes direct, indirect, and induced employment. The methodology provides no distinction in local versus national jobs, types of jobs or type of construction needed for the project. BART is currently estimating jobs for the AGT option on a much finer level. Providing an analysis using the macro-level estimation methodology would not provide additional insight into the options, and has been excluded from this analysis.

Permanent operations jobs for Rapid Bus and Full BRT are calculated based on the average ratio of bus operators to total employees at AC Transit, Golden Gate Transit, SamTrans, San Francisco Muni, and VTA, based on the 2008 National Transit Database. This ratio is 1.56. It was assumed that each bus in operation required 4.2 operator full-time equivalents (FTEs), with 3.0 FTEs required to provide weekday service and 1.2 FTEs required to provide weekend service. With 7 buses in service, the number of permanent operations jobs is estimated to be 46. AirBART provides half the level of service as Rapid Bus. AirBART was estimated to require 23 FTE's, half of Rapid Bus's figure of 46 FTE's. AGT is estimated to require approximately 27 operations jobs, according to a presentation to the BART Board of Directors on December 10, 2009 (**7**).

INTERMEDIATE STATIONS

The base conditions analyzed above assumed non-stop service between the airport and BART. The possibility also exists to include intermediate stations along the route. The AGT option includes an optional Doolittle station. For the BRT options, two intermediate stations were investigated along Hegenberger Road: one at Edgewater Drive and one at Pardee Drive. Each additional stop added to the route adds travel time: delay due to deceleration and acceleration, time to serve passenger boardings and alightings (dwell time), and, for the BRT options, potential delay caused by having to wait for a traffic signal to turn green again because it turned red while the bus was serving passengers. Added travel time also raises the potential for added operational costs (because extra buses might have to be operated to maintain a desired headway) or longer headways (because AGT vehicles take more time to make a round trip).

The publicly available material relating to the AGT option does not indicate how much additional round-trip travel time would be required to serve an intermediate station. For the sake of illustration, if a stop added (in a best case) 20 seconds of travel time per direction, the AGT headway would increase by 40 seconds to a total of 315 seconds, which would reduce the number of hourly AGT departures from 13 to 11. Hourly person capacity would be correspondingly reduced, from 1,950 per hour to 1,650 per hour.

For the Rapid Bus option, adding one stop would add approximately 40 seconds of round-trip travel time, while adding two stops would add approximately 117 seconds, as extra traffic signal delay would be incurred going from the airport to BART in addition to the extra time required to serve the second stop. In 2013, one stop could be accommodated without adding an eighth bus to the route, but two stops would require adding a bus.

For the Full BRT option, adding one stop would add approximately 40 seconds of round-trip travel time, while adding two stops would add approximately 187 seconds, as extra traffic signal delay would be incurred in both directions in addition to the extra time required to serve the second stop. In either case, in 2013, the route could be operated with the same number of buses (7) required for non-stop service. By 2030, an eighth bus would be required if two stops were used.

Section 5
Comparison Criteria

Comparison Criteria

The FEIR/FEIS included primary objectives and preliminary criteria by which to evaluate its three alternatives. These are provided below as Figure 17 (***11***). The FEIR/FEIS evaluation criteria are also used in this section to evaluate this report's four alternatives. In addition, this section uses several additional criteria—ridership, walk time, job creation, construction time, improved access for the local community which is primarily minority and low income groups, and fare level required to cover operating costs—that supplement the original evaluation criteria.

Each evaluation criterion is described separately below, including a description of the methodology used to evaluate the criterion and the results. This section concludes with a matrix summarizing the overall results.

SERVICE RELIABILITY

1. Provide reliable scheduled service between BART and Oakland International Airport.

As discussed in Section 4, reliability can be measured by buffer time, the amount of extra time that passengers should budget to be reasonably sure of arriving at their destination by their desired time. Section 4 presented buffer times under normal conditions, along with the extra delay associated with re-routing service to avoid Coliseum event traffic. These were:

- **AirBART:** Buffer time of 15 minutes, rerouting delay for special events of 3 minutes.
- **Rapid Bus:** Buffer time of 8 minutes, rerouting delay for special events of 3 minutes.
- **Full BRT:** Buffer time of 4 minutes, no special event impact.
- **AGT:** Buffer time is 0 minutes, no special event impact.

It should be noted that although AGT is assigned a buffer time of 0 minutes, if it did need to be shut down for some reason, passengers could experience significant additional travel time while a bus bridge to the airport was established, passengers were directed to alternative pick-up and drop-off locations, and buses traveled between BART and the airport without benefit of bus lanes or signal priority. If a bus broke down, passengers would only have to wait one headway (e.g., 4 minutes) for the next bus.

Figure 17 FEIR/FEIS Evaluation Criteria

Table 1.3-1 ***BART-Oakland Airport Connector Project Objectives***	
1.	Provide reliable scheduled service between BART and OIA.
2.	Provide flexibility to increase transit vehicle frequencies during periods of increased travel demand.
3.	Offer a competitive alternative to those who drive to OIA by providing predictable connections and travel time savings.
4.	Provide a convenient, safe, and comfortable connection between BART and OIA.
5.	Maximize BART ridership.
6.	Be cost-effective, recognizing budget constraints and available funding.
7.	Be consistent with BART's expansion policy, providing flexibility to accommodate potential intermediate stops that support local economic growth.
8.	Minimize significant environmental consequences of construction and operation.

Source: BART

Table 1.3-2 ***BART-Oakland Airport Connector Evaluation Criteria***	
1.	Provide reliable scheduled service between BART and OIA.
2.	Provide on-time performance equal to BART.
3.	Accommodate a minimum of 700 passengers per hour per direction.
4.	Ensure that transit vehicles arrive at least every 6 minutes.
5.	Ensure that the maximum wait time is no greater than 6 minutes.
6.	Complete trips between OIA and the Coliseum BART Station at least as quickly as motorists during off-peak weekday traffic.
7.	Allow capacity adjustments throughout the day.
8.	Provide flexibility to expand and upgrade the system to accommodate increases in ridership.
9.	Provide flexibility to serve intermediate stops.
10.	Minimize significant negative environmental effects.
11.	Be constructed and operated within reasonable costs
12.	Avoid substantial impacts to sensitive residential, public, and commercial land uses.
13.	Minimize the amount of private property needed for rights of way.
14.	Minimize the extent of displacement (e.g., businesses or parking).
15.	Avoid constraining known development plans.
16.	Avoid creating odd-shaped land areas with limited development potential.
17.	Support increased transit service for targeted redevelopment and revitalization areas to facilitate economic growth.
18.	Conform to the Airport Development Program.

Source: BART

2. Provide on-time performance equal to BART.

BART defines "on-time" as meaning a passenger arrival at their destination no more than five minutes past the scheduled time. According to BART's most recent available performance data (***19***), BART's passenger on-time performance was 95.4%, compared to a goal of 96%. The buffer time calculated above can also be used to evaluate this measure: a buffer time of 5 minutes, for example, would indicate that 95% of passenger trips were no more than 5 minutes longer than the scheduled time.

- **AirBART:** Buffer time is 15 minutes. On-time performance would be less than BART and does not meet the criterion.
- **Rapid Bus:** Buffer time is 8 minutes. On-time performance would be less than BART and does not meet the criterion.
- **Full BRT:** Buffer time is 4 minutes. On-time performance would be equal to BART and meets the criterion.
- **AGT:** Buffer time is 0 minutes. On-time performance would be equal to or better than BART and meets or exceeds the criterion.

As noted previously, having separate travel lanes or guideways would help protect the non-AirBART options from reductions in reliability, while AirBART would be subject to increasingly unreliability as traffic congestion increased.

CAPACITY

3. Accommodate a minimum of 700 passengers per hour per direction.

Providing sufficient capacity ensures that passengers can board the first vehicle that arrives (thus avoiding any delays and potential ridership loss due to overcrowding). Capacity can be measured in terms of *persons per hour* (seated and standing) or *seats per hour.* The level of service for 2013 and 2030 is the same, therefore the ability to accommodate 700 passengers per hour per direction is not different between the two years. The following results are summarized from Table 9.

- **AirBART:** 6 departures per hour, with 32 seats and 42 total passenger spaces per vehicle. Hourly directional capacities are 192 seated and 250 total, which is less than, and does not meet, the FEIR/FEIS criterion of 700 passengers per hour per direction.
- **Rapid Bus:** 15 departures per hour, with 47 seats and 60 total passenger spaces per vehicle. Hourly directional capacities are 705 seated and 900 total, which meets the FEIR/FEIS criterion.
- **Full BRT:** 15 departures per hour, with 47 seats and 60 total passenger spaces per vehicle. Hourly directional capacities are 705 seated and 900 total, which meets the FEIR/FEIS criterion.
- **AGT:** 13 departures per hour, with 40 seats and 150 total passenger spaces per vehicle. (Seated capacity is estimated from vehicle illustrations in the Flatiron/Parsons/Doppelmayr Executive Summary (***13***), assuming a 4-car train, 8 seats per car along the sides of each car

and 4 seating positions at each end of the train.) Hourly directional capacities are 520 seated and 1,950 total, which meets the FEIR/FEIS criterion.

7. Allow capacity adjustments throughout the day.

- **AirBART:** Capacity can be adjusted by adding or removing buses from service. The criterion is met.
- **Rapid Bus:** Capacity can be adjusted by adding or removing buses from service. A practical limit on headway, to avoid bus bunching issues, would be set by the intersection with the longest traffic signal cycle length in the corridor. The criterion is met.
- **Full BRT:** Capacity can be adjusted by adding or removing buses from service. A practical limit on headway, to avoid bus bunching issues, would be set by the intersection with the longest traffic signal cycle length in the corridor. The criterion is met.
- **AGT:** Peak capacity cannot be increased during the day (from an already-high starting point). Capacity can be reduced by increasing the time between train departures. The criterion is met.

8. Provide flexibility to expand and upgrade the system to accommodate increases in ridership.

- **AirBART:** Ridership increases could be accommodated by increasing frequency and using longer buses. The criterion is met.
- **Rapid Bus:** Ridership increases could be accommodated by increasing frequency. As noted above, there is a practical limit on bus headways. The criterion is met.
- **Full BRT:** Ridership increases could be accommodated by increasing frequency. As noted above, there is a practical limit on bus headways. The criterion is met.
- **AGT:** Capacity can only be increased by lengthening trains from 3 cars to 4 cars. The criterion is met.

FREQUENCY

4. Ensure that transit vehicles arrive at least every 6 minutes.

Headways, or the time between vehicles is taken from the discussion in Section 4, Direction Hourly Capacity and Demand.

- **AirBART:** Peak headways are 10 minutes, which does not meet the criterion.
- **Rapid Bus:** Peak headways are 4 minutes, which meets the criterion.
- **Full BRT:** Peak headways are 4 minutes, which meets the criterion.
- **AGT:** Peak headways are 4.6 minutes, which meets the criterion.

5. Ensure that the maximum wait time is no greater than 6 minutes.

This criterion reflects a combination of service frequency and the ability of the service to recover from delays so that the next trip departs on time.

- **AirBART:** Peak headways are 10 minutes, which does not meet the criterion.

- **Rapid Bus:** Peak headways are 4 minutes. Conceptual station designs provide separate loading and unloading areas, plus (at the Coliseum station) a layover area, allowing the service to recover from longer-than-normal travel times. The criterion is met.
- **Full BRT:** Peak headways are 4 minutes. Conceptual station designs provide separate loading and unloading areas, plus (at the Coliseum station) a layover area, allowing the service to recover from longer-than-normal travel times. The criterion is met.
- **AGT:** Peak headways are 4.6 minutes. According to data from the Flatiron/Parsons/ Doppelmayr Executive Summary, similar systems achieve 99%+ system reliability in terms of time in operation (***13***). No data was provided on other aspects of reliability (e.g., potential for delay due to doors being held), but any potential delays are assumed to not normally exceed 1.4 minutes. The criterion is met.

TRAVEL TIME

6. Complete trips between Oakland International Airport and the Coliseum BART Station at least as quickly as motorists during off-peak weekday traffic.

Travel time is defined as the in-vehicle travel time between the Coliseum BART station and the Oakland Airport station. The results are taken from Table 2 and Table 3.

- **AirBART:** AirBART travels non-stop between the airport and BART in general traffic and would therefore have the same speed as other motorists. Off-peak travel times are currently approximately 13 minutes in 2013, based on a 7.1-mile round trip and an average speed of 16.8 mph. In 2030 the in-vehicle travel time increases to 14.6 minutes due to increases in congestion. The criterion is met.
- **Rapid Bus:** Rapid Bus would travel more quickly than motorists, due to the use of curbside bus lanes and bus signal priority. Peak travel times in 2013 would be approximately 10.6 minutes. In 2030 the in-vehicle travel time increases to 12.2 minutes due to increased congestion. The criterion is met.
- **Full BRT:** Full BRT would travel more quickly than motorists, due to the use of median bus lanes, bus signal priority, and a flyover across South Coliseum Way. Peak travel times in 2013 would be approximately 9.6 minutes. In 2030 the in-vehicle travel time increases slightly to 10.1 minutes. The criterion is met.
- **AGT:** AGT travels on its own guideway and would have a peak travel time in 2013 of 8.2 minutes. The AGT would not be affected by any changes in traffic conditions. The criterion is met.

ENVIRONMENTAL IMPACTS

10. Minimize significant negative environmental effects.

The no build (AirBART) and AGT summary are taken directly from the March 2002 FEIR/FEIS. The FEIR/FEIS Enhanced Bus option is similar enough in scope to allow those results to be applied to the Rapid Bus and Full BRT options. Any potential differences have been highlighted.

- **AirBART:** No changes from March 2002 FEIR/FEIS.
- **Rapid Bus:** Hybrid buses would be used resulting in lower emissions and quieter operations than in the Quality Bus option of the March 2002 FEIR/FEIS. Improved over FEIR/FEIS.
- **Full BRT:** Hybrid buses would be used resulting in lower emissions and quieter operations than in the Quality Bus option of the March 2002 FEIR/FEIS. Improved over FEIR/FEIS.
- **AGT:** No changes from the March 2002 FEIR/FEIS.

PROJECT COST

11. Be constructed and operated within reasonable costs.

Costs are taken from Table 15, FTA Cost-Effectiveness Index which is calculated as the incremental cost of the option divided by the incremental ridership over the No Build (AirBART) option.

- **AirBART:** Not Applicable. AirBART, the no-build scenario, is the baseline against which the other three options are compared.
- **Rapid Bus:** The incremental cost per passenger is $6.83. The criterion is met.
- **Full BRT:** The incremental cost per passenger is $15.86. The criterion is met.
- **AGT:** Using the 2002 FEIR/FEIS capital costs of $204 million, the incremental cost per passenger is $37.97 with a $3 fare, and $53.74 with planning fare of $6. The current project has changed considerably since the FEIR/FEIS, with a current project cost of $459 million (***4***). At the time of this report, detailed cost data is not available for the current project that would permit recalculating the annualized AGT capital cost necessary for this measure. However, assuming that the types of capital expenditures have remained proportionate between the 2002 FEIS/FEIR and the current AGT project, and that various capital costs have risen proportionately between 2002 and the current project estimate, the incremental cost per passenger would be $68.17 with a $3 fare and $102.74 with planning fare of $6. The criterion is not met.

DEVELOPMENT AND NEIGHBORHOOD IMPACTS

This summary of impacts is based on the March 2002 FEIR/FEIS Chapter 2.3. The impacts of Rapid Bus and Full BRT alternatives are generally similar to the FEIR/FEIS Quality Bus option; any differences from that option are described in the sections below.

9. Provide flexibility to serve intermediate stops.

Intermediate stops included in this analysis include up to two optional stops along Hegenberger and an additional stop at the airport to serve a new terminal (***14***).

- **AirBART:** AirBART travels non-stop between the airport and BART in mixed traffic and does not make intermediate stops. The criterion is not met.

- **Rapid Bus:** Service to intermediate stops could be accommodated. Preliminary designs have been included in Appendix B for the Hegenberger/Pardee and Hegenberger/Edgewater intersections to demonstrate feasibility of the intermediate stations. The criterion is met.
- **Full BRT:** Service to intermediate stops could be accommodated. Preliminary designs have been included in Appendix B for the Hegenberger/Pardee and Hegenberger/Edgewater intersections to demonstrate feasibility of the intermediate stations. The criterion is met.
- **AGT:** Intermediate stops, other than the optional Doolittle stop, would require significant reconstruction of the AGT guideway. The criterion is minimally met.

12. Avoid substantial impacts to sensitive residential, public, and commercial land uses.

- **AirBART:** No change from the FEIR/FEIS.
- **Rapid Bus:** Hybrid buses would be used, resulting in lower emissions and quieter operations than in the Quality Bus option of the FEIR/FEIS. This criterion is improved over the FEIR/FEIS.
- **Full BRT:** Hybrid buses would be used resulting in lower emissions and quieter operations than in the Quality Bus option of the FEIR/FEIS. This criterion is improved over the FEIR/FEIS.
- **AGT:** No change from the FEIR/FEIS.

13. Minimize the amount of private property needed for rights of way.

- **AirBART:** AirBART travels in general traffic and would not require additional right of way. The criterion is met.
- **Rapid Bus:** This option can be implemented within the existing right of way. The criterion is met.
- **Full BRT:** This option can be implemented within the existing right of way. The criterion is met.
- **AGT:** Land acquisition was required and is complete. The criterion is not met.

14. Minimize the extent of displacement (e.g., businesses or parking).

- **AirBART:** AirBART travels in general traffic and would not require additional right of way resulting in no displacement. The criterion is met.
- **Rapid Bus:** This option can be implemented within the existing right of way with minimal loss of parking at intermediate stops, if implemented. The criterion is met.
- **Full BRT:** This option can be implemented within the existing right of way. On-street parking would be lost on one side of Hegenberger Road; however, businesses in the corridor rely on off-street parking. The criterion is met.
- **AGT:** Parking will be displaced at the Oakland Airport terminal and along the Hegenberger corridor. The criterion is not met.

15. Avoid constraining known development plans.

- **AirBART:** Does not conflict with policies promoting economic development in the Hegenberger Corridor. However, the lack of ability to serve intermediate stations does not enhance redevelopment of the Corridor. This criterion is minimally met.
- **Rapid Bus:** Does not conflict with policies promoting economic development in the Hegenberger Corridor. The potential for two intermediate stations would actively support redevelopment of the Corridor. This criterion is met.
- **Full BRT:** Does not conflict with policies promoting economic development in the Hegenberger Corridor. The potential for two intermediate stations would actively support redevelopment of the Corridor. Left-turn access to and from some properties would be removed, although right-turn access to Hegenberger would be preserved in all cases. This criterion is minimally met.
- **AGT:** Does not conflict with policies promoting economic development in the Hegenberger Corridor. The potential for one intermediate station would actively support redevelopment in part of the Corridor. This criterion is minimally met.

16. Avoid creating odd-shaped land areas with limited development potential.

- **AirBART:** No land acquisition is needed. This criterion is met.
- **Rapid Bus:** No additional right-of-way or land acquisition is needed. This criterion is met.
- **Full BRT:** No additional right-of-way or land acquisition is needed. This criterion is met.
- **AGT:** Several parcels of land are required for this option, with AGT generally running along parcel edges. In the one case where AGT splits a parcel, it would leave two developable parcels. Land acquisition is complete, no odd-shaped land areas were created; this criterion is met.

17. Support increased transit service for targeted redevelopment and revitalization areas to facilitate economic growth.

- **AirBART:** The lack of intermediate stations does not enhance redevelopment and revitalization of the Corridor. This criterion is not met.
- **Rapid Bus:** The potential for two intermediate stations would actively support redevelopment and revitalization of the Corridor. This criterion is met.
- **Full BRT:** The potential for two intermediate stations would actively support redevelopment and revitalization of the Corridor. This criterion is met.
- **AGT:** The potential for the optional Doolittle station would enhance redevelopment and revitalization in a portion of the Corridor. This criterion is minimally met.

18. Conform to the Airport Development Program

This criterion is interpreted here as "support the Airport Development Program," recognizing that the decision to provide a regional transportation connection may come from outside the Port of Oakland. The airport's master plan (***14***) states:

"The currently planned corridor for the BART Connector, the automated people-mover connection to the regional rail transit system, is shown on the figure with a blue dashed line. Following are BART Connector planning considerations:

- Constrained access corridor between outbound lanes of Airport Drive and the golf course;
- At-grade alignment preferred (where possible) to minimize the cost of the guideway;
- Airport station should serve existing and potential future terminal, and allow for potential new garage and other on-Airport facility development."

- **AirBART:** AirBART does not provide an automated people-mover connection, is at grade, has one central stop to serve all terminals and doesn't restrict future development potential. Two of the four elements are met.
- **Rapid Bus:** Rapid Bus does not provide an automated people-mover connection, is at grade, can serve multiple terminals through separate or shared stops, and doesn't restrict future development potential. Three of the four elements are met.
- **Full BRT:** Rapid Bus does not provide an automated people-mover connection, is at grade, can serve multiple terminals through separate or shared stops, and doesn't restrict future development potential. Three of the four elements are met.
- **AGT:** AGT provides an automated people-mover connection, is not at grade along Hegenberger, through the airport parking lot, or at the airport station, has one central stop to serve all terminals and doesn't restrict future development potential. Three of the four elements are met.

ADDITIONAL COMPARISON CRITERIA

A. Ridership on the Connector

The data for Table 16 has been extracted from Table 6 through Table 8 and the accompanying discussion.

Table 16 Summary of Daily Ridership

	AirBART $3 Fare	Rapid Bus $3 Fare	Full BRT $3 Fare	AGT $3 Fare	AGT $6 Fare
2010 base daily ridership	1,930	1,930	1,930	1,930	1,930
Estimated 2013 daily ridership	2,100	2,890	3,080	3,070	2,685
Estimated 2030 daily ridership (low forecast)	3,440	4,580	5,110	5,100	4,465
Estimated 2030 daily ridership (high forecast)	4,460	6,160	6,610	6,610	5,785

- **AirBART:** AirBART has the lowest ridership estimates of the Connector options.
- **Rapid Bus:** Rapid Bus ridership estimates are about 7% lower than the Full BRT ridership estimates in 2013 and 2030 due to slightly slower travel times, potential impacts of special events on travel time, and the lower level of branding and amenities, compared to Full BRT.

- **Full BRT:** Full BRT has operating characteristics similar to AGT and therefore has comparable ridership estimates when the fare is $3 for both alternatives.
- **AGT:** AGT has operating characteristics similar to Full BRT, and therefore has comparable ridership estimates assuming a $3 fare. Adjusting for the loss of ridership from a $6 fare, AGT would see 2013 ridership of 2,685, and 2030 ridership of 4,465 (low estimate) to 5,785 (high estimate). At this higher fare, AGT ridership is 12%-13% lower than Full BRT and approximately 7% lower than Rapid Bus.

B. Walk time: from BART to the Connector, from the OIA to the Connector

The travel time was included in the original comparison criteria. However, this does not capture the full trip time experienced by a traveler. To better capture the passenger experience, walk time between the Coliseum BART station and the connector, and from the connector to the terminal have been included as comparison criteria. Table 17, Transit Walk Time, has been extracted from Table 4, Transit Travel Time.

Table 17 Transit Walk Time

	AirBART	Rapid Bus	Full BRT	AGT
Walk time: Coliseum BART station	1.7	1.9	1.9	2.5
Walk time: Airport Terminal 1	*3.1*	*2.8*	*2.8*	*2.8*
Walk time: Airport Terminal 2	*1.7*	*2.0*	*2.0*	*5.3*
Average walk time at airport	2.4	2.4	2.4	4.1

- **AirBART:** AirBART has the shortest walk time at the Coliseum station. The AirBART, Rapid Bus and Full BRT options all have the same walk time at the terminal.
- **Rapid Bus:** Rapid Bus and Full BRT have the second lowest walk times at the Coliseum BART station, and the same walk time at the terminal as AirBART.
- **Full BRT:** Rapid Bus and Full BRT have the second lowest walk times at the Coliseum BART station, and the same walk time at the terminal as AirBART.
- **AGT:** AGT has the highest walk time at the Coliseum station and at the Terminal. Although the walk time to Terminal 1 is the same as the Rapid Bus options, the significantly higher walk time to Terminal 2 results in an overall higher walk time at the terminal.

C. Job creation – temporary, permanent.

Job creation is discussed in Section 4, Analysis of the Options. A detailed analysis of temporary jobs has been developed for the AGT, and is currently under revision to reflect a level of detail not supported for Rapid Bus and Full BRT in this report. As a result, a meaningful comparison of temporary employment created through this project is not available for this report. New permanent operations jobs are taken from Section 4, Job Creation.

- **AirBART:** 23 permanent operations jobs would be required.
- **Rapid Bus:** 46 permanent operations jobs would be required.

- **Full BRT:** 46 permanent operations jobs would be required.
- **AGT:** 27 permanent operations jobs would be required.

D. Construction time (how soon could service begin).

- **AirBART:** Service is available immediately.
- **Rapid Bus:** Construction time for the Rapid Bus and Full BRT alternatives is based on the estimated construction time for similarly sized BRT projects in Los Angeles, California, and Eugene, Oregon. For the approximate 2-mile segment along Hegenberger Rd and at the Coliseum and Airport stations, planning, design, and public outreach would take 6 months, and construction would require another 9 months with the first year of revenue service occurring as early as 2012.
- **Full BRT:** Construction time for the Rapid Bus and Full BRT alternatives is based on the estimated construction time for similarly sized BRT projects in Los Angeles, California, and Eugene, Oregon. For the approximate 2-mile segment along Hegenberger Rd and at the Coliseum and Airport stations, planning, design, and public outreach would take 6 months, and construction would require another 12-15 months with the first year of revenue service occurring as early as 2013.
- **AGT:** Construction of the AGT would take 3 to 4 years, with the first year of revenue service occurring as early as 2014. Note that in this analysis operational data is provided for AGT for 2013, recognizing that it is representing "start-up year" data, which would be 2014.

E. Improving access to transit for the local community

Two intermediate stops that support access to transit for the local community, which includes significant populations of minority and low income residents, are included as optional stops: Hegenberger at Edgewater and Hegenberger at Pardee.

- **AirBART:** AirBART travels non-stop between the airport and BART in mixed traffic and does not make intermediate stops. The criterion is not met.
- **Rapid Bus:** Service to intermediate stops is possible. In addition, service could be readily extended to the east to provide an improved connection between East Oakland and BART. Transit signal priority improvements could be made available to local transit service providers, providing more reliability service and additional benefit to the local community. The criterion is met.
- **Full BRT:** Service to intermediate stops is possible. Service could be extended to the east to provide an improved connection between East Oakland and BART. The flyover bridge would be available to local transit service providers, providing a higher level of reliability during events, and improving the quality of service for the local community. The criterion is met.
- **AGT:** Intermediate stops would require significant reconstruction of the AGT guideway. Extending service farther east would require reconstructing the Coliseum AGT station. The criterion is not met.

F. Fare levels required to cover operating expenses

This analysis is discussed in detail in Section 4, Fare Revenue and Operating Subsidy per Ride. Operating subsidy per ride is the level of funding needed over and above the fare to cover operating expenses. This can be achieved through higher fares, or with other operating revenues. Using a $3 fare for all options, the subsidy per ride is calculated to be $0.81 for AirBART, $2.33 for Rapid Bus, $1.95 for Full BRT, and $10.76 for AGT. When a fare of $6 is used for AGT, the higher fare revenue and lower ridership result in a subsidy per ride of $9.85.

COMPARISON SUMMARY

Table 18 summarizes the results of the comparison for the original FEIR/FEIS criteria, while Table 19 summarizes the results for the additional comparison criteria.

Table 18 Comparison Criteria Matrix

Original Criteria	AirBART	Rapid Bus	Full BRT	AGT
1. Provide reliable scheduled service between BART and OIA. (minutes)	Buffer: 15 Events: 3	Buffer: 8 Events: 3	Buffer: 4 Events: 0	Buffer: 0 Events: 0
2. Provide on-time performance equal to BART.	Does not meet	Does not meet	Meets	Meets or exceeds
3. Accommodate a minimum of 700 passengers per hour per direction.	250 passengers Does not meet	900 passengers Meets	900 passengers Meets	1,950 passengers Meets
4. Ensure that transit vehicles arrive at least every six minutes.	10 minutes Does not meet	4 minutes Meets	4-minutes Meets	4.6-minutes Meets
5. Ensure that the maximum wait time is no greater than six minutes.	Does not meet	Meets	Meets	Meets
6. Complete trips between OIA and the Coliseum BART Station at least as quickly as motorists during off-peak weekday traffic. (minutes)	2013: 13.0 2030: 14.6 Meets/Meets	2013: 10.6 2030: 12.2 Meets/Meets	2013: 9.6 2030: 10.1 Meets/Meets	2013: 8.2 2030: 8.2 Meets/Meets
7. Allow capacity adjustments throughout the day.	Meets	Meets	Meets	Meets
8. Provide flexibility to expand and upgrade the system to accommodate increased ridership.	Does not meet	Meets	Meets	Meets
9. Provide flexibility to serve intermediate stops.	Does not meet	Meets	Meets	Minimally meets
10. Minimize significant negative environmental effects.	No change from FEIR/FEIS	Improved over FEIR/FEIS	Improved over FEIR/FEIS	No change from FEIR/FEIS
11. Be constructed and operated within reasonable costs. (Cost per incremental ride [1])	Not Applicable	$3 fare: $6.83 Meets	$3 fare: $15.86 Meets	$3 fare: $68.17 $6 fare: $102.74 Does not meet
12. Avoid substantial impacts to sensitive residential, public, and commercial land uses.	No Change from FEIR/FEIS	Hybrid vehicles Improved over FEIR/FEIS	Hybrid vehicles Improved over FEIR/FEIS	No Change from FEIR/FEIS
13. Minimize the amount of private property needed for rights of way.	No acquisition required	No acquisition required	No acquisition required	Acquisition Does not meet
14. Minimize the extent of displacement (e.g., businesses or parking).	No displacement	Minimal parking displacement	Minimal parking displacement	Displacement required
15. Avoid constraining known development plans.	Minimally meets	Meets	Minimally meets	Minimally meets
16. Avoid creating odd-shaped land areas with limited development potential.	No acquisition required Meets	No acquisition required Meets	No acquisition required Meets	None created Meets
17. Support increased transit service for targeted redevelopment and revitalization areas to facilitate economic growth.	Does not meet	Meets	Meets	Minimally meets
18. Conform to/support the Airport Development Program.	Meets 2 of 4 elements	Meets 3 of 4 elements	Meets 3 of 4 elements	Meets 3 of 4 elements

[1] *AGT incremental costs assume that capital cost details for the current project ($459 million) are proportionate to the costs provided in the 2002 FEIR/FEIS (capital costs of $204 million). The cost per incremental ride calculated with the 2002 FEIR/FEIS data is $37.97 with a $3 fare and $53.74 with a $6 fare for AGT.*

Table 19 Additional Comparison Criteria

Additional Criteria	AirBART	Rapid Bus	Full BRT	AGT
A. Ridership on Connector (average daily rides) $3 Fare: $6 AGT fare:	2013: 2,100 2030: 3,440 – 4,460	2013: 2,890 2030: 4,580 – 6,160	2013: 3,080 2030: 5,110 – 6,610	2013: 3,070 2030: 5,100 – 6,610 2013: 2,685 2030: 4,465-5,785
B. Total walk time: From BART to the Connector, from the OIA to the Connector (minutes)	4.1 min	4.3 min	4.3 min	6.6 min
C. Job creation: permanent jobs required	23 jobs	46 jobs	46 jobs	27 jobs
D. Construction time: how soon could service begin	2010	2012	2013	2014
E. Improving access to transit for local community	No local stops Does not meet	Local stops are feasible Meets	Local stops are feasible Meets	One local stop is feasible Does not meet
F. Operating subsidy per ride	$3 fare: $1.29	$3 fare: $2.33	$3 fare: $1.95	$3 fare: $10.76 $6 fare: $9.85

Section 6
Conclusions

Conclusions

COMPARISON OF FOUR ALTERNATIVES

- **AirBART:** AirBART provides a low operating cost connection from the Coliseum BART station to the Oakland Airport. However, it does not meet comparison criteria requirements related to frequency, reliability, capacity, supporting the OIA Master Plan, and flexibility to serve intermediate stops, providing access to the local community which includes significant populations of minority and low-income residents. This indicates that AirBART is not a viable long term solution, and supports the need for an alternative mode of operation.
- **Rapid Bus:** This option provides a significant improvement over the existing AirBART service, with more frequent, faster service that could be implemented by 2012. Overall travel times are equal to AGT in 2013, as this option provides shorter transfer and walk times, despite having a longer in-vehicle trip between BART and the airport. In 2030, Rapid Bus loses its advantage and is 1.6 minutes slower than AGT. It is slower than Full BRT in 2013 and in 2030. Of the three new alternatives, Rapid Bus is the most cost-effective option at $6.83 per new ride, based on the Federal Transit Administration's (FTA) New Starts cost-effectiveness criterion. Because it uses a curb-side dedicate lane, Rapid Bus is the most flexible in adding stops to support local economic development plans and serve the local community. However, Rapid Bus does not meet the reliability criterion, has a slightly higher operating subsidy per ride than Full BRT ($2.33 for Rapid Bus compared to $1.95 for Full BRT), and attracts fewer rides than either Full BRT or AGT at a $3 fare. Rapid Bus has higher estimated ridership than AGT, however, with a $6 fare for AGT.
- **Full BRT:** Full BRT provides significant improvements over Rapid Bus, with more reliable service, requiring only a 4-minute buffer for reliability under normal operating conditions. Like AGT, Full BRT it is not affected by events at the Coliseum due to the construction of a flyover bridge on Hegenberger at South Coliseum Way. Full BRT has lower walk times than AGT at both the Coliseum BART station and the Oakland Airport terminal which results in an overall faster total trip time compared to AGT. Due to these operational improvements and the shorter walk time from the station to the Oakland Airport terminal, Full BRT has ridership comparable to AGT in 2013 and 2030, using a $3 fare. Using the current planning assumption of a $6 fare for AGT, Full BRT has approximately 13% higher ridership than the AGT option. Assuming a $3 fare, the Full BRT cost-effectiveness measure of $15.86 per new ride is significantly lower than for the AGT (see discussion below). Through the flexibility to have two local stops, this option provides more support to economic development plans and local communities. Full BRT also has the lowest operating cost per ride, and therefore the lowest subsidy per ride required, at $1.95. Overall, this option at least minimally meets all comparison criteria.
- **AGT:** Due to the separated guideway, AGT is the strongest of all options in terms of reliability. As a result of the level of construction required, AGT would be operational in 2014, compared to 2012 for Rapid Bus and 2013 for Full BRT. Ridership is comparable to

Full BRT with a $3 fare, and approximately 13% lower than Full BRT when using a fare of $6 for AGT. The operating cost per ride is the highest of all options, which leads to a subsidy per ride of $10.76 at a $3 fare and $9.85 with a $6 fare. Using 2002 FEIR/FEIS capital cost of $204 million, the cost-efficiency rating for AFT is $37.97 cost per incremental ride with a $3 fare and $53.74 with a $6 fare. Estimating the annual capital costs for the current $459 million project increases the cost-effectiveness measure to $68.17 per incremental ride if the fare is $3, and $102.74 per incremental ride if the fare is $6. The station at the airport will displace airport parking, while all other options have very minimal impact on parking or potential future development at the airport. AGT has the least amount of flexibility in additional stations. One optional station is possible at Doolittle, in conjunction with the maintenance facility, but no additional stations are feasible without a significant redesign of the system. As a result, the AGT minimally meets the evaluation criteria for flexibility to serve intermediate stops and improve access for the local community, and support economic development plans.

CONCLUSION

The overall best option, based on the comparison criteria, is Full BRT. It has a higher level of ridership than AGT when assuming the planned fares of $3 for Full BRT and $6 for AGT, a lower subsidy per ride and significantly lower cost per incremental ride. Total travel time is faster than AGT, including walk and in-vehicle time. While travelers would need to consider budgeting an extra 4 minutes for their trip in case of longer-than-normal travel times due to lower reliability on Full BRT, this time is likely inconsequential in comparison to total transit travel time and buffer time required for airport security and other flight considerations. Like AGT, the Full BRT option would not be affected by events at the Coliseum. The Full BRT option is more flexible than AGT in its ability to serve intermediate stations that can support economic development and provide improved service to the local community which includes a large population of low-income and minority riders.

It is possible to have a phased implementation of Full BRT so that transit signal priority and fare payment improvements occur relatively quickly, allowing some of the benefits to occur during construction of the Full BRT system.

Section 7
References

References

1. Wilbur Smith Associates. *BART to Oakland Airport Connector Ridership Update.* Final Report. October 17, 2005.

2. Wilbur Smith Associates. *BART–Oakland Airport Connector Patronage Refinement.* Final Report. April 24, 2007.

3. Wilbur Smith Associates. *BART–Oakland Airport Connector Ridership Update.* Final Report. May 5, 2009.

4. BART Board of Directors Agenda Packet. July 22, 2010.

5. BART Board of Directors Meeting, Discussion between Commissioner and Controller. http://www.archive.org/download/BartBoardMeeting121009/20091210_BART.mp3. Audio recording, time stamp 2:48.13 to 2:49.28, December 10, 2009.

6. BART Board of Directors Meeting, supplemental spreadsheet "OAC Cash Flow Cheat Sheet 071910 – for Scott.xlsx", July 2010.

7. BART Board of Directors Agenda Packet. December 10, 2009.

8. Center for Urban Transportation Research. *Characteristics of Bus Rapid Transit for Decision-Making.* Federal Transit Administration, Washington, D.C., 2004.

9. Center for Urban Transportation Research. *Characteristics of Bus Rapid Transit for Decision-Making.* Federal Transit Administration, Washington, D.C., February 2009.

10. Kittelson & Associates, Inc., Herbert S. Levinson Transportation Consultants, and DMJM+Harris. *TCRP Report 118: Bus Rapid Transit Practitioner's Guide.* Transportation Research Board of the National Academies, Washington, D.C., 2007.

11. Federal Transit Administration and BART. *BART–Oakland International Airport Connector Final Environmental Impact Report/Final Environmental Impact Statement.* March 2002.

12. City of Oakland and BART. *Coliseum/Oakland Airport BART Station Area Concept Plan.* Plan Summary. September 2003. http://www.oaklandnet.com/government/ceda/revised/planningzoning/commission/ZS03-040-A.pdf

13. Parsons/Flatiron/Doppelmayr. *Oakland International Airport Connector Project.* Executive Summary Parcel. 2009.

14. Port of Oakland. *Oakland International Airport Master Plan.* March 2006.

15. John E. Evans IV, et al. *TCRP Report 95: Traveler Response to Transportation System Changes.* Chapter 9, Transit Scheduling and Frequency. Transportation Research Board of the National Academies, Washington, D.C., 2004.

16. Brian E. McCollom and Richard H. Pratt, et al. *TCRP Report 95: Traveler Response to Transportation System Changes.* Chapter 12, Transit Pricing and Fares. Transportation Research Board of the National Academies, Washington, D.C., 2004.

17. Executive Office of the President, Council of Economic Advisors. *Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009.* May 2009.

18. Parsons/Flatiron/Doppelmayr. *Oakland International Airport Connector Project.* Operations and Maintenance Parcel. 2009.

19. BART Engineering and Operations Committee. *Quarterly Service Performance Review: Third Quarter, FY 2010, January–March, 2010.* May 13, 2010.

Appendix A

Traffic Count Data

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
610 SW Alder Street, Suite 700, Portland, OR 97205 P 503.228.5230 F 503.273.8169

MEMORANDUM

Date: August 3, 2010 Project #: 11072

To: Kathryn Coffel
Kittelson & Associates, Inc.

From: Eric Hathaway and Scott Beaird
Project: Oakland Airport Connector
Subject: Traffic Analysis Assumptions

This memorandum outlines the traffic operational analysis conducted to support an evaluation of potential alternatives to the Automated Guideway Transit (AGT) system for the proposed Oakland Airport Connector. This operational analysis evaluated existing and future 2030 traffic conditions along Hegenberger Road and Airport Road under three scenarios: 1) No Action 2) RapidBART, and 3) Full BRT.

DATA COLLECTION AND EXISTING CONDITIONS

All analyses were performed using Synchro Version 7 Software. Existing signal timing information was received from the City of Oakland to code existing conditions. Attachment A contains the existing weekday p.m. peak period turning movement counts and a summary of existing intersection geometry collected on June 11, 2010. Table 1 outlines the study intersections included in this evaluation. As shown in Table 1, under existing 2010 No Action conditions, all study intersections currently operate below capacity.

FUTURE NO ACTION TRAFFIC CONDITIONS

Future traffic volume projections were developed by using forecasted growth in passenger volume at the airport as a proxy for traffic growth along the Hegenberger Road corridor. The final report for the *BART-Oakland Airport Connector Ridership Update*[1] identifies a baseline average annual growth rate of 3.1% between 2009 and 2030. KAI assumed an annual growth rate of 3.1% for through movements along the Hegenberger Road corridor. Based on an assumption that the land uses along the corridor will not change significantly in the next 20 years, a nominal annual growth rate of 1.0% was applied to all turning movements along the corridor.

As shown in Table 1, with the exception of the Hegenberger Road/Edgewater Drive intersection, all study intersections are forecast to continue to operate below capacity under 2030 No Action conditions. The Hegenberger Road/Edgewater Drive intersection is forecast to operate at or slightly over capacity under 2030 No Action conditions.

[1] Wilbur Smith Associates. *BART-Oakland Airport Connector Ridership Update.* Pg. 2-13. May 5, 2009.

Table 1 Intersection Operational Analysis Results – Weekday PM Peak Hour

	2010 No Action		2010 RapidBART		2010 Full BRT	
	LOS	V/C	LOS	V/C	LOS	V/C
Hegenberger Road/South Coliseum Way	C	0.63	C	0.66	C	0.42
Hegenberger Road/I-880 SB Off-Ramp	B	0.57	B	0.57	B	0.64
Hegenberger Road/Edgewater Drive	C	0.78	C	0.71	D	0.78
Hegenberger Road/Airport Drive	C	0.61	C	0.64	C	0.64
Airport Drive/98th Avenue	C	0.62	C	0.62	C	0.62
Airport Drive/Doolittle Drive	C	0.53	C	0.53	C	0.53
	2030 No Action		**2030 RapidBART**		**2030 Full BRT**	
	LOS	V/C	LOS	V/C	LOS	V/C
Hegenberger Road/South Coliseum Way	E	0.88	F	0.97	C	0.51
Hegenberger Road/I-880 SB Off-Ramp	B	0.82	B	0.82	C	0.93
Hegenberger Road/Edgewater Drive	D	1.01	D	0.95	E	1.00
Hegenberger Road/Airport Drive	C	0.74	D	0.87	D	0.87
Airport Drive/98th Avenue	D	0.78	C	0.78	D	0.78
Airport Drive/Doolittle Drive	C	0.62	C	0.62	C	0.62

OAKLAND AIRPORT CONNECTOR ALTERNATIVES

The RapidBART and Full BRT alternatives are described in detail in the body of the report of which this memorandum is a supporting appendix. Table 2 describes the changes made to the No Action Synchro model to reflect changes to the number of general purpose traffic lanes associated with each of the two alternatives.

Table 2 Lane Adjustments for RapidBART and Full BRT Alternatives

Intersection	RapidBART	Full BRT
Hegenberger Road/South Coliseum Way	Converted NB Through/Right-turn to Right-turn/Bus only	Removed NB/SB through volumes, assumes all through vehicles use grade separation
Hegenberger Road/I-880 SB Off-Ramp	No Changes	Removed one NB through lane Removed one SB through lane
Hegenberger Road/Edgewater Drive	Converted NB Through/Right-turn to Right-turn/Bus only Converted SB Through/Right-turn to Right-turn/Bus only	Removed one NB through lane Removed one SB through lane
Hegenberger Road/Airport Drive	Removed one SB through lane	Removed one SB through lane
Airport Drive/98th Avenue	No Changes	No Changes
Airport Drive/Doolittle Drive	No Changes	No Changes

The lane adjustments described in Table 2 were applied to the 2010 and 2030 No Action models to develop the RapidBART and Full BRT Synchro models. The operational results for each of the alternatives under year 2010 and 2030 traffic conditions are summarized in Table 1.

The operational standard for the corridor are any of the following, based on the 2002 FEIR/FEIS:

1. Dropping level of service (LOS) from D to E as a result of a project alternative
2. Dropping LOS from E to F as a result of a project alternative
3. A project alternative adding 6 or more seconds of average delay to an intersection operating at LOS E
4. A project alternative adding 4 or more seconds of average delay to an intersection operating at LOS F

Based on these standards, potential mitigations were investigated for the Hegenberger Road/South Coliseum Way intersection under the 2030 RapidBART scenario and at the Hegenberger Road/Edgewater Drive intersection under the 2030 Full BRT scenario. With restriping of the southbound Hegenberger Road though/right-turn lane to a through-only lane, the Hegenberger Road/South Coliseum Way intersection is forecast to operate at LOS E instead of LOS F. With modification of the median on the west leg of the Hegenberger Road/Edgewater Drive intersection to accommodate a four-lane eastbound approach (left, left, through/left, right), LOS D can be achieved for the intersection. Attachment B contains the Synchro worksheets for the 2010 and 2030 No Action scenarios, 2010 and 2030 unmitigated alternatives, and 2030 mitigated alternatives conditions.

CONCLUSION

This analysis found that with the relatively minor mitigations described above, either the RapidBART or the Full BRT alternatives could be implemented while maintaining the operational standards identified in the 2002 FEIR/FEIS.

Attachment A

Existing Weekday P.M. Peak Period
Turning Movement Counts

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

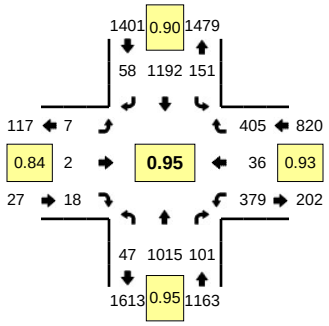
LOCATION: Hegenberger Rd -- South Coliseum Way

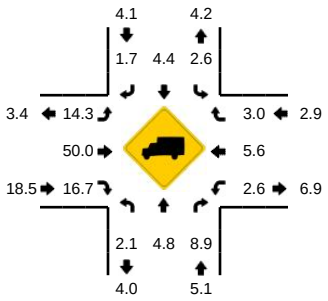
CITY/STATE: Oakland, CA

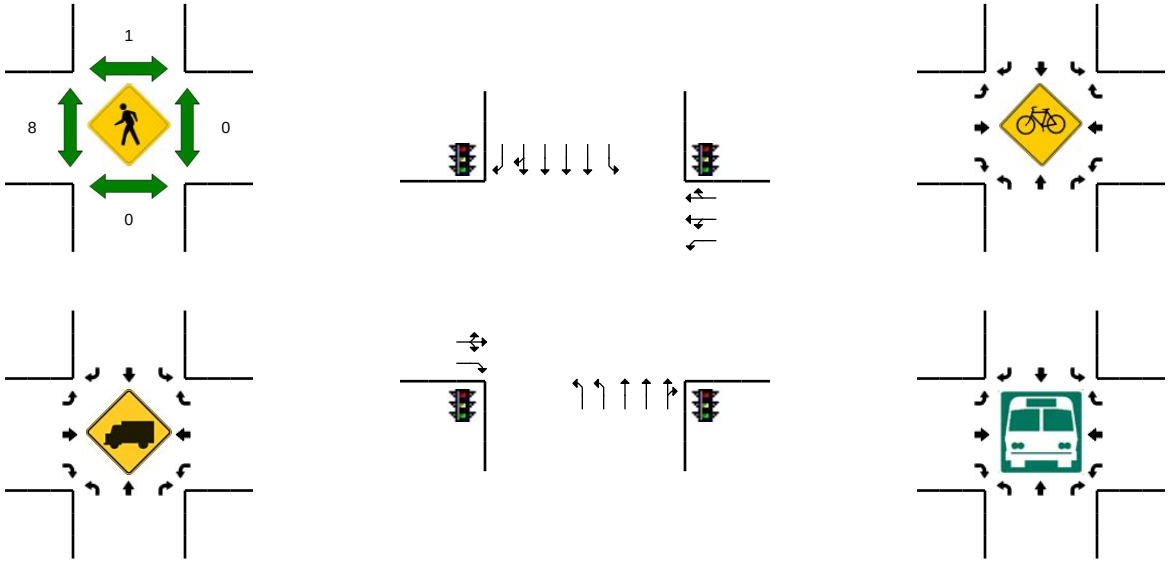
QC JOB #: 10513206

DATE: 6/11/2010

Peak-Hour: 4:15 PM -- 5:15 PM
Peak 15-Min: 5:00 PM -- 5:15 PM







15-Min Count Period Beginning At	Hegenberger Rd (Northbound)				Hegenberger Rd (Southbound)				South Coliseum Way (Eastbound)				South Coliseum Way (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	7	231	27	5	34	307	16	12	1	2	1	0	76	7	78	0	804	
4:15 PM	2	264	28	8	26	282	8	12	2	1	4	0	100	9	99	0	845	
4:30 PM	7	245	28	5	29	326	17	16	2	0	3	0	82	6	97	0	863	
4:45 PM	7	233	23	6	22	255	22	14	1	1	5	0	105	12	97	0	803	3315
5:00 PM	7	273	22	5	22	329	11	10	2	0	6	0	92	9	112	0	900	3411
5:15 PM	7	207	16	6	19	279	9	21	2	2	3	0	105	6	113	0	795	3361
5:30 PM	11	199	19	6	26	261	7	18	1	0	2	0	67	7	95	0	719	3217
5:45 PM	4	192	16	4	26	273	19	13	1	0	5	0	72	7	103	0	735	3149

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	28	1092	88	20	88	1316	44	40	8	0	24	0	368	36	448	0	3600
Heavy Trucks	0	48	12		4	72	4		0	0	0		8	4	12		164
Pedestrians		0				0				8				0			8
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

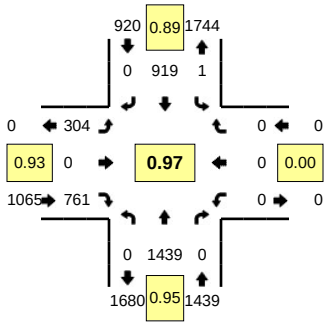
LOCATION: Hegenberger Rd -- I-880 SB Off Ramp

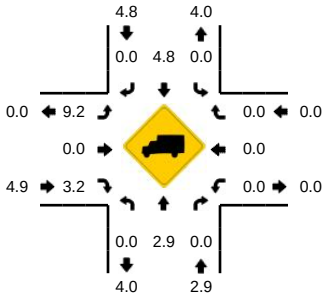
QC JOB #: 10513205

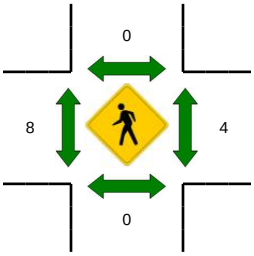
CITY/STATE: Oakland, CA

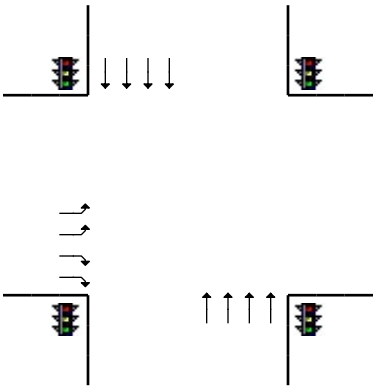
DATE: 6/11/2010

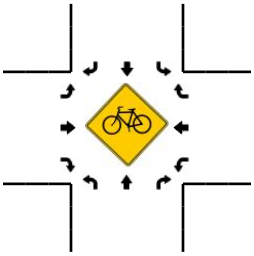
Peak-Hour: 4:15 PM -- 5:15 PM
Peak 15-Min: 4:30 PM -- 4:45 PM

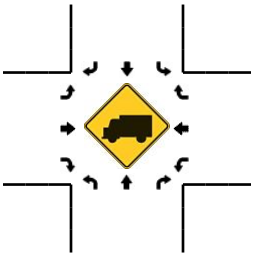


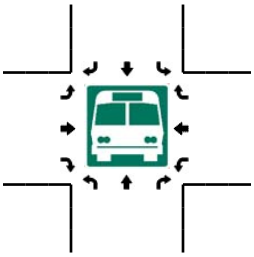












15-Min Count Period Beginning At	Hegenberger Rd (Northbound)				Hegenberger Rd (Southbound)				I-880 SB Off Ramp (Eastbound)				I-880 SB Off Ramp (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	341	0	0	0	217	0	0	79	0	170	0	0	0	0	0	807	
4:15 PM	0	376	0	0	0	213	0	0	74	0	179	0	0	0	0	0	842	
4:30 PM	0	351	0	0	0	242	0	0	80	0	205	0	0	0	0	0	878	
4:45 PM	0	332	0	0	0	245	0	0	76	0	193	0	0	0	0	0	846	3373
5:00 PM	0	380	0	0	0	219	0	1	74	0	184	0	0	0	0	0	858	3424
5:15 PM	0	300	0	0	0	276	0	0	68	0	150	0	0	0	0	0	794	3376
5:30 PM	0	299	0	0	0	199	0	0	48	0	187	0	0	0	0	0	733	3231
5:45 PM	0	282	0	0	0	194	0	0	57	0	219	0	0	0	0	0	752	3137

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	0	1404	0	0	0	968	0	0	320	0	820	0	0	0	0	0	3512
Heavy Trucks	0	60	0		0	36	0		20	0	28		0	0	0		144
Pedestrians		0				0				8				12			20
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of peak hour being reported: Intersection Peak

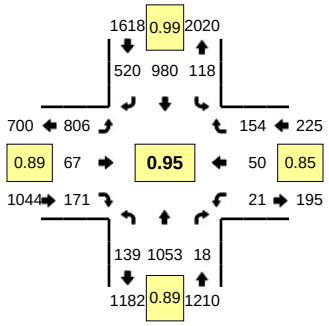
Method for determining peak hour: Total Entering Volume

LOCATION: Hegenberger Rd -- Edgewater Dr

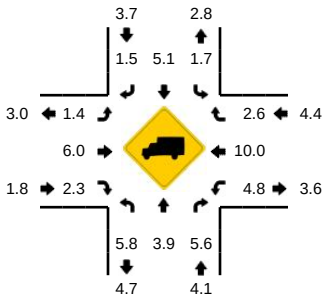
CITY/STATE: Oakland, CA

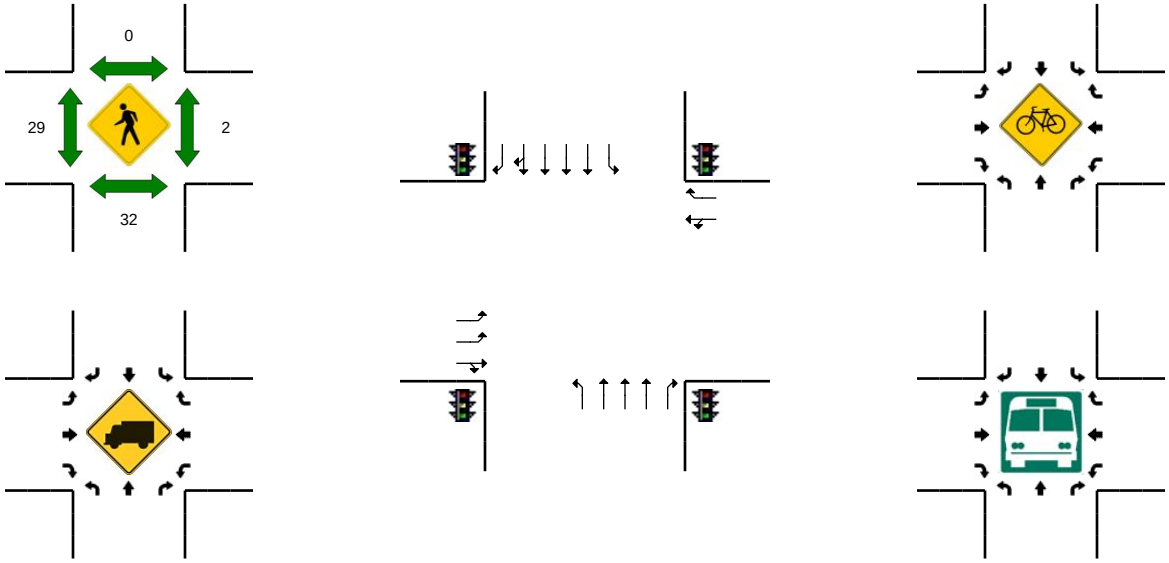
QC JOB #: 10513204

DATE: 6/11/2010



Peak-Hour: 4:15 PM -- 5:15 PM
Peak 15-Min: 5:00 PM -- 5:15 PM





15-Min Count Period Beginning At	Hegenberger Rd (Northbound)				Hegenberger Rd (Southbound)				Edgewater Dr (Eastbound)				Edgewater Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	36	251	6	4	38	198	140	1	201	22	34	0	2	13	49	0	995	
4:15 PM	27	242	4	4	31	221	141	1	228	26	39	0	3	10	35	0	1012	
4:30 PM	28	257	9	0	25	270	114	3	188	15	45	1	4	16	41	0	1016	
4:45 PM	30	265	3	2	29	240	143	1	170	10	44	0	5	15	30	0	987	4010
5:00 PM	44	289	2	4	25	249	122	3	219	16	43	0	9	9	48	0	1082	4097
5:15 PM	35	220	3	3	31	238	137	2	182	19	43	0	0	9	27	0	949	4034
5:30 PM	23	199	3	1	28	238	118	0	184	14	37	1	1	11	31	0	889	3907
5:45 PM	38	185	5	4	31	228	136	1	173	17	40	0	4	10	35	0	907	3827

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	176	1156	8	16	100	996	488	12	876	64	172	0	36	36	192	0	4328
Heavy Trucks	4	40	0		4	60	0		0	4	0		0	4	4		120
Pedestrians		12				0				32				0			44
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Hegenberger Rd -- Airport Dr

CITY/STATE: Oakland, CA

QC JOB #: 10513203

DATE: 6/11/2010

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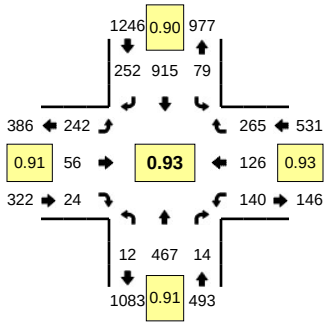
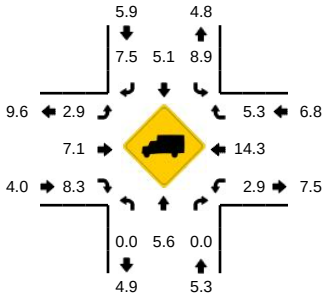
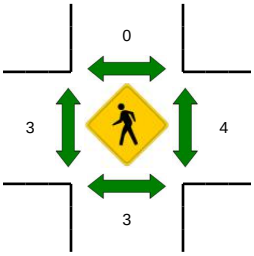
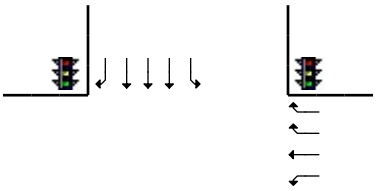
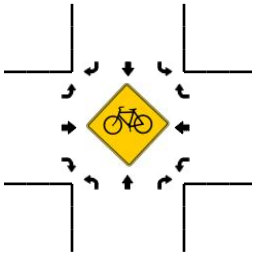
Peak 15-Min: 5:00 PM -- 5:15 PM

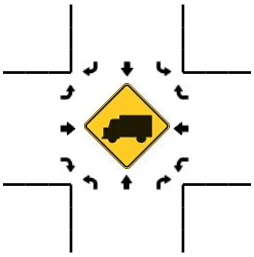


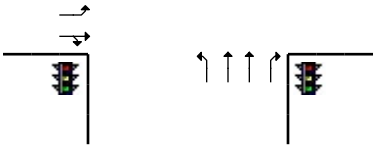


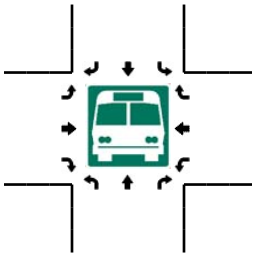












15-Min Count Period Beginning At	Hegenberger Rd (Northbound)				Hegenberger Rd (Southbound)				Airport Dr (Eastbound)				Airport Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	4	115	5	0	15	183	56	2	64	17	1	0	28	22	69	0	581	
4:15 PM	5	112	10	1	20	204	39	0	58	17	4	0	27	24	58	0	579	
4:30 PM	2	133	6	0	11	216	74	0	69	10	8	0	39	28	70	0	666	
4:45 PM	4	116	1	0	19	229	58	2	53	15	6	0	31	36	76	0	646	2472
5:00 PM	2	118	4	2	25	260	63	0	66	20	5	0	35	24	72	0	696	2587
5:15 PM	0	100	3	2	21	210	57	1	54	11	5	0	35	38	47	0	584	2592
5:30 PM	1	99	4	3	19	195	54	1	45	17	5	0	36	46	45	0	570	2496
5:45 PM	1	106	2	0	11	199	77	0	54	11	5	0	20	51	40	0	577	2427

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	8	472	16	8	100	1040	252	0	264	80	20	0	140	96	288	0	2784
Heavy Trucks	0	24	0		16	52	32		16	4	4		8	16	12		184
Pedestrians		0				0				4				8			12
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of peak hour being reported: Intersection Peak

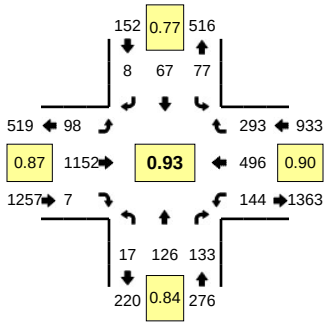
Method for determining peak hour: Total Entering Volume

LOCATION: Airport Dr -- 98th Ave

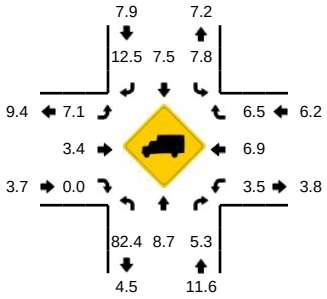
CITY/STATE: Oakland, CA

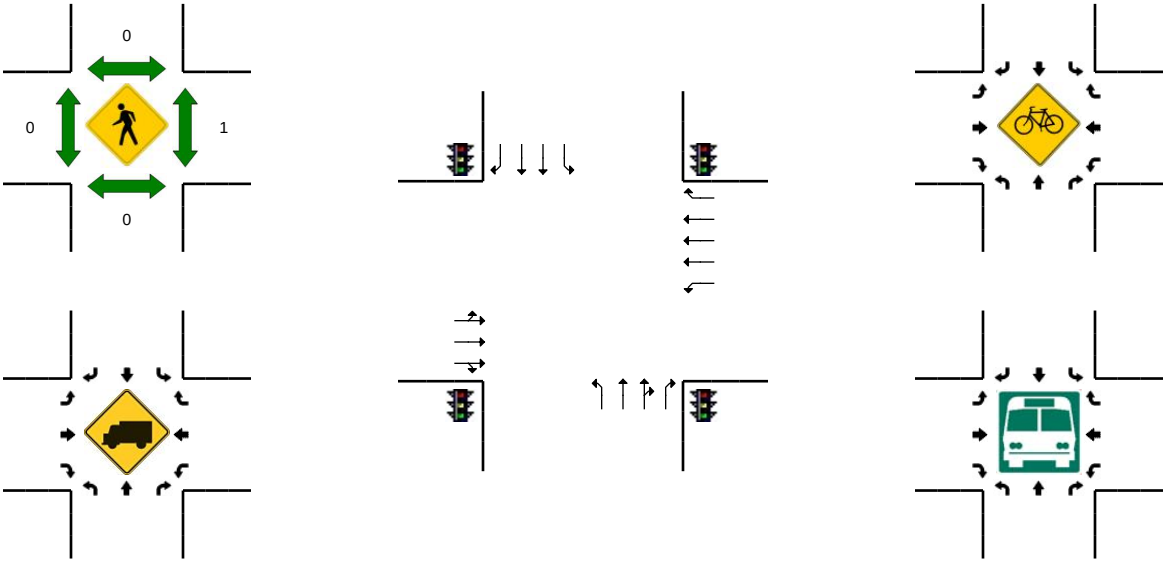
QC JOB #: 10513202

DATE: 6/11/2010



Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 4:45 PM -- 5:00 PM





15-Min Count Period Beginning At	Airport Dr (Northbound)				Airport Dr (Southbound)				98th Ave (Eastbound)				98th Ave (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	3	29	33	0	20	14	5	1	17	321	0	0	44	108	61	0	656	
4:15 PM	4	30	31	0	24	20	2	0	17	218	1	0	35	105	53	0	540	
4:30 PM	2	40	45	1	17	16	2	0	27	265	2	0	35	153	72	0	677	
4:45 PM	4	31	34	1	10	17	1	0	27	330	2	0	43	123	78	1	702	2575
5:00 PM	3	37	32	0	26	23	3	0	24	333	2	1	30	109	73	0	696	2615
5:15 PM	5	18	22	1	24	11	2	0	19	224	1	0	35	111	70	0	543	2618
5:30 PM	5	20	23	0	25	16	2	0	22	210	2	1	29	130	75	0	560	2501
5:45 PM	2	23	25	0	11	13	1	0	19	237	4	0	21	115	66	1	538	2337

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	16	124	136	4	40	68	4	0	108	1320	8	0	172	492	312	4	2808
Heavy Trucks	16	12	12		0	4	0		8	28	0		8	28	16		132
Pedestrians		0				0				0				0			0
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Type of peak hour being reported: Intersection Peak

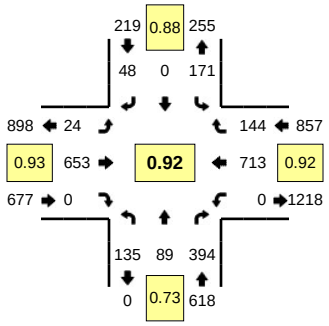
Method for determining peak hour: Total Entering Volume

LOCATION: Airport Dr -- Doolittle Dr

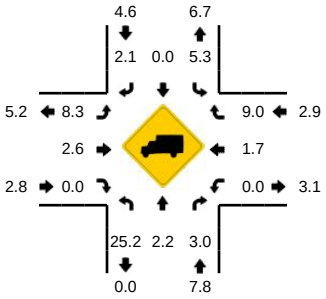
CITY/STATE: Oakland, CA

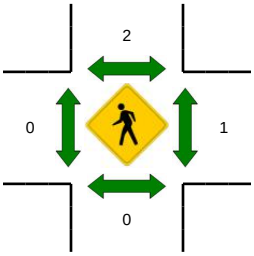
QC JOB #: 10513201

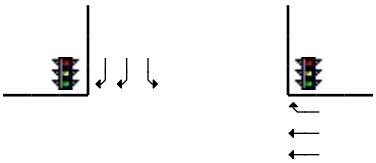
DATE: 6/11/2010

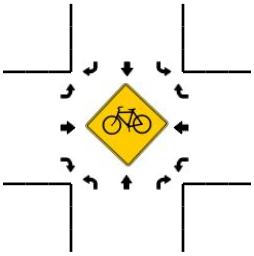


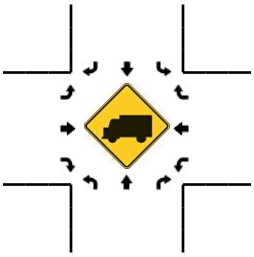
Peak-Hour: 4:30 PM -- 5:30 PM
Peak 15-Min: 5:00 PM -- 5:15 PM

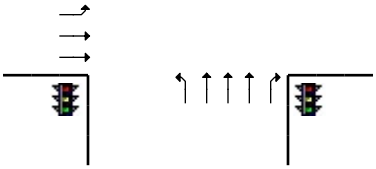


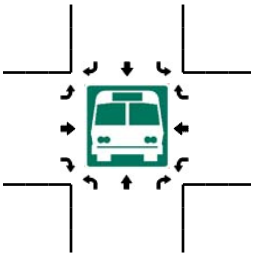












15-Min Count Period Beginning At	Airport Dr (Northbound)				Airport Dr (Southbound)				Doolittle Dr (Eastbound)				Doolittle Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	36	23	89	0	55	0	9	0	8	137	0	0	0	145	35	0	537	
4:15 PM	29	21	63	0	38	0	15	0	6	162	0	0	0	190	28	0	552	
4:30 PM	34	20	78	0	40	0	13	0	3	150	0	0	0	172	45	0	555	
4:45 PM	35	24	86	0	39	0	16	0	6	156	0	2	0	198	39	0	601	2245
5:00 PM	38	33	142	0	51	0	9	0	5	164	0	0	0	167	36	0	645	2353
5:15 PM	28	12	88	0	41	0	10	0	8	183	0	0	0	176	24	0	570	2371
5:30 PM	24	7	92	0	35	0	9	0	7	179	0	0	0	162	30	0	545	2361
5:45 PM	39	20	67	0	19	0	6	2	6	144	0	1	0	145	20	0	469	2229

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	152	132	568	0	204	0	36	0	20	656	0	0	0	668	144	0	2580
Heavy Trucks	40	4	16		4	0	0		4	12	0		0	4	12		96
Pedestrians		0				0				0				0			0
Bicycles																	
Railroad																	
Stopped Buses																	

Comments:

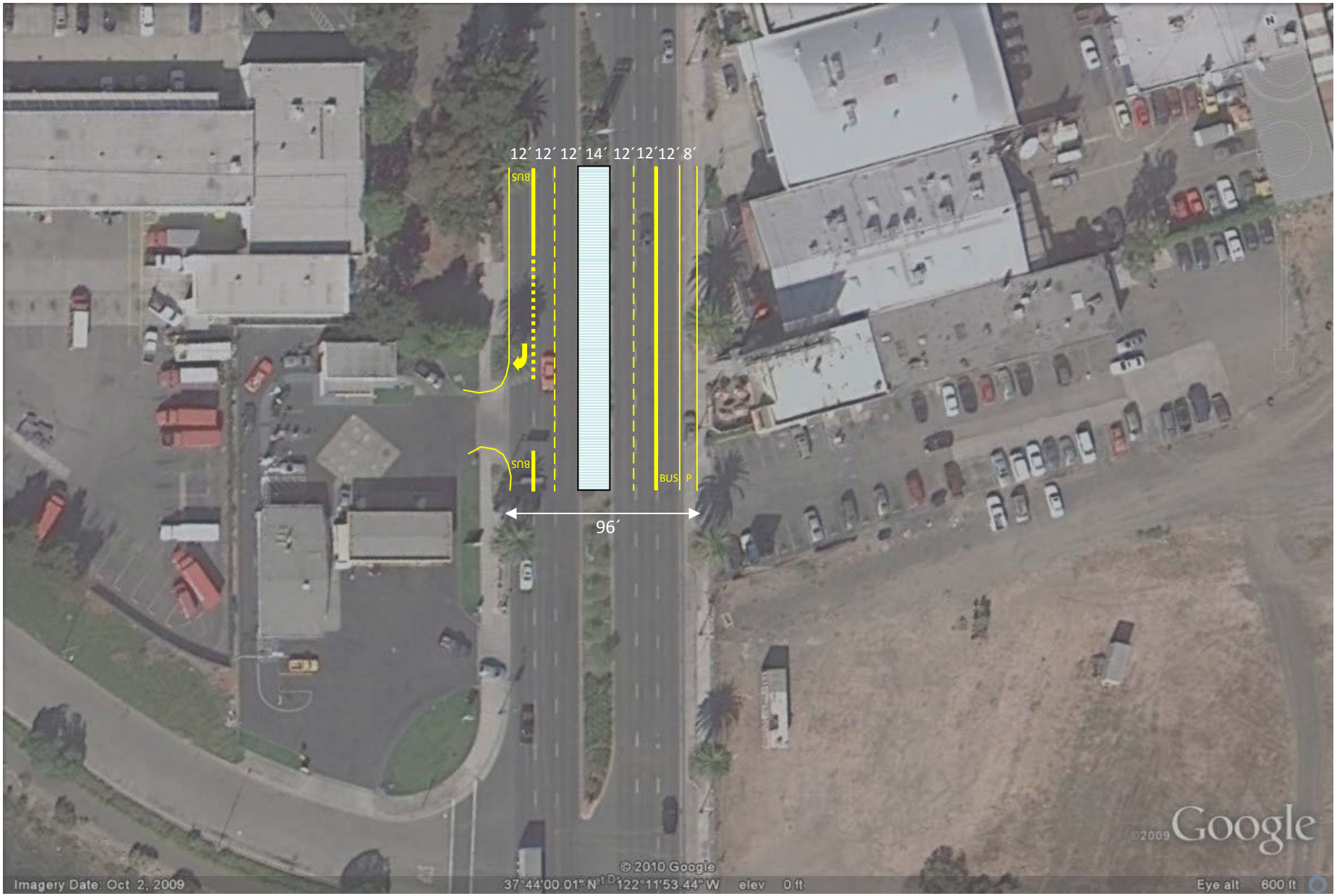
Report generated on 6/30/2010 10:25 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net)

Appendix B

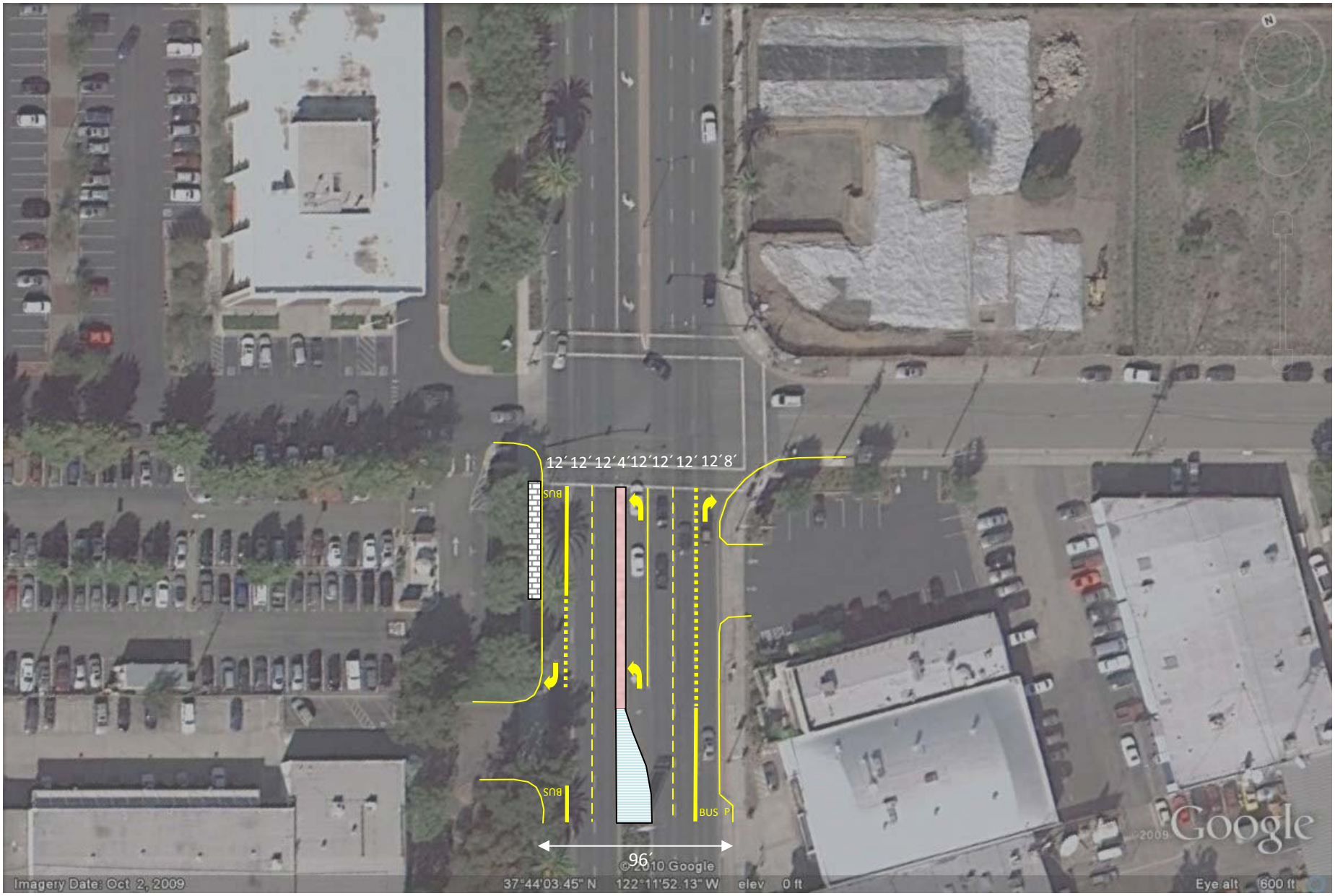
Conceptual Street Cross-Sections

Hegenberger mid-block west of I-880: Rapid Bus option

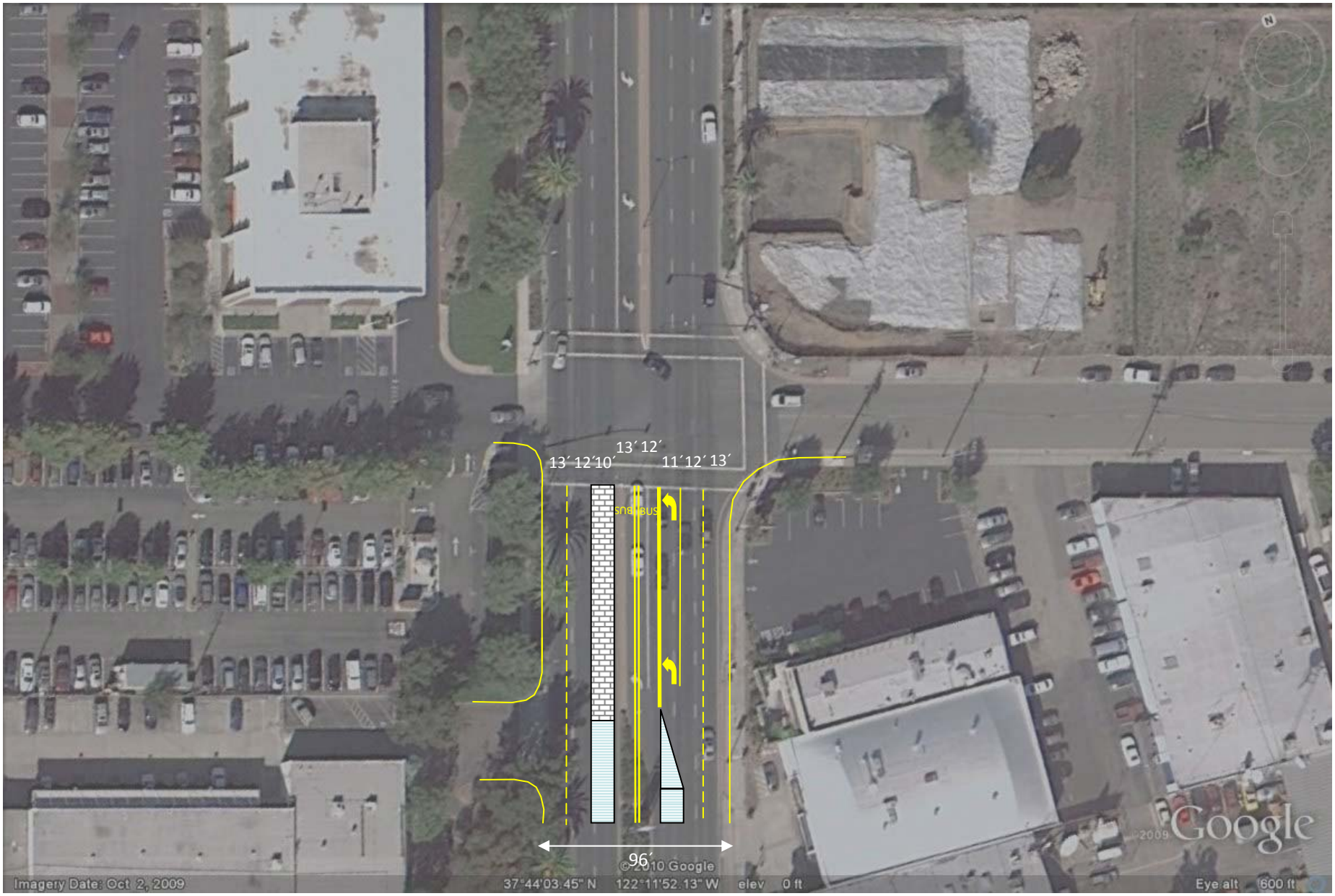


Hegenberger mid-block west of I-880: Full BRT option

Hegenberger intersection west of I-880: Rapid Bus option

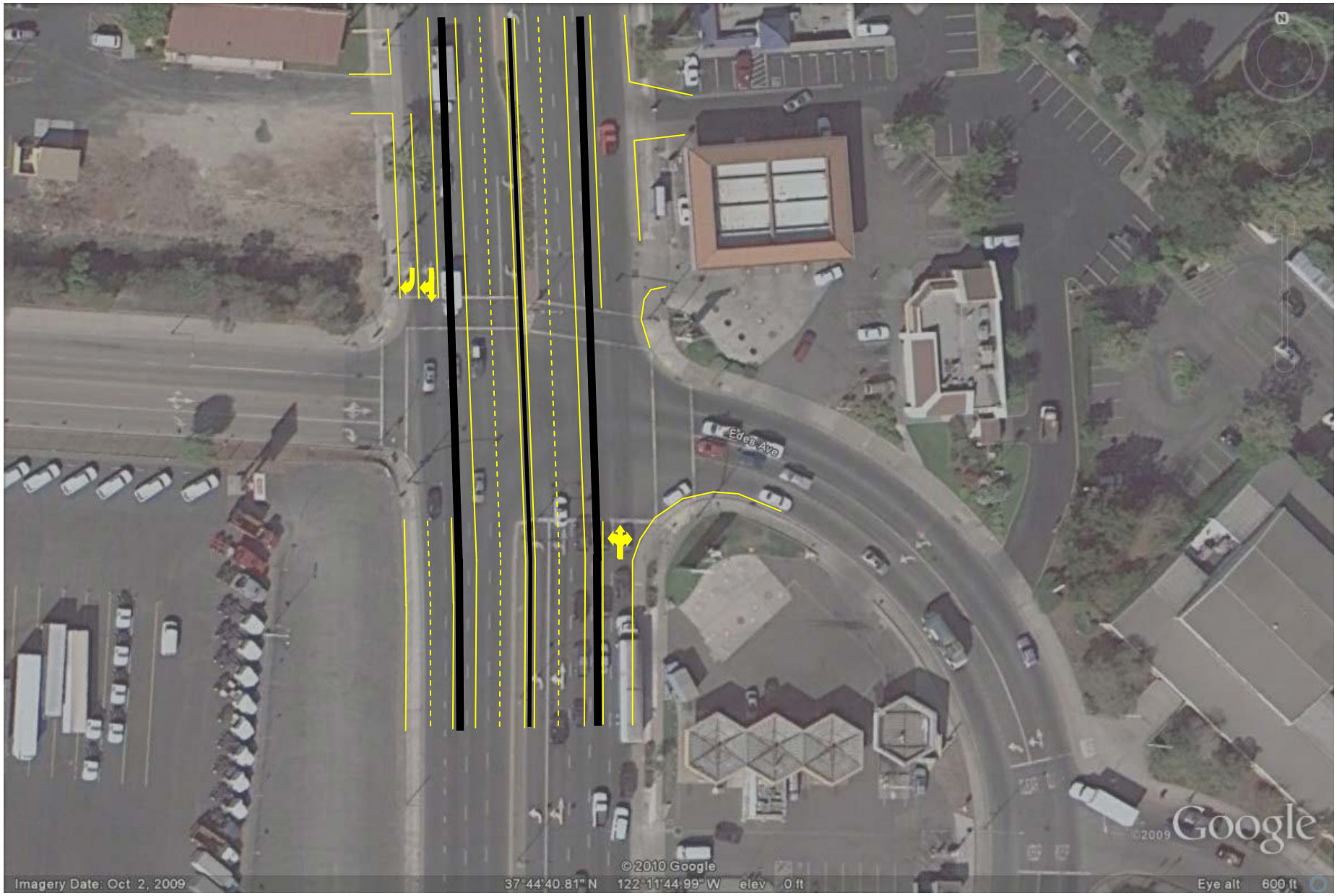


Hegenberger intersection west of I-880: Full BRT option

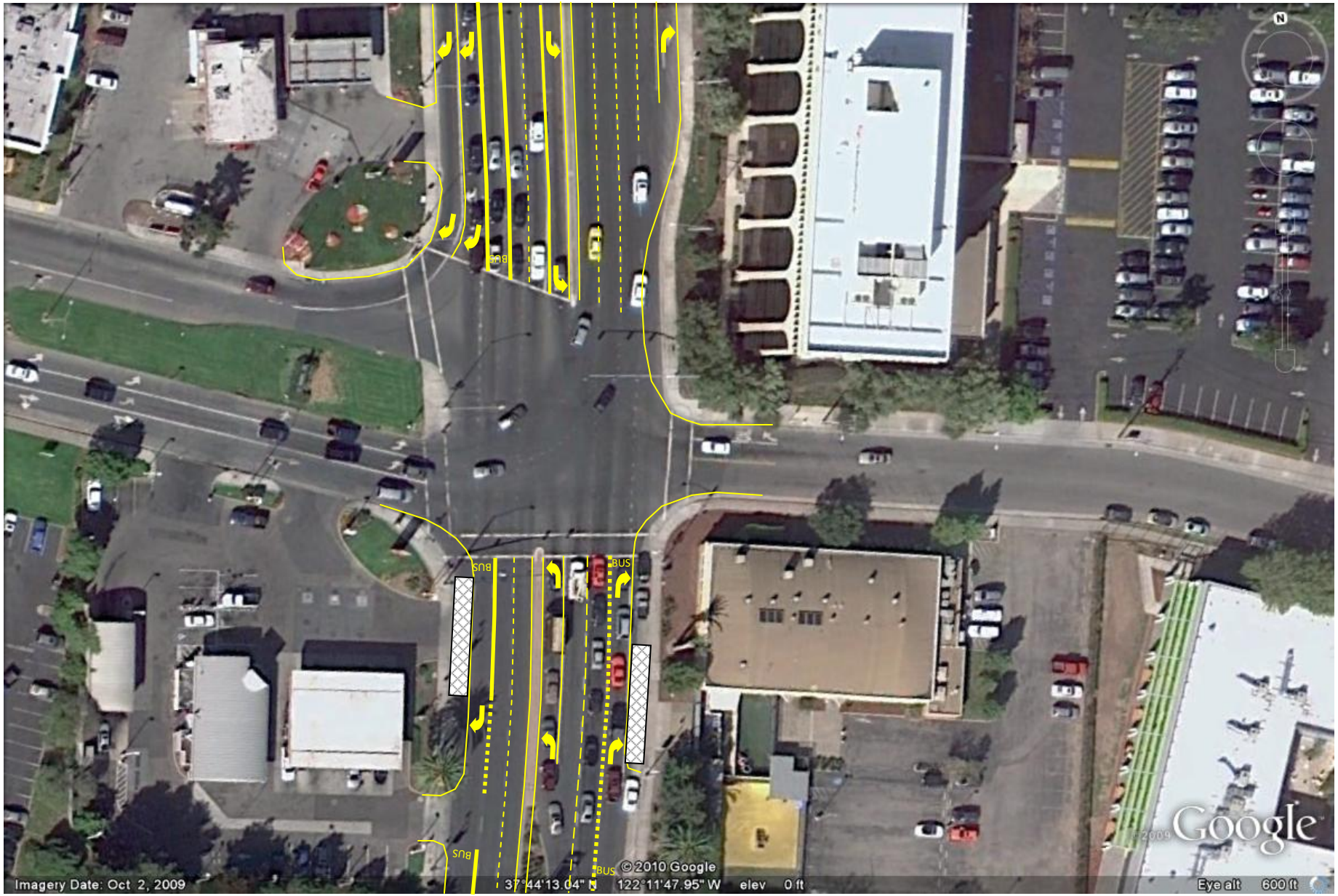


Hegenberger/South Coliseum Way intersection: Rapid Bus option

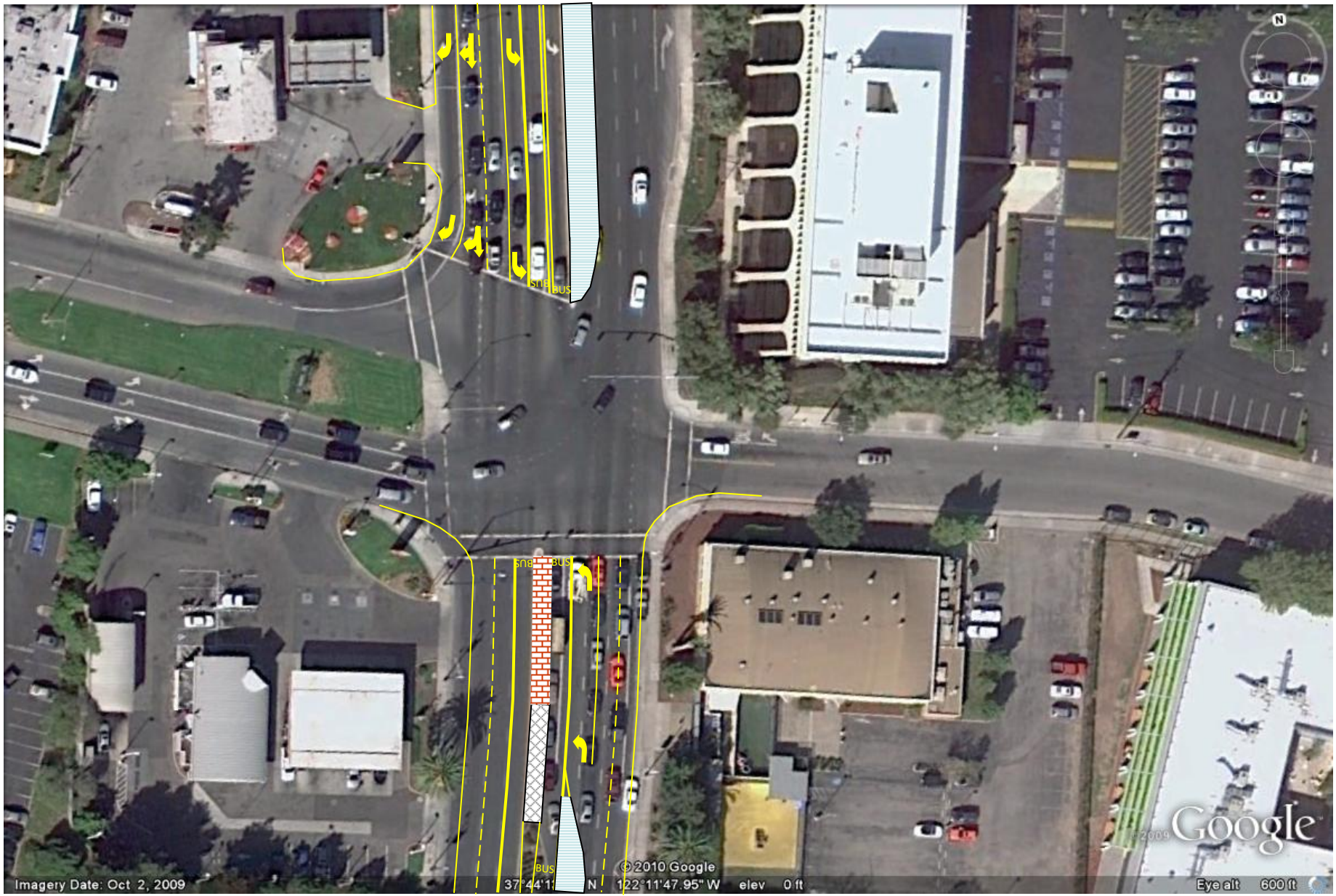
Hegenberger/South Coliseum Way intersection: Full BRT option



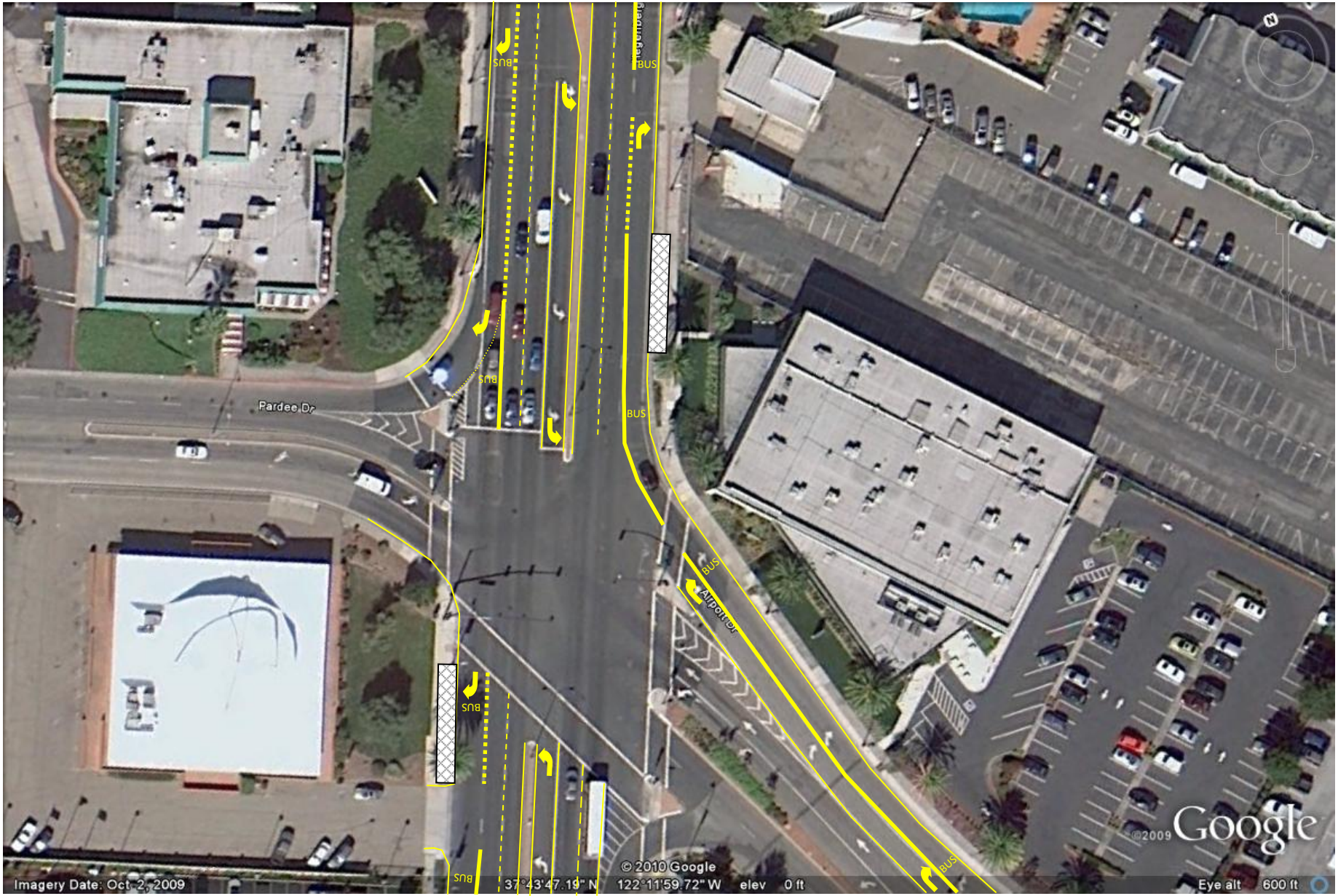
Edgewater: Rapid Bus option



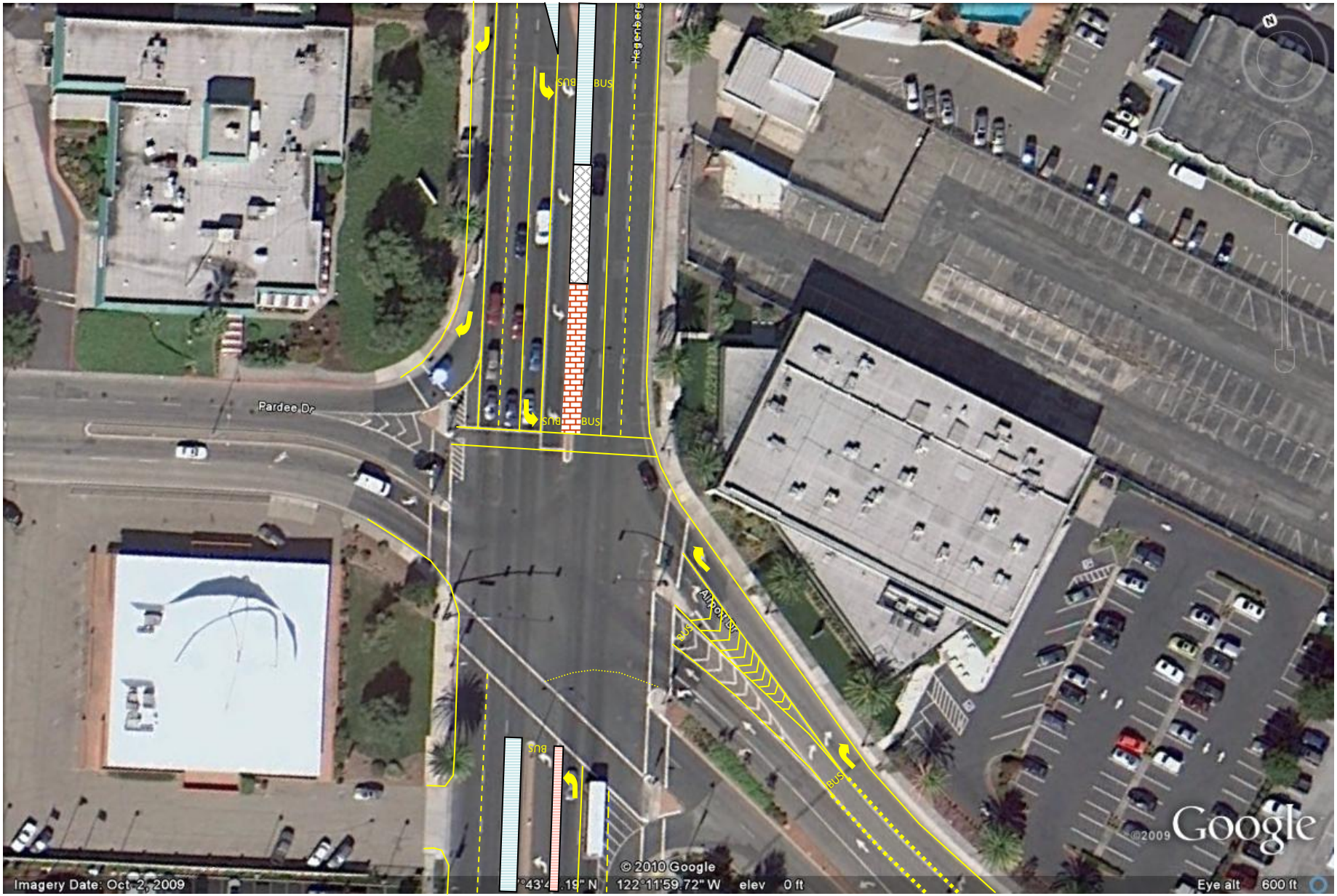
Edgewater: Full BRT option



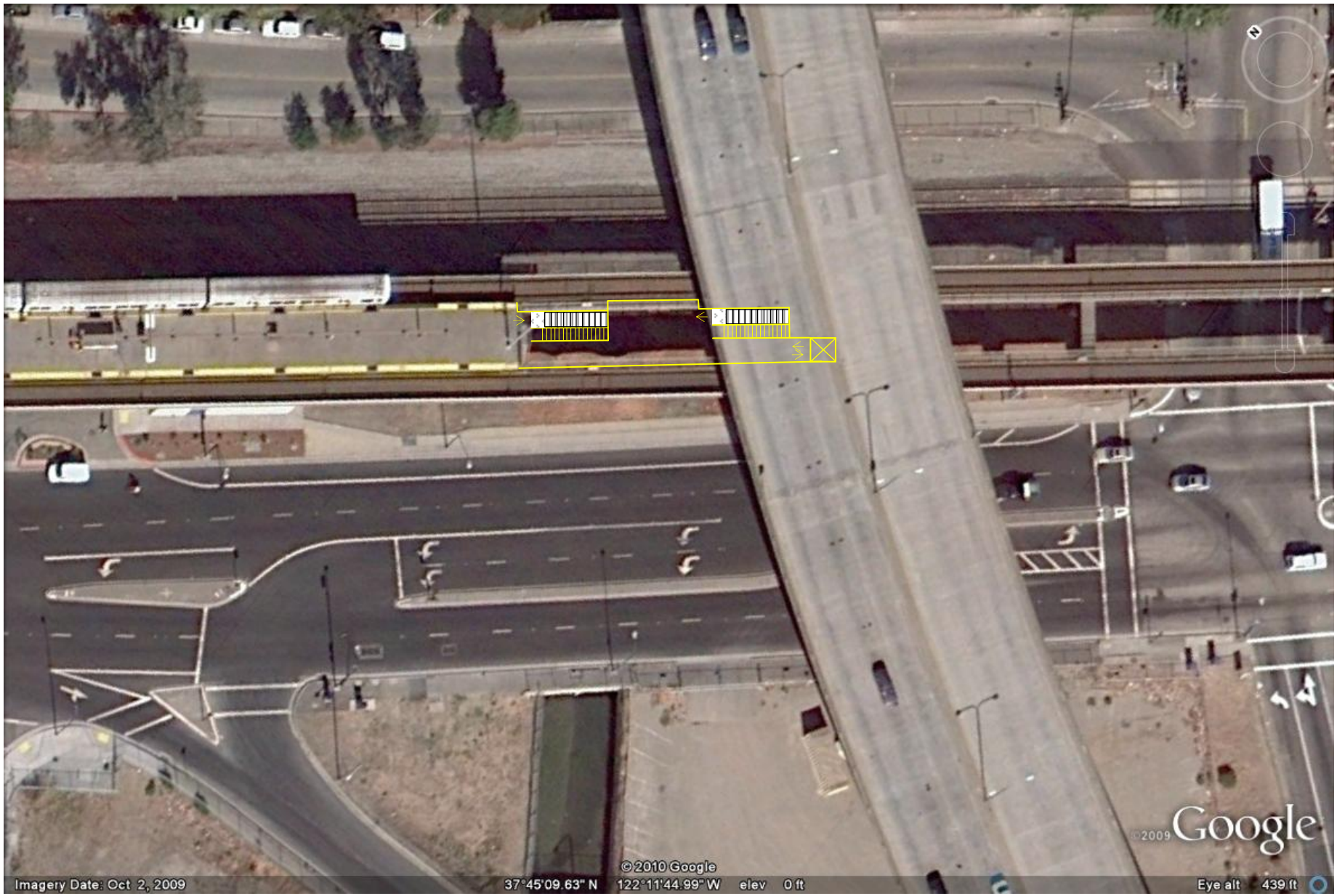
Pardee: Rapid Bus option



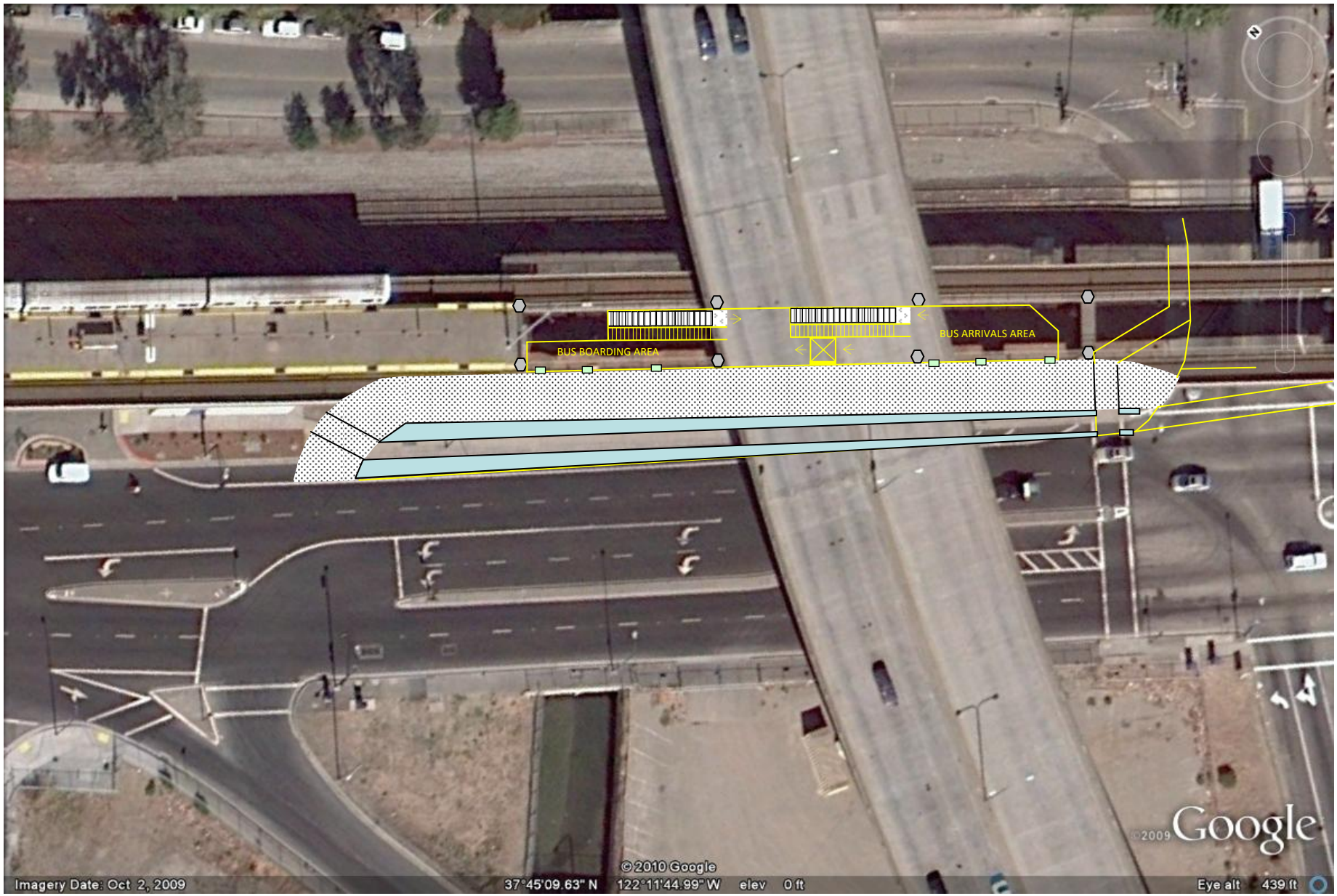
Pardee: Full BRT option



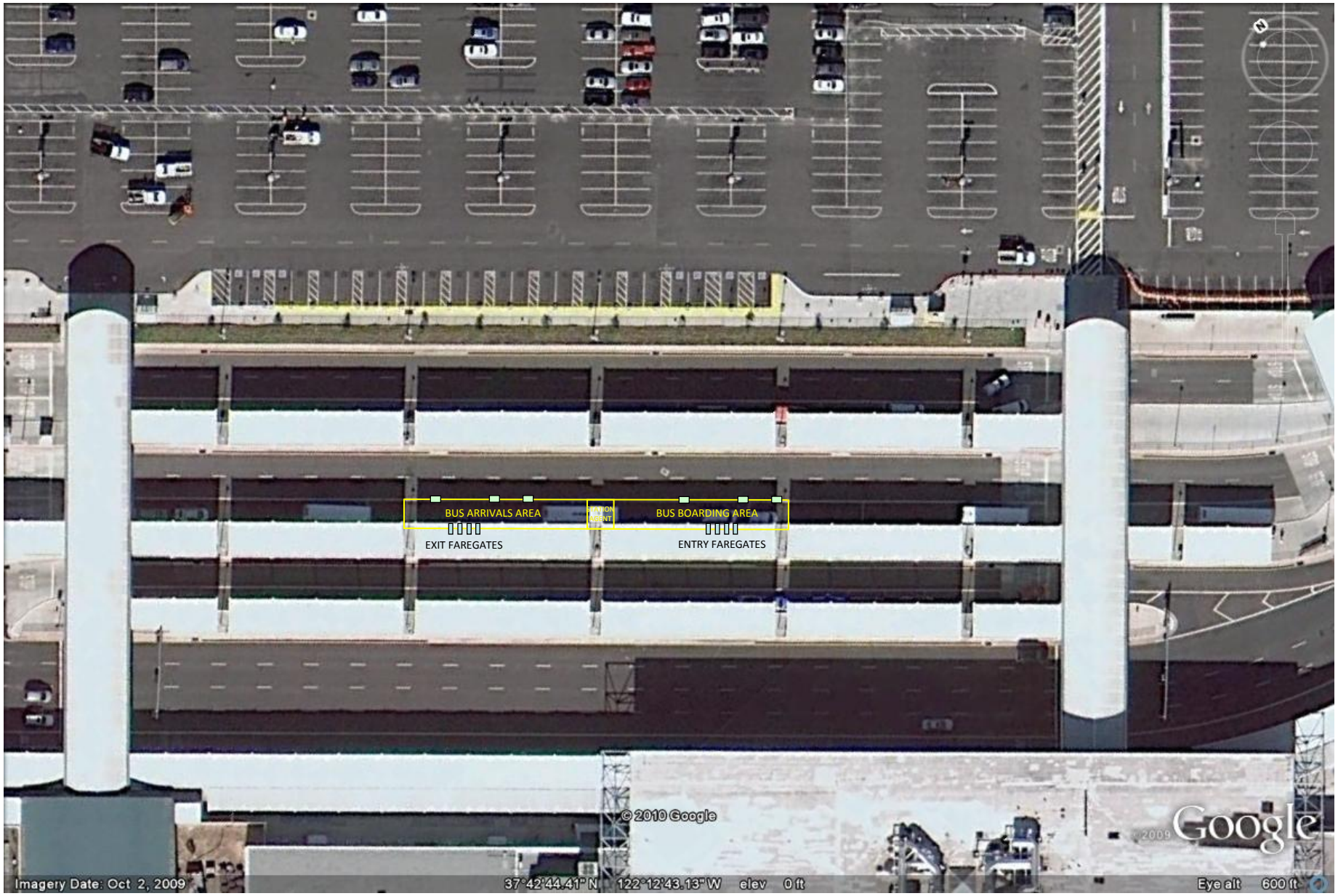
OAC Coliseum Station: Train Platform Level



OAC Coliseum Station: Ground Level



OAC Airport Station



Media Release

Eye-popping $102 tax subsidy for each new trip on slow airport tram:

New study shows RapidBART with dedicated lanes is faster, one sixth the cost. Transit Advocates call for MTC to base decision on new study - say upcoming vote to support $500 million in subsidies hurts transit riders and deepen deficits.

For Immediate Release: August 30, 2010
For More Information: TransForm's Stuart Cohen, 510-543-7419 or John Knox White, 510-277-2089

As Bay Area transit agencies get ready to vote on yet more funding for a $500 million tram between BART and the Oakland Airport parking lot, an updated study is showing it requires a $102 taxpayer subsidy for each new rider to go just 3 miles. By comparison a stretch limo could pick up 8 people at their doorstep anywhere in the East Bay -- even Dublin or Livermore -- and take them straight to the terminal for just $99.

The study, released with a companion video by TransForm and conducted by a nationally recognized transit planning firm, used the latest data about the proposed tram and compared that to alternative to alternatives that BART failed to analyze. The result shows a stark choice for Bay Area transit agencies: continue plans to subsidize the tram with over $350 million plus $105 million in new BART debt, or use those funds for a better connector and to protect and improve service for tens of thousands of residents.

TransForm, the Bay Area's leading transit advocacy group, says that this latest information from a leading transit planning firm needs to be the final straw. They point out that the current tram bears little resemblance to what had been promised: the average speed would be 23.4 mph (BART had planned it 50% faster), passengers will be dropped in the parking lot instead of the terminal, and fares have doubled to $6 each way, on top of the BART fare. Projected ridership for this 3-mile tram ride has plummeted.

"How can any elected official consider forcing taxpayers to pay $408 for a family of 4 to go 3 miles, just to get dropped in the parking lot," said Stuart Cohen, TransForm's Executive Director, "We are calling on all of these agencies about to funnel millions more to this project to read this study and call off their votes. On the one hand our regional agency, MTC, just warned that our transit systems are threatened by $17 billion in unfunded needs just to maintain our system, and on the other hand they may recommend the most outrageous waste of taxpayer money since the bridge to nowhere".

The preferred option from the new study is called RapidBART. With its own dedicated transit lane along Hegenberger, it avoids delays. Access is more convenient, with shorter walks and fewer escalators. Fares would remain $3 each way. The study predicts it will attract 60% more new riders than the tram and do more to boost Oakland's economy. And it does all this for $350 million less than the elevated tram.

"The incredible thing about RapidBART is that it meets all the goals that Oakland and BART said they wanted in 2002, but no longer have with the elevated tram -- supporting economic development along Hegenberger and faster access to the airport -- without crippling BART and other agencies," said John Knox White, Program Director at TransForm. "This report updates all of the information, and the final result for the proposed tram is very ugly."

Three votes in September could provide relief for transit riders by cutting off subsidies for the tram: the Port of Oakland on September 7, the Metropolitan Transportation Commission (MTC) on September 8, and the California Transportation Commission on September 22. If any of the agencies don't support the project, or if the federal government doesn't give $25 million BART has requested, BART will have to go back to the drawing board and figure out a new funding plan.

TransForm staff believe this would be a huge boon for Bay Area transit. "Not only would we get a better, faster airport-connector by using RapidBART, but with the $350 million we'd save the region could improve safety and access at all 43 BART stations, greatly speed up transit for tens of thousands of transit riders in Oakland, and make MUNI more reliable," said Cohen. Adding, "The only thing standing in the way of a more sustainable transit system is power politics and BART's ongoing propaganda."

The new report *Oakland Airport Connector Options Analysis* was produced by Kittelson and Associates (KAI), which has offices around the country. KAI has conducted transit studies for dozens of transit agencies and has authored several manuals on planning and evaluating bus and rail operations for the national Transportation Research Board. Kittelson spent nearly three months collecting data and comparing alternatives to better connect with BART with the Oakland Airport.

TransForm is sending a letter to BART and MTC inviting them to an open dialogue on the study, and said the goal should be 100% transparency for the public and for their decision-makers. "We are providing complete transparency with this report and are asking BART to do the same: the last thing this region needs before making this $500 million decision is more heat. It is time to shine some light on this issue" said Cohen.

###

Key Study findings:

RapidBART is:

More Convenient: RapidBART reduces lugging suitcases by over 35% (shorter walk distances, fewer escalators)

Faster: RapidBART will reduce BART travellers time to the Airport, even as traffic increases in 2030!

Ridership higher: Ridership is 63% higher on RapidBART than the OAC

Lower Subsidy: RapidBART requires 1/6 the subsidy per rider than the OAC, protecting BART's core system from financial risk

Lower Capital Costs: A full-service, exclusive lane RapidBART project cost $125 million vs $492 million for the tram.

More Cost Effective: Rapid BART would have a cost per rider that is 86% lower the Tram's $102 per ride.

More Flexible: RapidBART can serve the community at intermediate stops, a third airport terminal (if built), and become the first phase of an East Oakland serving Bus Rapid Transit system from Eastmont Mall to the Airport connecting with BART and the International BRT.