San Francisco Bay Area
Rapid Transit District

Access BART

Final Report

Funded by Caltrans
in association with
MTC and FTA

December 2006

Produced by:

ARUP

In association with:

Fehr & Peers Transportation Consultants

Strategic Economics

Nelson Nygaard consulting associates

Richard Willson, PhD

Bay Area Rapid Transit District

Access BART

Final Report

FINAL

December 2006

Ove Arup & Partners California Ltd
901 Market Street, Suite 260, San Francisco, CA 94103
Tel +1 415 957 9445 Fax +1 415 957 9096
www.arup.com

Job number 130635

Contents

1 Executive Summary

The San Francisco Bay Area is expected to add one million new jobs and nearly two million new residents in the next few decades. To manage this growth, the Bay Area's regional agencies developed a Smart Growth Strategy based on a "Network of Neighborhoods" linked by transit. An essential component of this vision is for more infill development in existing urban cores and transit-oriented development (TOD) at suburban BART stations. In addition, the State of California's Department of Business, Transportation and Housing (BT&H) completed a study by UC Berkeley to assess the viability of accommodating future housing needs within walking distances of existing and future transit stations. The UC Berkeley study offers policy direction on how future growth within California can be accommodated. BART, as a regional transit provider, has a critical role in supporting these regional and State strategies as there is expected to be strong transit ridership growth. The BART Board has directed staff to accommodate this ridership growth through station access improvements that increase transit, bicycling and pedestrian mode shares. To accomplish this, BART will need to carefully consider trade-offs involved in the use of BART's land resources and transit capacity. The objective of the "Access BART" study is to develop a strategic assessment of BART station areas that evaluates trade-offs between TOD opportunities and access investments (e.g., parking garages, bicycle facilities, etc.) at a system- and corridor-level, while also considering the known capacity constraints on existing transit infrastructure. The outcome of the study will be to provide long-term direction for BART's TOD and access planning, and the strategies will be used when station plans are initiated or revisited with local communities. BART values its relationships with local community partners and with the development community and the strategies developed through this study do not alter the District's existing commitments to recently prepared station area plans or development arrangements.

This effort builds upon BART's recent analyses from the *Core Stations Capacity Study* and the Transit-Oriented Development Policy Review, as well as using the MTC Bay Area TOD Study as a foundation. Another foundational document was the BART A-Line study which was a pilot study testing the approach and methodology that was further refined as a part of the Access BART initiative.

This strategic assessment helps BART approach station access and land use strategies at a systems level to enhance planning at the station level. It will be used to help guide access (including parking) and transit-oriented development programs to better manage existing and future system capacity constraints. The four main goals of the study were to:

- Evaluate how land use and access scenarios optimize ridership;
- Understand how land use (TOD) / Access strategies impact peak and off peak ridership
- Develop station typologies to inform access targets;

- Develop an access investment approach that is based on station typologies and access targets.

Together, these will help reinforce current planning at BART to support infill and TOD on and around BART stations while also helping shape future choices about investments in access.

The Access BART study focused primarily on the East Bay BART stations for a number of reasons including:

- East Bay stations have large parking areas that could continue to provide parking or be converted to joint development projects. San Francisco is built out and land uses are already transit oriented.
- East Bay stations have a large share of morning commute access by BART patrons who drive to the station alone. There is great potential for shifting to alternative modes while stations in San Francisco have high amounts of alternative mode share access to BART.
- When the 1998 passenger survey was conducted, the San Mateo extension was not built.
- The San Mateo transit agency, SamTrans, is conducting their own similar study in San Mateo County. The Access BART team shared information and presented to the group working on this other initiative.

While this study explored questions of TOD and access focused on East Bay stations, the findings and recommendations are applicable to all stations within the system.

1.1 Outcomes

The outcomes of the Access BART study include the following:

- An understanding of ridership impacts of TOD / access scenarios;
- Refinements to the Direct Ridership Model (DRM) allowing the model to predict ridership across a broader spectrum of modes and times of day;
- Application of a system-based strategy for TOD and access, which offers more flexibility because it is not tied to individual stations;
- A station classification system, which can be used to develop a station investment approach;
- An access based approach for investing access funds;

- A demand based approach for providing pick-up and drop off facilities;
- Improvements to the evaluation tool to weigh tradeoffs between development on BART property and the provision of parking;
- A better understanding of station access needs;
- A comparison between BART and other North American rail systems with a different land use pattern; and
- Stronger partnerships between BART and local jurisdictions

1.2 Study Process

The Access BART study began as a pilot approach tested on the A-Line which runs from Lake Merritt to Fremont. The A-Line study was conducted in the spring of 2005 and offered an opportunity to develop an approach for assessing how land use and access can stimulate transit ridership on the BART system at a corridor level. In the spring of 2006 with the support of a Caltrans grant, the larger Access BART study began. A similar approach was followed for the systemwide study with refinements to the development of scenarios for testing, the development of station typologies, and the additions to the DRM.

The general approach to this study included:

- Meetings with local jurisdictions, transit agencies and BART staff
- Coordination with SamTrans, MTC and other agencies with related studies
- Development of the DRM to predict for different modes and different times of day
- Development of land use and access scenarios
- Application of the DRM
- Reporting of findings

The study findings fall broadly into two categories: those related to TOD strategies and those related to access enhancements. The key highlights include:

- Transit oriented development offers ridership benefit
- BART can realize a 26% ridership gain with the land use intensification called for in the regional smart growth vision
- Access strategies can be considered in tandem with land use development and change
- Shuttles and distribution service can boost transit ridership as found at MacArthur BART station
- Access typologies can influence investment decision-making
- Development of a direct ridership model

More specific findings are discussed in the findings section of this report.

This Access BART report summarizes the findings and provides direction on the implications for current and future planning activities at BART and is organized in the following manner:

- Executive Summary
- Findings and Recommendations
- Analysis Results
- Access Improvements
- Peer Region Comparison
- Technical Appendix

2 Findings and Recommendations

2.1 Transit-Oriented Development Findings

Overall, the study findings reinforce current efforts to support TOD and infill development around BART stations in the region. General findings related to TOD include:

- Land use intensification around the BART system consistent with both the 2030 growth scenarios from ABAG and the refined forecasts developed for this study hold the greatest potential for increasing BART ridership without imposing significant access enhancement costs.
- The majority of jurisdictions throughout the BART system believe the ABAG growth forecasts are achievable with the exception of some core urban cities where some concerns about the level of growth were expressed.
- If local jurisdictions are able to achieve the regional growth strategy, BART will realize a ridership gain of 26% over the next 25 years.
- All day boardings could be increased up to 29% without building a single additional parking space via land use intensification.
- Land use intensification holds the greatest potential for building off peak ridership, especially during the midday period. TOD offers BART the opportunity to build all day and off peak ridership which takes advantage of capacity in the existing BART system without imposing additional costs on the system.
- For the system as a whole, a parking space yields 1.0 trips per day. Findings from the Direct Ridership Model suggest that a household yields from about 0.35 to about 1.1 depending on household size and income. This changes from line to line. For example there is a greater yield from both TOD and parking provision. It was found that TOD has the potential of generating 1.76 times the number of daily boardings as it generates in the AM peak period along that corridor.
- Research by Lund and Ceverro work reported in *Travel Characteristics of Transit Oriented Developments in California* shows that BART capture rates are 3 – 4 times higher in the ½ mile area around a station. The Direct Ridership Model and analysis of Bay Area Travel Survey data suggest capture rates for BART in the range of 20%. These findings demonstrate the important role of proximity and accessibility in terms of making the choice to ride BART.
- Peer systems that have greater land use intensification in station areas have less pronounced spikes during peak hour commuters and more stable demand pattern throughout the day. Representative of these systems attribute land use intensification as a critical factor in overall demand and their demand profile.
- Peer systems are pursuing land use intensification strategies on or beyond their property to build ridership.
- TOD coupled with transit service can allow BART to serve more people with fewer parking spaces.

2.2 Access Enhancements

- Given the all important role proximity of housing plays in generating additional riders, pedestrian and bicycle connections to BART, as well as bicycle storage at BART, should be strengthened in areas where high levels of development are forecast near BART stations.
- Without any increase in parking, the ABAG 2030 scenario would lead to a reduction of drive alone access mode share from 56% presently (1998) to 53% in 2030. All day SOV mode share would decline from 31% to 28%.
- Expanded station access, with no net increase in parking and an 8% increase in feeder bus service, when coupled with the TOD intensive land use strategy, results in a 19% increase in AM boardings and a 29% increase in daily boardings for all stations in the system.
- Additional parking yields riders for the BART system but not to the same degree as land use intensification. For the system as a whole, a parking space yields 1.1 riders today. In select corridors, this rate can vary due to the access and land use context of individual corridors.
- If BART wanted to focus exclusively on residential TOD, in order for a ridership neutral proposition, residential development must be at least 70 units per acre and 80% of the BART parking must be retained.
- Shuttles are an important access element with ridership benefit for BART as illustrated by DRM results and field observations. Stations such as MacArthur illustrate how shuttles serving office, retail, and housing more than a short walk away can still be served by BART if a convenient local shuttle is also provided.
- Ridership loss due to parking reductions can be regained to some extent through TOD and land use intensification. In some cases, TOD can replace all riders lost to parking reduction; in other cases, some riders will shift to other stations.
- Off-peak parking spaces have the potential of generating on average 1.38 times the number of boardings as the number generated in the AM peak period.
- Key bus intermodals include Bayfair, Fruitvale, El Cerrito del Norte, Walnut Creek, Concord, Pittsburg/Bay Point, Fremont, and Dublin/Pleasanton.

2.3 Scenarios Tested in the Access BART Study

Four scenarios were evaluated for the access and ridership benefits for BART. The scenarios represent a 2030 plan year and the assessment focused on the ½ mile area around each station (as shown below in orange) as well as the broader station catchment area.

Each scenario is described briefly below:

Scenario 1: ABAG 2030

The first scenario uses ABAG *Projections '05* for population and employment. Under this scenario, there is a 39% increase in population living within the ½ mile airline radius around each station (station area population) and a 19% increase in station catchment area population. The number of transit feeder buses and the parking supply at BART stations is unchanged.

Scenario 2: Refined ABAG 2030

In Scenario #2, station area population increases 46% while the broader catchment area population stays constant at 19% (growth is redistributed to the station area from areas further out). The redistribution reflects known land capacity constraints or increased TOD demand at some stations as compared to the published ABAG 2005 projections. Employment is also redistributed in this scenario with a focus of employment growth around existing job centers. Employment growth typically occurs in and around existing job centers rather than evenly across a region and this is reflected in the reallocation approach.

Scenario 3: Enhanced Access

This scenario uses the adjusted ABAG land use inputs first introduced in Scenario #2. It also introduces changes in station access. Parking is reallocated at key stations having some stations with a greater amount of parking while others had less resulting in no net change in parking systemwide. The number of feeder transit buses on key lines serving BART stations is expanded by approximately 8%. This includes expansion of key AC Transit, County Connection, and LAVTA routes. A few Muni and SamTrans services were also included.

Scenario 4: Extensions

The last scenario combines the modified ABAG land use inputs from Scenario #2, the access changes from Scenario #3, and anticipated ridership due to rail expansion projects with direct connections to BART: the BART extension to San Jose; eBART; BART to Warm Springs; West Dublin BART infill station; Dumbarton Rail; and Oakland Airport Connector extension. Parking supply expands from 44,436 to 48,586 (9%).

The four scenarios that were developed are summarized in the table below.

Table 1 - DRM Scenarios

#	Scenario	Land Use Input	Access Approach	Extensions
1	ABAG 2030	ABAG P2005	Existing Access Characteristics	No
2	Refined ABAG 2030	Modified ABAG P2005	Existing Access Characteristics	No
3	Access Enhancements	Modified ABAG P2005	Access Enhancements Investments	No
4	Extensions	Modified ABAG P2005	Access Enhancements Investments	Yes

Station catchment areas were determined using survey data from the BART 1998 survey, which was the last year a comprehensive customer survey was conducted.

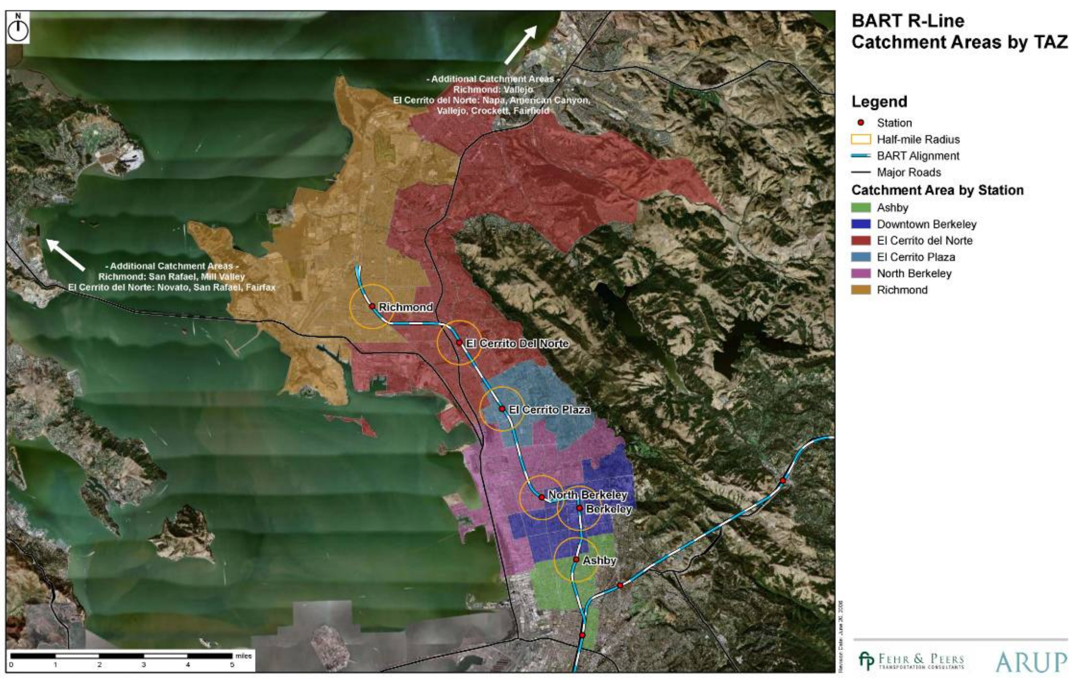


Figure 1 – Example of Station Catchment Areas for R Line as Defined by 1998 Travel Survey

BART catchment areas were defined using the 1998 systemwide survey which was the last comprehensive survey of patrons on the BART system. San Mateo stations were not open at this time and station catchment areas for the airport extension are approximated based on BART operating budgets.

2.3.1 Key BART Travel Markets

BART's key function is providing a high capacity, high quality transit link between the East and West Bay and to link the communities of Alameda, Contra Costa, San Francisco and San Mateo Counties to key employment and activity centers. BART is also the backbone of the regional transit network carrying people across much greater distances than local bus or light rail services. This function results in a dominant pattern of morning peak period flow to downtown San Francisco and Oakland from more residential areas of the region and outbound evening flows from these areas. In addition to serving this dominant market, BART also provides important connections to UC Berkeley, the Oakland Coliseum, Walnut Creek and Concord Employment Centers, and two of the airports in the region [Oakland International Airport (OAK) and San Francisco International (SFO) Airports] to name a few important centers found across the system.

While the dominant pattern on BART today is serving job centers in Oakland and San Francisco and key activity nodes, there is great potential for developing secondary transit markets along the corridors of the system. While peak period, peak direction trips are difficult to accommodate given costs and constraints of providing service for those trips, the excess capacity in other parts of the system allow BART to serve additional trips with this capacity and at no incremental cost. Adding capacity from Orinda or Rockridge to San Francisco during the AM peak means additional trains, operators, or physical change which impose higher operating or capital costs on BART. Alternatively, serving a trip in the AM peak period from San Francisco to Walnut Creek does not impose the same costs as trains are already running to Walnut Creek with capacity available for people to use. With the right blend of land use and access enhancements, stronger markets may emerge in some of BART's secondary markets. For example, with the opening of eBART in East Contra Costa County (East County), commuters form East County can take advantage of available capacity from Pittsburg/Bay Point to Concord or Walnut Creek and exit the system before commuters from Concord and Walnut Creek board to travel to San Francisco. Similarly, stronger job centers in Oakland or Berkeley could result in more commuters traveling in the reverse direction to these centers from San Francisco or parts of Alameda and Contra Costa.

BART Strategic Plan

Transit Travel Demand

Goal 1: We will work to understand changing transit demand patterns and be prepared to respond to them, and we will work proactively to influence travel demand trends in the region that support transit ridership.

Goal 2: We will optimize the use of existing capacity

Figure 2 – Excerpt from BART Stategic Plan relating to demand patterns.

To illustrate this point, the map on the following page shows existing job centers as defined by the Metropolitan Transportation Commission's study of transit oriented development study. The size of each dot indicates the size of each center relative to the others with San Francisco being the largest job center along the BART systsem. To illustrate growth over time, employment growth in these centers is indicated by the dark banding. The arrows show "secondary" markets where BART ridership would be most beneficial to BART and BART patrons as there is additional capacity available in direction of travel indicated by the arrows.

This is an important planning finding as it suggests the benefit of having BART work with local and regional agencies to grow demand in these secondary markets. With larger and stronger job centers in these areas, a more balanced ridership profile may emerge for the system as found in other regions such as Vancouver or Toronto. It also serves as a reminder that office based TOD may offer a greater benefit to the system in terms of developing a different travel market while overemphasizing housing based TOD could result in additional demands for capacity in markets where BART is operating at or near capacity at present.

An anecdotal example helps illustrate this point. Reportedly, one of the busiest times at Powell Street is now Friday afternoon (*Hallidie Plaza Design Charrette.* 2005). This is a result of additional hotels, cultural uses, and retail expansion in the community around Powell Street. Travelers to Powell Street are taking advantage of capacity in the system outside of the peak direction of travel making this an ideal situation for BART. Replicating this success at East Bay job centers will make BART more efficient and allow BART to serve more trips without compromising customer comfort or experience and also saving in terms of operating costs.

The key AM peak period secondary markets that could be developed include:

- East County to Central Contra Costa County job centers
- San Francisco to East Bay job or activity centers
- Western Contra Costa and Alameda County to Central Contra Costa job centers
- Western Contra Costa and Alameda County to Berkeley or Oakland
- Southern Alameda County to Pleasanton and Silicon Valley

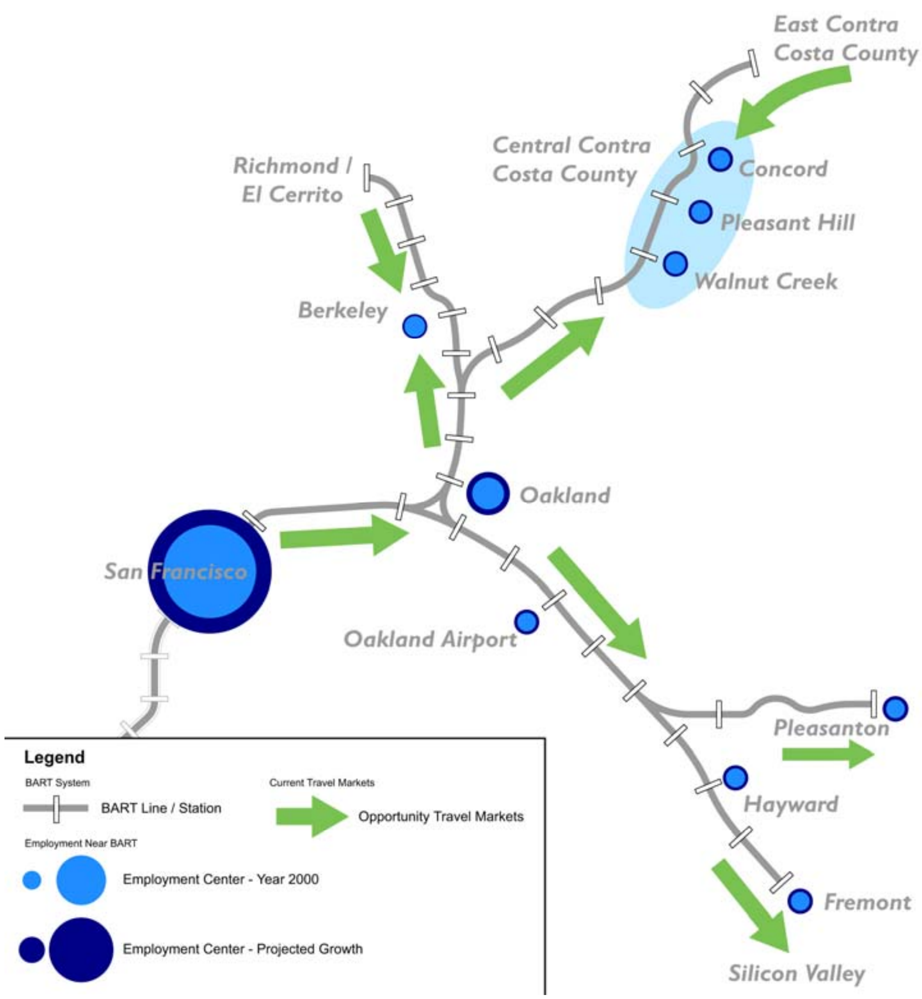


Figure 3 – AM Peak Period Opportunity Markets for BART

Direct Ridership Model Conclusions

Preliminary results from the Direct Ridership Model by scenario are reported below:

Scenario 1: ABAG 2030

- 19% increase overall system catchment population, including a 39% increase in population within one-half mile of BART stations

Scenario 2: Refined ABAG

- 19% growth in catchment population with a more intensely populated station area representing a 46% increase

Scenario 3: Expanded station access

- Refined ABAG land use scenario described above
- 8% increase in feeder bus service
- Parking is redistributed but net change in supply is less than 1%

Scenario 4: Extensions

- Refined ABAG land use scenario
- BART extensions and related parking requirements

2030 System-Wide Land Use, Station Parking and Bus Service

Table 2 – Summary of System Totals

	Numerical Value					Change from 2000			
Model	Base	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 1	Scen. 2	Scen. 3	Scen. 4
1 - PM Peak Boardings	97,933	130,080	130,131	130,131	148,831	33%	33%	33%	52%
2 - Off Peak Boardings	133,333	167,084	168,462	174,165	202,467	25%	26%	31%	52%
3 - AM Peak Boardings	90,226	103,790	105,012	107,526	125,788	15%	16%	19%	39%
4 – Daily Boardings	324,537	408,208	410,859	419,076	484,771	26%	27%	29%	49%
5 - AM Walk + Bike Boardings	18,769	27,142	28,408	27,167	30,329	45%	51%	45%	62%
6 – Daily Walk + Bike Boardings	151,779	215,006	217,181	215,765	243,259	42%	43%	42%	60%
7 - AM Peak Drive Alone Share	56.65%	54.81%	54.31%	54.10%	56.21%	-3%	-4%	-4%	-1%
8 - AM Peak Park and Ride Share	80.14%	81.06%	80.98%	81.03%	82.05%	1%	1%	1%	2%

Source: Fehr & Peers, 2006.

Source: Fehr & Peers, 2006.

- The Base numbers for Models 1-3 include 2000 totals for the core stations and Colma, and 2005 totals for South San Francisco, San Bruno, and Millbrae
- The Base number for Model 4 includes 2000 totals for the core stations and Colma, and 2005 totals for South San Francisco, San Bruno, and Millbrae, and San Francisco International Airport
- The Base numbers for Models 5, 6, 7 and 8 do not include South San Francisco, San Bruno, or Millbrae, because no data was available
- Daily Boardings is the only total that includes the SFO station, so Daily boardings are slightly higher than the sum of boardings from Models 1-3
- Scenario 4 totals does not include riders that stay internal to the eBART or SRVT Extensions, or riders that board at extension stations and alight at core stations.
- West Dublin / Pleasanton was only included in Scenario 4 (Extensions)
- Some transit service declines due to limited funding for operating service forecast through 2030.

2.4 Implications for BART

The findings from the Access BART study reinforce current policy initiatives at BART to support land use intensification at and around BART stations. Land use offers great promise in terms of building BART ridership without the burdens associated with parking expansion – those burdens being financial, social and environmental. Strategic application of access strategies can enhance BART ridership and complement visions for future land use intensification around the system. The implications of these findings for BART are summarized below:

1) Prioritize station area planning to stations with active land use change occurring

Land use intensification (Scenarios 1 and 2) may result in a 27% increase in system ridership. With the addition of feeder bus service and strategic reallocation of parking (Scenario 3), a 29% ridership increase is forecast. Thus, 27% of the forecast ridership increase could be realized through land use intensification alone and without expenditures of access funds on parking or transit service enhancements. For stations where future intensification is planned, BART should evaluate how well the station is connected to the local community for walking and bicycling as well as evaluating the quality of the feeder bus service to the station. BART would be well served by improving pedestrian, bicycle and transit connectivity in these local communities.

2) Think broadly about TOD and ridership benefits from this form of development

If BART chooses to relocate parking space areas to development, low- and moderate-density residential TOD alone is not enough to replace ridership losses associated with parking loss. At BART stations where retail, office or mixed-use development is present and combined with local feeder bus service, ridership can be generated to offset the ridership loss associated with the parking loss.

3) Distributing patrons from BART to local worksites and office centers is key for developing the reverse commute market

Strengthening the transit market to East Bay office centers holds the promise of building additional ridership without imposing additional costs to the system. These riders can take advantage of available capacity on trains traveling in off peak directions. While access investments are often focused on getting people to the BART system, in areas of office parks and employment centers, access investments must also be oriented around distribution, local circulation and connections from BART to office centers. Circulators (buses and shuttles) at Bishop Ranch and Emeryville illustrate how this can be achieved.

4) Some parking can be lost to support residential TOD

If BART wanted to focus exclusively on residential TOD, in order for a ridership neutral proposition, residential development must be at least 70 units per acre and 80% of the BART parking must be retained.

5) Access typologies can help inform investment choices

BART stations can generally be grouped into five types: urban, urban with parking, balanced multimodal, auto reliant, and auto dependent. Based on this typology, access investments can be focused to complement the station types. For example, at an urban station, access strategies might be focused exclusively on walk and transit strategies while at balanced multimodal or auto reliant stations, access strategies might be a mix of automobile, transit or bike access enhancements.

6) Explore new station configurations and designs with BART access staff and local community stakeholders

When development is expected to intensify and change local land use patterns (either on or off BART property), revisiting station designs and station layout can help improve local area connectivity to the BART station. Currently, BART stations themselves can be the largest barrier between local communities and BART. Reconfiguration of stations when new development is expected, as is the case with Walnut Creek and Pleasant Hill stations, offers significant potential to expand walk, bike and transit trip shares.

7) Rethink how BART addresses access needs

The Access BART study demonstrated the powerful role of land use change in building ridership for the BART system. Further, peer systems with higher levels of land development around their systems have less pronounced peaking and higher levels of all day ridership. As reported by leadership at TransLink in Vancouver, BC and Toronto Transit Commission in Toronto, their ridership levels and profile result from a more intense land use pattern around their systems.

In the years ahead, given the capital needs of BART's emerging renovation and reinvestment plan, BART could choose not to expand parking supply. Instead, BART could implement a variety of access strategies that encourage the use of alternative modes to reach BART. Better pedestrian and bicycle linkages could be provided across BART parking areas. Discounts could be offered to BART patrons taking buses or shuttles to BART stations. For parking, BART currently has an existing reserve parking program, and in FY06, did begin charging daily parking fees for all spaces at 10 additional stations, bringing the total number of stations with all paid parking to 12 (including Colma and Daly City). BART could choose to apply a parking pricing strategy system-wide to manage this access resource and as a strategy to encourage the use of alternative modes of transportation.

While BART has many access strategies at its disposal, the expansion of local bus and shuttle services is a more complex question as BART has little control of the level of feeder bus service serving BART stations. BART should continue to work in partnership with local bus operators to ensure the optimal level of feeder bus and shuttle.

Car sharing offers some potential for serving BART patrons – especially if car sharing models are modified to be more like station cars rather than traditional car sharing operations. Many of the office centers in the East Bay while close to BART, are far enough away that the last leg of the transit journey may not be walkable or convenient by transit. If pools of cars are available for short term use to help close the gap, the transit trip on BART might be more attractive to commuters coming to the East Bay job centers.

8) TDM strategies can build off peak ridership for BART

Land use intensification and BART extensions will greatly increase demand for available BART capacity over time. If this demand can be targeted towards segments or directions where capacity is available, BART could be well positioned to serve this increase in demand without imposing additional infrastructure or operating costs on the system. If, however, this demand is layered into the current peak directions along heavily utilized segments, it could require additional infrastructure and operating costs on the system. If BART can work with local jurisdictions to strengthen East Bay job centers and make these centers more attractive to new riders to the system, it will allow BART to serve additional trips without additional cost. Further, this situation highlights the importance not only of residentially based TOD but office centered TOD as well. If the region encourages more housing near BART without helping to create new trip pairs in the system, more demand might be placed on the existing system bottlenecks.

To help make these centers attractive, land use, shuttles, and improved connections to BART stations hold the potential to manage transit demand and offer opportunities to build demand outside of off peak times when it is easier and less expensive for BART to operate service. Pricing peak period, peak direction travel can result in less demand during these times and higher levels of ridership when there is more capacity. Seeking a balanced array of TOD around the system also helps to dampen peak period, peak direction travel. While existing land use settlement patterns result in the dominant pattern being from residential areas to San Francisco and Oakland, if office centers can grow and mature in central Contra Costa County, a different commute pattern may emerge on the BART system.

3 Access BART Study Methodology

The purpose of the Access BART study is to develop a strategic corridor-level approach that enables transit-oriented development and accommodates future station access enhancements to the BART system. The classification system reflects station attributes and provides some sense of whether a station is more likely to offer Transit-Oriented Development (TOD) opportunities or if the station is more appropriate for parking expansion to become more of an access location. While these are the main emphasis areas, most stations will offer a blend of TOD potential and access expansion opportunities. Each BART station in the East Bay has a station profile which was developed as a part of the study which then framed discussions about station priorities throughout the system.

3.1 Overview

This study builds upon the methodology first introduced and validated in the precursor BART A-Line study. Land use and access characteristics for all BART stations are collected. The data are used to guide classification decisions and to develop scenarios for input into the Direct Ridership Forecasting Model, which estimates affects on ridership as a result of varying the land use and access characteristics. The steps for this process include:

Step 1: Collect data for land use and access indicators for each station.

Step 2: Develop a station profile for each station, reporting the data collected for the indicators.

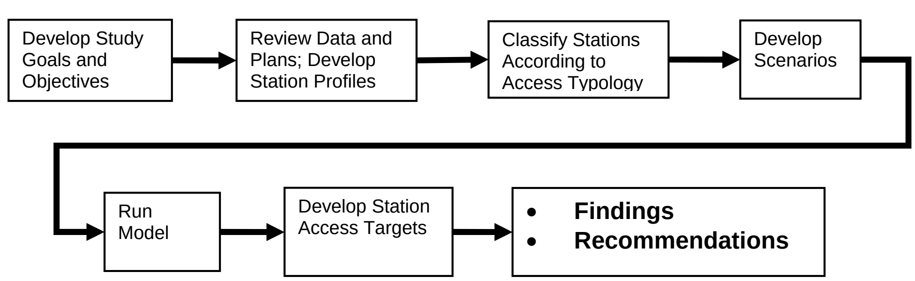
Step 3: Evaluate and classify each station based on access indicators using an Access Typology, with stations falling into a range of five prototypical station types.

Step 4: Prepare future development and access scenarios for testing in the ridership forecasting model. These scenarios consist of different combinations or levels of TOD projects, parking provision, transit provision, and future extensions of the BART system.

Step 5: Based on outputs from the model and other analytical work, develop a list of recommendations for land use and access initiatives that enhance BART station ridership.

A flowchart of the study process is illustrated below.

Access BART Study Process Flowchart



3.2 Station Assessment

This section discusses the data that were gathered for use in the Access BART study.

3.2.1 Station Profiles

Using the indicators and other background data collected for the Access BART study, the study team developed a profile of each BART station. Each profile presents the following information (with some sample data types listed):

- **Overview** – a brief narrative of the station area land use and access characteristics
- **Community** – population and employment data and projections (from ABAG Projections 2005)
- **Station Characteristics** – surrounding street network type, BART transit-oriented development status
- **Station Access** – daily mode share and trip purpose characteristics (from the 1998 BART ridership survey)
- **Parking Supply and Demand** – number of parking spaces, fill time, distance to nearest highway
- **Transit Providers** – number of feeder buses per hour, number of bus bays, transit operators serving the station

The profiles were used as a data sharing tool during discussions with transit operators, local jurisdiction staff, the study team, and BART staff.

Many sources of data were used, including ABAG Projections 2005, BART ridership and access data, existing plans, site visits, aerial photos (Google Earth), and interviews with local jurisdictions and transit operators. BART also conducted an internal data-gathering workshop. The consultations with local jurisdictions and transit operators and the internal BART workshop are elaborated below.

Profiles of each station are provided in the Appendix.

3.2.2 Consultations with Local Jurisdictions and Transit Operators

Meetings were held with some of the local cities and with major transit operators to gain a better understanding of current development activities and future plans, local parking needs, and desired access improvements.

The table below lists the cities and transit operators present at each station discussion. Meeting notes from each discussion are included in the Appendix. Several cities in the A-Line corridor (San Leandro, Oakland, Union City) as well as AC Transit were consulted in a similar fashion during the A-Line study. The points raised during those conversations were incorporated into the station profiles.

Table 3 – Transit Operators

BART station	Local Jurisdiction(s)	Transit Operator(s)
Pittsburg / Bay Point	City of Pittsburg Contra Costa County	
Concord, North Concord	City of Concord	County Connection
Pleasant Hill	Contra Costa County	County Connection
Walnut Creek	City of Walnut Creek	County Connection
City of Orinda	City of Orinda	County Connection
City of Lafayette	City of Lafayette	County Connection
Dublin / Pleasanton	City of Dublin City of Pleasanton	Livermore Amador Valley Transit Authority and County Connection
Oakland Stations	City of Oakland	AC Transit
El Cerrito del Norte, El Cerrito Plaza	City of El Cerrito	AC Transit Golden Gate Transit
North Berkeley, Berkeley, Ashby	City of Berkeley	AC Transit

3.2.3 BART Internal Workshop

BART staff met to review current and planned activities for stations throughout the system. The areas of interest included: 1) opportunities for transit-oriented development; 2) barriers or other problems; and 3) access/parking considerations/issues.

The discussion included use of the station profiles developed earlier and aerial photographs of each station area to look at station-specific issues. The ultimate goal of the workshop was to develop consensus among the various BART departments. The workshop drew upon the collective experience of members from the Property Development, Customer Access, and Planning Departments.

3.3 Overview of the Direct Ridership Model

Direct Ridership Models represent a precise, quick-response alternative for forecasting transit patronage. They are directly and quantitatively responsive to land use and transit service characteristics within the immediate areas of existing transit stations. They respond directly to factors such as parking, feeder bus levels, and data on station-area households and employment to estimate ridership.

Eight direct ridership models were developed for BART to provide comparative analysis of TOD throughout the system given different parking access, feeder bus levels, and land use changes within the immediate areas of prospective transit stations and within the entire station catchment areas. Given the number of TOD alternatives under consideration, the forecasting models were designed for quick response evaluation of alternatives. These models depart from the methodology used in formal patronage forecasts for major transit investment studies in the following respects:

- They avoid the insensitivities of even state-of-practice four-step models to reflect effects of localized conditions within communities and transit station areas (i.e. at the TAZ level)
- They assume that patronage at any given transit station depends primarily on the characteristics of the neighborhood surrounding the station, rather than the trip generators at other stations in the network. Unlike conventional modeling, the newly developed methodology makes no use of network files or origin-destination matrices.
- They provide a predictive method based on existing rail transit service and with demonstrated ability to match ridership relationships measured on those services
- They accommodate data and budget limitations that preclude development of major enhancements to existing four-step models.
- Results were submitted to a series of reasonableness checks by comparing to other existing BART ridership forecasts.

The eight models of interest to the Access BART study include:

1 - PM Peak Boardings

2 - Off Peak Boardings

3 - AM Peak Boardings

4 - Daily Boardings

5 - AM Walk + Bike Boardings

6 - Daily Walk + Bike Boardings

7 - AM Peak Auto Access Share

8 - AM Peak Park and Ride Share

The starting point for the Access BART models was the system-wide direct ridership model developed for the I-580 Corridor Transit Study. The model is sensitive to the number of station parking spaces and land use density (population and employment on all properties within a half mile of each station). The I-580 Corridor Transit model is effective across the system, as it is based on data from all existing BART stations. The A-Line study re-examined the I-580 Corridor Transit Study Data and equations using different data combinations to include distinct analysis of boardings versus alightings and mode-of-access as a function of employment density, retail density and residential density, parking supply, and local feeder bus service. The Access BART study further refined the models by adding separate equations to distinguish park-and-ride auto access from total access; distinguishing total auto access boardings by time of day; and modeling walk and bike access. The relationships of ridership to a wide range of variables were tested both individually and in combination.

3.4 Scenario Development

Of the many inputs into the Direct Ridership Model, two of the most important demographic variables include 1) population within a defined catchment area per station, and 2) population within a half-mile radius of each station.

Station catchment areas are determined by the 1998 systemwide survey of BART patrons which is the last comprehensive data set on BART passengers. The surveys asked numerous questions, two of which included the origin of the trip and the mode to reach the station. This information is used to establish the geographic area from which BART patrons are drawn. Maps of the catchment areas used in the Access BART study are included in the Appendix.

The half-mile radius around each station represents an approximately 500-acre area in which TOD would have the most benefit. Residents of TODs within the half-mile station area are more likely to use BART for their commute trip and walk or bike than residents living further away.

The station catchment area population figures are used as control totals. When population is allocated into or out of the ½ mile station area, the catchment area population is kept the same. The numbers shift up or down within the station area inverse to the station catchment area. This is apparent in the differences in land use inputs between Scenarios 1 and 2 that were tested, which are described in the next chapter. The SFO extension (South San Francisco to Millbrae) had a slightly different definition for station catchment area as there was no data from the 1998 survey to use for catchment area definition. Instead, BART's Operating Budgets Department defined the station catchment areas for these stations.

Employment figures as reported by ABAG in the *Projections '05* were used for the purposes of this analysis. Under Scenario 1, the ABAG distribution of jobs was used. For Scenario 2, the initial ABAG employment projection was redistributed from a general allocation across the region to a more concentrated allocation of growth around the key job centers in the region. Job growth in each corridor was focused around the existing job centers that were previously identified in MTC's Transit Oriented Development study. Historically, job growth occurs in and around existing job centers rather than generally across a region which is why the study team chose to redistribute the growth for study purposes. These reallocated employment figures were used in Scenarios 3 and 4.

The extensions studies for Access BART included:

- eBART – new rapid transit service from the existing Pittsburg / Bay Point BART station to East Contra Costa County;
- BART to Warm Springs
- Silicon Valley Rapid Transit (SVRT) – extension of BART from the new Warm Springs BART station to downtown San Jose and Santa Clara;
- Capitol Corridors – service enhancements between Sacramento and San Jose;
- Dumbarton Rail – new commuter rail service from Union City BART station to the Peninsula; and
- Oakland Airport Connector (OAC) – an automated people mover system connecting the Coliseum / Oakland Airport BART station to the Oakland International Airport
- West Dublin/Pleasanton station is also included in this scenario.

3.5 Congestion Factors and the DRM

MTC forecasts a 40% reduction in freeway travel speeds between 2000 and 2030. The eroding time performance of automobile travel results in a relative 40% improvement in BART service speed relative to competing auto modes. Additional service frequencies (from 4 to 5 trains per hour) also strengthen BART performance relative to the car. Congestion factors were applied and the results are reported in Section 4.

3.6 Access-Based Station Typology

Concurrent with the data collection for and development of the Direct Ridership Model, stations characteristics were studied to develop a set of station types (“typologies) to help group stations and understand them from an access perspective. The typologies are intended to be used in the development of access mode share targets. Access mode share targets in turn will guide investment strategies for BART.

A station typology report is included in the Appendix. The report consists of an introduction to the access elements that were taken into consideration, the typologies that were explored, the recommended access-based station typology, and suggested next steps. This section presents some of the highlights of the access-based station typology.

The access-based station typology consists of five station types, which are:

- Urban
- Urban with Parking
- Balanced Multimodal
- Auto Reliant
- Auto Dependent

Each of the five station types has a set of characteristics associated with it. There are three general categories of characteristics: 1) Scale, 2) Transportation Setting, and 3) Mode Share. Each characteristic used in the station typology is described below:

Table 4 – Scale

Characteristic	Measures	Description
Ridership	**Low: <5,000** **Moderate: 5,000-10,000** **High: >10,000**	This describes the ridership volume at a station, in weekday entries.
Station footprint	**Underground: 0** **Small: <10** **Medium: 10-20** **Large: >20**	The physical size of a station, including intermodal facilities and parking, in acres.

Table 5 – Transportation Setting

Characteristic	Measures	Description
Street network	**Urban grid / historic grid** **Suburban grid** **Suburban residential** **Suburban hillside**	The street network can help determine the station's setting. A downtown or urban area would be characterized by a closely-spaced rectilinear street grid, a suburban area could be either curvilinear residential street pattern, or it could be a large-block industrial grid pattern. More remote areas may have hillside development with a widely-spaced, curvilinear street network.
Proximity to freeway off-ramp	**Adjacent: <0.5 mi** **Nearby: 0.5-1.5 mi** **Far: >1.5 mi**	This measures how easy a commuter can reach a station from a highway. The number of miles from a highway off-ramp to the nearest parking lot entrance is reported. However, commute-direction off-ramps are preferred over non-commute-direction off-ramps, even if they require a longer travel distance.
Parking capacity	**No Parking** **Small: <700** **Medium: 700-1,800** **Large: >1,800**	A station, classified according to the total number of parking spaces at the station. Shared use parking is also considered as appropriate – when and where BART can pool parking resources with others.
Parking fill time	**No parking** **Before 8 a.m.** **After 8 a.m.** **Does Not Fill**	The time the parking spaces at a station fill, if applicable.
Transit service types	**Local** **Corridor** **Regional** **All**	A categorization based on the connecting transit modes that serve the station. • **Local:** shuttle bus or local feeder bus • **Corridor:** Rapid Bus, BRT, LRT, etc. • **Regional:** long-distance express bus, Transbay bus, commuter rail, etc. • **All:** a full range of connecting transit options
Number of buses per hour	**Low: <20** **Moderate: 20-45** **High: >45**	The number of buses serving the station per hour, during peak periods. This is calculated by multiplying the number of routes serving a station by the average service frequency.
Number of bus bays	**Small /on-street: 0-6** **Medium: 6-12** **Large: >12**	The number of bus bays serving the station. On-street bays are considered small, in that there is no possibility of redevelopment.

Characteristic	Measures	Description
Walk access share	**Low: <20%** **Average: 20-33%** **High: >33%**	The walk access mode share arriving at a station.
MTC regional hub?	**Yes** **No**	Whether a station is designated a regional hub via the MTC Transit Connectivity Study or if the station connects to a Resolution 3434 expansion project. Res. 3434 is the regionally agreed transit expansion policy and governs the expenditure of Federal New Starts funds in the region.

Table 6 – Mode Share

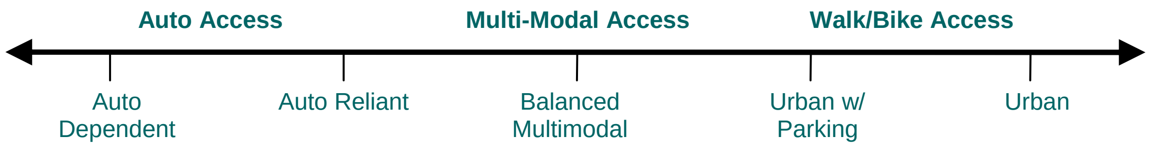
Characteristic	Measures	Description
Recommended mode share	**Auto** **Transit** **Walk** **Bike**	A set of recommended access targets by station type, based on the stations that fall within each type.

Together, these characteristics are used to help group stations into typologies. The matrix of the station types and their associated characteristics is summarized on the following page.

Access-Based Station Typology Matrix

Descriptors	Scale		Transportation Setting									Mode Share Range
Characteristic:	**Ridership**	**Station footprint**	**Street network**	**Proximity to freeway off-ramp**	**Parking capacity**	**Parking fill time**	**Transit service types**	**Number of buses per hour**	**Number of Bus Bays**	**Walk access share**	**MTC regional hub?**	**Range of Mode Shares**
Measure:	Weekday Entries	Physical Size	Description	Distance from highway exit to station	Spaces	Time	Service Areas/Types	# of buses per hour	# of bays	Access share	MTC designated regional hub	% by mode
Description of Measures:	Low: < 5,000 Moderate: 5,000 - 10,000 High: > 10,000	Underground: 0 Small: < 10 Medium: 10 - 20 Large: > 20	Urban grid / historic grid Suburban grid Suburban residential Suburban hillside	Adjacent: <0.5 mi Nearby: 0.5-1.5 mi Far: >1.5 mi	No Parking Small: <700 Medium: 700 - 1,800 Large: >1,800	No parking Before 8 a.m. After 8 a.m. Does Not Fill	Local Corridor Regional All	Low: < 20 Moderate: 20-45 High: > 45	Small/on-street: <6 Medium: 6-12 Large: >12	Low: <20% Average: 20-33% High: >33%	Yes/No	%
Proposed Station Types												
Urban	High	Underground or Small	Urban grid/ historic grid 	Far	No Parking	No parking	All	High	Small/on-street	High	Yes	Auto: 10-16 Transit: 33-42 Walk: 41-47 Bike: 2-3
Urban w/ Parking	High	Underground or Small	Urban grid/ historic grid 	Far	Small	Early	All	High	Small/on-street	High	Yes	Auto: 39-45 Transit: 17-23 Walk: 31-37 Bike: 3-4
Balanced Intermodal	Moderate	Small or Medium	Urban grid/ historic grid, surburban grid 	Far or Nearby	Small or Medium	Early	Corridor, Local	Moderate or High	Medium or Large	Average	No	Auto: 54-60 Transit: 17-23 Walk: 17-23 Bike: 2-3
Intermodal - Auto Reliant	Moderate	Medium	Suburban grid, suburban residential 	Adjacent or Nearby	Medium or Large	Morning	Local, Regional	Moderate	Medium or Large	Low	Yes	Auto: 70-76 Transit: 13-19 Walk: 7-13 Bike: 1-2
Auto Dependent	Low - Moderate	Large	Suburban residential, suburban hillside 	Adjacent	Medium or Large	Morning	Local	Low	Small or Medium	Low	No	Auto: 76-82 Transit: 8-14 Walk: 5-11 Bike: 1-2

The station types have been developed with the broad range of BART stations in mind. Generally, station access can be placed on a spectrum which ranges from auto-based access to transit-based access to walk/bike-based access. The station types provide logical groupings at main points along this access spectrum.



Each station type is described below.

1. Urban

This station type is a high-ridership station with a high walk, bike, and transit access share and no parking. Almost all auto access is from drop-off activity; highway access is not convenient. The station can be often found in a downtown or neighborhood business district. The street system is typically an urban or historic grid. The station may be underground or otherwise has a smaller footprint than a typical BART station. The station is well-served by many types of transit service that stop on adjacent streets.

2. Urban with Parking

This station type has the same characteristics as "Urban" station type with the exception of parking. Stations included in this category have small parking lots with limited spaces which fill up in the early morning. A higher auto share than found at Urban stations exists at Urban with Parking. Transit shares tend to me lower as many of the patrons accessing these stations arrive by walking or bicycling rather than riding transit.

3. Balanced Multimodal

A multimodal station is well-served by transit, though there might be some provision for parking on a small or medium size station footprint. The station would typically be found on an urban or suburban grid network. A medium-to-large transit terminal is provided on-site, serving primarily corridor and local transit. Walk access is about average. Parking spaces fill early because the parking lot is not very large.

4. Auto Reliant

Although this station type is also well-served by transit, there is more provision for parking on a medium size station footprint. The station would be found in a suburban grid or suburban residential area. A medium-to-large transit terminal is provided on-site, serving regional and local transit; the station is probably designated a regional transit hub. Walk access is lower than average. Parking spaces do not necessarily fill early because there is a large amount of parking. Nonetheless, parking utilization rates are high.

5. Auto Dependent

This station represents the highest level of investment in auto-based access. With a large station footprint, structured and/or surface parking, and adjacent highway access, the station's ridership is considered low to moderate. The large footprint may also allow for a small to moderate-sized multimodal station. For many stations with parking garages, transit and walk mode shares vary widely. Walnut Creek, Daly City, and Fruitvale all have structured parking but they also have high levels of transit use and walk access. Other stations with structured parking such as Colma have little utilization of alternative modes. It is important to note that a station which is considered Auto Dependent is predominantly an auto-only station with lower levels of transit use and walk access.

3.6.1 Station Type Mode Shares

Each BART station was classified according to the station typology. One of the results of the classification is the following table, which shows the range of access mode shares represented by the stations within each station type.

Table 7 – Access Type Mode Share Ranges Based on 1998 Survey[1]

Access Type Mode Share Ranges Based on 1998 Survey						
	Access Mode Share Ranges (Weekday Home Origins) (%)					
	AM Peak			Daily		
Station Type	**Auto**	**Transit**	**Walk & Bike**	**Auto**	**Transit**	**Walk & Bike**
Urban	10-16	36-42	45-51	6-12	17-23	69-75
Urban with Parking	40-46	17-23	34-40	33-39	19-25	39-45
Balanced Multimodal	57-63	17-23	17-23	47-53	25-31	20-26
Auto Reliant	71-77	12-18	9-15	61-67	17-23	13-19
Auto Dependent	78-84	7-13	6-12	70-76	9-15	12-18

Table 8 – Access Type Mode Share Ranges Based on DRM Results

Access Type Mode Share Ranges Based on DRM Results, Scenario #3						
	Access Mode Share Ranges [2]					
	AM Peak			Daily		
Station Type	**Auto**	**Transit**	**Walk & Bike**	**Auto**	**Transit**	**Walk & Bike**
Urban	6-12	32-38	52-58	2-8	17-23	72-78
Urban with Parking	40-46	17-23	35-41	30-36	18-24	43-49
Balanced Multimodal	62-68	14-20	15-21	48-54	18-24	25-31
Auto Reliant	69-75	13-19	16-22	59-65	12-18	20-26
Auto Dependent	77-83	7-13	7-13	67-73	5-11	19-25

[1] Totals may not equal 100% due to rounding within each category.
[2] Totals may not equal 100% due to rounding within each category.

In Fall, 2005 and Spring, 2006, BART conducted passenger surveys at selected stations. The daily mode share at those stations is shown below.

Table 9 – Mode Share Examples from 2005/2006 Access Surveys

Mode Share Examples from 2005/2006 Access Surveys[3]				
		Access Mode Share (Daily) (%)		
Station	**Existing Station Type**	**Auto**	**Transit**	**Walk & Bike**
Bay Fair	Balanced Multimodal	54	21	25
Daly City	Balanced Multimodal	45	40	15
Dublin/ Pleasanton	Auto Dependent	88	6	5
Lake Merritt	Urban w/ Parking	28	11	60
MacArthur	Urban w/ Parking	24	39	36
South Hayward	Auto Reliant	64	12	24

[3] Totals may not equal 100% due to rounding within each category.

3.7 Scenario Development

Using information from the station profiles, the internal BART workshops, and consultations with local jurisdictions and transit operators, a set of four scenarios was developed that could be tested using the Direct Ridership Forecasting Model. Effort was focused on selecting scenarios that would test a wide enough range of alternatives while still allowing enough overlap to observe the effects of individual policy changes between scenarios. As such, the numbers used in the scenarios were test cases and did not represent specific policy recommendations.

The three key policy variables desired to be tested were:

- **TOD (Transit-Oriented Development)** – the intensity of transit-oriented development, represented as the number of households within a 1/2–mile radius of each station;
- **Access Approach** – whether parking supply at a station would be reduced as a result of TOD, replaced (kept the same as existing), or augmented; and potentially whether transit service would increase on key routes;
- **Extensions** – how ridership would change based on demand from four potential regional rail extension projects – eBART, Silicon Valley Rapid Transit (SVRT), Warm Springs, West Dublin/Pleasanton, Dumbarton Rail, and Oakland Airport Connector (OAC).

The four scenarios that were assembled were:

Table 10 – DRM Scenarios – Horizon Year 2030

#	Scenario	Land Use Input	Access Approach	Extensions
1	ABAG 2030	ABAG P2005	Existing Access Characteristics	No
2	Refined ABAG 2030	Modified ABAG P2005	Existing Access Characteristics	No
3	Access Enhancements	Modified ABAG P2005	Access Enhancements Investments	No
4	Extensions	Modified ABAG P2005	Access Enhancements Investments	Yes

The components of each scenario are described below. The growth forecasts for population and employment were developed using ABAG ’05 Projections. ABAG reports projections by census tract. In order to use these forecasts in transportation analysis, the forecast must be broken down into Travel Analysis Zones (TAZ) which is done by MTC. In most cases, the census track and the TAZ are the same. For the Access BART study, TAZ level data was used. To determine population and employment within the ½ mile around the station, population and employment projections were pro-rated to this area from the larger geographic TAZ boundaries. Population totals throughout were controlled by the larger catchment areas determined by the BART 1998 survey.

The catchment area populations were constant among scenarios and population was reallocated from the catchment area to the ½ mile in some cases as described below.

The Appendix contains details for these variables on a station-by-station basis. Focusing on the system as a whole, the four scenarios may be characterized as follows.

3.7.1 Scenario #1 – ABAG 2030

Scenario #1 used the Association of Bay Area Governments (ABAG) *Projections 2005* estimate of future employment and households in the year 2030. *Projections 2005* is a refinement of *Projections 2003*, which was ABAG's first attempt to allocate regional growth using a policy-tempered "smart growth vision." In *Projections 2005,* ABAG considered existing land use policies and land availability, but also emphasized a regional policy of intensified growth on infill parcels to reduce the development of sprawling communities. TAZ-level data is derived from ABAG Projections 2005 (reported as census tracts by ABAG and converted to Travel Analysis Zones by MTC) was pro-rated to the ½ mile station area based on land area. In Projections 2005, ABAG considered existing land use policies and land availability, but also emphasized a regional policy of intensified growth on infill parcels to reduce the development of sprawling communities. Relative to 2000 land use, station-area population is projected to grow by 39%, while the average population growth over the entire BART catchment area is 19%. Station-area non-retail employment grows by approximately 25% and retail employment by 27%. As shown in the Appendix, in percentage terms, 2030 TOD increases are most dramatic at West Oakland, Union City, Coliseum, and Pittsburg / Bay Point. The land use changes are lowest at Lafayette, Orinda, and North Berkeley. Employment figures for West Oakland are likely to be overstated due to the proximity of the station to the Port of Oakland and the reporting of Oakland jobs figures in the TAZ.

3.7.2 Scenario #2 – Refined ABAG 2030

This scenario presents a refinement of the ABAG forecast. The scenario differs in two important ways: i) a supply check was made against TOD projections to ensure that enough developable land was available to accommodate the forecast, and ii) employment forecasts were reallocated to existing employment centers from a more generalized approach used in Scenario 1. These reallocations resulted in lower forecast on the Richmond Line in comparison to ABAG and a reallocation of growth away form stations such as 16th Street Mission to downtown San Francisco, and other stations in the East Bay to downtown Oakland, Berkeley, Walnut Creek and Concord. Relative to 2000 land use, this alternative assumes a 46% increase in population within a half-mile of BART stations, compared with 39% for the Scenario 1 ABAG projections. Scenario 2 assumes the same increase in catchment population as Scenario 1 (19%). Scenario 2 assumes a slightly lower growth in employment than Scenario 1 (24% and 23% for non-retail and retail respectively). Employment growth occurs most frequently around existing job centers. New job centers take a long time to emerge. The ABAG forecast distributed future job growth throughout the region and this was used in the first scenario. For Scenarios 2 – 4, the employment forecast was redistributed from area wide growth to growth around the existing job centers to reflect existing trends.

3.7.3 Scenario #3 – Access Enhancements

Scenario 3 uses the land use scenario from Scenario 2 and makes selective changes to station area parking and bus service in support of the higher intensity transit-supportive land use associated with the refined land use. Station area population and employment growth are the same as Scenario 2. Parking is reduced or increased at selected stations for an overall core BART system (38 stations) or no net change, and a decrease of 14%, or 1100 spaces on the Colma to Millbrae line (5 stations), as compared to 2005 parking supply. Feeder bus frequency is assumed to increase by 8% over year 2000.

3.7.4 Scenario #4 – Extensions

This scenario used the same land use and access enhancements investments from Scenario #3, namely the increased parking and increased bus service levels.

In addition, the anticipated ridership from regional rail extension projects was incorporated. Specifically, the extensions included:

- eBART – new rapid transit service from the existing Pittsburg / Bay Point BART station to East Contra Costa County;
- BART to Warm Springs
- Silicon Valley Rapid Transit (SVRT) – extension of BART from the new Warm Springs BART station to downtown San Jose and Santa Clara;
- Capitol Corridors – service enhancements between Sacramento and San Jose;
- Dumbarton Rail – new commuter rail service from Union City BART station to the Peninsula; and
- Oakland Airport Connector (OAC) – an automated people mover system connecting the Coliseum / Oakland Airport BART station to the Oakland International Airport
- West Dublin/Pleasanton station is also included in this scenario.

Parking supply was expanded to accommodate the new extensions with an additional 4,150 spaces systemwide.

3.8 Summary of Inputs

The table below summarizes the primary land use and access inputs for each of the scenarios and compares each scenario's change to the baseline year 2000.

Table 11 – 2030 System-Wide Land Use, Station Parking and Bus Service

2030 SYSTEM-WIDE LAND USE, STATION PARKING AND BUS SERVICE

Variable	Numerical Value					Change from 2000			
	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	2000	ABAG	Refined ABAG	Refined ABAG + Access	Extensions	ABAG	CTOD	CTOD + Access	Exten-sions
1/2 Mile Population	389,919	540,423	568,683	568,683	572,892	39%	46%	46%	47%
Catchment Population	3,386,351	4,039,883	4,039,883	4,039,883	4,039,883	19%	19%	19%	19%
1/2 Mile Non-Retail Emp.	747,912	933,736	926,626	926,626	930,751	25%	24%	24%	24%
1/2 Mile Retail Emp.	62,489	79,066	76,994	76,994	83,148	27%	23%	23%	33%
Feeder Transit	1,503	1,495	1,495	1,622	1,636	-1%	-1%	8%	9%
Parking Spaces - Core System	36,724	36,724	36,724	37,624	41,974*	0%	0%	2%	11%
Parking Spaces - Colma to Millbrae	7,712	7,712	7,712	6,612	6,612	0%	0%	-14%	-14%
Parking Spaces - Total System	44,436	44,436	44,436	44,436	48,586	0%	0%	0%	9%

Source: Fehr & Peers, 2006.

Notes:

- San Francisco International Airport (SFO) station is not included in the totals due to the unique attributes of the airport and land uses in the area. Thus, it was not modeled.
- West Dublin / Pleasanton was only included in Scenario 4 (Extensions)
- Totals for the Base Scenario include 2000 totals for the core system and Colma, and 2005 totals for South SF, San Bruno, and Millbrae
- Some transit service declines due to limited funding for operating service forecast through 2030

* Inclusive of 1,100 parking spaces at West Dublin/Pleasanton.

4 Analysis Results

The summary results are provided in this chapter. A detailed discussion of the modeling inputs and results is included in the Appendix.

A total of eight analyses were developed for the Access BART study. They are:

1 - PM Peak Boardings

2 - Off Peak Boardings

3 - AM Peak Boardings

4 - Daily Boardings

5 - AM Walk + Bike Boardings

6 - Daily Walk + Bike Boardings

7 - AM Peak Auto Access Share

8 - AM Peak Park and Ride Share

Summarized by scenario, the results for each model are shown in the table below.

Table 12 – 2030 System-Wide Land Use, Station Parking and Bus Service

SUMMARY OF SYSTEM TOTALS (ALL STATIONS INCLUDED)

	Numerical Value					Change from 2000			
Model	Base	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 1	Scen. 2	Scen. 3	Scen. 4
1 - PM Peak Boardings	97,933	130,080	130,131	130,131	148,831	33%	33%	33%	52%
2 - Off Peak Boardings	133,333	167,084	168,462	174,165	202,467	25%	26%	31%	52%
3 - AM Peak Boardings	90,226	103,790	105,012	107,526	125,788	15%	16%	19%	39%
4 - Daily Boardings	324,537	408,208	410,859	419,076	484,771	26%	27%	29%	49%
5 - AM Walk + Bike Boardings	18,769	27,142	28,408	27,167	30,329	45%	51%	45%	62%
6 - Daily Walk + Bike Boardings	151,779	215,006	217,181	215,765	243,259	42%	43%	42%	60%
7 - AM Peak Drive Alone Share	56.65%	54.81%	54.31%	54.10%	56.21%	-3%	-4%	-4%	-1%
8 - AM Peak Park and Ride Share	80.14%	81.06%	80.98%	81.03%	82.05%	1%	1%	1%	2%

Source: Fehr & Peers, 2006.

Source: Fehr & Peers, 2006.

- The Base numbers for Models 1-3 include 2000 totals for the core stations and Colma, and 2005 totals for South San Francisco, San Bruno, and Millbrae
- The Base number for Model 4 includes 2000 totals for the core stations and Colma, and 2005 totals for South San Francisco, San Bruno, and Millbrae, and San Francisco International Airport
- The Base numbers for Models 5, 6, 7 and 8 do not include South San Francisco, San Bruno, or Millbrae, because no data was available
- Daily Boardings is the only total that includes the SFO station, so Daily boardings are slightly higher than the sum of boardings from Models 1-3
- Scenario 4 totals does not include riders that stay internal to the eBART or SRVT Extensions, or riders that board at extension stations and alight at core stations.
- West Dublin / Pleasanton was only included in Scenario 4 (Extensions)
- In all future scenarios, PM peak period ridership is projected to grow at a higher rate than AM peak period ridership. Some possible explanations for this are:
    - AM peak period ridership is constrained by parking supply to a greater degree than is ridership in the PM peak period.
    - AM peak period ridership is primarily for commuting purposes, whereas PM peak period ridership attracts a more diverse market, including evening social activities. These purposes represent greater and greater shares of regional travel over time.
    - An increase in flexible working hours will shift ridership growth away from its most congested period, the AM peak.
    - In percentage terms, employment growth near downtown San Francisco stations (a primary generator of AM boardings) is projected to grow at a lower rate than retail, residential and employment at other stations in the system (primary generators of PM boardings).
    - To a minor extent, the continued use of casual carpooling may continue to result of higher BART use in the PM for commuting than in the AM.
-

The Access BART daily ridership forecasts presented above compare closely with 2030 forecasts prepared by MTC and are within about 8% of forecasts produced using BART's Dovetail model. To compare on a common basis, the Access BART DRM forecasts need to be adjusted to take into account two factors considered in the MTC and Dovetail forecasts: intra-line trips on the eBART and San Jose extensions, and the effects of increased freeway congestion and increased train service.

Figure 3 presents historic trends in BART ridership drawn from the Short Range Transit Plan. These ridership trends are then forecast through 2030. Compared to the trend line of actual ridership are the four BART scenarios tested with the Direct Ridership Model. As discussed above, the Access BART forecasts are somewhat lower than what was reported in the SRTP.

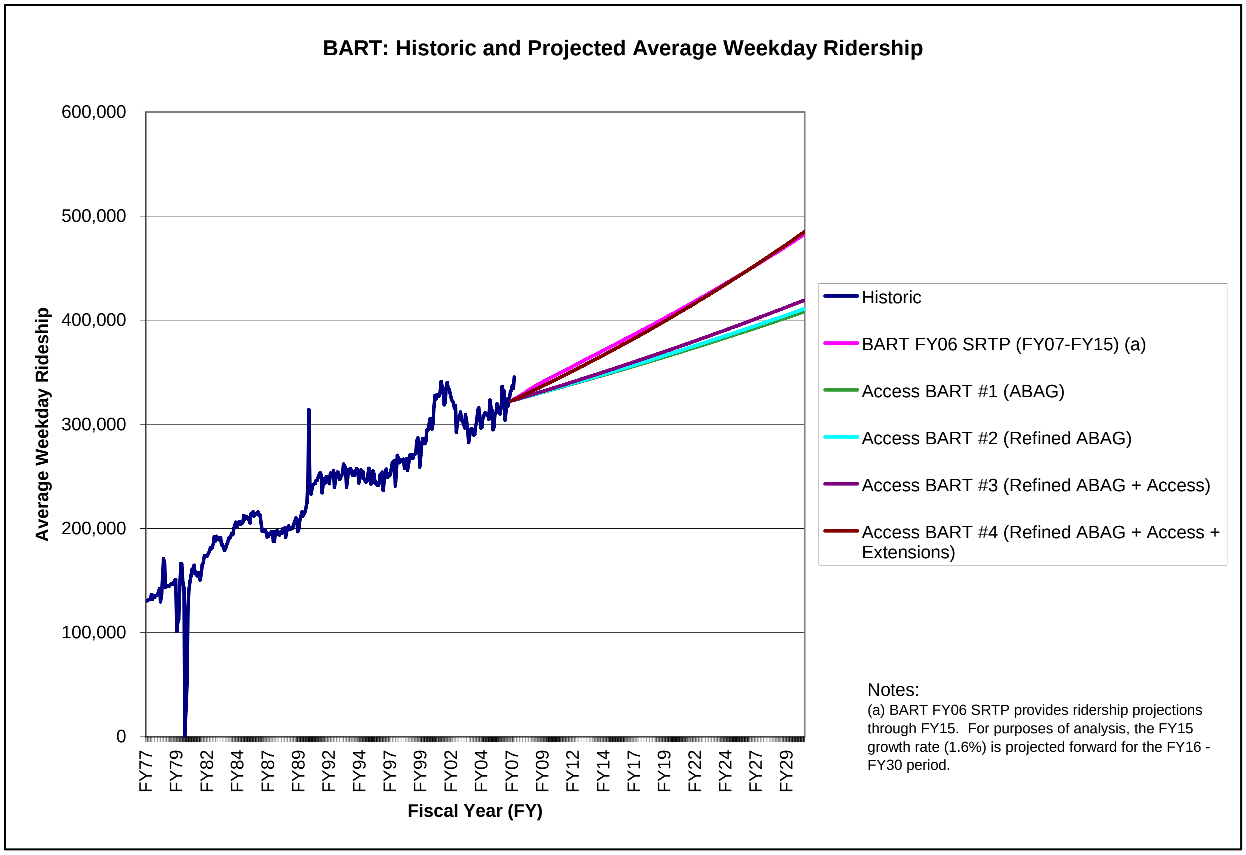


Figure 4 – Historic Ridership Trends and Ridership Forecasts

The Scenario 4 forecast of about 445,000 riders per day produced by the DRM does not include riders that stay internal to the eBART or San Jose extensions. If those riders are added (1,400 for eBART and 42,500 for San Jose), the total daily ridership for 2030 under Scenario 4 becomes approximately 489,000. It should be noted that riders that board at an extension station and alight at an existing station are already counted in the Scenario 4 forecast on their return trips, when they board at the existing station.

Another difference between the DRM forecasts and MTC's 2005 Regional Transportation Plan (RTP) forecast relates to the effects of highway congestion on the forecasts. Both the MTC and Dovetail forecasts take into account the effects of highway congestion in BART corridors, which will degrade times and the attractiveness of auto. To adjust the Access BART forecasts to account for this condition, Fehr & Peers calculated elasticities using the ACCMA and CCTA models that indicate the effect on ridership of changes in core BART service speed and frequency:

- Ridership elasticity with respect to core BART service speed : 0.20
- Ridership elasticity with respect to core BART service frequency: 0.04

MTC forecasts a 40% reduction in freeway travel speeds between 2000 and 2030. This decline in freeway speed results in a relative improvement in BART operating speeds of 40% (BART speeds being constant but improved in comparison to freeway speed). This change in relative performance would add 8% to BART ridership. If BART service frequencies improve by 25% (from 4 trains per hour to 5 trains per hour), one could expect another 1% increase in ridership. Thus, a forecast that accounts for highway conditions and BART service improvements would be about 9% higher than the basic DRM forecast, which does not account for such improvements. Applying this 9%, factor results in a service-adjusted system-wide ridership estimate of 533,000.

As shown in Table 12, the comparable DRM forecast is within about 1% of the MTC RTP forecast of 540,000.

The Table also indicates that the Access BART forecast is about 8% lower than the BART Dovetail forecasts that include the VTA extension and adjustments for BART service frequency and speed improvements, better traveler information systems, and increases in freeway congestion. Reasons that predicted DRM boardings are slightly lower than Dovetail forecasts include:

- the fact that DRM forecasts are based solely on station-of-origin data, and may not fully account for boardings related to the corresponding return trips.
- The Dovetail model doesn't account for access constraints

A recent independent review of the Dovetail model forecasts for an individual expansion station concluded that the model may systematically over-predict ridership to a modest degree, concluding that for a specific group of three stations, the best boardings forecasts would be somewhere between the Dovetail estimate and a number about 22% lower than the Dovetail estimate.

Overall, we conclude that the system ridership forecasts produced by the DRM for Access BART are very close (within about 5%) of the forecasts produced by the best alternate forecasting methods.

Table 13 – Systemwide Daily Ridership Comparisons*

Access BART Direct Ridership Forecasts	BART Dovetail Forecast	MTC 2005 RTP Update
533,000	575,000	540,000
* Includes eBART and San Jose extensions		

5 Access Improvements

One of the outcomes of the access-based station typology is the ability to prioritize access improvements. The study team investigated a possible prioritization scheme by examining the 20 East Bay stations, devising access improvement strategies for each station, and grouping them by station type. The five station types are:

- Urban
- Urban with Parking
- Balanced Multimodal
- Multimodal-Auto Reliant
- Auto Dependent

While these typologies were derived using the East Bay stations for the development of typologies, they can be applied to stations throughout the system.

5.1 Access Priorities by Station Type

It is in BART's best interest to concentrate access improvements where ridership potential is optimized and where mode shift objectives can be realized. Ultimately, these decisions are made on a station by station basis, and improvement by improvement basis. However, the table below summarizes a general priority scheme for investments by station type. It shows that to meet both ridership and mode shift objectives, efforts to strengthen the middle tier of stations are the highest priority, particularly from an opportunity cost perspective.

Urban stations already have high rates of access by walk, transit and bike. Mode shares for these stations won't greatly change these rates in most cases as they are already the predominant mode of access. When ridership increases over time, it is likely to be distributed across the current modal categories. Development within walking distance of the station is a much more effective tool to increase overall patronage, but BART has a very limited role in encouraging this development. Urban parking lots are generally too small to have a major impact on patronage through transit-oriented development, although reuse may meet other public policy objectives. Access investment choices should be oriented around better bicycle and pedestrian connections, neighborhood wayfinding, land use intensification, and station capacity enhancements.

Urban with parking stations are also in environments where walking, bicycling and transit are dominant forms of access with a limited supply of parking for those who choose to drive to BART. Mode shares for these stations are also heavily oriented towards alternative forms of transportation and ridership increases over time are likely to be distributed across the same modal groups. Urban parking lots are generally too small to have a major impact on patronage through transit-oriented development, although reuse may meet other public policy objectives. Access investment choices should be oriented around better bicycle and pedestrian connections, neighborhood wayfinding, land use intensification, and station capacity enhancements.

The **Balanced Multimodal**, and to a lesser extent the **Auto Reliant**, have the greatest potential for mode share shift (and, therefore reclassification) due to their locations in suburban settings where the existing grids can be strengthened. From a BART perspective, the station site itself can be an effective agent to strengthen connectivity, through strategic development of transit villages, more effective pedestrian paths, and additional bus services linking surrounding neighborhoods to the station site. Expanded feeder buses and local shuttles also hold the potential to redistribute access mode shares as demonstrated by DRM results where office development is coupled with shuttle services and based on experiences at stations such as MacArthur where the Emery Go Round has had a measurable effect of mode share ranges which is reported above.

Likewise, for **Auto Dependent** stations, the low density land use environment of the station environs determines that access improvements are not effective in encouraging much mode share shift in the short term. For some of these stations, however, future development within the station area can strengthen long term patronage prospects.

Table 14 – 2030 System-Wide Land Use, Station Parking and Bus Service

Station Type	Rider-ship	Street Network	Walk Mode Split	Transit Mode Split	Development Potential (on and off-site)	Priority Access Actions
Urban	High	Urban	Very High (44%)	High (39%)	Moderate / High	Limited ability for further mode shift through bike/transit improvements, focus on patronage growth
Urban w/Parking	Moderate / High	Urban	High (34%)	Moderate (20%)	Low / Moderate	Limited ability for further mode shift; focus on patronage growth
Balanced Multimodal	Moderate	Urban / Suburban	Moderate (20%)	Moderate (20%)	Low / Moderate	Strengthen pedestrian and transit connections, encourage transit villages. Focus on mode shift potential.
Auto Reliant	Moderate	Suburban / Suburban residential	Low (10%)	Low / Moderate (16%)	Moderate	Strengthen pedestrian and transit connections. Ensure adequate roadway and parking capacity. Focus on mode shift potential where possible.
Auto Dependent	Low / Moderate	Suburban residential / suburban hillside	Low (8%)	Low (11%)	Variable – very low to high	Strengthen transit, (focus on future land use). Potential parking expansion and roadway capacity enhancements.

A list of recommended access projects has been developed during the course of the Access BART study.

5.2 Methodology for Assessing Replacement Parking Issues

BART commissioned the development of an access methodology in 2004/2005 that culminated in a report entitled *Replacement Parking for Joint Development: An Access Policy Methodology* (BART, April, 2005). That report includes an access and TOD spreadsheet model (Access Policy Methodology) for assessing alternatives to the 1:1 replacement of commuter parking at stations. The assessment framework examines alternative TOD/replacement parking/access scenarios, tallying new revenues associated with fares, parking, ground rent, and partnerships. On the cost side, the model incorporates changes in BART operating costs, parking operating costs, and other expenditures. This quantitative information is placed in the context of broader BART goals. This methodology was presented to the BART Board as part of the TOD Policy that was adopted in 2005.

Since that time, BART has gained experience in applying the Access Policy Methodology model to BART decisions concerning station area land. In addition, BART commissioned the A-Line Study (2005) and this Access BART report (2006), which includes more detailed modeling of factors to predict station-level ridership responses to changes in station area population, employment, and access.

The methodology model has been refined to respond to issues that have arisen in the implementation of the methodology as well as consideration of the forecasting capabilities of the Direct Ridership Model (DRM). The revised methodology provides the following:

- expanded capabilities to assess impacts outside the BART land;
- discussion of the sensitivity of the model to land value and ways of addressing those issues; and
- guidance on considering a wider range of land use types for TOD development and improved ridership estimation procedures.

The specific changes are detailed in a technical report contained in the Appendix. The technical report is intended to be a companion to the April 18, 2005 *Replacement Parking for Joint Development: An Access Policy Methodology* report.

6 Peer Region Comparison

Typically, ridership on transit agencies peaks during the morning and afternoon commuting rush hours, and falls drastically during the intervening periods. Operations, fleet, and staff procurement are based on peak-period demand. Throughout the rest of the day, however, operational capacity is underutilized. As such, many operators and transport-related agencies have sought to increase off-peak ridership through policy as well as planning measures to take advantage of the excess capacity during the off-peak.

To encourage off-peak ridership, a potentially powerful tool can be the application of land use and transit-oriented development (TOD) principles, especially along rail transit corridors. Coupled with land use intensification, access services and investments help strengthen ridership in off peak periods. BART expressed an interest in exploring how land use and TOD have been implemented elsewhere (in a system and corridor level, not just at single stations) and what the resulting impact has been on the ridership profile of the related operators.

The study team prepared a memo for BART which: (i) provides an overview of the system and ridership profiles of BART and two comparable transit operators in North America (Vancouver's SkyTrain and Toronto's Rocket); and (ii) highlights key policy and planning measures that have influenced the ridership profiles on the comparison operators – which may be applicable to BART and its future development programs.

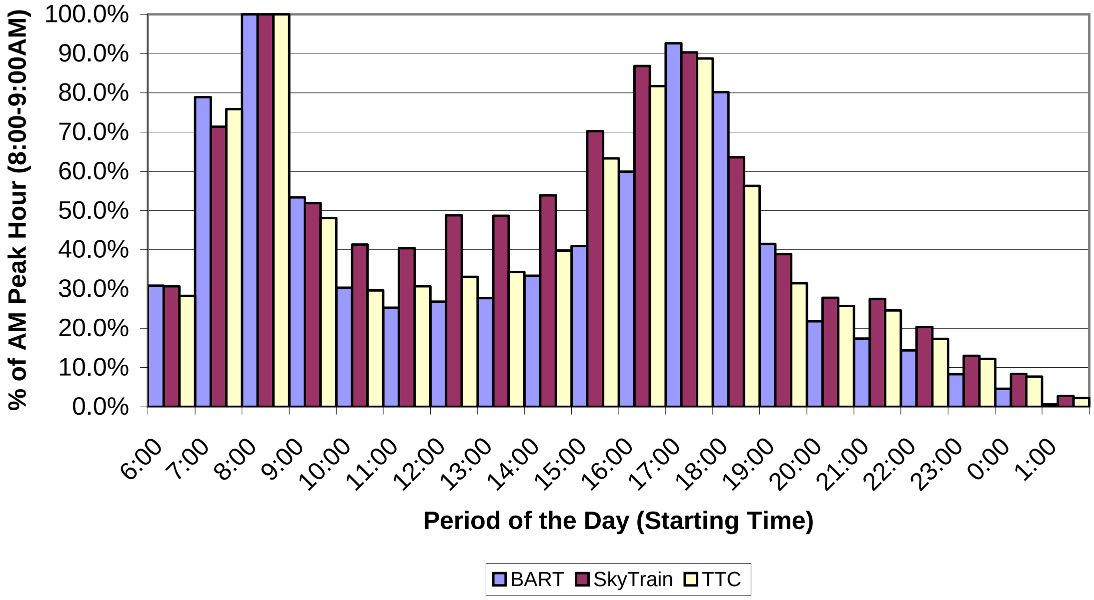
The key findings from this analysis are as follows:

- All operators have a pronounced peak and off-peak period;
- SkyTrain and the Rocket, however, exhibit greater off-peak utilization compared to BART (when comparing hourly demand versus the peak morning demand), with SkyTrain, in some cases, having 20% more ridership compared to its morning peak than BART does during the off-peak; and

- One potential explanation for this is that SkyTrain and the Rocket operate in regional metropolitan areas where adopted inter-connected land use and TOD policies to encourage development around stations and on corridors served by rail transit modes.
- SkyTrain offers 1,200 parking spaces, the Rocket offers approximately 14,000 spaces while BART offers nearly 47,000 parking spaces in the system

The following chart displays hourly demand normalized against the busiest peak period (the morning peak for all operators).The two cases cited are only a few examples of how a comprehensive transit system, combined with appropriate land use and transit-oriented development can influence travel behavior and demand (in this case, off-peak and total transit ridership).

Table 15 – Peer Region Comparison of Ridership Profiles



The lessons learned in Vancouver, Toronto, and other cities around the world can facilitate discussion and subsequent development of comprehensive, area-wide growth plans to stimulate transit-reliant corridors, encourage transit usage, and decrease automobile reliance – all of which serve to better utilize the existing untapped capacity of transit in the Bay Area. BART, with its well-established heavy rail infrastructure, is in excellent shape to capitalize on these developments, particularly in the non-commuting hours of the day.

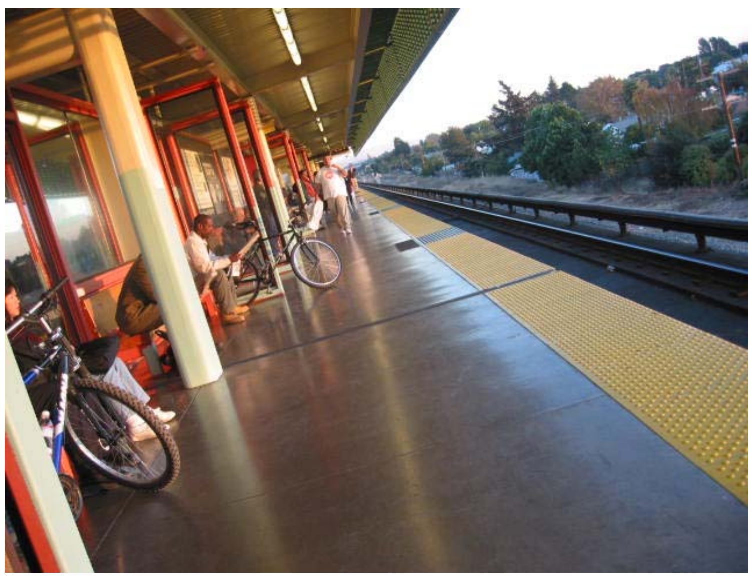
Other factors may be attributed to this pattern such as the limited parking supply or the nature of how the transit system is operated in the region. For example, in Vancouver many of the bus transit lines feed the SkyTrain system. Both operators, however, attribute one of the main influencers of this ridership pattern to the characteristics of land use in their region.

The full memo is included in the Appendix.

The other important finding from the comparison is the relationship of demand in midday and evening periods relative to the peak hours. As the table below illustrates, midday and evening shares of riders are higher in both Vancouver and Toronto. Management at both properties report their land use patterns result in more off peak and evening ridership when compared to systems with more dispersed land use patterns.

Table 16 – 2030 System-Wide Land Use, Station Parking and Bus Service

Ridership by Time of Day, Compared to AM Peak				
	Time Period			
System	**AM**	**Midday**	**PM**	**Evening**
BART	100%	< 30%	90%	< 20%
SkyTrain	100%	40% - 50%	90%	28%
TTC	100%	> 30%	90%	25%



Next Steps

With the Access BART study completed, BART has a strong analytical base from which it can create compelling discussions with local jurisdictions and transit operators. BART also has implementation tools it can apply. The actions are reflected in the recommended next steps outlined below:

- Apply the methodology to assess the benefit to BART for TOD/Transit-Oriented Development as outlined in *Replacement Parking for Transit-Oriented Development.*
- Begin implementing the project lists associated with the station typology report.
- Review the Access BART study findings with local jurisdictions.
- Begin a planning approach for working with local jurisdictions where TOD is estimated to have a strong influence on ridership to try to achieve the ABAG projections. Comprehensive station planning and access planning might be the most appropriate path for stations such as North Concord, MacArthur, San Leandro, Berkeley, Lake Merritt, or Bay Fair to name a few where rapid change or existing needs warrant a more in depth investigation of station issues.
- Work with local transit operators to more effectively design and manage multimodal stations.
- Seek funding for a systemwide passenger survey and update BART passenger profiles accordingly.
- When initiating CEQA review for Transit Oriented Developments on BART property or in the area around BART stations, develop a station access plan to complement the new development and accommodate future growth.
- Continue to monitor and evaluate regional growth strategies and align part station area planning activities with long-term regional growth initiatives. Alternatively, ensure the region accounts for BART station and systemwide capacity needs in corridors where future development is desired.

The Access BART study is a foundational analytical piece which supports the policy direction taken by BART in recent years and can be used to help influence thinking about mobility and implementation of a different growth pattern for the region.