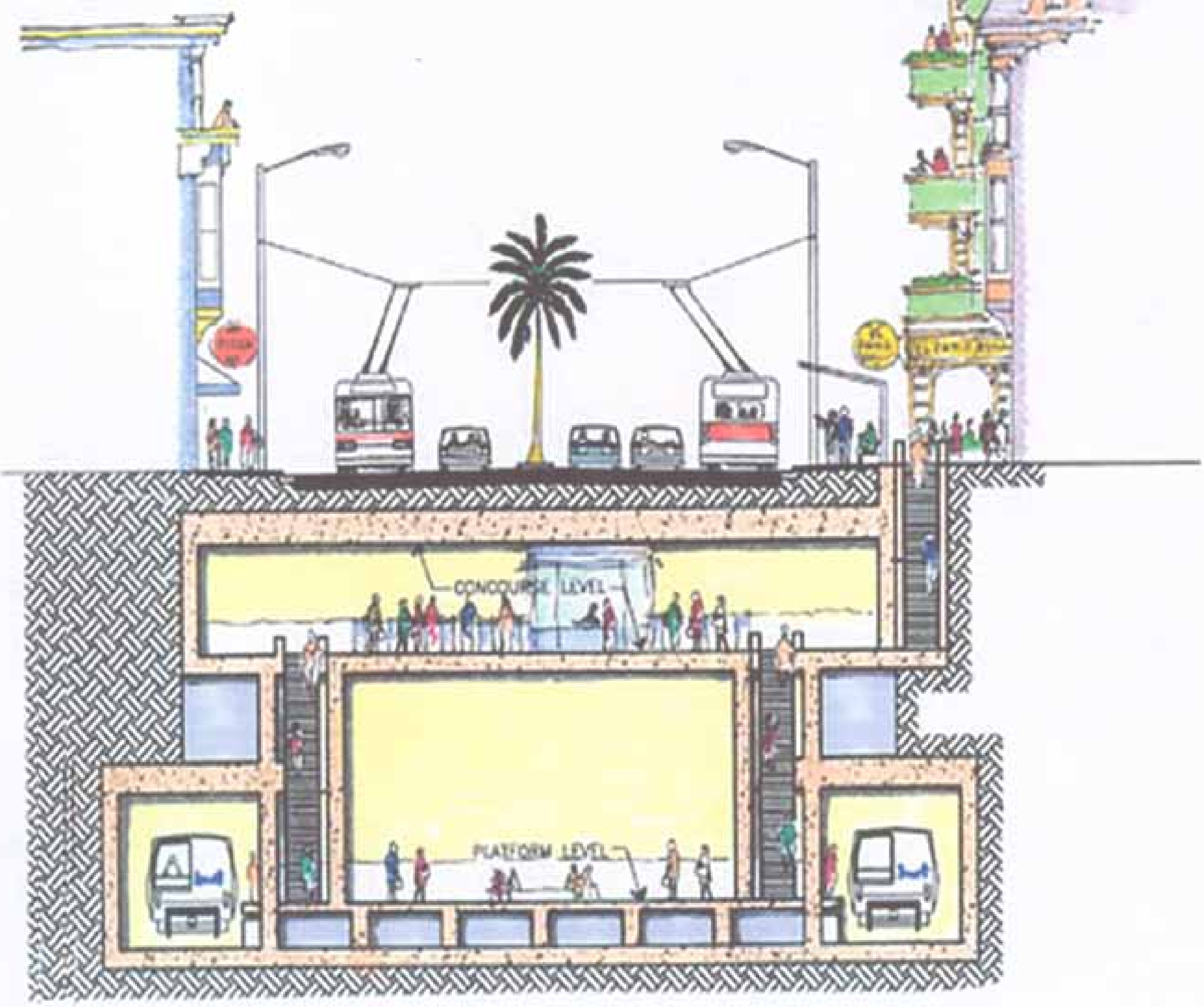
FEASIBILITY STUDY FOR AN INFILL BART STATION
In San Francisco, at 30th & Mission Streets

Prepared for the Bay Area Rapid Transit District
by John T. Warren & Associates, Inc.

In Association with
Gary A. Weinstein, Consulting Engineer
Robin Chiang & Company
Bernal Heights Neighborhood Center



Final Report
MAY 2003

1404 FRANKLIN STREET, 4th FLOOR, OAKLAND, CA 94612

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May 1, 2003 Project No. 280004

Mr. James Gravesande, P.E.
Project Engineer
Stations Capital Program
Bay Area Rapid Transit District
1000 Broadway
Oakland, CA 94604-2688

Subject: Transmittal of Study Report for a 30th and Mission Street In-Fill Station in San Francisco

Dear Mr. Gravesande:

John T. Warren & Associates takes pleasure in providing to you the Final Report for the subject engineering study.

The study has been developed following the guidance of BART, as well as generally known policies of the City of San Francisco and input from a broad range of neighborhood groups and individuals. We trust that the report analyses and conclusions will be useful in charting a course for further progress on the station project.

We have appreciated the fine support and assistance that we have received from you and all the BART Staff in conducting this study, and we look forward with anticipation to participate with you on additional steps in the implementation process.

If you have any questions, please contact us at your convenience.

Very truly yours,

JOHN T. WARREN & ASSOCIATES, INC.

Kenneth W. Heilig, P.E.
Project Manager

John T. Warren, P.E.
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FINAL REPORT

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Bay Area Rapid Transit District

FEASIBILITY STUDY FOR AN INFILL BART STATION

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EXECUTIVE SUMMARY

Introduction

This study is intended to assess the feasibility of constructing a new Bay Area Rapid Transit (BART) Station on the existing BART Mission Street line between the existing stations at 24th Street and Glen Park. This study has been funded by an earmarked State grant of $400,000.

The scope of this technical study is limited to the engineering, construction impacts and costs, as well as operational factors involved in the development of a new infill station at 30th Street. The scope of the study does not include the potential for transit improvements other than a BART station. Nor does it address city or urban planning factors nor an assessment of the potential environmental impacts. The purpose of the study is to evaluate, not to advocate.

The original BART system was completed along the Mission Street Corridor in the late 1960's. Stations were constructed at 16th Street, 24th Street, and at Glen Park. More recently, the potential need for additional transit access in the area between the existing 24th Street and Glen Park Stations has been identified. The distance between the 24th Street and Glen Park Stations is the longest between any two adjacent San Francisco BART stations.

Origins of the Concept: *Director Tom Radulovich of BART had long been interested in the idea of a 30th Street infill station. In 1998, his idea prompted a review of ridership potential by the San Francisco County Transportation Authority for a new BART station at 30th and Mission, selected for its centrality, potential for joint-development, and immediate connections to several major MUNI bus and light rail lines. In 2000, Director Radulovich worked with California Assemblyperson Carole Migden (D-San Francisco) to secure a State budget grant to study the feasibility of this proposal in greater detail.*

Neighborhood Context: *By reducing the longest station gap in the San Francisco BART line, the new station would serve the Mission, Bernal Heights, Upper Noe Valley, Fairmont Heights and Glen Park neighborhoods. It would also generate new transit trips. In addition, the station could provide excellent connections between BART and several important MUNI routes. The 30th and Mission Street Station could also support the goals of the San Francisco housing and economic development programs.*

The project has won support from a broad range of neighborhood groups and individuals. San Francisco Supervisors Tom Ammiano and Mark Leno have endorsed the idea, as have the Upper Noe Neighbors, Bernal Heights Democratic Club, Noe Valley Democratic Club, and the Mission Merchants Association. Three public meetings have been held in the vicinity of the site.

BART Operational Improvements: *The possibility of a major construction project at this location along the BART line also affords an opportunity to make other physical improvements to BART fixed facilities that could be beneficial in supporting and improving BART operations. For example, construction of a 'pocket track' in conjunction with the station could provide a turnback for some trains and for storing disabled trains to permit more flexible operations.*

BART Policy on System Expansion: *Implementation of the 30th and Mission Street Station project would have to meet requirements of the new BART Policy on System Expansion.*

Existing Conditions

Existing BART Alignment: *The existing BART line in this vicinity is a twin track tunnel approximately 30-40 feet below street level. The proposed new station site is located along a segment of 3.12 per cent grade.*

Existing BART Operations: *Four of the five BART lines pass through the station site. Train headways (time intervals between trains) vary between 3.5 and 10 minutes, depending on time of day and day of the week. All trains that operate through the proposed site must also transit the Transbay Tube, which is the main capacity restraint in the BART system. Minimum train headway along this line is presently 2.5 minutes (24 trains per hour). However, BART is installing an Advanced Automatic Train Control (AATC) system that will result in reduction of the minimum headway and increase capacity. Existing BART ridership through this segment is about 130,000 passengers on each weekday.*

Existing Surface Street and Right-of-Way Conditions: *The proposed station site occupies a segment of Mission Street which extends from 30th Street/Eugenia Street on the south to 29th Street at the north. Mission Street is about 56 feet wide, curb to curb, accommodating four through-traffic lanes and curb parking.*

Buildings are from two to four stories high, mostly pre-World War II construction of commercial and residential use. However, there is one large modern four-story apartment building with street level commercial on the east side of Mission Street. A large Safeway parking lot occupies the west side of Mission Street just south of Virginia.

Existing MUNI Transit Service: *The San Francisco MUNI operates seven routes through the proposed station vicinity. Of note is the 14-Mission trolley bus, which provides local transit service generally above and parallel to the BART line along the entire Mission Street Corridor. The nearby J-Church light rail line on San Jose Avenue and Church Street is an alternative downtown rail transit route. The 24-Divisadero and 49-VanNess trolley buses are important crosstown routes.*

Applicable Project Guidelines & Design Criteria

The most important design criteria as they relate to a possible 30th Street Station are:

- Design Speed: *Maximum speed of 80 mph and 36 mph for track approaches near station platforms and through turnout (switches).*

- Track Gradient: *The maximum gradient for the track at platforms is 1.0 per cent.* ***This is a very important criterion, and it is a defining standard for this project.***
- Platform Gradient: *This is limited by the Americans with Disabilities Act (ADA) which requires that the platform be nominally level, but no more than 1.5 per cent.*
- Platform Length: *Shall be adequate for a ten-car train, about 700 feet*

Other BART Functional Criteria: *The following criteria relate to providing for certain needed functions of the proposed new facility:*

- Maintain Line Capacity: *The new station should not significantly degrade the capacity of the BART line.*
- Construction Impacts: *The construction of the new facility should not unduly hinder BART train operations during the course of the work.*
- Provide Mainline Bypass Track: *With a bypass track, some trains may not have to stop at the station. Accordingly, these trains would have a shorter travel time and provide better service to those passengers who do not need to use the new station. However, this would increase the wait time for those passengers that do wish to use the station. This issue introduces the concept of 'off-line' vs. 'on-line' platforms, which is addressed further for the specific alternatives.*
- Train Turnback: *A train turnback capability can be considered to permit reversal of revenue trains (trains carrying passengers) or for side-tracking of malfunctioning trains. However, the additional cost of such an adjunct should be considered separately from the basic station cost.*

Alternative Development

All potentially feasible alternatives need to be developed with a common philosophy and approach, and must have certain basic features in common:

1. Basic Station Configuration: *The new station must provide separate platform and mezzanine levels.*
2. Station Grade: ***The requirement to revise the track grade at the platforms from the existing 3.1 percent to a flatter 1.0 per cent obligates the design to include extensive reconstruction, including long approach tunnels, to provide the needed transition.*** *This results in a construction segment considerably longer and more costly than would have been the case if the grade-reduction problem did not exist.*
3. 'Off-Line' Construction: *Because the new tracks must be constructed on a different profile grade than the existing, the new tracks and platforms must be constructed separate from, and away from the existing tunnels.*
4. Merge of New Work into the Existing Tunnels: *At the extreme ends of the new tunnels and trackage these have to be connected into the existing tunnels and tracks. Much of the construction work at the four merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended.*

5. Operational Considerations: *The introduction of a new additional station on the line would result in an increase of travel times for all trains that stop at the station.*

Alternatives Considered: *A total of seven alternatives were originally developed and considered. In addition, an on-line alternative using the existing tunnels and tracks was also previously suggested. The latter concept is now considered infeasible. The two most promising alternatives were chosen by BART staff so as to best represent two fundamental objectives.* ***Alternative 'A' – On-Line Station with Optional Turnback*** *has been developed as a lowest-cost option.* ***Alternative 'B' –Off-Line Station with Full Turnback*** *has been developed as an option that could support optimum operations of the BART system.*

Alternative 'A' Description: On-Line Station with Optional Turnback (Least Cost Alternative):

This concept, as shown in Report Figure 5, involves construction of the new northbound and southbound station platforms and tracks on the outside flanks of the existing BART tunnels. The new station is planned on a 1.0 per cent grade and thus new approach tunnels are required to conform back to the existing tunnels on south end. In this scheme, the two BART tracks would be relocated to the new station and tunnels and there would be no other tracks provided. The center platform would extend across between the two tracks.

The basic scheme requires no track turnouts or junctions, however, a separate Option has been analyzed to provide a turnback pocket track to the south of the new station in the space between the two new main line tunnels. The purpose of the turnback would be to permit reversal of some revenue trains from the north and/or as a location to remove disabled trains from the main line.

Alternative 'A' Advantages:

- *Simplest track configuration and train operations*
- *All trains would stop at the new station*
- *A narrower mezzanine is needed than for Alternative 'B' thus reducing property impacts*
- *The single, wide center station platform is a passenger amenity*
- *The basic scheme does not include crossover tracks or turnouts, which would be disruptive to train service to construct*
- *An optional turnback track is possible at extra cost*
- *The basic scheme has marginally lower construction cost than Alternative 'B'*

Alternative 'A' Disadvantages:

- *The new station stop would reduce BART main line capacity*
- *New track curves may impose additional train speed restrictions*
- *Less operational flexibility than Alternative 'B' which permits train bypass of the station*
- *The optional turnback track is costly and is not easily accessible from the south*
- *The station platform level would need to be constructed in two stages*

Alternative 'B' Description - Off-Line Station with Full Turnback (Optimum BART Operations):

This scheme, shown in Report Figure 6, provides for new station platforms and tracks in addition to retaining the existing tracks and tunnels as a main line bypass. This Alternative also provides an operational option for turnback capability and/or disabled storage train. Many features are similar to Alternative 'A' but, unlike Alternative 'A', this alternative utilizes turnouts at all the tunnel merge locations so that trains approaching the station may either proceed to a stop at the platforms or bypass the station using the pre-existing tunnels and tracks.

This scheme could accommodate express trains that would bypass the station. This type of operation would improve speed and runtime of some trains and thus support higher line capacity. But if too many of the trains were express runs, service to the new station would be diminished. The double crossover north of the station could serve as a revenue turnback for trains to/from the north. However, the use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time.

Alternative 'B' Advantages:

- *Provides bypass tunnels facilitating express train operations*
- *Compared to Alternative 'A', minimizes capacity reduction in BART system*
- *No new restrictions on express train speed*
- *More flexibility in turnback operations and for sidetracking and holding trains*
- *The station platform construction could be completed in one stage*

Alternative "B" Disadvantages:

- *Greater operational complexity*
- *Potential for delay of trains reentering main line from the platform tracks*
- *All trains may not provide service to the station*
- *Express train turnback operations and disabled train storage are mutually exclusive uses of the second pair of tracks*
- *The turnback capability is available only to/from the north*
- *More complex trackwork, especially the crossovers, may increase service interruptions during construction*
- *More right-of-way needed than the basic Alternative 'A'*
- *Separate narrow platforms are less attractive for passenger use than a center platform, and need additional escalators and elevators resulting in higher operating costs*
- *The separate platforms might also be more confusing to use for passengers boarding or transferring to/from turnback trains.*
- *Slightly higher construction cost than Alternative 'A'*

Right-of-Way and Construction Impacts

The station consisting of the mezzanine and most of the platform area is too large to be tunneled or excavated out exclusively from below. Instead, open pit excavations would be needed for *most of the station box construction. These pit areas, which would be temporarily decked over, would also provide ingress for construction and egress for removal of excavated earth material.*

Right-of-Way: *The 'footprint' of the station and its tunnel approaches extend beyond the right-of-way lines on both the east and west sides of Mission Street. Because much of the property frontage on the west side of the street is occupied by a Safeway parking lot, the station layout should favor right-of-way takes along the west side. The Safeway lot could then be rebuilt after project completion. However, some buildings on both the east and west sides would be demolished. Some tunnel segments of the work, due to their depth, might be completed beneath existing buildings without disturbing them.*

Areas of Open Excavation: *Three or four excavation pits would be required. The other station segments might be tunneled from below in order to save property impacts and buildings. The main pit would be excavated at the location of the station mezzanine. It would be located in the vicinity of Virgina Avenue and Godeus Street, at the Safeway parking lot. A second excavation would be located between 29th Street and Valencia Street, to the north of the main pit. The third excavation would be needed only for the Alternative 'A' option that includes the pocket track ('wishbone') connections. It would be located just south of the main pit. The fourth excavation pit would be further to the south, in the south quadrant of the Chenery Street/Miguel Street intersection. This site would provide for construction of the south tunnel-merge structures.*

Property Acquisition: *The approximate number of properties likely to be taken vary from about 23 for the basic Alternative 'A' to 32 for the Alternative 'A' option with a pocket track. In addition, there would be numerous buildings along Mission Street and above the south approach tunnels that would not be physically disturbed, but would be tunneled beneath within a subsurface right-of-way easement.*

Construction Impacts: *The station box structures, which would accommodate the station platform and mezzanine and also the north tunnel-merge structures, would have to be constructed by cut-and-cover means. Due to the extreme depth of the southerly tunnel-merge location, excavation of the large pit all the way down from the surface there might not be feasible or desirable. If such is the case, the underground excavation would need to be accomplished working mostly from below.*

Staging and Sequencing: *First, utilities would be relocated. In the next stage special 'soil mix' walls would be drilled along the street. Then a temporary deck would be constructed along one half of Mission Street while two lanes of traffic are rerouted onto the other half of the street. Excavation would proceed below. After traffic can be redirected onto the completed temporary decking, the second half of the street would be drilled and decked. The excavation could then proceed to completion beneath the full-width temporary decking, and at that time, all four traffic lanes could be restored to Mission Street. After the excavation had reached its full depth, the station box structure would be constructed.*

Tunneling and 'Cut-In' to the Existing Tunnels: *The bored tunnels would be constructed from below grade so that the surface could remain undisturbed. At the extreme ends of the new tunnels and trackage, these would have to be connected into the existing tunnels. The merge construction of the project is highly problematic as it involves potential interruption of train* *traffic and single-tracking of train service while the work proceeds. Much of the construction work at the merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended.*

Track Construction: *Construction of the trackwork and its foundations at the 'cut-in' locations would also be especially difficult, accomplished by three possible means:*

1. Modify Track Slab Fixation: *This would be the preferred approach. New fasteners would be slipped under the existing rails and bolted onto the supported concrete. Initially, the new fasteners would be adjusted to support the existing rails. Then the pre-existing rail fasteners would be removed and the new fasteners quickly readjusted the new rail fittings.*
2. Use of 'Boot-Ties': *These could be used in some locations in lieu of the special new fasteners.*
3. Conventional Switch Ties: *Ties could be inserted one-by-one from the side of the track. However, a major disadvantage of this approach is the greater depth needed in cutting out the base slab. Either timber or concrete ties could be utilized.*

With any of these methods, all of the proper tie plates and fasteners to support each turnout would have been installed during a preparatory phase during numerous evening/night time service-interruption windows, which would involve single-track operations. Completion of the trackwork for insertion of the new segments of rail would require weekend-long service interruptions.

Surface Traffic Detouring and MUNI Routes: *During almost all of the construction period, vehicular traffic, including all MUNI bus routes, could be maintained on the surface of Mission Street on a temporary deck. However, during initial temporary deck construction and again during its removal, traffic would have to be restricted to only two lanes, one in each direction. On-street parking would have to be prohibited during the entire course of construction in order to free up room for construction vehicles. All MUNI bus routes, including the electric trolley buses, could be kept operating over the temporarily decked street at almost all stages of construction.*

Construction Schedule: *The general sequencing would be similar for Alternatives 'A' and 'B'. The total time requirement from inception of construction to completion would be about three and a half years.*

High-Risk Construction Issues: *This project involves many unusual and difficult operations that entail risk. The meaning of risk is that there is a reasonable probability that unforeseen problems may arise or that foreseen problems might become more problematic than originally expected. Such factors include the possibility and increased potential for hazard during underground construction in constrained areas, and for construction near an operating rail system. To address these potential problems, all construction operations must be undertaken with utmost caution, with the most conservative safety measures fully enforced. In addition, costly special insurance policies might be warranted.*

Maintenance of BART Service During Construction

Useful construction windows cannot be provided during regular nighttime service suspension. Instead, construction on the tracks must involve reductions in revenue train service and single-tracking operations. Although it is possible in theory to set up substitute bus service ('bus-bridges'), there are serious deficiencies to that approach.

Therefore the option of single-tracking is the only remaining possibility; one of the two BART tracks is shut down for construction while trains from both directions take turns using the remaining track. This would impose considerable delay and inconvenience on patrons. It is not feasible to operate more than one line over the single track. Therefore, one of the two lines (such as operate on Sundays) would have to be turned back at each end of the single-track segment.

It might be possible to supplement the single-track service with a bus-bridge or possibly with augmented parallel MUNI and/or Caltrain service. However, these are not sufficient alone to completely replace BART service. Substitute bus service was considered as a alternative, but was not found to be adequate.

Operations Qualitative Review

The following are the benefits and drawbacks of each Alternative:

Alternative 'A' – Benefits:

- *The basic scheme has no switching, thus there is no additional delay created by merging revenue trains.*
- *See below for benefits of turnback option.*

Alternative 'A'- Drawbacks:

- *This scheme requires all trains to stop at 30th Street and so lengthens end-to-end runtimes for all routes. This might require additional revenue vehicles to maintain headways.*
- *All trains stopping at 30th Street would have to stop on a main line track, thus significantly reducing line capacity in both directions.*

Alternative 'B' – Benefits:

- *Permits 'skip-stop' (express) operation past 30th Street.*
- *Compared to Alternative 'A', this scheme provides a four-track segment that has improved potential for delay mitigation.*

Alternative 'B' - Drawbacks:

- *There is a potential for very long station dwell during the peak period for those trains that stop at the platforms and having to wait for a 'gap in the bypass track schedule.*
- *With very close headways and the potential train interactions, any delays or 'off-set' in timing for diverted trains to merge back onto main line, may result in reduced capacity.*

Alternative 'A' includes a turnback pocket track as an extra-cost Option. Alternative 'B' does not include a special turnback track, but would permit use of the two center bypass tracks for turnback as an operational option. If the center track were to be used for turnback/storage *function, it could not be simultaneously available as a bypass/express track. There are also two types of turnback use – One for reversing revenue trains, and a second for storage and reversing of disabled trains.*

Alternatives 'A' and 'B' Turnback Track – Benefits:

- *Operational flexibility by allowing revenue trains to turn back at 30th Street, out of the way of main line traffic.*
- *Depending on the schedule, there may be the ability to reduce the need for rolling stock.*
- *Capability to temporarily store disabled trains on the center track(s), out of the way of mainline traffic.*

Alternatives 'A' and 'B' Turnback Track – Drawbacks:

- *Operational complexity requires merging of trains leaving the pocket track into the main line.*
- *For revenue turnback, trains would require three separate dwells (stop and starts).*
- *The three possible uses of the center tracks of Alternative 'B' – (express trains, revenue train turnback and disabled train storage) are mutually exclusive at the same time.*
- *The 3.21 per cent grade of the center tracks in Alternative 'B' is disadvantageous for their most effective use for train turnback and storage.*
- *Construction of the Alternative 'B' double crossover tacks on the existing mainline could disrupt train operations.*

Capacity Review

Two separate analyses were undertaken by BART staff to address system capacity. These include a headway simulation and a line capacity review:

Analysis of train operations with and without a 30th Street Station was conducted by BART staff. A computer simulation was utilized based on operating assumptions with the objective to define train headways as the major index of system capacity 'thruput'. Conclusions of the simulation clearly describe a degradation of BART line-haul services if a 30th Street station is implemented. The simulation shows that the addition of a new station would set back BART operations to a condition similar to that which prevailed before implementation of the new AATC system.

In addition, a line capacity review was conducted to assess the impacts on Transbay capacity of adding an infill station. This additional analysis approached the 'thruput' problem by determining the magnitude of excess capacity of the Transbay line. It was then assumed that any such excess capacity would be available to serve the needed extra service demand of a new 30th Street Station. The analysis focused on estimating the available line capacity sufficient to meet Transbay demand during am and pm peak hour, peak direction, as these are the periods during which rolling stock and resources are taxed to the maximum.

Significant eastbound line capacity for FY2020 may be available west of the major downtown stations, however this capacity is needed to satisfy Transbay demand and, therefore, should be reserved to meet the greatest demand at the maximum load point station, which is Embarcadero. Thus, eastbound Transbay traffic generated by the 30th Street Station, while assumed to be low, *would have detrimental impact on line capacity to the Eastbay, if it were to exceed the available Transbay capacity.*

Therefore both the simulation analysis as well as the line capacity review were in agreement that any additional traffic generated by a 30th Street Station, or any other infill station on the line, would be a detriment to BART system line capacity.

Ridership

The 1998 ridership projections by the San Francisco County Transportation Authority that showed between 3,700 to 5,000 riders using the 30th Street Station, did not anticipate the opening of the BART extension south of Colma nor include riders using BART to reach San Francisco International Airport or Millbrae and the Caltrain connection to points south. In addition, land use changes since that time and as proposed for the future by the City of San Francisco were not addressed.

Currently, the San Francisco Planning Department and various neighborhood groups are planning to revisit zoning, land use and housing changes in the immediate vicinity of 30th and Mission. The outcome of these efforts would be essential in establishing the full magnitude of ridership and benefits of any new station there.

Intermodal Considerations

BART/MUNI Transfer: *The service impact of a new BART station would generally occur in one of three ways relating to the existing MUNI routes:*

1. *Those MUNI routes that run approximately parallel to the BART line, (14, 14L, 26, 29 and 'J') and that already serve other existing BART stations, would be expected to lose only a very small amount of patronage to BART.*

2. *For a crosstown MUNI route such as the 24-Divisadero, which presently does not serve any BART station, it would be expected that related transfer ridership would increase on both MUNI and BART. Indeed, a transfer between BART and the 24-Divisadero would be the greatest single intermodal improvement of the proposed project. The Hunter's Point connection of the 24-line would be the most significant.*

3. *For a local shuttle route such as the 67-Bernal Heights line, which already serves another BART station at 24th Street, it would be unlikely that a new 30th Street Station would have great impact on ridership.*

Parking: *The objectives of this project do not include provision of BART station parking. Parking impacts of a new station would be limited to that resulting from surface street modifications needed to construct the new station.*

Handicapped Access: *With respect to ADA and handicapped patron transfer to MUNI at a new 30th Street BART Station, it is expected that few special facilities would be needed on the surface* *of Mission Street. There would be a slight improvement to handicapped transit access due to improved interconnectivity and access to the fully accessible BART system.*

Cost Estimates

	Alternative 'A' On-Line Station *Basic*	**Alternative 'A'** *with Pocket Track*	**Alternative 'B' Off-Line Station**
Construction Cost:	**$261,261,000**	**$309,183,000**	**$271,133,000**
Contingencies @ 25%	65,315,000	77,296,000	67,783,000
Administration, Engineering and Operations ('Soft Costs')	117,567,000	139,132,000	122,010,000
TOTAL Project Facilities Construction:	**$444,143,000**	**$525,611,000**	**$460,926,000**

Right-of-way and certain other costs are not included in the estimates.

Conclusions

This study concludes with the following findings:

- *The three evaluated Alternatives are each basically feasible*
- *All the Alternatives are very costly projects*
- *The defining track gradient limitation of one percent (compared to the existing grade of 3.12 percent) is a major influencing factor that drives up the cost for a project of this type*
- *The Alternative 'A' basic scheme is least costly*
- *The Alternative 'A' scheme with a Pocket Track Option is most expensive*
- *Alternative 'B' includes the most important benefits and is only marginally more expensive than the lesser-cost Alternative 'A'*
- *This would be a very difficult and risky project to construct*
- *Property and business disruption impacts would be substantial*
- *Constriction traffic impacts would be significant, but subject to mitigation*
- *Local access to regional transit via BART at 30th Street would be greatly improved*
- *Station ridership potential has been estimated at 3,700 to 5,000 users, but newly-developing factors could result in more users, and further study is called for*
- *Alternative 'B' offers superior operational flexibility and means to recover from delay.*
- *Alternative 'A' is not as operationally beneficial as Alternative 'B'*
- *A 30th Street Station may contribute to limited capacity constraints at 24th and 16th Street Stations*

- *With Alternative 'A' train headways would be increased by up to 49 per cent with corresponding reduction in line capacity*
- *With either of the two Alternatives, there will probably be sufficient am peak hour capacity in the southbound/westbound direction*
- *New northbound/eastbound traffic generated at a 30th Street Station would limit the critical pm peak hour eastbound Transbay capacity by FY2020*
- *Operational benefits of a turnback can be provided, but only at extra cost*
- *Improvements to MUNI transfer and local transit would be minimal*
- *The 24-Divisadero MUNI line would benefit the most by the station*
- *Transit choices and handicapped access would be improved*
- *The potential for neighborhood beneficial improvements might be substantial, but evaluation of these are beyond the scope of this study*
- *The potential for joint development would be important, but evaluation of this is beyond the scope of this study*

Next Steps

- *Circulation, review and acceptance of this report*
- *Designation of a sponsoring agency*
- *Appointment of administrative staff*
- *Selection of oversight committees for policy and technical direction*
- *Establishment of ongoing lines of communication to other affected agencies*
- *Initiation of a community planning effort:*
  - *Updating of ridership projections*
  - *Improvement in definition of the alternative designs*
  - *Undertaking of focused technical and property studies*
  - *Refinement of cost estimates*
  - *Encouragement of companion studies for related neighborhood improvements and for possible joint development*
  - *Preparation of fully detailed cost/benefit studies*

FINAL REPORT

Bay Area Rapid Transit District

FEASIBILITY STUDY FOR AN INFILL BART STATION

In San Francisco, at 30th & Mission Streets

1. INTRODUCTION

This study is intended to assess the feasibility of constructing a new Bay Area Rapid Transit (BART) Station on the existing BART Mission Street line between the existing stations at 24th Street and Glen Park. Figure 1 shows the location of the proposed new station.

The scope of this technical study is limited to the engineering and construction impacts as well as operational factors involved in the development of a new 'infill' station at 30th Street. The study also provides an initial assessment of potential costs and possible benefits of such a station, a train operations simulation analysis, as well as a review of passenger ridership/capacity factors.

The scope of the study does not include the potential for transit improvements other than a BART station. Nor does it address city or urban planning factors which may relate to such a station, nor an assessment of the potential environmental impacts.

What is this Study? (and what is it not?)

- Study does not advocate a station
- Feasibility, not Preliminary Engineering
  - Is it possible?
  - Define range of alternatives
- Gather Data and Report Findings
- Anticipate Next Steps

Specifically, the scope of the present technical study includes:

- Investigation of the feasibility of the infill station concept, given track grade and other site constraints on the engineering
- An assessment of construction impacts on the surrounding neighborhood and on the existing BART system
- Review of operational issues including the benefits of construction of an optional pocket track at this site
- An analysis of current and future local transit connections and impacts associated with development of a station
- Review of capacity/ridership issues

This study has been funded by an earmarked State grant of $400,000.

FIGURE 1
30TH & MISSION BART INFILL STATION STUDY

FOR STUDY PURPOSES ONLY

Background and Need

The original BART system was completed along the Mission Street Corridor in the late 1960's. Stations were constructed at 16th Street, 24th Street, and at Bosworth and Diamond Streets in Glen Park. The original selection of station locations was based upon cost and operational factors as well as consideration of neighborhood benefits. Even at the onset of the original BART planning, it was fully intended that the BART project have a beneficial impact on the Mission Street neighborhoods by promoting their economic development, as well as improved transit access.

More recently, the potential need for additional transit access in the area between the existing 24th Street and Glen Park Stations has been identified. The distance between the 24th Street and Glen Park Stations is about 8,500 feet, which is the longest distance between any two adjacent San Francisco BART stations. (This compares, for example, with spacing of only 2,000 feet between the Montgomery and Embarcadero Stations, which are the most closely spaced stations on the BART system). This distance results in pedestrian access from the 30th Street vicinity to the existing stations being less convenient than elsewhere. Also discouraging easy pedestrian access to BART is the hilly topography, especially in the southern direction toward Glen Park.

Why This Location?

- Transit Connections to four MUNI bus lines and J-Church MUNI Metro
- Mid-point of large gap on BART line in San Francisco
- Serves five neighborhoods not directly served by BART: Bernal Heights, Outer Noe Valley, Fairmount and Outer Mission

The confluence of improved local transit connections, possible improved BART operational features and the potential for joint development have formed the impetus to conduct this study. A new BART station at 30th and Mission Streets would be the first new BART station in San Francisco since the completion of the Embarcadero Station in the mid-1970's. It would also be amongst only a few infill stations (together with the proposed West Dublin/Pleasanton Station) considered since that time.

Origins of the Concept

Director Tom Radulovich of BART had long been interested in the idea of a 30th Street infill station. In 1998, his idea prompted a review of ridership potential by the San Francisco County Transportation Authority for a new BART station at 30th and Mission, selected for its centrality, potential for joint-development, and immediate connections to several major MUNI bus and light rail lines. In 2000, Director Radulovich worked with California Assemblywoman Carole Migden (D-San Francisco) to secure a State budget grant to study the feasibility of this proposal in greater detail.

In order to submit the funding application together with Assemblywoman Migden, Director Radulovich requested that BART staff delineate a schematic plan for the station. This plan included a 'pocket' track that would enable disabled BART trains to be removed from revenue service and turned back in the opposite direction. The original concept plan also included a simple pair of platforms parallel to the tracks, with a mezzanine located directly above them. This scenario was only illustrative, however, it formed the basis for the full feasibility review for which the funds were appropriated.

Because future ridership projections need to include consideration of existing and future land use conditions, the San Francisco Planning Department has been interested in undertaking an effort to review the Mission Corridor for development potential of high-density, mixed use projects. While the 30th Street and Mission location was considered for such land uses, the Planning Department had lacked the funding and resources to pursue a more intensive look at when and how such development might be encouraged.

Accordingly, in June of 2000, under the leadership of Assemblywoman Carole Migden, as Chairperson of the Assembly Appropriations Committee, $400,000 in State budget funds was earmarked to study a BART station at 30th and Mission Streets.

Neighborhood Context

By reducing the longest station gap in the San Francisco BART line, the new station would serve the Mission, Bernal Heights, Upper Noe Valley, Fairmont Heights and Glen Park neighborhoods. It would also generate new transit trips. In addition, the station could provide excellent connections between BART and several important MUNI routes, including the J-Church, 14-Mission, 24-Divisadero, 26-Valencia, 49-Van Ness, and 67-Bernal Heights lines. It could also reduce some of the passenger load on MUNI and possibly obviate the need for expanded service on some MUNI routes that feed BART.

The 30th and Mission Street Station could also support the goals of the San Francisco housing and economic development programs. The area surrounding the station has many potential sites for infill housing including vacant lots and underutilized locations which might be beneficially redeveloped with compatible uses. The project would offer a chance to reshape the Mission corridor in the vicinity of 30th Street, now dominated by a gas station, a Walgreen's, and a Safeway. The station could also present an opportunity to develop a comprehensive neighborhood plan, incorporate housing, neighborhood economic development, and make other traffic, transit, and pedestrian improvements. The station could provide better transit service to the Cortland Avenue, Mission Street, and Church Street neighborhood commercial districts.

The 30th Street Station could also support economic development of the Bayview-Hunters Point commercial district and the redevelopment of the Hunters Point Shipyard, by providing the regional transit connection for these areas via the San Francisco Municipal Railway (MUNI) 24-Divisadero trolley bus line.

The project has won support from a broad range of neighborhood groups and individuals. San Francisco Supervisors Tom Ammiano and Mark Leno have endorsed the idea, as have the Upper Noe Neighbors, Bernal Heights Democratic Club, Noe Valley Democratic Club, and the Mission Merchants Association.

Community Process

The study process has been intended as a means to elicit community response and input. Three community meetings were co-hosted by BART together with the Bernal Heights Neighborhood Center to describe the process for the feasibility study, and to solicit community input. The meetings were attended by residents of the Mission, Noe Valley, Bernal Heights and Fairmount neighborhoods, local merchants and representatives of City of San Francisco agencies, including MUNI, Parking and Traffic and the San Francisco Police Department. The first meeting was held in November 2000, in which the project was described and input collected on how BART might devise and refine alternatives for review.

A major aspect of the community process was to establish project goals and objectives. For example, amongst important community objectives was that BART service not deteriorate below existing levels of access and frequency north of 24th Street and south of Glen Park, as a result of the 30th Street Station project. The community also clearly wished a station that was not a terminus on a line stub, but rather that direct main-line BART access to both the northbound and southbound directions would be available. These objectives were set at both the first and second meetings, and were later used to constrain the alternatives.

The second meeting, which was held in November 2001, (after BART received the State grant appropriation) reviewed several possible alternatives for a station configuration. It also was a forum for discussion of basic technical requirements. Amongst these were those factors BART engineers must consider in order to assess the feasibility of alternatives. At the meeting, BART staff presented the two Alternatives (described in detail in a following section) that were advanced for more intensive review. This included attention to operational factors and identification of impacts on the entire BART system associated with the construction of this station.

A third community meeting was held in April 2002 at which BART staff described construction phasing, construction costs and the need to develop community consensus in order to proceed with an implementation program.

The community meetings have also been a forum which participants have utilized to promote the project. Dave Monks, President of the Noe Valley Democratic Club and a leading advocate of the station, was pleased with progress. Said Mr. Monks, *"This funding is a welcome surprise. We're on the transportation radar now, and it will be up to surrounding community groups to come together, follow the project, and make sure we turn out at meetings where the big decisions get made. It's great to see creative thinking and community support win the day."* Project opponents were also given an early opportunity by this process to make their position known or to state their preferences.

At the third community meeting, there was continued strong support amongst attendees for the station concept. However, stated concerns included the need for property takes that would reduce the housing supply and about the potential for security problems around such a station.

BART Operational Improvements

The possibility of a major construction project at this location along the BART line also affords an opportunity to make other physical improvements to BART fixed facilities that could be beneficial in supporting and improving BART operations. For example, construction of a 'pocket track' in conjunction with the station could provide a turnback for northbound and/or southbound trains. A new pocket track for storing disabled trains would permit more flexible operations and quicker recovery from system delays. Thus a new station, in combination with a new pocket track, could result in operating cost savings.

Potential System Benefits:

- Increase in operational flexibility
- Train turnback potential
- Enhancement to failure management / recovery
- Increase ridership

Operational factors also need to be considered in context with the soon-to-be-opened south extension of BART to San Francisco International Airport (SFO), and the Caltrain transfer station in Millbrae.

Summary of Goals and Objectives

Primary Objectives:

- Improve regional transit access and increase regional and local ridership
- Improve pedestrian access to transit
- Improve local transit connections to BART
- Maintain BART line capacity and train frequency
- Provide convenient local access to all BART destinations
- Provide impetus for neighborhood housing and economic improvements

Secondary Objectives:

- Provide neighborhood amenity
- Improve BART operations by addition of new track turnbacks
- Improve surface transportation features
- Limit construction and operating costs
- Minimize right-of-way impacts
- Minimize construction impacts

BART Policy on System Expansion

The ultimate implementation of the 30th and Mission Street Station project would have to meet requirements of the new BART Policy on System Expansion. A copy of the "*System Expansion Criteria and Process*" policy is included in Appendix 'A'.

The BART Board of Directors first adopted a Policy Framework for System Expansion on December 2, 1999, and directed BART staff to undertake its full development. This was to include conduct of subregional stakeholder outreach, and completion of a detailed policy for Board review and approval to guide the identification, prioritization and phasing of system expansion opportunities. The detailed policy was completed and was adopted by the Board on December 5, 2002.

This process has included a systemwide strategic expansion opportunities assessment to address proposed Extension Staging Policy projects and other expansion projects that may have significant potential. It considered a range of opportunities (i.e. possible project phasing) that might include interim service options and be completed through local partnership with the communities that would be served. Staff also sought to identify and analyze the issues and alternatives the District would need to consider in developing institutional and financial arrangements to support system expansion.

Policy Framework Goals for System Expansion:

1. Enhance regional mobility, especially access to jobs
2. Generate new ridership on a cost-effective basis
3. Demonstrate a commitment to transit-supportive growth and development
4. Enhance multi-modal access to the BART system
5. Develop projects in partnership with communities that will be served
6. Implement and operate technology-appropriate service
7. Assure that all projects address the needs of District residents

Strategies to be Utilized by BART in Pursuing System Expansion:

1. *Partnerships*: Seek partnerships with other agencies, local communities and private entities to plan and implement service expansion
2. *Transit Service Options*: Explore new BART and other transit service technologies (i.e., commuter rail, light rail, quality bus) where appropriate and possibly as interim services.

3. *Criteria for Project Advancement*: For all new expansion projects (new extensions, new in-fill stations) develop criteria that will assure that projects are:
   - Cost effective, (i.e., minimize the need for operating subsidies)
   - Integrated with other services and facilities in an intermodal regional network
   - Able to maximize ridership by supporting smart, efficient and desirable growth patterns
   - Accommodated without adversely affecting existing system capacity, quality and financial health
   - Adequate for bus, bicycle and pedestrian feeder service

2. EXISTING CONDITIONS

BART Facilities

The existing BART line in this vicinity, as illustrated in Figure 2, is a twin track tunnel approximately 30-40 feet below street level. These tunnels were constructed by boring from below, without disruption of the ground surface. The tunnel cross section south of 24th Street Station is circular, with the two tunnels separated by about 20 feet, and consisting of 18-foot diameter bolted steel tunnel segment rings, with a poured (direct fixation) concrete trackbed. North of Glen Park Station the cross section is a bored concrete tunnel of circular cross-section. The BART running rails are directly bolted to the concrete tunnel invert without ties or ballast.

The horizontal alignment in this segment between 24th Street and Glen Park Stations consists of a 'broken back' curve (two curves separated by a straight tangent) with radii of about 1,400 feet and 2,700 feet, respectively from north to south. The intermediate tangent between the two curves through the proposed new station site is about 2,500 feet long. The design speed of the curves is similar to that of most of the BART system main line, about 80 mph.

The vertical alignment in the segment includes a short sag curve just south of the 24th Street Station, leading to sustained grades of 3.12 per cent and then 0.67 per cent up to Glen Park Station. The net difference in elevation between track levels at 24th Street and Glen Park Stations is about 110 feet. The proposed new station site is located along the segment of the 3.12 per cent grade.

There are vertical vent shafts connecting the BART tunnels with the surface in the vicinity of Valencia Street and San Jose Avenue.

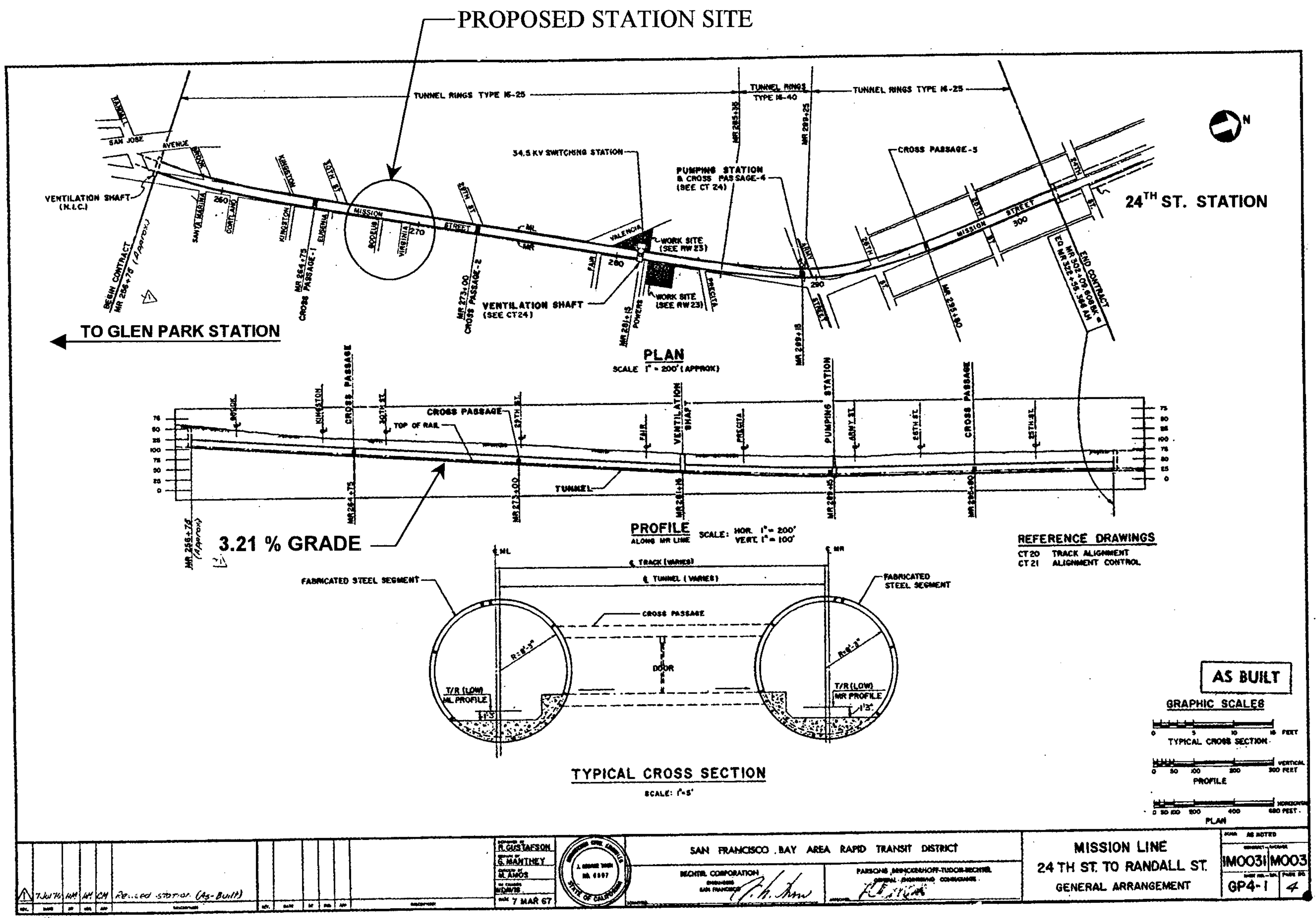
Existing BART Operations

Four of the five BART lines (all the lines except the Richmond-Fremont Line) pass through the station site, and thus all BART destinations can be reached from this location without transfer. (Except Saturday evenings and Sundays, when only two lines operate.)

BART Line Headways (minutes)

	Richmond	Pittsburg/Bay Point	Fremont	Dublin/Pleasanton	All
Weekday Peak	15	10	15	15	**3.5**
Mid-Weekday	15	15	15	15	**4**
Weekday Evening	*	20	*	20	**10**
Saturday	20	20	20	20	**5**
Saturday Evening	**	20	**	20	**10**
Sunday	--	20	--	20	**10**
Sunday Evening	--	20	--	20	**10**

*No service after 7:30 pm
**No service after 7:00 pm



BART EXISTING CONDITIONS

FOR STUDY PURPOSES ONLY

FIGURE 2
30th & MISSION BART INFILL STATION STUDY

FIGURE 2

Highest train speed is about 70 mph between the existing 24th Street and Glen Park Stations. The trains are programmed for 50 mph speeds south of 24th Street Station, with the 70 mph speed north of Glen Park Station. Train headways (time intervals between trains) are approximately as indicated in the table above.

All trains that operate through the proposed site must also transit the Transbay Tube, which is the main capacity restraint in the BART system. Minimum train headway along this line is presently 2.5 minutes (24 trains per hour). However, BART is committed to a program of train control system improvements including conversion to an Advanced Automatic Train Control (AATC) system which will result in reduction of the minimum headway. Train control features are more fully addressed in the Section on Operations.

Maximum train length is 10 cars, or about 700 feet.

Existing BART ridership through this segment is about 130,000 passengers on each weekday.

Existing Surface Street and Right-of-Way Conditions

The proposed station site occupies a segment of Mission Street right-of-way which extends from 30th Street/Eugenia Street on the south past Godeus and Virginia Streets north to 29th Street.

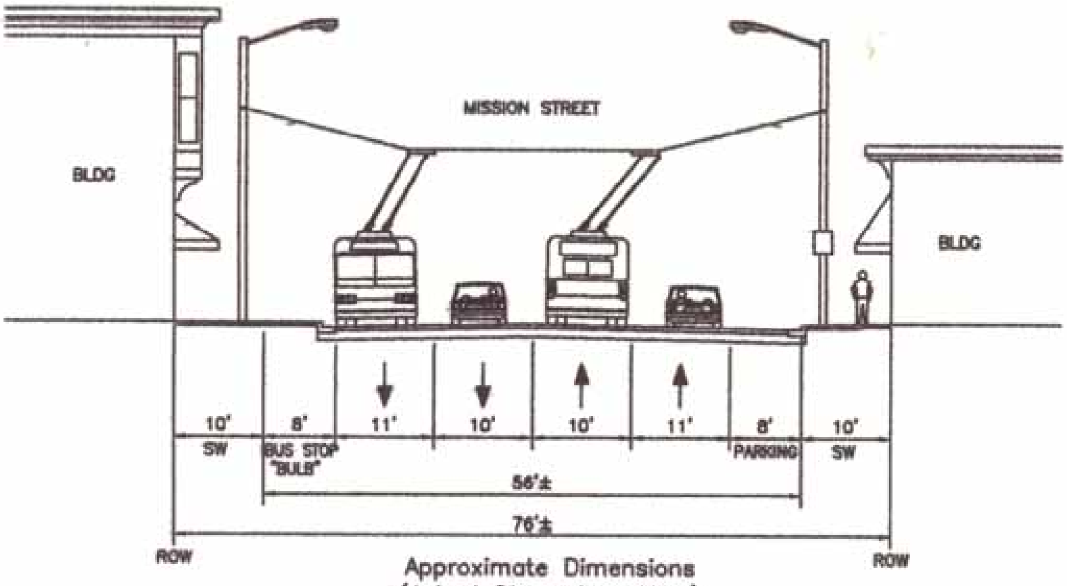
Mission Street is a main arterial street about 58 feet wide, curb to curb. As shown in Figure 3, it accommodates four through–traffic lanes as well as parallel curb parking on both the east and west sides. There are no turning lanes north of San Jose Avenue. Traffic signals exist at 29th Street, Virginia Street and 30th Street.

Lane widths are generally less than the 12-foot national standards, from 10 to 11 feet in width. Sidewalk widths on each side of the street range from about 10 to 12 feet. At bus stops, the sidewalks are widened into 'bulbs' with buses stopping in the right lane to load. A layout plan of the traffic lane configuration is included in Appendix 'B'.

The distance between building lines is about 78 feet, this also being the width of the City street and sidewalk right-of-way. Buildings are from two to four stories high, mostly pre-World War II construction of commercial and residential use. However, there is one large modern four-story apartment building with street level commercial (BigLots store) on the east side of Mission Street, north of Virginia Street. A large Safeway parking lot occupies the west side of Mission Street just south of Virginia.

Existing MUNI Transit Service

The San Francisco Municipal Railway (MUNI) operates the following routes, as shown in diagram of Figure 4-A, through the proposed station vicinity:



Approximate Dimensions
(Actual Dimensions Vary)

MISSION LOOKING SOUTH FROM VIRGINIA

MISSION LOOKING NORTH FROM KINGSTON

FIGURE 3
30th & MISSION INFILL STATION STUDY
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Route No.	Type of Vehicle	Service Orientation	Peak Hour Headway
14-Mission*	Electric Trolley Bus	Downtown	5 minutes
14L-Mission*	Diesel Bus	Downtown Limited	9 minutes
24-Divisadero	Electric Trolley Bus	Crosstown	15 minutes
26-Valencia	Diesel Bus	Downtown	15 minutes
49-Van Ness*	Electric Trolley Bus	Crosstown	7 minutes
67-Bernal Heights*	Diesel Bus	Local Shuttle	20 minutes
J- Church *	Light Rail Transit	Downtown	6 minutes

* Presently connects directly to a BART station.

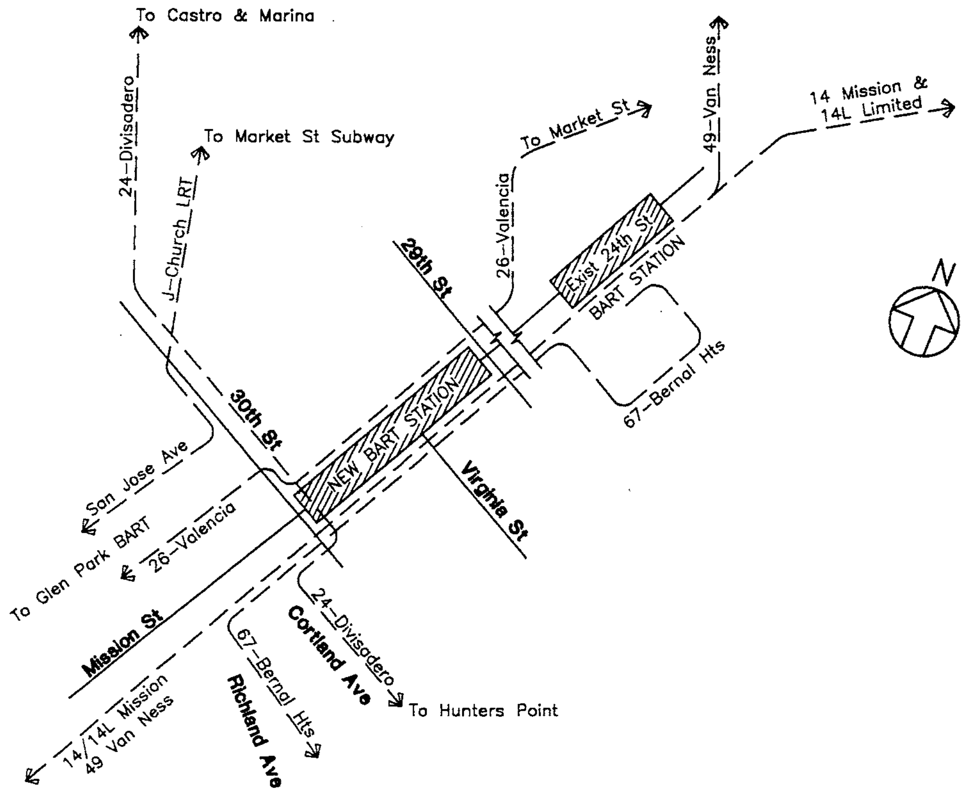
Daily boardings of selected MUNI lines were tabulated in 1998 for the boardings in the immediate area of the proposed new 30th Street Station, for the following routes:

- J-Church: 2,500 passengers
- 14-Mission: 2,300
- 24-Divisadero: 1,500 – 2,000
- 67-Bernal Heights: 2,500

TOTAL: 9,000 passengers (approximate)

Of special note is the 14-Mission trolley bus, which provides local transit service generally above and parallel to the BART line along the entire Mission Street Corridor. The 26-Valencia also is a downtown route that generally parallels BART only one block to the west on Valencia Street. The nearby J-Church light rail line on San Jose Avenue and Church Street is an alternative downtown rail transit route, running very generally parallel to BART and entering the Market Street subway. The other bus lines are either crosstown or local routes. The 24-Divisadero trolley bus is a very important crosstown route. It extends from the Marina District in the north through the Castro District all the way to the Bayview District to the southeast. The 49-Van Ness trolley bus extends north to the Fort Mason area and south to City College.

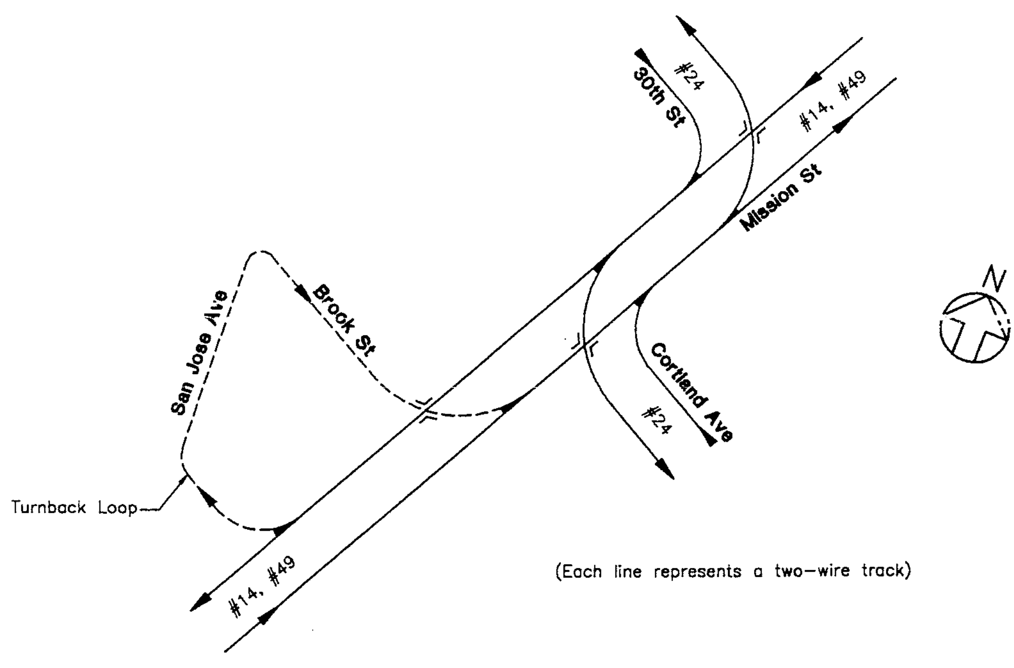
The MUNI trolley bus wire layout along Mission Street is illustrated in Figure 4-B. The 14-Mission wire tracks run along the entire Mission Street segment. The 24-Divisadero wires enter/leave the Mission Street wires at the 30th Street intersection and leave/enter the Mission Street tracks at the Cortland Street intersection. Thus there are two major wire junctions, each consisting of two turnouts and a diamond crossing at these two intersections. In addition, there is a trolley bus turnback loop for the 14-Mission which diverges from the Mission Street wires southbound and traverses San Jose Avenue, to reenter Mission Street northbound via a left turn from Brook Street. The latter includes one turnout and one diamond crossing.



SF MUNI TRANSIT ROUTES

(See also Figure 1 for MUNI Route Extensions)

FIGURE 4-A



EXISTING MUNI TROLLEY BUS WIRES

FIGURE 4-B

30TH & MISSION BART INFILL STATION STUDY
John T. Warren & Associates, Inc

FOR STUDY PURPOSES ONLY

Fig–4b.Dwg

Existing Surface Traffic

The City of San Francisco Department of Parking and Traffic has conducted the "Bernal Heights Traffic Calming Study" from which excerpts with traffic and accident data are included in Appendix 'B'. In summary, the total daily traffic volumes on Mission in the segment south of Cesar Chavez Street is 10,668 vehicles (counted on Monday, February 26, 2001). Traffic design is based on peak hour volumes:

- Morning Peak Hour Volume: 987 vehicles, Northbound
- Evening Peak Hour Volume: 702 vehicles, Northbound

The theoretical capacity of a free-flowing (freeway) traffic lane is 2,000 vehicles per hour. For a signalized urban arterial street, this is reduced to about 1,500 vehicles per hour through each point of conflict between crossing lanes at an intersection. This impact is, however, highly subject to modification due to signal timing and the allocation of signal 'green time' to the conflicting flows. Lane capacity can also be reduced by substandard width, adjacent parking, left-turns, driveways, pedestrians and heavy vehicles in the traffic flow.

Therefore the actual traffic capacity of the Mission Street lanes is reduced according to these factors. Also, the City of San Francisco has a deliberate policy to promote the movement of buses on transit-oriented streets. On Mission, bus stop sidewalks 'bulbs' have been constructed to facilitate bus loading, but this requires the buses to block the right traffic lane. The advantage to the buses is that unlike but 'duck-outs' which are more common in other cities, the sidewalk bulbs do not require that buses leave the traffic lane or wait to remerge into the traffic flow. This design policy is to the clear benefit of transit, but at the expense of the traffic capacity of the right lane.

The City Department of Traffic study states that excessive traffic volumes in residential areas are associated with queuing, aggressive driving and cut-through traffic. During the outreach efforts of the study, the community had expressed concerns about traffic levels on several streets within the study area. However, the results of the traffic survey actually demonstrated that volumes are comparatively light.

The study also showed that Mission Street had a relatively large number of pedestrian accidents, with the Cortland Avenue intersection having the highest rate. This accident trend illustrates that the highest numbers of accidents generally occur at locations with relatively higher traffic volumes together with significant pedestrian movements.

Existing Utilities

Utilities consist of the following types:

Overhead Utilities:

- MUNI electric trolley bus traction power overhead wire system

Underground Utilities:

- Combined drainage and sanitary sewer lines
- City water lines
- PG & E electric power lines
- Telephone and TV cable conduits
- PG & E gas lines
- City traffic signal and street light electric conduits
- MUNI electric trolley bus traction power feed cables

The MUNI trolley bus overhead system consists of a pair of trolley contract wires (two wires per 'track') in each direction, charged with 600 volts DC. These are supported at about 100-foot intervals by cross span wires which are in turn attached to street lighting poles ('joint' poles) along the sides of the street. This is a simple 'fixed termination' type trolley system without counterweights or complex tensioning devices.

Additional information on existing utilities is included in Appendix 'C'.

For the purposes of this study, utility relocation issues are relatively minor and will not be a deciding factor in evaluation of alternatives. They are also a comparatively minor cost factor.

Soil Conditions

The existing underground soil conditions in the vicinity of the proposed project are very well documented due to the original BART tunneling. The more alluvial soils tend toward the north of the segment along Mission, with rock encountered in the south near Glen Park Station. Appendix 'D' includes sample soils information.

3. APPLICABLE PROJECT GUIDELINES & DESIGN CRITERIA

As most transportation agencies, BART has codified its most important engineering standards for design of its facilities. These formal criteria include those that establish dimensions and numerical indices for its physical plant. In addition, there are operational factors that limit how a particular facility may be configured, so as to adequately serve its intended function. The BART staff had developed an original station criteria list, which is included in Appendix 'E'. The most important of these as they relate to a possible 30th Street Station are described below:

BART Design Configuration Criteria

- *Design Speed:* This is the highest train speed that the trackway and facilities must accommodate. The present design speed for this segment is set by the radii and superelevation of the existing nearby horizontal curves, and is 80 mph. It would be preferred to design the new station and its track approaches so that this speed not be diminished. However, since trains stopping at the new station would have to slow down, a lower train speed might be acceptable approaching the station from either direction. Such a lower speed has been provisionally set at about 36 mph for the track approaches near the station platforms.
- *Track Gradient:* The desirable gradient along station platforms is zero (flat grade), and most existing BART stations are so configured. The maximum gradient for the track at platforms is 1.0 per cent. This gradient at stations is limited by major hardware and software constraints built into the BART vehicle and control systems. **This is a very important criterion, and it is a defining standard for this project.** (However, even if the 1.0 per cent criteria could be relaxed, the platform gradient limit of 1.5 per cent would then govern the track as well, as described below.) For other track segments on the most demanding grades approaching the new station, a 4.5 per cent maximum grade limitation is proposed for short distances.
- *Platform Gradient:* This is limited by the Americans with Disabilities Act (ADA). The ADA criteria require that the platform be nominally level. ADA defines level as a maximum gradient of 1:50 (2.0 per cent) on a constant plane in any direction. However, to allow for platform drainage, the platform should also have a cross-slope and 1.5 per cent is the standard used. The resulting maximum allowable combined longitudinal/traverse slope is then 1.322 per cent. The 1.5 per cent platform cross slope is also a BART standard. Also, all vertical circulation elements (i.e. stairways, elevators, and escalators) need to be founded on a platform with a gradient which does not exceed 1.5 per cent. Therefore, taken together with the track grade criteria, a maximum longitudinal grade of 1.5 per cent is confirmed for the station platforms.
- *Platform Length:* Shall be adequate for a ten-car train, about 700 feet.
- *Vertical Curvature of Tracks:* The BART Standards do not permit vertical curvature (changes in grade) along station platforms. However, again for the purposes of this study, and due to the constraints of the site, a relaxation of the standards is suggested, subject to further study. Thus for any alternative with vertical curves at platforms which

are not on the main line tracks ('off-line' platforms), these may encroach into platform areas beyond a central 'touch down zone' reserved for the vertical circulation elements. This enroachment zone should not exceed 150 feet from the ends of the platforms.

- *Track Turnouts (switches):* Turnouts to off-line station platforms and/or pocket tracks shall be #15 right hand and left hand, and #10 equilateral. This corresponds to a design speed of 36 MPH.

Exceptions and Deviations from Design Criteria

The above are the most important numerical design criteria. In those cases as described above, the suggested project criteria are somewhat less conservative than the regular BART standards presently allow. The reason for this is that the constraints of the site are severe, and if the BART criteria were strictly enforced, either no alternative would be feasible or a compliant design would be extremely costly.

In such cases, the BART engineering department, as is the case with most other engineering agencies, may allow a digression from a particular established standard, subject to certain conditions. These would include limiting the magnitude of the digression and also assuring that the digression does not introduce a safety or operational or other functional problem. Obtaining such an exception to the rules would require a detailed engineering review, which is outside the scope of the present study. Therefore the results of this study, where they are based on use of some non-standard features, need to be considered provisional only, subject to further review, verification and approval.

Engineering Challenges:

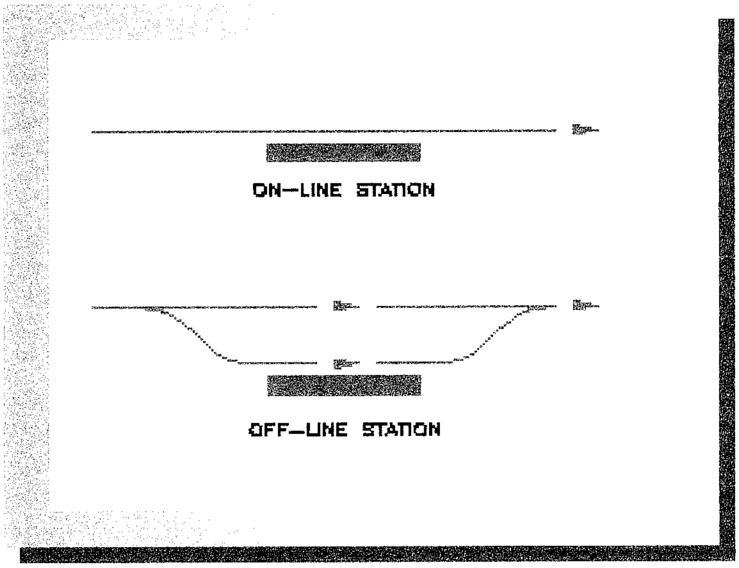
- Existing track grade is greater than three per cent
- No decrease in system service levels permitted
- Provide both northbound and southbound service access
- Maintenance of service throughout construction
- Minimization of disruption to existing communities

Other BART Functional Criteria

The following criteria relate to providing for certain needed functions of the proposed new facility: The first two criteria are obligatory, while the following criteria are either desirable or optional.

- *Obligatory – ADA Compliance:* Handicapped and elderly are to be provided convenient access to all public areas. All BART stations must meet the various published building codes, including adherence to ADA requirements for handicapped access.
- *Obligatory – Provide Station Mezzanine:* BART requires that passenger access to the track platform level be via a mezzanine/concourse level for fare collection and related functions.

- *Obligatory/Desirable – Maintain Line Capacity:* The new station should not significantly degrade the capacity of the BART line. This criterion should be considered *Obligatory* for at least one design alternative.
- *Desirable – Construction Impacts:* The construction of the new facility should not unduly hinder BART train operations during the course of the work. Although at least some disruption of service at limited times is unavoidable, various alternatives may have differing impacts on maintenance of train service.
- *Desirable – Provide Mainline Bypass Track:* With a bypass track, some trains may not have to stop at the station. Accordingly, these trains would have a shorter travel time and provide better service to those passengers who do not need to use the new station. However, this introduces potential operational problems and increases the wait time for those passengers that do wish to use the station. This issue introduces the concept of 'off-line' vs. 'on-line' platforms and is addressed further under each of the specific alternatives.



- *Optional – Revenue Train Turnback:* The opportunity afforded by construction of a station along the BART line provides the option of improving other BART functions as part of the project. A train turnback capability can be considered to permit reversal of revenue trains (trains carrying passengers), either to/from the north or south. This would permit easier adjustment of line capacity in different segments of the line, and could allow for improved overall passenger service. However, the additional cost of such an adjunct should be considered separately from the basic station cost because its incremental extra cost needs to be separately justified by its specific benefits.

  Any station with turnback function also would need to include train crew facilities, which are obligatory at such 'terminal zones'. These are breakroom facilities, restrooms, lunch area and the like.
- *Optional – Disabled Train Storage:* A pocket track might be added for side-tracking of malfunctioning trains. This is also an extra cost item.

Non-BART Standards

These would apply to surface street and utility reconstruction made necessary by excavation for the new station.

Surface street standards would be those by the City of San Francisco Department of Public Works, as for lane widths, sidewalk and bike lanes, traffic signal, street lighting, sewer facilities and the like.

San Francisco MUNI standards would apply to reconstruction of the trolley bus overhead system and for bus stops. Other utility standards would be as required by the utility companies such as PG&E.

Where major street reconstruction is required, consideration might be give to reconstruction to higher, more modern standards. Such 'betterments' as widened traffic lanes, improved bus loading features, turn pockets, new bike lanes and landscaping might be considered if additional right-of-way becomes available. The requirements for these are outside the scope of the present study.

4. ALTERNATIVE DEVELOPMENT

Basic Design Approach

In order to comply with site constraints as well as applicable design criteria and operational standards, all potentially feasible alternatives need to be developed with a common philosophy and approach, and must have certain basic features in common. These include:

1. <u>*Basic Station Configuration:*</u> All alternatives involve underground subway stations. While other types of stations such as open cut types, might be theoretically possible, the limited surface area, track grade requirements and potential environmental impacts dictate that only a subway station is considered feasible. The new station also must provide separate platform and mezzanine levels. Due to the depth of the tracks, the mezzanine level would be above the track level and below the surface street level.

   Station platform length must be adequate for a 10-car train, about 700 feet, but the mezzanine level may be considerably shorter. The size of the mezzanine level would be subject to later detailed study but must be large enough to accommodate elevator/escalator access to/from the track level below and the street level above. It must provide sufficient space for the various mezzanine functions such as fare collection, attendant booth, BART systems enclosures, and security features. In general, a minimum size mezzanine would be least costly and most secure, while a larger mezzanine would provide more opportunity for street entrances and easier pedestrian access from different directions. Another factor which influences mezzanine length, is the requirement for this infill station to be constructed on no more than a 1.0 per cent grade. Despite this, the mezzanine level should be flat. This fact imposes another length constraint on the mezzanine.

   Escalator, elevator and stair access from the street level down to the mezzanine are subject to considerable flexibility as to location. These need not always be located directly above the mezzanine or the main station box structure. Alternatively, they may be oriented in various directions, east-west for example, if such might yield more patron-friendly entry points. Sometimes the pedestrian entrances can be constructed more distant from the station box by excavating subsurface pedestrian corridors to more convenient entry locations. However, each corridor like this would add cost and construction disruption, and might be regarded as a potential security problem when complete.

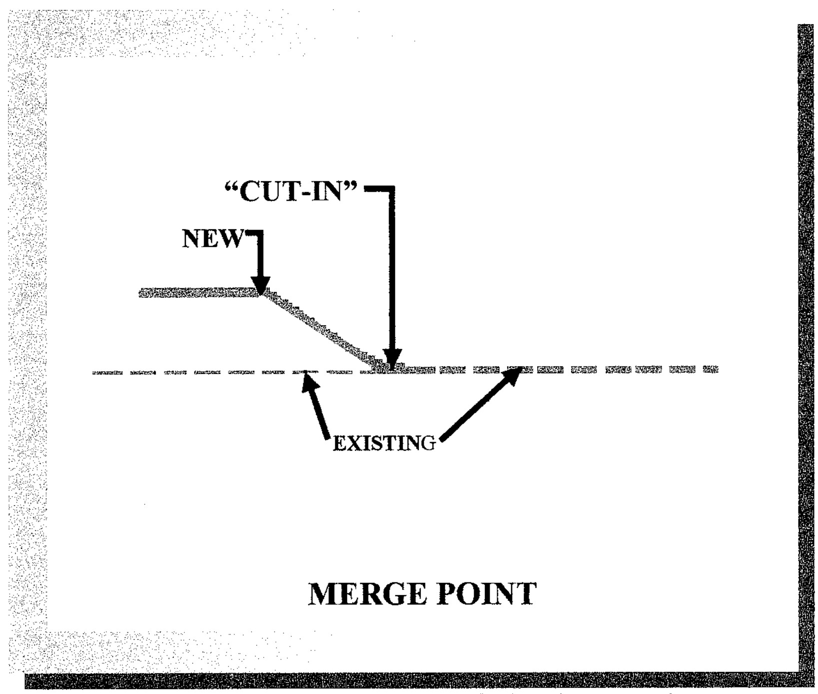
2. <u>*Station Grade:*</u> **The requirement to revise the track grade at the platforms from the existing 3.1 percent to a flatter 1.0 per cent obligates the design to include extensive reconstruction, including long approach tunnels, to provide the needed transition.** This involves a profile with several new vertical curves, and results in a construction segment considerably longer and more costly than would have been the case if the grade-reduction problem did not exist.

3. <u>*'Off-Line' Construction:*</u> Because BART train service must be maintained during construction, and also because the new tracks must be constructed on a different profile grade

than the existing, the new tracks and platforms and the tunnels that contain them must be constructed separate from, and away from the existing tunnels.

4. *Merge of New Work into the Existing Tunnels:* At the extreme ends of the new tunnels and trackage these have to be connected into the existing tunnels and tracks. When complete, the new work must be switched over to or 'cut-in' at the limits of the new construction. There are two such locations along each track direction, totaling four 'cut-in' merge points. Each of these would resemble a branch in the tunnel configuration.

   This aspect of the project is highly problematic as it involves potential interruption of train traffic while the work proceeds. The underground location of all the construction also entails extreme difficulty because work area is limited and access is very awkward. Much of the construction work at the four merge locations would be in close proximity to the operating tracks and could only be safely performed while BART service is suspended. Thus regular BART service would have to be cut back during evening and weekend periods with resort to single-track operations, possibly augmented with extra bus service. (See following Sections on Construction Impacts and on Operations.)



5. *Operational Considerations:* The introduction of a new additional station on the line would result in an increase of travel times for all trains that stop at the station. The implications of this are that travel time for system users would be increased, and that the number of trains (i.e. the amount of rolling stock) might be subject to an increase in order to support the existing service. These issues are addressed more fully in the following Sections of this report on operations and capacity.

   Due to the 'off-line' nature of the construction, as described above, there is an option to retain the existing tunnel in service for a bypass or 'express' track so that some trains could travel past the station without net increase in their travel time. However, this would reduce utility of the new station, as the wait for a train would be longer than at other stations.

   Other operational options involve the possibility of a turnback of some trains. This would require a more complex track and tunnel configuration. The potential benefit would be to facilitate adjustments in line capacity and service in various segments of the BART system. This feature does not now exist along this line segment, and it may become more important with extension of the BART system to the south. The improved ability to turn back trains could reduce the schedule demand on the very costly BART fleet of rolling stock.

For example, certain trains arriving from downtown might be turned back at 30th Street Station if it is determined that train capacity is underutilized to the south. Or alternatively, trains from the south might be turned back at 30th Street toward Millbrae/SFO if it is determined that the line toward the Eastbay cannot accommodate them all. The presence of a turnback can also facilitate the use of shorter trains on more frequent headways if this is deemed beneficial for certain segments. (The addition of new crossover tracks elsewhere on the BART system is currently under consideration because of these same operational benefits.)

A turnback and tail track could also be used to remove disabled trains from service and so reduce service interruptions.

Alternatives Considered

Following a 1998 'Sketch Study' by BART, a total of seven alternatives were later developed and considered. Initially, the present study had included the following six:

1. Double Pocket Turnback Station with Crossovers
2. Single Pocket Turnback Station with Crossovers
3. Single Pocket Station with Stub-end Storage Track and Crossover
4. Two-way Single Center Pocket Turnback Station with Third Level Platform
5. Stacked Back-to-back Center Pocket Turnback Station
6. Double Pocket Turnback Station

In addition, an on-line alternative using the existing tunnels and tracks was also previously suggested. It was illustrated in a brief May 1988 submittal prepared by BART staff and Bay Area Transit Consultants (BATC), and is illustrated in Appendix 'F'. This concept is now considered infeasible because of the need to revise the track gradient and for other reasons described above.

History and Selection of Alternatives

- 1998 Sketch Study by BART
- Established minimum design criteria
- Developed approximately ten alternatives
- Initial alternative screening
- Identified engineering & operational challenges

At an October 2001 meeting, BART staff reviewed progress on the above six alternatives and concluded that the first and sixth alternatives merited further study and refinement. The other four alternatives are considered to have little overall merit and include some features that are very unattractive, especially from the operational standpoint, thus constituting 'fatal flaws'. Therefore these alternatives have been dropped from further analysis, but are described in Appendix 'G' as "Other Alternatives Considered".

The two most promising alternatives were chosen by BART staff so as to best represent two fundamental objectives. The sixth alternative entails a basically feasible lowest cost station option. It has been redesignated, **Alternative 'A' – On-Line Station with Optional Turnback** and is further described below. Certain modifications to the initial rendition of this alternative have been made in order to further reduce its cost. For example, the turnback function has been removed from the basic scheme, although the turnback may still be considered as an extra cost option.

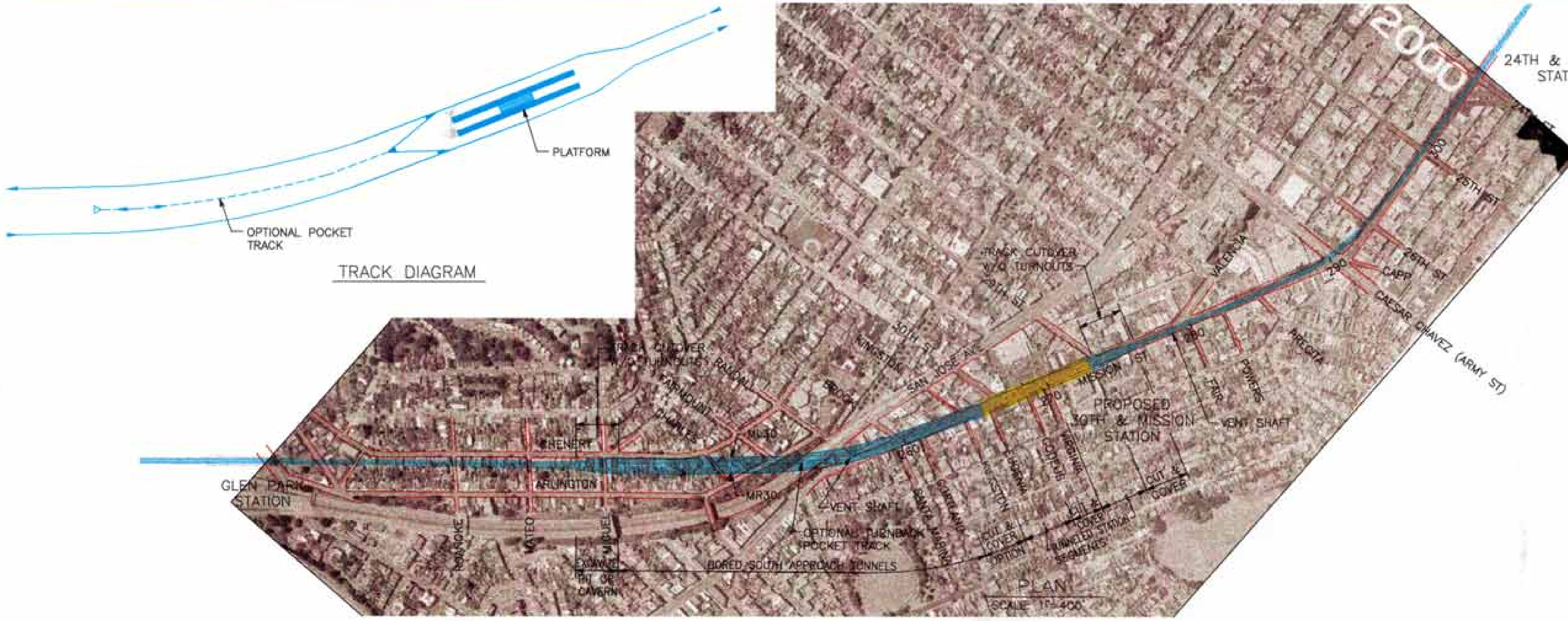
The first original alternative involves a higher-cost station configuration that is considered fully adequate to support optimum operations of the BART system. The operations benchmark used for the basis of this design is that level of service anticipated as a result of all current BART systemwide programs of improvement. This scheme has been redesignated **Alternative 'B' – Off-Line Station with Full Turnback**, and is further described below. Again, certain modifications to the original rendition of this alternative have been made, in this case also to reduce its cost.

***Alternative 'A' Description: On-Line Station with Optional Turnback** (Low Cost Alternative)*

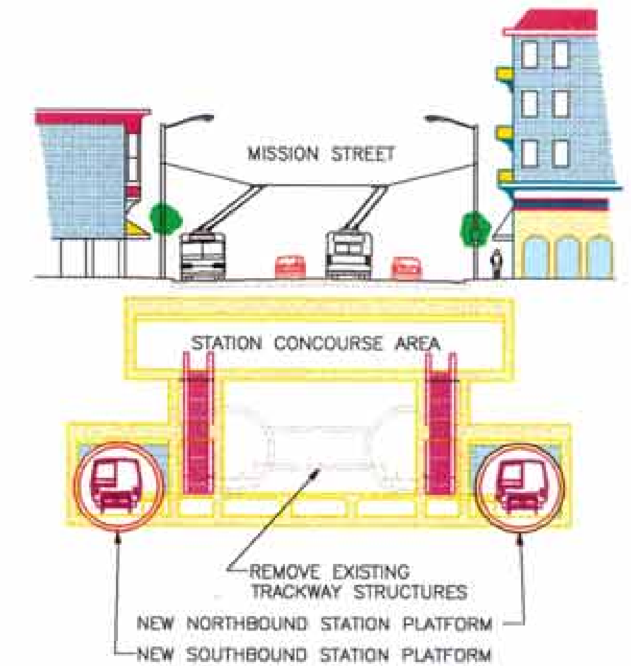
This concept, as shown in Figure 5, involves construction of the new northbound and southbound station platforms and tracks on the outside flanks of the existing BART tunnels. The positions of the new tunnels are defined by the closest distance to the existing tunnels that would facilitate safe construction. The new station is planned on a 1.0 per cent grade and thus new approach tunnels are required to conform back to the existing tunnels on both the north and south ends. The profile as shown dictates that the approach tunnels to/from the south be considerably longer, at about 2,500 feet, than those to/from the north. The approach tunnel grade of 3.12 per cent was selected to duplicate the existing grade of the BART line at this location.

The intent of this scheme is to completely replace the existing tunnels at this location, and the existing tunnel segments at the platform location would be demolished and removed. Other abandoned segments of the existing tunnels would be left in place and might be used to accommodate BART systems facilities or utilities or storage.

In this scheme, the two BART tracks would be relocated to the new station and tunnels and there would be no other tracks provided. Accordingly, the merge locations into the exiting tunnels would need to accommodate track geometry adequate for the highest speed train anticipated to travel through these locations. This design speed would need to provide for any trains that might not actually stop at the station including out-of-service trains or any skip-stop trains anticipated in future operating plans. For this reason, geometry of the tunnel merges would be longer for the track curvature needed for this scheme.



TRACK DIAGRAM



SECTION A–A
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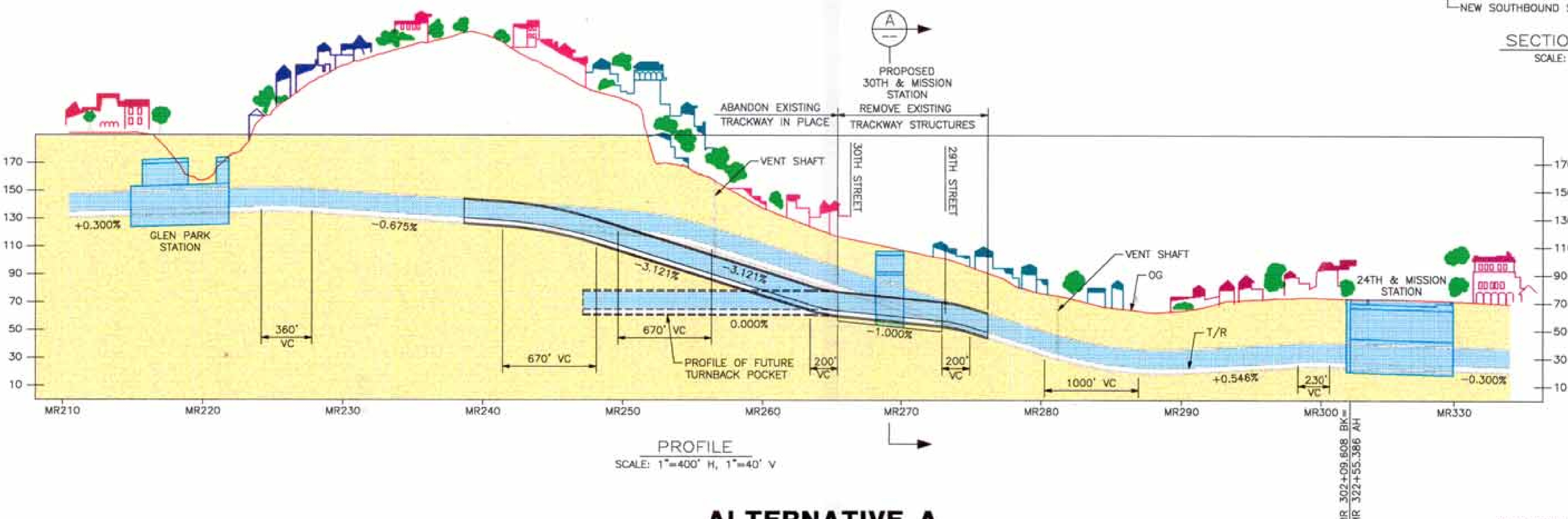

PROFILE
SCALE: 1"=400' H, 1"=40' V

FOR STUDY PURPOSES ONLY

ALTERNATIVE A

ON-LINE STATION WITH MODIFIED PROFILE AND FUTURE TURNBACK POCKET TRACK

BASIC CONCEPT

FIGURE 5

30TH & MISSION BART INFILL STATION STUDY

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altA-1.dwg

The station platform anticipated by this scheme is very generous in width because it must extend across the area previously occupied by the pre-existing tunnels. Nevertheless, the overall station footprint is conservative with respect to right-of-way width. The mezzanine/pedestrian concourse length is shown as a minimum length (much shorter than that at the adjacent 24th Street Station) option in order to save cost and minimize construction impact.

The center platform would have the configuration of an 'H' with the central area beneath the mezzanine, about 300 feet long and extending fully across between the two tracks. The balance of the 700-foot long platforms would be in the form of single platforms (the 'legs' of the 'H') along each track with each extending about 200 feet outward in both directions from the central area. This configuration would permit the four narrower segments of the platforms to be constructed within mined tunnels, so that the size of the cut-and-cover excavation pit could be minimized. The potential to retain existing buildings undisturbed on the surface could thus be improved. (See following Section on Right-of-Way Issues.)

The basic scheme requires no track turnouts or junctions, however, there is an additional option to provide a turnback pocket track (illustrated in dashed lines) to the south of the new station in the space between the two new main line tunnels. This would entail the provision of three track turnouts in the shape of a 'wishbone' as shown. The purpose of the turnback would be to permit reversal of some revenue trains from the north and/or as a location to remove disabled trains from the main line. The turnback tunnel, as illustrated, is preferred to be on a flat grade. It should be about 1,500 feet long, to accommodate two full 10-car trains.

Due to the additional cost of the turnback track, its benefits need to be balanced against its costs as if it was a separate project.

Station Function - Alternative 'A'

Train movements through the station would be similar to those at other existing BART stations. These consist of deceleration of the train into the station, station dwell, and acceleration out of the station in the same direction. The optional turnback track could be used in one of two basic ways:

1. If used for revenue train turnback, a southbound train would enter the station from the north and stop to discharge all passengers. It would then proceed onto the turnback track and stop there. The train operator would then move to the opposite end of train ('change ends') and prepare for departure. Departure of the train to the north would be only at a time when BART Central Control had identified an adequate schedule 'gap' between the northbound trains approaching from the south, so as to accommodate safe entry of the turnback train onto the main line. The train so accommodated would proceed into the station and stop to board passengers for subsequent departure to the north. The turnback track as illustrated has no direct connection to the south and thus could not accommodate revenue train turnback from that direction.

2. The second type of usage would be to store a disabled train. For a disabled train arriving from the north, entry into the pocket track would be similar to a revenue service train from that direction. But a disabled train arriving from the south would have to stop at the station and then proceed into the pocket track by means of a reverse maneuver. This would entail changing ends at the platform and would require more time, while blocking the main line. The disadvantage of this needs to be balanced against the probability that such a maneuver would be very common. A further unillustrated option would be to add additional track access from the south. This would add greatly to cost and require a revision away from the preferred flat grade for the turnback.

Alternative 'A' Advantages

- Simplest track configuration and train operations
- All trains would stop at the new station
- A narrower mezzanine is needed than for Alternative 'B', thus minimizing property impacts
- The single, wide center station platform is a passenger amenity
- The scheme does not include crossover tracks, which would be disruptive to train service to construct
- An optional turnback track is possible at extra cost
- The basic scheme has marginally lower construction cost than Alternative 'B'

Alternative 'A' Disadvantages

- The new station stop would reduce BART main line capacity
- New track curves may impose additional train speed restrictions
- Less operational flexibility than Alternative 'B' which permits train bypass of the station
- The optional turnback track is costly and is not easily accessible from the south
- The station platform level would need to be constructed in two stages (see section on Construction Impacts)

Alternative 'B' Description - Off-Line Station with Full Turnback *(Optimum BART Operations)*

This scheme, shown in Figure 6, provides for new station platforms and tracks in addition to retaining the existing tracks and tunnels as a main line bypass. This alternative also provides an operational option for turnback capability and/or disabled storage train.

Similar to Alternative 'A', Alternative 'B' also involves the construction of two new station platforms and tunnels to the outside flanks of the existing tunnels. Also similar to Alternative 'A' a new flattened track grade of 1.0 per cent is provided, and approach tunnels are needed in a similar configuration. Unlike Alternative 'A', this alternative utilizes turnouts at all the merge locations so that trains approaching the station may either proceed to a stop at the platforms or bypass the station using the pre-existing tunnels and tracks.

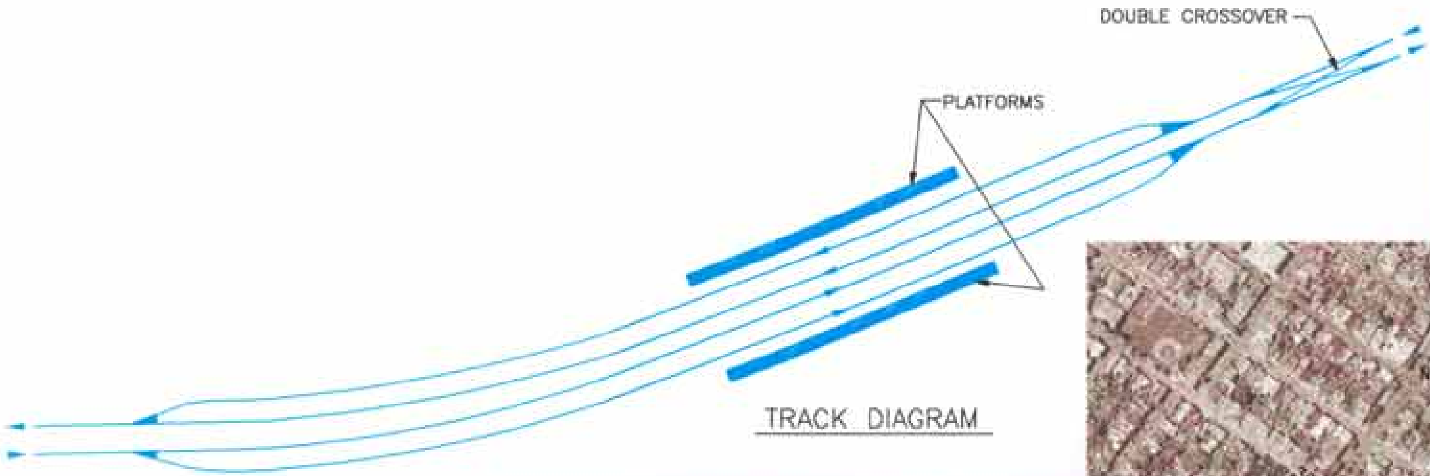
Because only those trains stopping at the station would need to diverge (at about 36 mph) from the higher speed alignment, it is possible that the merge locations might be constructed in a more limited space. This could save construction time and reduce interference with train operations during 'cut-in'. However, these merge junctions would need to accommodate more complex trackwork and signaling features related to the turnouts.

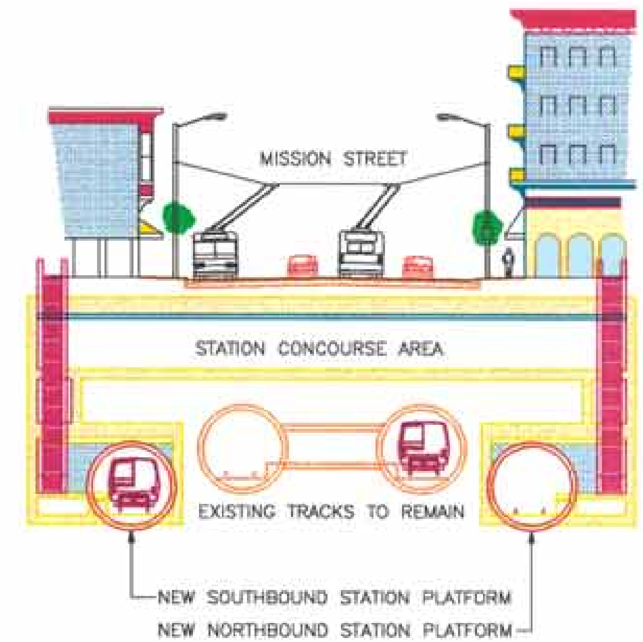
Station Function - Alternative 'B'

This scheme could accommodate express trains that would bypass the station. This type of operation would improve speed and runtime of some trains and thus support higher line capacity. On the other hand, if there were too many express trains, service to the new station would be diminished. Furthermore, this limited project would not be sufficient to result in substantial development of express train service because the bypass track would not extend beyond this single station.

For trains stopping at the station, operations would entail the usual deceleration and stop, either northbound or southbound. But departure from the station would be more complex if the main line bypass track was being used. In that case, the stopped train would have to await a 'gap' in the schedules of the bypass trains, and that might result in an elongated dwell time and increased delay for passengers on the stopped trains that serve the station. (See following Section on Operations).

The scheme includes a main line double crossover track just north of the station. This occupies more space than does Alternative 'A'. The location of the crossover is such that the existing vent shaft to the immediate north should remain undisturbed. The double crossover could serve as a revenue turnback for Transbay trains to/from the north but not to/from the south. However, the use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time, although the tracks could serve different functions at different time periods.





SECTION A–A
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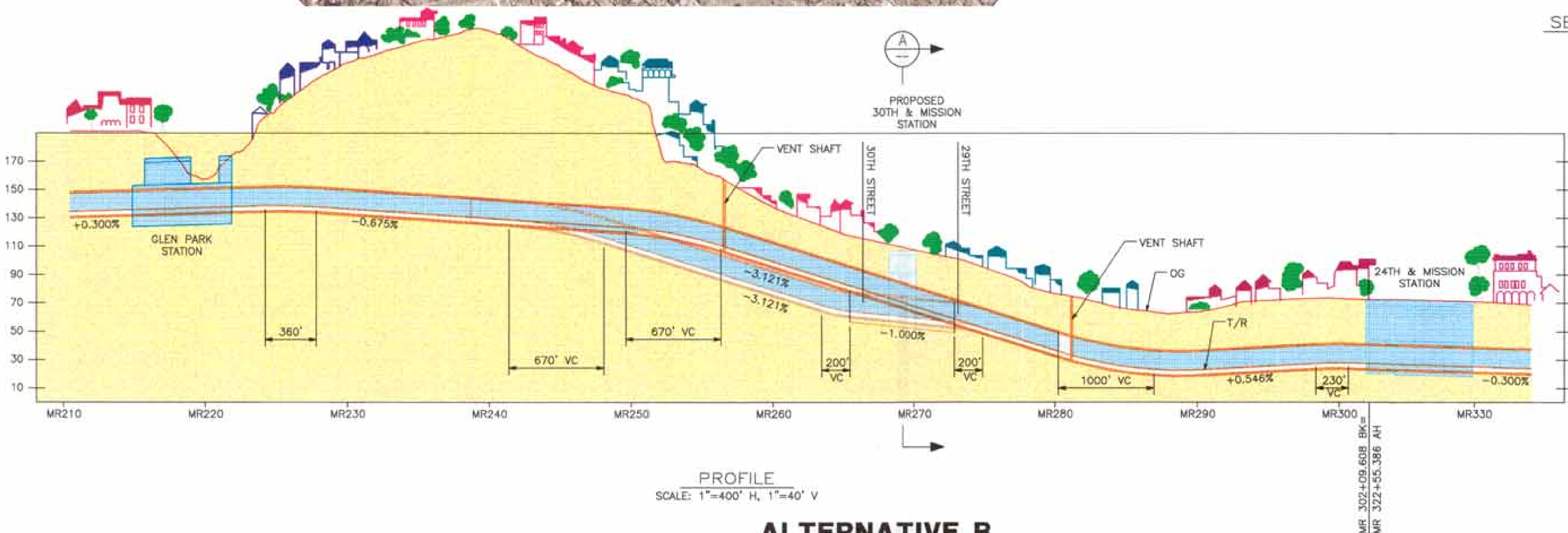

PROFILE
SCALE: 1"=400' H, 1"=40' V

FOR STUDY PURPOSES ONLY

ALTERNATIVE B
OFF-LINE SIDE PLATFORM STATION WITH NORTHBOUND TURNBACK CAPABILITY

FIGURE 6
30TH & MISSION BART INFILL STATION STUDY
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altb-1.dwg

Alternative 'B' Advantages

- Provides bypass tunnels facilitating express train operations
- Compared to Alternative 'A', minimizes capacity reduction in BART system
- No new restrictions on express train speed
- More flexibility in turnback operations (to/from north and south)
- The station platform construction could be completed in one stage (see section on Construction.)

Alternative "B" Disadvantages

- Greater operational complexity
- Potential for delay of trains reentering main line from the platform tracks
- All trains may not provide service to the station
- Express train turnback operations and disabled train storage are mutually exclusive uses of the second pair of tracks
- The turnback capability is available only to/from the north
- More complex trackwork, especially the crossovers, may increase service interruptions during construction
- Slightly more right-of-way needed than for the basic Alternative 'A'
- Separate narrow platforms are less attractive for passenger use than a center platform, and need additional escalators and elevators resulting in higher operating costs
- The separate platforms might also be more confusing to use for passengers boarding or transferring to/from turnback trains. This is because the transfer might entail level changes via the mezzanine which would be needed to get from one platform to the other
- Slightly higher construction cost than Alternative 'A'

'Things to Consider' for BART Operations

The following table is derived from the listing of BART staff concerns circulated during the initial study discussion phase. It is a list of things to consider when analyzing the advantages and disadvantages of the 30th Street infill station:

'THINGS TO CONSIDER'	*Basic Alt 'A'*	*Alt 'A' w/Pocket Track*	*Alt 'B'*
SERVICE			
– *Will the station provide staging for events and special service, pocket tracks, additional thru tracks, etc?*	*No*	*Minimum*	*Maximum*
– *Will the station impact existing service? (Increase in runtime may require additional consists and slow travel times)*	*Yes*	*Yes*	*Sometimes**
– *Will the station impact proposed AATC service increases?*	*Yes*	*Yes*	*Sometimes**
– *Will the station enhance service optimization? (Can it be used as a turnback station for one or more lines thereby saving cars?)*	*No*	*Yes*	*Sometimes**
DELAY MANAGEMENT			
– *Will the station allow for truncation of service or act as turnback station?*	*No*	*Yes*	*Yes*
– *Will the station provide for bad order storage?*	*No*	*Yes*	*Sometimes**
– *Can 'swapping' of trains be improved to maintain schedule? (trains timed to turnback in correct scheduled slot)*	*No*	*Yes*	*Sometimes**
– *Will the location of the station improve chances for single tracking during 12, 15, or 20-minute service?*	*No*	*No*	*Yes*
SERVICE DESIGN IMPACT			
– *Will runtimes and dwells change the sequencing of service or layover times?*	*No*	*No*	*Yes*
– *Will headways limit storage?*	*N/A*	*No*	*Sometimes**
– *Will headway limit turnbacks and sequencing?*	*N/A*	*Yes*	*Sometimes**
CONSTRUCTION IMPACT			
– *Will construction have impact on mainline operations?*	*Yes*	*Yes*	*Yes*
– *Will cut-over be minimally invasive with little impact on mainline operations? (one or two weekends for cut-over)*	*Less*	*Less*	*More*
– *Will road manual operation, restricted speeds, single-tracking be used minimally?*	*Less*	*Less*	*More*
– *Will a bus-bridge be feasible, available, affordable?*	*No*	*No*	*No*

* *'Sometimes' indicates that the operational impacts will depend on exactly how the two additional tracks are utilized. The use of the center tracks for either turnback or storage conflicts with their possible function as bypass tracks. These different functions cannot occur at the same time, although the tracks could serve different functions at different time periods.*

5. RIGHT-OF-WAY ISSUES

As described earlier, in order to maintain BART train service during construction, and also because the new tracks must be constructed on a different profile grade than the existing, the new tracks and platforms and the tunnels that contain them must be constructed separate from, and away from the existing tunnels. The magnitude of the lateral (sideways) shift must be sufficient to provide protection of the existing tunnels from potential construction damage caused by the work. A separation of one tunnel-diameter is considered desirable to assure this. Special construction techniques as described later can be utilized to minimize, but not eliminate the tunnel space requirements, right-of-way takes, and surface property impacts.

The station itself, consisting of the mezzanine and most of the platform area, is too large to be tunneled or excavated out exclusively from below. Instead, open pit excavations would be needed for most of the station box construction. These pit areas, which would be temporarily decked over, also provide ingress for construction equipment and materials and egress for removal of excavated earth material. This method is almost universal for subway construction and was used for all the other BART subway stations. (Stations completely constructed in mined tunnels do exist, but they are relatively rare. They are very difficult and costly to construct except where very favorable rock conditions exist, and are used only due to extreme depth or other special conditions.) However, this study does consider construction of a portion of the station by tunneling, in order to minimize the size of the open excavation pits.

Right-of-Way

As illustrated, the 'footprint' of the station and its tunnel approaches extend beyond the right-of-way lines on both the east and west sides of Mission Street. Because much of the property frontage on the west side of the street is occupied by a Safeway parking lot, the station layout should favor right-of-way takes along the west side. The Safeway lot could then be rebuilt after project completion. However, some buildings on both the east and west sides would be demolished.

Some tunnel segments of the work, due to their depth, might be completed beneath existing buildings without disturbing them. Also, configuration of the mezzanine walls might be designed to skirt as many buildings as possible. However, the scheme does require a greater width than the available right-of-way, and some new right-of-way and building acquisition could not be avoided.

Land Use Considerations:

- BART promotes station planning where higher number of riders will justify investment
- BART recognizes that its San Francisco stations are amongst the highest generators of its ridership
- A Transit Oriented Development program would boost ridership and could make use of vacated right-of-way parcels
- Underground station construction in high-density areas has ridership benefits, but results in major right-of-way impacts

Areas of Open Excavation: Figures 5 and 6 illustrate the approximate limits of the areas that would have to be constructed from the surface by open 'cut-and-cover' means and also those segments that might be tunneled from below. Figures 7-A, 7-B, 7-C and 7-D show the approximate outlines of the surface excavations.

Three or four excavation pits would be required. The main pit, shown in Figure 7-A, would be excavated at the location of the station mezzanine, and its 'footprint' would generally correspond to the mezzanine perimeter measuring about 300 feet long by 200 feet wide. It would be located at the vicinity of Virgina Avenue and Godeus Street, and envelope the east side of the Safeway parking lot.

The outlines of the excavation pits as shown are necessarily diagrammatic at this stage. In general, the attempt is made to minimize the number of buildings taken. However, for the main pit shown in Figure 7-A, it has been assumed that a slightly more generous size excavation would be needed to accommodate the mezzanine level. This leads to the possibility of taking the row of buildings on the east side of Mission Street. Because these buildings would likely need to be taken, the excavation there is illustrated extending all the way back to the east property line. It follows that if these buildings are taken at all, it would therefore seem most desirable to utilize the entire property width, to be made available to enlarge the station mezzanine to the east.

However, the exact requirement for the mezzanine remain to be determined at a later design stage. It is quite possible that one or more of these buildings might be saved by refinement of the design. A more detailed design effort would not only address the mezzanine and building-take requirements of the tunnel alignments as now shown, but also consider the possibility of minor shifts in the tunnel positions themselves so as to further minimize property takes.

A second excavation, shown in Figure 7-B, would be located between 29th Street and Valencia Street, to the north of the main pit. This excavation would enable cut-and-cover construction of the subway structures that would accommodate the north track merge connections (and the crossovers of Alternative 'B'). This excavation, about 75-100 feet wide, and 200 feet long. (500 feet long for Alternative 'B'), might be narrower than the main pit because these is no mezzanine here. The west-side buildings are therefore shown as being saved. However, as indicated above, detailed design study is needed to verify the exact need for building takes. It is possible that some or all of the west-side buildings might actually need to be acquired.

The third excavation would be needed only for the Alternative 'A' option that includes the pocket track. This pit would enable the construction of the structure that would accommodate the 'wishbone' track connections. As shown in Figure 7-C, it would be located just south of the station about 250 feet south of the main pit. It would measure about 75 feet wide by 250 feet long.

The fourth excavation pit would be much further to the south, in the south quadrant of the Chenery Street/Miguel Street intersection as shown in Figure 7-D. This site would provide for construction of the south tunnel-merge structures. Due to the extreme depth here of over 100 feet, this would be a difficult excavation, and there is the alternative possibility of constructing a