Tunneling Methodology Background

In previous engineering phases (2004-2009), the planned methodology for constructing VTA's BART Silicon Valley Phase II Extension Project's underground stations and tunnel system included a twin-bore tunnel design with cut-and-cover station construction. The twin-bore design option includes two approximately 20-foot diameter tunnels that would be constructed with one or two tunnel-boring machines (TBMs), and would each house tracks for a single direction of travel. Underground stations would be constructed with cut-and-cover or open-cut construction, which would excavate ground material from the surface down to the depth of a station or facility within the public right-of-way or on off-street parcels. Cut-and-cover construction in areas of public right-of-way (such as downtown San Jose) would require relocation of underground utilities, and have significant impacts to existing infrastructure and street level activities.

In 2014, as Phase II planning efforts were renewed, staff began studying advances made in the tunneling industry since completing engineering on the twin-bore tunnel design in 2008, identifying lessons learned from other tunneling projects, and reviewing the feasibility of alternate tunneling methodologies. VTA's other objectives in reviewing the project plans were to ensure the best project was being built for Santa Clara County and to look for opportunities to minimize impacts to streets, VTA's light rail system, bus operations, and underground utilities that would be caused by cut-and-cover construction.

In 2015, after reviewing the project plans and receiving comments from stakeholders and the public at environmental scoping meetings, along with interactions with tunneling subject matter experts, staff identified a single-bore tunneling methodology as a possible option to further study.

The design concept for the single-bore tunneling methodology option included a tunnel constructed with a tunnel boring machine and compartmentalized into two trackways separated by fire-rated center walls or fire-rated concrete slabs. A benefit of this concept is that it would allow station boarding platforms to be entirely accommodated within the tunnel rather than constructed by a cut-and-cover construction technique. All other station facilities, including vertical circulation elements (elevators, escalators and stairs), station agent booths, ticket vending machines, fare gates, etc. necessary to access the platforms would be constructed via open-cut construction on off-street parcels and connect to the single-bore tunnel via mined passageways below ground. Because most open-cut construction would be located off-street outside the public right-of-way (similar to a high- rise development with underground parking), impacts to street level activities and underground utilities would be significantly reduced. A single-bore tunneling methodology option and related station construction approach would offer operational flexibility and enables station construction with reduced impacts to street level activities and underground utilities. Preliminary analysis of the single-bore tunneling methodology option indicated it would be feasible to construct and operate.

In early 2016, VTA reviewed the preliminary analysis for the single-bore tunneling methodology with BART and FTA, and elected to analyze the environmental impacts of both tunnel

construction approaches in the project's *Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report (SEIS/SEIR).* Later in 2016, VTA initiated additional technical studies to further analyze and to develop concepts for key areas of the tunnel and station system configurations.

In October 2016, VTA initiated *VTA's BART Silicon Valley Phase II Single-Bore Tunnel Technical Studies*. This report, based on the criteria established in consultation with BART, provided verifications of the preliminary findings and conceptual designs for a single-bore tunnel alignment, profile, station configuration, station and tunnel ventilation, and emergency egress and response based on current national codes and standards, including the National Fire Protection Association (NFPA 130), California Building Code (CBC), and applicable BART Facility Standards (BFS). The findings of the report confirmed that the single-bore tunneling methodology would meet applicable industry and applicable BART facility standards.

To aid in selecting the tunneling methodology, VTA initiated an independent risk assessment in March 2017 to comprehensively evaluate risks associated with overall project cost, schedule, constructability and operability of both the twin-bore and single-bore tunneling options. The objective of the analysis was to compare common subsurface elements of each tunneling option, and determine risk impacts to project cost, schedule, and performance. Due to differing levels of design for each option, uncertainties related to the single-bore option are greater until additional design is completed. However, the majority of uncertainties are expected to be eliminated through the technical work in the next phase of engineering.

The study concluded that baseline capital costs and operations and maintenance costs were relatively close on a rough order of magnitude, while single-bore tunnel subsurface elements could be completed in a shorter time duration than twin-bore tunnel subsurface elements.

To further assist in the selection of a tunneling approach, representatives from VTA, BART and the City of San Jose traveled to Barcelona, Spain, in July 2017 to meet with officials of the Line 9 metro system and experience the system's operations. Line 9 includes a single-bore tunnel containing two independent stacked trackways. The platforms are within the tunnel with entrances connecting to the side of the tunnel. Discussions with the Line 9 system officials included system operations and maintenance, systems safety, and features such as platform edge doors and high speed elevators.

At the September 22, 2017 VTA Board of Directors Workshop, VTA staff presented tunneling methodologies and station location options for the project description that were included in the Draft SEIS/SEIR. Criteria used to evaluate the options included constructability, safety and security, operations and maintenance, passenger experience, cost and schedule, and economic impacts. Exhibit 1 provides descriptions of constructability, system operations, economic development, and passenger experience related to the twin-bore and single-bore options. After comparing the single-bore option against the twin-bore option in the listed areas, staff found that the single-bore option was equal to or superior to the twin-bore in all of the areas. Therefore, staff made a preliminary recommendation for the single-bore tunneling methodology.

At the September 28, 2017 joint VTA and BART Board of Directors meeting, VTA and BART agreed to engage a panel of peers from public transit agencies currently operating heavy rail subway systems with deep stations to review the single-bore tunneling methodology concept with a focus on operations and safety. The peer review panel met the week of November 13, 2017, and included current and retired managers from Los Angeles Metropolitan Transportation Authority (LAMTA), Washington Metropolitan Area Transit Authority (WMATA), Metropolitan Atlanta Rapid Transit Authority (MARTA), New York City Transit (NYCT), New York Metropolitan Transportation Authority (NYMTA), and San Francisco Municipal Transportation Agency (SFMTA). Key considerations for the panel were the risks and/or challenges associated with the single-bore option; and, whether the option could be operated and maintained safely as an extension of the BART system.

As part of the peer review process, the panel heard presentations from VTA and BART staff regarding relevant aspects of the single-bore and twin-bore options and opined that a single-bore tunnel could be operated safely as an extension of the BART system, and with some operational refinements, VTA could address BART's operational preferences. However, due to timing constraints related to the federal funding schedule and BART's strong preferences, the panel advised that twin-bore tunnels were the preferred option for Phase II of VTA's BART Silicon Valley Program.

In December 2017, after considering the rationale for the panel's conclusions, VTA formally requested a three-month extension of time from the Federal Transit Administration (FTA) to complete the Project Development Phase of the New Starts Funding Program. This request, which was granted in February 2018, provided time for VTA to address BART's operational safety concerns related to the single-bore configuration.

DISCUSSION

Conceptual design for the single-bore option meets applicable industry and BART facility standards for operations and safety, provides operational flexibility, and would reduce impacts to street level activities and underground utilities that would occur with construction of the twin-bore option.

After receiving feedback from the Peer Review Panel, VTA engaged with BART staff and management and subject matter experts to come to a consensus regarding BART's operational-related concerns with or the single-bore option.

As a result of the discussions between VTA and BART, VTA staff and their design consultants considered potential operational-related approaches to address BART's preferences for the single-bore design, including, fire/life/safety criteria, emergency evacuation procedures, platform capacity and configurations, tunnel guideway safety features, etc.

VTA also held a twin-bore construction workshop with tunnel construction experts to review and re-evaluate the proposed engineering and construction approaches for VTA's twin-bore concept. The workshop concluded that there are no new practical mining techniques that could be used to construct the Downtown San Jose Station and crossover box in a manner that would reduce

impacts to surface activities and utility relocations, which had been thoroughly analyzed in the Draft SEIS/SEIR.

Cost

The independent risk assessment of the two tunneling options included an evaluation of the estimates and risks associated with implementation of both options. This assessment indicated that the two tunneling options would have similar rough order of magnitude costs with different contingency levels based on the level of designs and implementation challenges.

The single-bore option is designed to a conceptual level. Due to the level of design, the estimate includes a higher level of contingency to address uncertainties in material quantities and other details normally resolved in later stages of design development. The cost estimate will be refined as design progresses resulting in a reduction of contingency. As a result, for decision making purposes, both options can be considered comparable in regards to cost.

Moreover, as Phase II progresses into the Engineering Phase, design refinements are inherent. VTA will continue to work with BART in the Engineering Phase to explore further design refinements that may enhance BART's operations. If any of these design refinements are later proposed for approval by the Board, VTA would undergo CEQA review prior to their approval, to the extent required by law.

Staff recommendation

Throughout the process of determining a preferred tunneling methodology to select, VTA has emphatically stressed a commitment to designing a safe project while recognizing BART's operational requirements and preferences as the future system operator. At the same time, VTA has stressed a commitment to the downtown San Jose community and the need to minimize construction impacts to street level activities during project construction.

In summary:

- Preliminary analysis indicated that the single-bore tunnel would be feasible to construct and operate.
- *VTA's BART Silicon Valley Phase II Single-Bore Tunnel Technical Studies*, verified preliminary findings, further developed conceptual design, and determined applicable industry standards are satisfied.
- The opinion of the Peer Review Panel indicated that a single-bore tunnel could be operated safely as an extension of the BART system with some adjustments to address BART's operational safety comments.
- That for decision-making purposes, the cost estimates for both tunneling options are comparable within a rough order of magnitude.

VTA staff's recommendation is based on evaluation of recent tunneling industry advancements, review of feasible alternative tunneling methodologies to reduce cut-and-cover construction and minimize impacts to street level activities in downtown San Jose, a peer agency review, and the following key benefits listed below.

The single-bore tunneling methodology would:

- Provide for greater operational flexibility as compared to the Twin-Bore Option, allowing for the ability to provide multiple crossover tracks and areas to store train cars within the tunnel for emergencies, special events, or regular maintenance activities;

- Provide for reduced tunnel maintenance resulting from minimal groundwater intrusion, because egress passageways would be built inside the tunnel, and the only key interfaces connecting to the tunnel structure would be the station entrances and ventilation structures.

- Reduce impacts to vehicular traffic, bicyclists, and pedestrians as compared to the Twin-Bore Option because it would not require the closure of Santa Clara Street and adjacent roadways during construction;

- Eliminate impacts to VTA's light rail service as compared to the Twin-Bore Option because the north/south light rail trackways that cross Santa Clara Street at 1st and 2nd Streets would not have to be temporarily closed for months with service maintained by bus bridges.

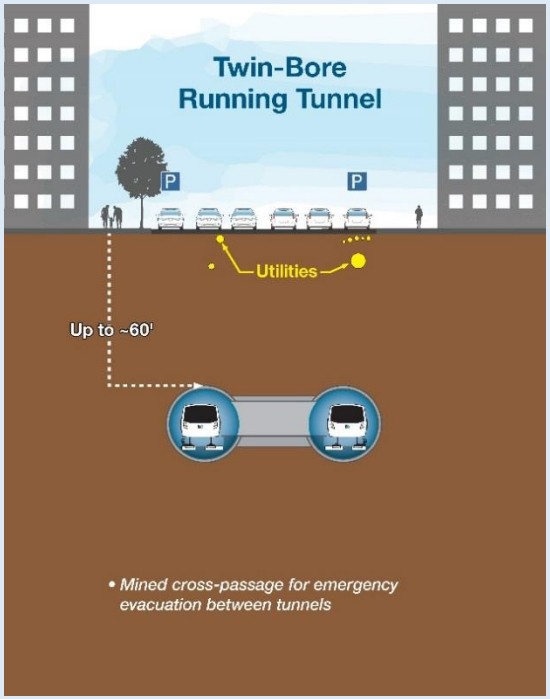
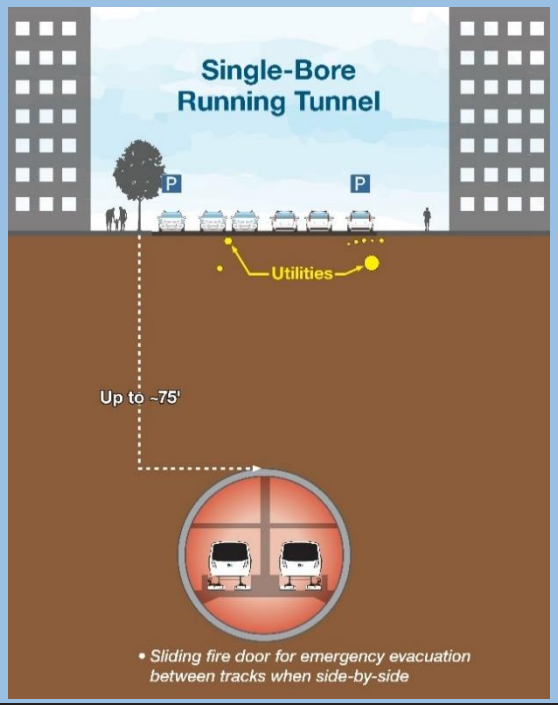
- Reduce impacts to bus service as compared to the Twin-Bore Option because key bus transfer stations on Santa Clara Street would not have to be relocated;

- Result in limited excavation within the street right-of-way, with most construction activities limited to off-street station entrance areas, which would result in less construction impacts to businesses and the community during construction as compared to the Twin-Bore Option; and

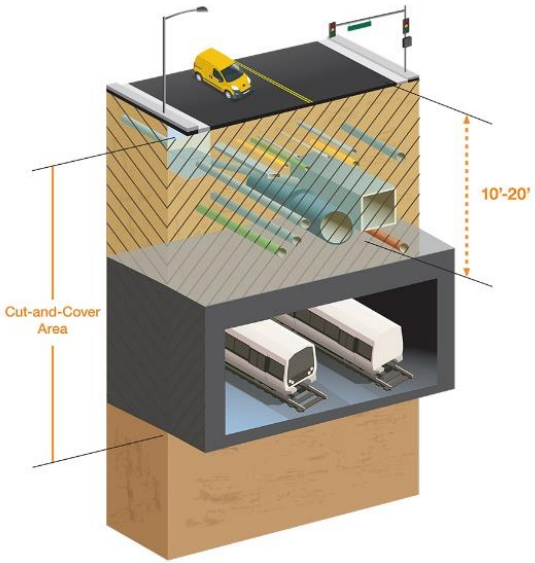
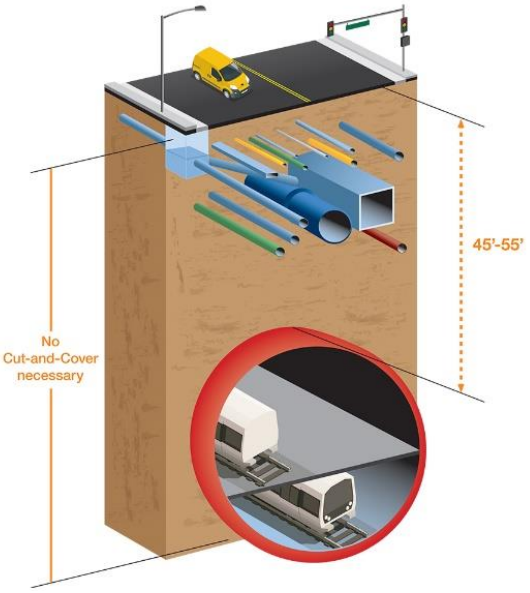
- Result in a greatly reduced area of cut-and-cover construction near historic buildings fronting Santa Clara Street as compared to the Twin-Bore Option and therefore would require a much lower level of effort for the mitigation measures to protect historic buildings.

Based on the foregoing, VTA staff recommends the single-bore tunneling methodology option.

Attachment B Tunneling Methodology Background - Exhibit 1

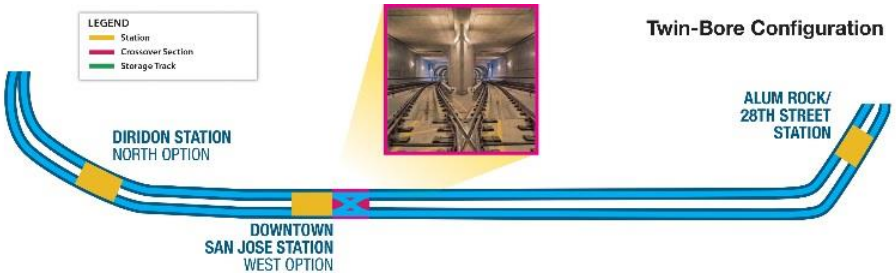
	Twin-Bore Configuration	Single-Bore Configuration
Description		
	Two approximately 20-foot diameter tunnels, would each contain tracks for a single direction of travel. The two tunnels would be constructed with tunnel boring machine(s) side-by-side approximately 20 feet apart. Thirty-three cross passages (nominally 600 feet apart) connecting the two tunnels would be constructed throughout the 5-mile tunnel alignment for emergency passenger egress between the tunnels. Three underground stations, a downtown underground crossover structure, and two mid-tunnel ventilation structures would all be constructed with cut-and-cover construction and integrated with the bored tunnels. Stations facilities including station agent booths, ticket vending machines, fare gates and vertical circulation elements to the boarding platforms would be located on a concourse level. The concourse level is above the boarding platform and below the surface level. Access to the concourse would be through passenger stairs, escalators and elevators from the surface level.	One approximately 45-foot diameter tunnel would contain tracks for both directions of travel Tracks would be constructed inside the single-bore separated by a concrete slab or wall. The design developed during the technical studies has a total of 76 cross passageways (nominally 300 feet apart) within the tunnel. Passenger boarding platforms for the three underground stations, crossover and pocket tracks, cross passageways for emergency passenger egress, and other ancillary facilities would be constructed within the single-bore tunnel without cut-and-cover excavation. Mid-tunnel ventilation shafts would be constructed at off-street locations and connect to the single-bore tunnel via below-ground passageways. Station facilities, including station agent booths, ticket vending machines, fare gates and vertical circulation to platforms would be constructed and located on off- street parcels and connect to station platforms inside the single-bore tunnel via below-ground passageways.

Constructability		
	Twin-Bore Configuration	**Single-Bore Configuration**
Method	The two tunnels would be constructed with tunnel boring machines (TBM), excavating ground material, creating the tunnel structures and removing the excavated material.	The tunnel would be constructed with a tunnel boring machine (TBM), which excavates ground material, creates the tunnel structure and removes the excavated material. Based on technical studies, a 47-ft diameter tunnel boring machine would be used for tunnel construction.
Cut-and-Cover Requirements	The underground stations, downtown crossover, portals and mid-tunnel ventilation structures would be constructed with cut-and-cover construction in both on- street and off-street locations. The cut-and-cover box in Downtown San Jose would be approximately 1,500 feet long along Santa Clara Street. At the Alum Rock/28th Street station and Diridon station, the cut-and-cover box would be approximately 900 feet long. The depth of the cut/ excavation would be about 80 feet and the width is approximately 65 feet. Cut-and-cover construction excavates ground material from street level down to the depth of the station facilities or tunnel structure. Support of excavation for the cut-and-cover structures include slurry walls with embedded steel reinforcing or steel beams that will extend below the bottom of the cut-and-cover excavation. For excavation in Santa Clara Street or other public right-of-ways, the excavated area is covered (or decked) in sections to allow for surface activities to resume as station construction continues below the decking. After construction of the structure is completed, the area above the station is backfilled for surface level activities to return to existing conditions. In downtown San Jose, excavation in sidewalk areas along Santa Clara Street is expected in the construction of passageways/station entrances. Means and methods for these techniques will be determined by the construction contractor, but will be coordinated with local residents and businesses to minimize the impacts. A majority of construction for the Downtown San Jose station would take place on-street. This involves street and sidewalk closures to install and remove the decking.	The portals and mid-tunnel ventilation structures would be constructed primarily within off-street parcels with cut-and-cover construction. The underground station entrances would be constructed similar to high- rise buildings with underground parking with excavation to required depths. Based on a concept developed during the technical studies, the downtown San Jose station would have a main entrance at the VTA block and an east entrance on the north side of Santa Clara Street. Cut-and-cover construction excavates ground material to the depth of the station platforms or tunnel structure. Much of the excavation is out of public right-of-way areas. Depending on the need, the excavated area could be covered (or decked) during construction to allow for surface activities to take place as construction continues below ground. After construction of the structure is completed, the area above is backfilled to return to existing conditions. A majority of construction would take place off-street, with minimal impacts to automobile traffic and bicycle and pedestrian routes. Soil improvement techniques are expected in the construction of the connections between the station facilities to the platform areas of the single-bore tunnel. Means and methods for these techniques will be determined by the construction contractor, but will be coordinated with local residents and businesses to minimize the impacts.

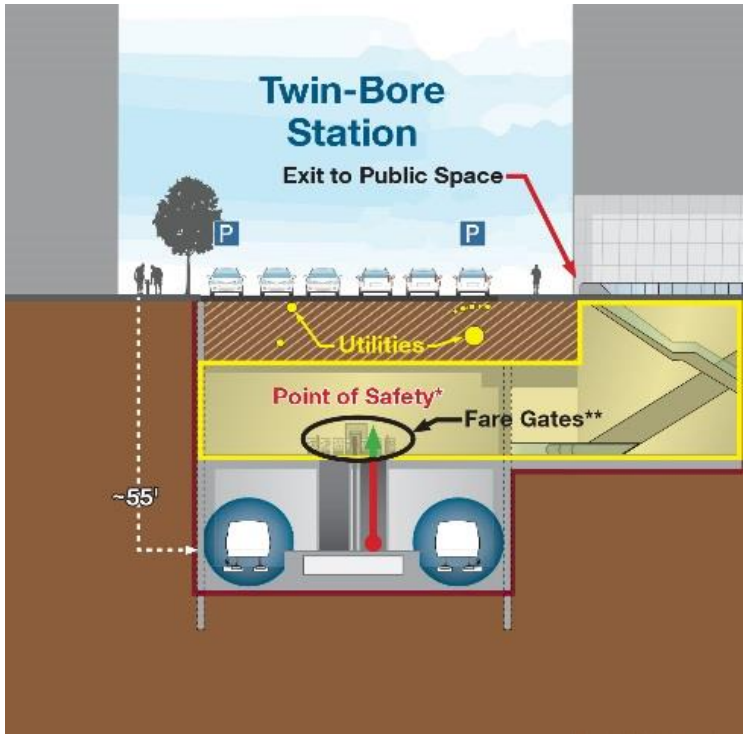
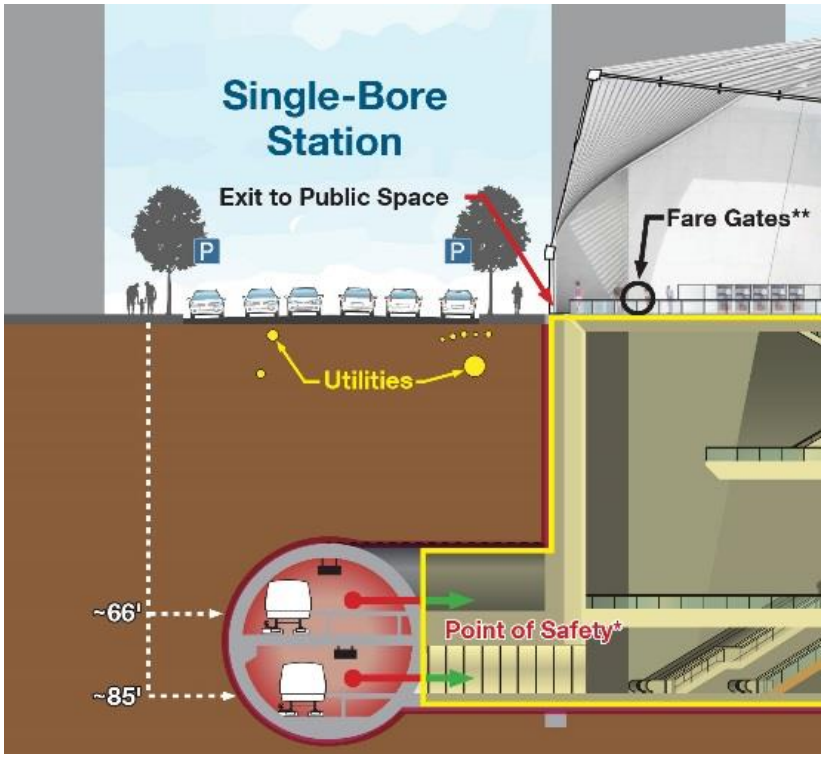
Constructability (Cont.)		
	Twin-Bore Configuration	**Single-Bore Configuration**
Emergency Egress Passages	Emergency egress from the incident tunnel into the non- incident is made via cross passages between tunnels. These cross passages would be constructed using mining techniques between the bored tunnels. The current twin-bore design includes 33 cross-passages located along the subway alignment. Several of the areas identified as locations for cross passages would require treatment to improve the ground for mining either from within the tunnel or surface level. Means and methods for improving the ground conditions would depend on location. Ground treatment, when performed from the surface, involves lane and sidewalk closures and detours impacting automobile traffic and bicycle and pedestrian routes.	The single-bore tunnel has concrete walls and floor slabs creating two independent sections for tracks. Emergency egress from the incident section into the non-incident section of the tunnel is made via fire- rated doors between trackways. The design developed during the technical studies has a total of 76 cross-passages. Emergency passageways between trackways would be constructed within the divided tunnel. Because the construction is within the tunnel, no external ground improvement is necessary and an increased number of cross passages can be built.
Utility Relocation Impacts	Cut-and-cover construction would require relocation of or strengthening of all public and private utilities that pass through the planned cut-and-cover structure. An advance utility relocation contract, of up to 24 months, is expected before cut- and- cover construction activates for Downtown San Jose station would commence. During station construction, major utilities can be supported from below the decking structure and above the station box. Utility relocation in an older downtown active street is a high risk item for the project as it can have severe impacts to the community and there is uncertainty in the number of utilities known and unknown as well as the condition of the utilities.  	Limited cut-and-cover construction may take place in the street right of way at mid-tunnel ventilation structures, portals and station access locations which may involve some utility relocation or strengthening. 

Constructability (Cont.)		
	Twin-Bore Configuration	**Single-Bore Configuration**
Transportation Impacts	On-street cut-and-cover construction would extensively impact street level activities, including circulation of auto traffic, bicycle and pedestrian movements, and operations and access for businesses, residences, and other entities within the vicinity of cut-and-cover construction. In downtown San Jose, the VTA light rail system (for Downtown San Jose Station West Option) and bus routes would be extensively impacted and operations would be altered, including potential temporary closures of light rail stations and sections of track, potential single tracking of service, and use of buses to bridge service gaps. Bus stops in the vicinity of the station and crossover box would potentially be relocated and bus routes rerouted during the construction period. Means and methods for improving the ground for cross passage mining could also impact street level activities, including circulation of auto traffic, bicycle and pedestrian movements, and operations and access for businesses, residences and other entities. Significant construction-related traffic due to hauling of excavated material from the cut-and-cover station boxes would occur over 2 to 3 years.	Impacts to auto traffic and bicycle and pedestrian routes would be less than twin bore for tunnel or station construction. The single-bore option has minimal impacts to VTA light rail and bus infrastructure and services. With emergency egress passageways built into the single-bore tunnel, there would not be a need for mined construction or ground treatment activities for these passageways. Construction-related traffic due to hauling of muck from the cut-and-cover off street station entrances would occur for a period of time significantly shorter than twin-bore. Truck traffic estimated to be 50% less due to smaller excavation footprint at station areas.
Business Impacts	Construction of station, crossover, tunnel portals, and mid-tunnel ventilation structures involves a significant amount of cut-and-cover construction that would take place on-street in the public right-of-way. On-street cut- and-cover construction would extensively impact street level activities, including operations and access for businesses, residences, and other entities within the vicinity of cut-and-cover construction. VTA will work closely with businesses and residences during the construction to allow for access and coordinate operational needs.	Station construction involves mainly off-street construction activities. Construction of mid-tunnel ventilation structures, portals, and station access locations involves partial on-street cut-and-cover construction that would impact some street level activities. Impacts to businesses, residences, and other entities within the vicinity of cut-and-cover construction would be less than twin-bore for tunnel or station construction.
Diridon Station	The location of the Diridon Station North Option extends below the Caltrain tracks south of Santa Clara Street. The station would require cut-and-cover construction while construction of the station box beneath the Caltrain tracks would require Caltrain tracks to be supported.	The station entrance for the Diridon station would be south of Santa Clara Street in the areas of the existing Caltrain parking lot with cut-and-construction methods. The station platforms would be constructed within the tunnel, under Santa Clara Street.

Constructability (Cont.)		
	Twin-Bore Configuration	**Single-Bore Configuration**
Seismic Design	Based on information released by the United States Geological Survey in 2010 about the North Silver Creek Fault, the twin-bore tunnel configuration does not allow for periodic realigning of the tracks after a seismic event involving the North Silver Creek fault, including fault creep. The redesign may result in potential changes to the tunnel configuration at this location.	Based on the concept design of the single-bore tunnel, the configuration provides space planning to accommodate BART seismic clearance envelope and allows for periodic re-aligning of tracks after seismic event involving the North Silver Creek fault, including fault creep.
Cultural Resources	The Twin-Bore Option would result in a much greater area of cut-and-cover construction potentially near historic resources as compared to the Single-Bore Option, especially along Santa Clara Street adjacent to and within the historic district. Therefore, it is anticipated that the Twin-Bore Option would require a much greater level of effort for the implementation of mitigation measures to protect historic resources as compared to the Single-Bore Option.	The Single-Bore Option would result in a reduced area of cut-and-cover construction near historic resources as compared to the Twin-Bore Option. Therefore, it is anticipated that the Single-Bore Option would require a much lower level of effort for the mitigation measures to protect historic resources as compared to the Twin- Bore Option.

System Operations		
	Twin-Bore Configuration	**Single-Bore Configuration**
Train Operations	The Twin-Bore Option is configured similar to most existing BART subway tunnels and stations. This design would allow for a crossover adjacent to the Downtown San Jose Station for trains to change tracks in the event of emergencies, special events, or regular maintenance activities. The crossover requires a reduced speed from BART's preferred crossover speed, as the crossover length is limited due to the desire to limit the extent of the cut-and-cover construction in downtown. 	The Single-Bore Option would be a new configuration in the BART system, primarily in which the platforms at the stations would be in a stacked configuration. However, in BART's existing system, both 12th Street/ Oakland City Center and 19th Street Oakland underground stations are configured with a center platform above another lower side platform. This configuration would require additional training for operations, maintenance and safety and security personnel. A crossover is provided east of Downtown San Jose station. Due to greater available space in the single-bore, the crossover would not impact train speed as much as the crossover in the twin-bore configuration. This design also allows for the ability for multiple crossover tracks and areas to store train cars within the tunnel for emergencies, special events, or regular maintenance activities. 
Station Operations	The current station design is similar to the subway stations BART operates today. Most existing BART stations typically operate with one station agent per shift on the station concourse. Many existing stations include entrances at street/ surface levels entering the free area of the concourse before purchasing fare and entering the paid area. The free concourse area has presented some recently identified safety and security concerns. To address these concerns, reconfiguration of this design at ticketing, fare gates, and security doors locations may be needed.	Based on the current concept design, there is no shared concourse between station entrances at Downtown San Jose station. Therefore, it is assumed that this underground station will need two station agents during peak hours or the times both entrances are open. The station configuration is designed to have limited free area that would reduce present safety and security concerns
Ventilation	The ventilation system developed for the Twin-Bore Option meets a medium fire growth rate per industry codes and standards with facilities sized accordingly.	The ventilation system developed for the Single-Bore meets a medium fire growth rate, consistent with the twin- bore. The cross sectional area within the tunnel requiring ventilation is similar to that of twin-bore.

System Operations (Cont.)		
	Twin-Bore Configuration	**Single-Bore Configuration**
Platform Width & Capacity	The Twin-Bore Option has a 28 ft. wide center platform with 9ft.-3in. unobstructed width in each direction of travel. This equates to approximately 18,000 square feet of unobstructed area on the platform. The remaining platform area provides for vertical circulation elements as well as passenger movement/queuing. The platform size meets BART passenger-per-square-foot standards. Post-event passenger surges at Diridon Station would need to be further evaluated and addressed. The center- platform configuration may enable additional queuing on the platform intended for the less-dominate direction of travel.	The design for the Single-Bore Option would have two 15'6" unobstructed platforms (one per direction of travel) equating to approximately 21,700 total square feet of unobstructed area and exceeding current BART passenger-per-square-foot standards. Post-event passenger surges at Diridon Station can be accommodated via patron staging in oversized entrance facilities and/ or concourse area. In addition, the ability to have more crossovers or areas to store trains with the single-bore design allows for flexibility of operations in the extension and potential to clear platforms faster.
Tunnel Emergency Egress	The current design, with BART's concurrence, includes 33 cross passages provided for emergency egress situations within the tunnel. The cross passages are at a nominal spacing of 600 feet. The non-incident tunnel is the Point of Safety.	The concept design includes 76 emergency egress passages for emergency situations within the tunnel. The spacing is 300 feet between passages along most of the alignment. The increase in the number of emergency egress passages decreases the evacuation time. The non-incident and fully independent section of the tunnel is the Point of Safety.
Tunnel Maintenance	The interfaces connecting the tunnel to the three underground stations, two mid-tunnel ventilation structures and 33 cross passageways are points of vulnerability for water intrusion. The twin-bore tunnel requires special seismic design to make sure the re- entrant joints between the tunnel and cross passage joints remain closed after a seismic event. In addition, water intrusion can occur between the slurry support of excavation walls wall and the permanent concrete wall. As water intrusion is a main contributing factor to building damage, maintenance efforts are significant to BART and require routine pumping and maintenance.	With emergency egress passageways built into the tunnel, there is no potential for groundwater intrusion associated with egress passageways. The interfaces connecting the single bore tunnel to the station entrances and two mid-tunnel ventilation structures are points of vulnerability for water intrusion. Groundwater intrusion would require routine pumping and maintenance.

System Operations (Cont.)		
	Twin-Bore Configuration	**Single-Bore Configuration**
Station Emergency Egress/Point of Safety	To meet National Fire Protection Association (NFPA) 130 requirements and applicable codes, standards, and ridership criteria, the underground stations in the twin-bore tunnel option requires an engineered solution as Point of Safety. The station exiting needs to be re-evaluated to reflect the changes in applicable codes, standards, and ridership criteria. Changes from this review may impact the station design, including the design of station ventilation and footprint. 	To meet National Fire Protection Association (NFPA) 130 requirements and applicable codes, standards, and BART passenger crush load criteria, the underground stations in the single-bore tunnel option requires an engineered solution as Point of Safety. Based on the technical studies of the downtown San Jose station concept, station exiting calculations meet current applicable codes, standards and BART passenger crush load with the adit/ passageway adjacent to the station platform as the Point of Safety. 
Vertical Circulation	Vertical circulation elements such as stairs, elevators, and escalators in the stations would be in a similar configuration as other BART underground stations.	The station configuration involves longer or additional vertical circulation elements than those incurred with a twin- bore option due to the depth of the station. Additional personnel may be required to maintain the elevators and escalators due to a higher number of these vertical circulation elements.

Economic Development		
	Twin-Bore Configuration	**Single-Bore Configuration**
Community Impacts	In the downtown San Jose area, construction impacts due to the utility relocations and cut and cover operations will be extensive from Market Street to 4th Street along and near Santa Clara Street. VTA will work with the community and affected businesses to develop a program of solutions for large and small businesses and other types of entities. Outreach and communications must be at a robust level in staffing.	Due to limited excavation within the street right-of-way, in the vicinity of the underground stations, there would be less construction impact to businesses and other entities during construction. Most construction impacts will be limited to station entrance areas. VTA will work with the community and affected businesses to develop a program of solutions for large and small businesses and other types of entities.
Development	The off-street location of station entrances presents limited opportunities to integrate development and land uses at the street level. Development requires coordination with VTA, BART, and other stakeholders to avoid any impacts above the station box which can potentially limit development in the station area.	The off-street location of station access and vertical circulation elements presents opportunities to integrate development and land uses at the street level. Development requires coordination with VTA, BART, and other stakeholders to avoid impacts to the tunnel. Since station platforms are within the single-bore tunnel and does not require a station box, this option could have a larger developable area.
Diridon Station	For the north option for the Diridon station, the twin- bore station box would be located south of Santa Clara Street. Development above the station box could potentially be limited.	For the north option for the Diridon station, the single- bore tunnel would house the platforms located below Santa Clara Street. The station entrance would be south of Santa Clara Street and have a smaller surface footprint allowing for easier incorporation into the future San Jose Diridon Intermodal Facility.

Passenger Experience		
	Twin-Bore Configuration	**Single-Bore Configuration**
Accessibility	The twin-bore methodology allows for several station entrance options, including sidewalk entrances. Station entrance locations would be more typical of the existing underground BART stations where passengers could access a station from both sides of the street. A minimum of one elevator is provided for ADA access. Two separate elevator trips would be required for ADA passengers, one from surface to concourse level followed by another trip from concourse to platform.	Due to the tunneling methodology and location of station platforms stacked one above another within the tunnel, station entrances would be limited to being located on one side of the bored tunnel. The current design concept includes two entrances to support passenger access to stations and platforms at both levels. A minimum of one elevator per entrance is provided for ADA access. Only one elevator trip would be required for ADA passengers as fare gates are at surface level allowing for passengers to pay fare and proceed taking the elevator to the boarding platforms.
Station	The Twin-Bore Option is configured similar to existing BART underground stations with multiple entrances leading to and concourse level below ground including a free area and a paid area. Patrons access the boarding platform that is below the concourse through escalators, elevators, and/or stairs.	The Single- Bore Option contains platforms located within bored tunnel. The station depths in the design concept are relatively deeper than any current underground BART station, but are not uncommon to other subway stations nationally and internationally. The design concept includes additional vertical circulation elements (e.g. high-speed, high-capacity elevators) to accommodate passenger volumes to the platform levels.