FEHR PEERS

MEMORANDUM

Date: March 8, 2012

To: Linda Heineck, City of Menlo Park
Thomas Rogers, City of Menlo Park

Copy to: Mark Hoffheimer, Perkins + Will

From: Jane Bierstedt

Subject: ***Task N – East-West Connectivity***

SJ09-1089

PURPOSE

The proposed curb extensions or bulbouts at the downtown intersections (El Camino Real at Oak Grove Avenue, Santa Cruz Avenue and Menlo Avenue/Ravenswood Avenue) have been removed in the Final Specific Plan at the City Council's direction due to concerns they limit future cross-section options on El Camino Real in the downtown area, such as adding bicycle lanes or providing six travel lanes. More information about lane configurations in this area is available in the Task A memorandum. This memorandum addresses other measures that were considered (and rejected) to increase east-west pedestrian connectivity and provides more discussion on traffic signal timing/phasing changes.

The City Council direction regarding removal of bulbouts was focused on the downtown intersection. As such, bulbouts are still an option at other intersections, subject to more detailed project-level review.

KEY FINDINGS

- Curb extensions were initially included in the Draft Specific Plan because they improve pedestrian safety by slowing down vehicles turning across the crosswalk, create a larger sidewalk area for pedestrians at the intersection corner, and shorten the pedestrian crossing distance and exposure time to moving traffic. In addition, they are consistent with intersection crossing improvements identified in the *Grand Boulevard Multimodal Transportation Corridor Plan*.

- Other measures that were considered and rejected include a pedestrian overcrossing/bridge, trenching (or tunneling) through lanes on El Camino Real, and a pedestrian scramble phase at the intersection of Santa Cruz Avenue and El Camino Real.

- An intersection level of service analysis was conducted to evaluate the effect of a pedestrian scramble phase on vehicle traffic operations. The results show that it would

cause vehicle operations to degrade to an unacceptable level with projected traffic volumes and the existing four-lane cross section.

- If El Camino Real is reconfigured to have a six-lane cross-section and the pedestrian scramble phase is introduced, acceptable traffic operations could be retained. (See memorandum on *Task A – El Camino Real Street Sections Revisions* for discussion of the six-lane alternative, including review of associated negative effects on the north-south pedestrian environment.)
- Other signal timing and phasing changes were tested but none resulted in improved pedestrian east-west connectivity and acceptable intersection vehicular operations.
- North-south pedestrian connectivity may be improved on Santa Cruz Avenue at El Camino Real by increasing the frequency of the north-south pedestrian phase. The signal could be modified to provide a pedestrian walk phase when the pedestrian button is pushed *after* the start of the concurrent vehicle phase. (Currently, the walk phase is only provided if the button is pushed *before* the north-south through phase starts.) The City, working in conjunction with Caltrans, can decide how to modify the signal timing and which mode of travel (vehicles or pedestrians) should be prioritized.
- Curb extensions should be retained in the Specific Plan.

RECOMMENDED SPECIFIC PLAN REVISIONS

It is recommended that curb extensions be retained in the Specific Plan and that supporting text be added.

METHODOLOGY

Text was created to explain the rationale for curb extensions, along with some supporting materials, and to discuss other measures that were considered. The findings of a previous memorandum discussing a pedestrian overcrossing and the results of the preliminary tunnel study for El Camino Real were incorporated. Intersection level of service calculations were conducted to evaluate the effect of a pedestrian scramble phase at the intersection of El Camino Real and Santa Cruz Avenue on vehicle operations using traffic projections consistent with the Specific Plan's environmental impact report.

DISCUSSION OF FINDINGS

One of the goals of the *Menlo Park El Camino Real/Downtown Specific Plan* was to increase east-west connectivity, especially for pedestrians and bicycles. El Camino Real, with its high traffic volumes and fast vehicle travel speeds, creates a barrier for pedestrians and bicyclists. The Specific Plan addresses improving east-west flow for pedestrians by recommending enhanced pedestrian crossing treatments (basic and special) at numerous locations as illustrated on Draft Specific Plan Figure F2, Pedestrian Improvements. The basic treatments include marked crosswalks, accessible pedestrian signals, and sidewalk extensions, and special treatments include high visibility

crosswalks with enhanced pavement, accessible pedestrian signals, countdown pedestrian signals, sidewalk extensions, and median islands/pedestrian refuges.

A discussion of the rationale for including bulbouts is presented in the memorandum for *Task A – El Camino Real Street Sections Revisions* and dated February 10, 2012. That discussion is summarized in this memorandum as well. Other measures that were considered (and rejected) to increase east-west pedestrian connectivity are then presented. Additional measures, including traffic signal timing/phasing changes, are also discussed.

Rationale for Curb Extensions

There are numerous treatments that can be implemented to enhance pedestrian crossings. A table summarizing several of these treatments is attached to this memorandum. Most of these treatments are applicable for unsignalized or uncontrolled crossings. A recent publication from America Walks, "Signalized Intersection Enhancements that Benefit Pedestrians" is also attached. Many of the applicable enhancements in this attachment are currently being provided or are included in the recommended special treatments for the downtown intersections. One option to enhance signalized crossings is curb extensions. This option works well at locations with a high volume of traffic and on-street parking because they can be installed without reducing the number of travel lanes. Curb extensions improve pedestrian safety by calming or slowing down vehicles turning across the crosswalk, and by creating a larger sidewalk area for pedestrians at the intersection corner. Of primary importance for El Camino Real is that they shorten the pedestrian crossing distance and exposure time to moving traffic. Curb extensions were included in the Draft Specific Plan because of these numerous benefits, and are consistent with intersection crossing improvements identified in the *Grand Boulevard Initiative Multimodal Transportation Corridor Plan*.

As shown on Figure F1, Vehicular Circulation, in the Draft Specific Plan, the curb extensions would involve the removal of some of the right-turn lanes on El Camino Real at the downtown intersections. Implications of these turn-lane removals are discussed in the Draft EIR.

Other Improvements Considered but Not Included

There were several other improvements that were considered but not included in the Draft Specific Plan. These include a pedestrian overcrossing (or pedestrian bridge), depressing, trenching, or tunneling through lanes on El Camino Real, and pedestrian scramble phasing at Santa Cruz Avenue.

<u>Pedestrian Bridge</u>

The applicability of a pedestrian bridge over El Camino Real was addressed in a memorandum dated June 11, 2009. A copy of that memorandum is attached. The conclusions are:

"A pedestrian bridge over El Camino Real would not be an appropriate solution to provide improved pedestrian crossing and should not be considered. Improving the at-grade crossings

would provide more overall benefit at a much lower cost. This conclusion is based on the following:

1. There is insufficient room for the bridge's ramping system or elevator and stairs, unless the elevator and stairs can be incorporated into a new building to be built on a redeveloped site.

2. The pedestrian crossing time with the bridge and ramps would be 226 seconds, compared to the 26-to-186-second at-grade crossing time. Therefore the pedestrian bridge would be less convenient and people would not be inclined to use it.

3. The crossing time with an elevator would be shorter than with the ramps, but not always shorter than the at-grade crossing time. Elevators have other disadvantages, including unavailability during breakdowns and maintenance checks and security.

4. If the bridge were constructed, people would continue to cross El Camino Real at-grade because the crossing time would be shorter (see #2). The crosswalk and pedestrian signals would likely be removed at the bridge location thus creating an unsafe situation.

5. Measures to reduce pedestrian waiting times, decrease pedestrian crossing distances, and slow traffic speeds on El Camino Real would be less costly and more beneficial and therefore should be considered instead of a pedestrian bridge."

Trenching/Tunneling Through Lanes on El Camino Real

Another idea that was considered was to put the through lanes on El Camino Real in a trench or tunnel below grade with the cross streets, turn lanes, on-street parking, and pedestrian crossings remaining at-grade. The benefit of this option is an enhanced pedestrian environment at the downtown intersections. With less traffic at these intersections, there would be more signal time for pedestrians and pedestrians would have less exposure to moving vehicles. There is also the opportunity for increased landscaping and other amenities. Right-of-way was the primary constraint that made this option infeasible. It would be necessary to have one lane plus a shoulder in each direction in the trench/tunnel; with only one lane, a disabled vehicle would block an entire direction. There is not enough right-of-way on El Camino Real to accommodate a surface travel lane in each direction, the retaining walls for the trench, plus two travel lanes, two shoulders with a median in the tunnel. In addition, the areas between Middle and Roble Avenues and between Oak Grove and Valparaiso Avenues would have 750-foot ramps, creating extremely poor aesthetics, loss of street trees, removal of on-street parking, and removal of two traffic lanes. Cost implications are likely significant, and construction would be likely to be extremely disruptive. A copy of the preliminary tunnel study with more discussion of this option is attached.

Pedestrian Scramble Phasing

A pedestrian scramble phase is when traffic on all approaches of an intersection is stopped (gets a red signal indication) and pedestrians can cross in all directions, including diagonally. This type of signal phasing is considered at locations with high pedestrian volumes and high volumes of

turning traffic. The length of the pedestrian scramble phase is based on the maximum diagonal crossing distance and an average walking speed of 3.5 feet per second. The diagonal crossing distance at El Camino Real and Santa Cruz Avenue is 130 feet requiring a minimum crossing time of 37 seconds. For comparison purposes, the crossing distance across El Camino Real is 95 feet, or a minimum crossing time of 27 seconds and the crossing distance across Santa Cruz Avenue is 17 seconds. The pedestrian scramble phase would require 10 additional seconds per cycle than the longest pedestrian phase with the current signal phasing. These 10 seconds would be deleted from the available signal time for vehicle traffic in order to accommodate pedestrian traffic.

Intersection level of service calculations were conducted to evaluate the effect of the scramble phase on intersection operations. Cumulative plus Project traffic projections from the Specific Plan's Draft Environmental Impact Report were used in the analysis. The calculations were conducted with the program Synchro as it is sensitive to signal timing and phasing changes. The results for both the existing four-lane cross-section and alternative six-lane cross-section are presented in Table 1.

TABLE 1:
EL CAMINO REAL AND SANTA CRUZ AVENUE
INTERSECTION OPERATIONS WITH PEDESTRIAN SCRAMBLE PHASE

El Camino Travel Lanes	Peak Hour	Without PED		With PED	
		Delay	LOS	Delay	LOS
Four Lanes (Existing)	AM	33.3	C	42.6	D
	PM	47.4	D	101.3	F
Six-Lane Alternative	AM	23.9	C	29.5	C
	PM	33.5	C	54.4	D

PED – pedestrian scramble phase
Delay –Weighted average control delay per vehicle in seconds.
LOS – Level of service
Source: Fehr & Peers

The implementation of a pedestrian scramble phase would result in unacceptable intersection operations (LOS F) during the PM peak hour with the existing four-lane cross-section. The intersection would retain acceptable operations with the pedestrian scramble phase and the added capacity with the six-lane alternative. However, the delay to vehicles would be increased compared to conditions without the scramble phase. Implementing a scramble phase at El Camino Real and Oak Grove Avenue would likely have similar effects. Adding one at El Camino Real and Ravenswood/Menlo Avenue would likely have significantly worse implications, given that intersection's already challenged operations and the fact that it does not currently have a standard four-leg crosswalk layout. (The crosswalk is missing on the south leg.)

The pedestrian scramble phase was rejected for further consideration because of its negative effect on traffic operations with the current four-lane cross-section and because it would not

serve desired pedestrian operations. (Based on field observations, most pedestrians at El Camino Real and Santa Cruz Avenue either cross El Camino Real or Santa Cruz Avenue – few cross both legs which would be supported by the pedestrian scramble phase.) The City could consider installing a pedestrian scramble phase if six-travel lanes were provided on El Camino Real and pedestrian travel patterns support it.

Other Options – Aggressive Traffic Signal Timing

The traffic signal timing on El Camino Real has been developed to move large groups of vehicles. Therefore the El Camino Real approaches receive a large percentage of the green time and signal cycles are long. As a result, the average east-west pedestrian crossing time (which includes the wait time plus the walking time) is about 100 seconds.

Many traffic signal timing and phasing changes were tested but none resulted in improved pedestrian east-west connectivity and acceptable intersection vehicular operations. The pedestrian wait time can be reduced by shortening the cycle length. The consequence is reduced vehicle capacity.

Another option that may be considered would be north-south pedestrian connectivity on Santa Cruz Avenue at El Camino Real, but not east-west connectivity. The signal could be modified to increase the frequency of the north-south pedestrian walk phase by allowing that phase to be activated when the pedestrian button is pushed *after* the start of the concurrent vehicle phase. (Currently, the walk phase is only provided if the button is pushed *before* the north-south through phase starts.) The City, working in conjunction with Caltrans, can decide how to modify the signal timing and which mode of travel (vehicles or pedestrians) should be prioritized.

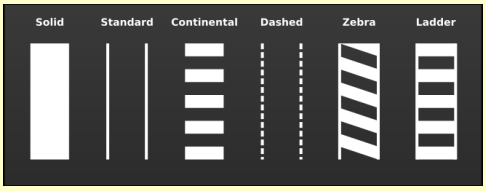
Conclusions

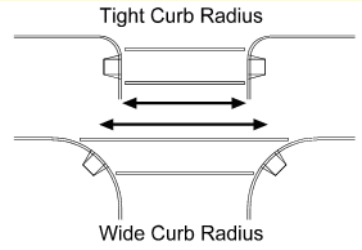
Curb extensions or bulbouts should still be considered to improve east-west connectivity for pedestrians. Their removal from the Specific Plan was directed by the City Council to allow a future six-lane cross-section or bicycle lanes on El Camino Real. Providing six-lanes on El Camino Real reduces east-west connectivity for pedestrians as it increases the distance pedestrians are exposed to high volumes of moving vehicles. Plus a six-lane cross-section creates minimal traffic operational improvements and has other drawbacks compared to the four-lane alternatives as discussed in the memorandum *Task A – El Camino Real Street Sections Revisions*, dated February 10, 2012. Depending on the precise four-lane alternative selected, bulbouts could potentially be retained.

REFERENCES

Fehr & Peers, *Crosswalk Treatment Identification Tool Users Guide*
America Walks, "*Signalized Intersection Enhancements that Benefit Pedestrians*"

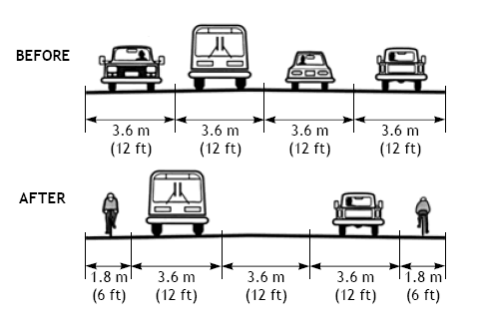
ATTACHMENTS

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
Level 1			
Marked Crosswalk  *Image source: exodusinnovations.com*	Marked crosswalks should be installed to provide designated pedestrian crossings at major pedestrian generators, crossings with significant pedestrian volumes (at least 15 per hour), crossings with high vehicle-pedestrian collisions, and other areas based on engineering judgment	Marked crosswalks provide a designated crossing, which may improve walkability by signaling a clear "channel" for pedestrian pathways to both pedestrians and vehicles.	Marked crosswalks alone should not be installed on multi-lane roads with more than about 10,000 vehicles/ day. Enhanced crosswalk treatments (as presented in this table) should supplement the marked crosswalk.
High-Visibility Signs and Markings 	High-visibility markings include a family of crosswalk striping styles such as the "ladder" and the "continental." High-visibility fluorescent yellow green signs are made of the approved fluorescent yellow-green color and posted at crossings to increase the visibility of a pedestrian crossing.	FHWA recently ended its approval process for the experimental use of fluorescent yellow crosswalk markings and found that they had no discernable benefit over white markings.	Beneficial in areas with high pedestrian activity, as near schools, and in areas where travel speeds are high and/or motorist visibility is low.
Advanced Yield or Stop Lines *Image source: www.saferoutesinfo.org*	Standard white stop or yield limit lines are placed in advance of marked, uncontrolled crosswalks. Stop or yield lines are determined based on state vehicle codes (requiring the driver to either stop or yield to the pedestrian).	This measure increases the pedestrian's visibility to motorists, reduces the number of vehicles encroaching on the crosswalk, and improves general pedestrian conditions on multi-lane roadways. It is also an affordable option.	Useful in areas where pedestrian visibility is low and in areas with aggressive drivers, as advance limit lines will help prevent drivers from encroaching on the crosswalk. Addresses the multiple-threat collision on multi-lane roads.

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
In-Street Pedestrian Crossing Signs	This measure involves posting regulatory pedestrian signage on lane edge lines and road centerlines. The In-Street Pedestrian Crossing sign may be used to remind road users of laws regarding right of way at an unsignalized pedestrian crossing. The legend STATE LAW may be shown at the top of the sign if applicable. The legends STOP FOR or YIELD TO may be used in conjunction with the appropriate symbol.	This measure is highly visible to motorists and has a positive impact on pedestrian safety at crosswalks.	Mid-block crosswalks, unsignalized intersections, low-speed areas, and two-lane roadways are ideal for this pedestrian treatment. The STOP FOR legend shall only be used in states where the state law specifically requires that a driver must stop for a pedestrian in a crosswalk.
Level 2			
Curb Extension/ Bulb Outs *Image source: Dan Burden*	Also known as a pedestrian bulb-out, this traffic-calming measure is meant to slow traffic and increase driver awareness. It consists of an extension of the curb into the street, making the pedestrian space (sidewalk) wider.	Curb extensions narrow the distance that a pedestrian has to cross and increases the sidewalk space on the corners. They also improve emergency vehicle access and make it difficult for drivers to turn illegally.	Due to the high cost of installation, this tool would only be suitable on streets with high pedestrian activity, on-street parking, and infrequent (or no) curb-edge transit service. It is often used in combination with crosswalks or other markings.
Reduced Curb Radii  *Image Source: www.ci.austin.tx.us*	The radius of a curb can be reduced to require motorists to make a tighter turn.	Shorter radii narrow the distance that pedestrians have to cross; they also reduce traffic speeds and increase driver awareness (like curb extensions), but are less difficult and expensive to implement.	This measure would be beneficial on streets with high pedestrian activity, on-street parking, and no curb-edge transit service. It is more suitable for wider roadways and roadways with low volumes of heavy truck traffic.

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
Staggered Median Pedestrian Island *Image Source: www.tfhrc.gov/*	This measure is similar to traditional median refuge islands; the only difference is that the crosswalks in the roadway are staggered such that a pedestrian crosses half the street and then must walk towards traffic to reach the second half of the crosswalk. This measure must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel.	Benefits of this tool include an increase in the concentration of pedestrians at a crossing and the provision of better traffic views for pedestrians. Additionally, motorists are better able to see pedestrians as they walk through the staggered refuge.	Best used on multi-lane roads with obstructed pedestrian visibility or with off-set intersections
Level 3			
In-Roadway Warning Lights *Image Source: www.tfhrc.gov/*	Both sides of a crosswalk are lined with pavement markers, often containing an amber LED strobe light. The lights may be push-button activated or activated with pedestrian detection.	This measure provides a dynamic visual cue, and is increasingly effective in bad weather	Best in locations with low bicycle ridership, as the raised markers present a hazard to bicyclists. May not be appropriate in areas with heavy winter weather due to high maintenance costs. May not be appropriate for locations with bright sunlight. The lights may cause confusion when pedestrians fail to activate them and/or when they falsely activate.
Overhead Flashing Beacons *Image source: tti.tamu.edu*	Flashing amber lights are installed on overhead signs, in advance of the crosswalk or at the entrance to the crosswalk.	The blinking lights during pedestrian crossing times increase the number of drivers yielding for pedestrians and reduce pedestrian-vehicle conflicts. This measure can also improve conditions on multi-lane roadways.	Best used in places where motorists cannot see a traditional sign due to topography or other barriers.

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
Stutter Flash* *Image source: mutcd.fhwa.dot.gov*	The Overhead Flashing Beacon is enhanced by replacing the traditional slow flashing incandescent lamps with rapid flashing LED lamps. The beacons may be push-button activated or activated with pedestrian detection.	Initial studies suggest the stutter flash is very effective as measured by increased driver yielding behavior. Solar panels reduce energy costs associated with the device.	Appropriate for multi-lane roadways.
Level 4			
Hawk Beacon Signal* *Image Source: www.tfhrc.gov/*	HAWK (High Intensity Activated Crosswalks) are pedestrian-actuated signals that are a combination of a beacon flasher and a traffic control signal. When actuated, HAWK displays a yellow (warning) indication followed by a solid red light. During pedestrian clearance, the driver sees a flashing red “wig-wag” pattern until the clearance interval has ended and the signal goes dark.	Reduces pedestrian-vehicle conflicts and slows traffic speeds	Useful in areas where it is difficult for pedestrians to find gaps in automobile traffic to cross safely, but where normal signal warrants are not satisfied. Appropriate for multi-lane roadways.
Level 5			
Traffic Signal *Image source: www.livablestreets.com*	Conventional traffic control devices with warrants for use based on the Manual on Uniform Control Devices (MUTCD)	Reduces pedestrian-vehicle conflicts and slows traffic speeds	Must meet warrants based on traffic and pedestrian volumes; however, exceptions are possible based on demonstrated pedestrian safety concerns (collision history)

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
Pedestrian Overpass/ Underpass *Image source: omahamidcenturymodern.blogsome.com*	This measure consists of a pedestrian-only overpass or underpass over a roadway. It provides complete separation of pedestrians from motor vehicle traffic, normally where no other pedestrian facility is available, and connects off-road trails and paths across major barriers.	Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic. However, for underpasses, security is known to be a major issue.	Grade separation via this measure is most feasible and appropriate in extreme cases where pedestrians must cross roadways such as freeways and high-speed, high-volume arterials. Use of either type of facility falls off rapidly when the additional time required for such use amounts to 20% or more of the time required to cross at grade. This measure should be considered only with further study.
Consider for All Multi-Lane Roads			
Road Diet (aka Lane Reduction)  *Image Source: www.tfhrc.gov/*	The number of lanes of travel is reduced by widening sidewalks, adding bicycle and parking lanes, and converting parallel parking to angled or perpendicular parking.	This is a good traffic calming and pedestrian safety tool, particularly in areas that would benefit from curb extensions but have infrastructure in the way. This measure also improves pedestrian conditions on multi-lane roadways.	Roadways with surplus roadway capacity (typically multi-lane roadways with less than 15,000 to 17,000 ADT) and high bicycle volumes, and roadways that would benefit from traffic calming measures.

CROSSWALK TREATMENTS			
Measure	**Description**	**Benefits**	**Application**
Median Pedestrian Island *Image source: http://thegoodcity.wordpress.com/category/transportation/*	Raised islands are placed in the center of a roadway, separating opposing lanes of traffic with cutouts for accessibility along the pedestrian path.	This measure allows pedestrians to focus on each direction of traffic separately, and the refuge provides pedestrians with a better view of oncoming traffic as well as allowing drivers to see pedestrians more easily. It can also split up a multi-lane road and act as a supplement to additional pedestrian tools.	Recommended for multi-lane roads wide enough to accommodate an ADA-accessible median
Source: Fehr & Peers, *Crosswalk Treatment Identification Tool Users Guide*. * Treatment not included in the current version of the MUTCD			

America WALKS

SIGNALIZED INTERSECTION ENHANCEMENTS THAT BENEFIT PEDESTRIANS

Making America a Great Place To Walk

Table of Contents

Introduction ii

Geometric Treatments 1

Signal Hardware 4

Operational Measures 6

Prepared for America Walks by

FEHR PEERS

America WALKS

Making America a Great Place To Walk

WELCOME

America Walks is a national resource which fosters walkable communities by engaging, educating, and connecting.

Walking is a healthy, environmentally friendly, and socially equitable form of transportation. Improvements to the safety and convenience of walking are critical to maximizing the number of people who walk.

According to *Bicycling and Walking in the United States – 2010 Benchmarking Report* (Alliance for Biking & Walking, 2010), pedestrians account for 11.3% of all traffic fatalities nationwide and 25% of all traffic fatalities in major U.S. cities. Signalized intersections are an inherent element of the roadway network in cities; they are a common point of convergence for pedestrians and vehicles and many pedestrian traffic fatalities occur at signalized intersections. Improving safety at signalized intersections is therefore critical to reducing the number of pedestrian traffic fatalities.

The purpose of this resource is to educate decision makers, planners, engineers, and citizens on signalized intersection enhancements that can improve pedestrian safety and convenience. This resource is intended to summarize a wide array of potential treatments for a variety of signalized intersections; not all of the treatments summarized in this resource are appropriate for every signalized intersection.

This resource categorizes signalized intersection enhancements into three types:

- Geometric treatments
- Signal hardware
- Operational measures

America WALKS

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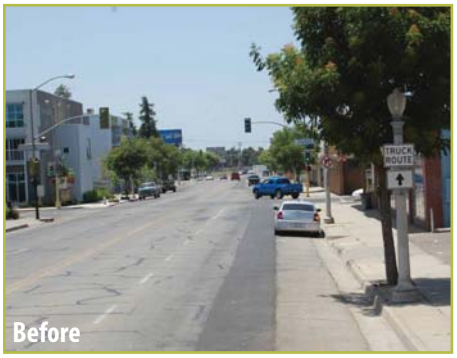
GEOMETRIC DESIGN TREATMENTS

Geometric design treatments are those that relate to an intersection's physical attributes: it's dimensions, pavement or concrete layout, and striping pattern.

Fewer Travel Lanes



Fewer travel lanes decrease roadway width and crosswalk length. It takes an average pedestrian almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases sharply with increased vehicle speed.

Narrower Travel Lanes

Travel lanes are typically designed to be 12 feet wide. Where fewer travel lanes are not possible, research shows travel lanes can be safely narrowed to as little as nine feet, especially left- and right-turn pockets. Narrower travel lanes decrease roadway width and crosswalk length, thereby minimizing the amount of time that pedestrians are in the crosswalk.

Median Pedestrian Island

Median pedestrian islands provide a safe place for pedestrians to stand if they do not have sufficient time to cross a street. They can be enhanced with median pedestrian push buttons.

Corner Bulbouts

Corner bulbouts extend the curb and sidewalks further into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. Corner bulbouts can be constructed with reduced curb radii and to accommodate ADA improvements, such as directional curb ramps.

Reduced Curb Radius

Vehicles travel faster through turns with a large turn radius than turns with a small curb radius. Reducing the radius of a corner curb is an effective way of reducing vehicle speeds. In suburban

environments turn radii generally do not need to exceed 30 feet. In urban environments turn radii can be 10 feet or less, especially where the meeting of one-way streets prohibits turning movements. Where on-street parking is permitted on one or both streets, consideration for further reductions of radii should occur acknowledging that the effective radius is increased with on-street parking. Corner curb radii on multi-lane streets should acknowledge that trucks turning right can turn into two lanes.

Directional Curb Ramps (with Truncated Domes)

Curb ramps offer wheelchair access to/from the sidewalk and crosswalk. Truncated domes, which are often yellow, warn pedestrians with limited or no sight that they are about to enter a crosswalk. The best practice for curb ramps is to install two per corner so that each ramp points directly into the crosswalk and to the curb ramp at the other side of the street. Directional curb ramps help blind pedestrians by pointing them in the correct direction while crossing. Corner bulbouts can be used to increase the amount of space available for directional curb ramps. Flared sides may not be necessary when two ramps are provided per corner.

Raised Crosswalk

Raised crosswalks are speed tables (flat-topped speed humps) outfitted with crosswalk markings and signage, providing pedestrians with a level street crossing. By raising the level of the crossing, vehicles drive more slowly through the crosswalk and pedestrians are more visible to approaching motorists. At signalized intersections, they are most appropriate where "pork-chop" islands separate channelized right-turn lanes from the adjacent through lanes.

Improved Right-Turn Slip-Lane Design

Free right-turns allow vehicles to turn right on red without stopping. Since the vehicles are never controlled by the traffic signal, pedestrians must always treat crosswalks across a free right-turn lane as an uncontrolled crosswalk. Controlled right-turn movements are preferable for pedestrians because they require a vehicle to stop on red before turning right. Where "pork-chop" islands that channelize right-turns are necessary to provide acceptable turning radii, raised crosswalks are a pedestrian enhancement. The geometry of the free right-turn lane can enforce a safe turning speed.

Advanced Yield Lines

Advanced yield lines, often referred to as "sharks teeth", are placed in front of uncontrolled crosswalks to improve yield compliance. At signalized intersections, they can be used to remind free right-turning vehicles to yield to pedestrians.

Textured Pavement

Textured pavement can be used in crosswalks or in intersections as an aesthetic enhancement. Because of its texture, it also calms traffic by slowing vehicles before they cross an intersection. It can also make crosswalks more visible. Textured pavement can be made of brick or, alternatively, both concrete and asphalt can be stamped to look like brick or stone.

Anti-Skid Surfacing

Roadway paint, including the paint used to mark crosswalks, can become slippery when wet. Alternative pavement marking materials, such as tape and thermoplastic, are less slippery than paint when wet.

Advanced Stop Bars

Advanced stop bars are placed in front of crosswalks. They keep vehicles from encroaching into the crosswalk when stopped at a red light. On multi-lane roads, advanced stop bars placed at least one car-length back from the crosswalk allow pedestrians to be seen by drivers in adjacent lanes.

Marked Crosswalks (on all approaches)

Marking a crosswalk across all approaches of an intersection improves pedestrian accessibility. At a four-way intersection, a missing crosswalk forces pedestrians to cross three times instead of once. Crosswalks on all approaches can often be accommodated without a significant impact to traffic signal operations.

High-Visibility Markings

Design policies should require different crosswalk markings for controlled and uncontrolled crosswalks. Standard crosswalks are generally acceptable across controlled approaches; however, high-visibility crosswalks are appropriate in areas with high pedestrian volumes. High-visibility crosswalks should also be used across uncontrolled locations including midblock and at free right-turns. Continental, zebra, ladder, or triple-four crosswalks are all examples of high-visibility crosswalks. High-visibility markings improve yield compliance. Having a uniform design policy for marked and unmarked crosswalks delivers a clear message to pedestrians when they are about to enter a crosswalk.

Colored Crosswalks / Intersections

Colored crosswalks improve crosswalk visibility for motorists. They can be designed to complement the colors of a city or school.

Proper Locations for Signal Controllers

Signal controller boxes should be located such that they do not present a barrier for pedestrians. The best placement for signal controller boxes is completely off of the sidewalk, but still accessible for maintenance.

SIGNAL HARDWARE

Signal hardware includes all of the physical elements of a traffic signal: signal heads, pedestrian signals, and push buttons.

Blank Out Turn Restriction LED Signs

The ubiquity of conventional turn restriction signs, usually for no right-turn on red, contributes to their disregard by motorists. Blank out turn restriction signs, usually for no right-turn on red, activate only when the specified movement is prohibited.

Protected Left-Turn Signals

The "Walk" signal at a crosswalk usually begins at the same time that through- and turning-vehicles in the same direction receive a green light. Where permitted left-turns are allowed, denoted by a "Left Turn Yield on Green" sign, left-turning vehicles can conflict with pedestrians in the crosswalk. By making the left-turn protected, so that it is allowed only with a green arrow, the "Walk" signal at a crosswalk occurs at the same time that through- and right-turning vehicles in the same direction receive a green light. This reduces the risk of left-turning vehicle conflicts with the opposing crosswalk; since left-turns typically occur at a higher speed than right-turns, collisions of increased severity can be avoided by protecting left-turns.

Pedestrian Signals

Pedestrian signal heads minimize vehicle-pedestrian conflicts by assisting pedestrians in deciding when to begin crossing the roadway. For best results, post pedestrian signal heads in the same general vicinity as vehicle heads for conflicting movements such that pedestrians know what to expect from traffic. This is especially important where permitted left-turns are allowed, denoted by a "Left Turn Yield on Green" sign.

Pedestrian heads should be located on the same post as the vehicle indications and on the intersection side of the crosswalk rather than at the back of the crosswalk. This reduces the likelihood of view obstruction by large vehicles.

Pedestrian Countdown Signals

Pedestrian countdown signals give pedestrians "Walk" and "Don't Walk" signals and inform them how long they have to cross the street. Research suggests that pedestrians are more likely to obey the "Don't Walk" signal when delivered using a countdown signal. The 2009 Manual on Uniform Traffic Control Devices requires that all new pedestrian signals be countdown signals.

Animated Eyes Pedestrian Signals

Animated eyes pedestrian signals feature eyes that look from side to side when a "Walk" signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk. Research has indicated that animated eyes pedestrian signals reduce conflicts between vehicles and pedestrians.

Pedestrian Push buttons

To receive a "Walk" signal at a crosswalk, pedestrians are often required to use a push button. The location and design of buttons should comply with ADA guidelines.

Median Pedestrian Push buttons

Where median pedestrian islands exist, median pedestrian push buttons can be provided for pedestrians who become stranded mid-crossing. Occasionally, pedestrians who walk slowly, such as the elderly or children, are unable to cross the street in one cycle length. Providing a push button in the pedestrian median island allows them to receive a "Walk" signal for the next phase of their crossing. In general, the benefits of a median pedestrian push button are more pronounced when the total crossing distance is 60 feet or greater.

Passive Detection Devices

Passive detection of pedestrians, which can be accomplished using video or radar detection devices, register the presence of a pedestrian waiting to cross a street without the use of a push button. Additionally, they can track the location of a pedestrian as he crosses the street to determine if more crossing time is needed. Advances in video and infrared technology are improving the reliability of passive detection devices; in Santa Clara, CA, the City recently began using infrared technology at traffic signals to extend the crossing time when needed.

Accessible Pedestrian Signals

Accessible pedestrian signals and detectors provide information, such as "Walk" indications and direction of crossing, in non-visual formats to improve accessibility for blind pedestrians. Audible options for accessible pedestrian signals include audible tones and speech messages. Vibrotactile push-buttons are effective options that alleviate the impacts of noise created by audible pedestrian signals.

Braille Wayfinding

Braille characters can be added to the "Push Button for Walk Signal" plaques to provide basic information about the intersection.

Extended Push button

Some pedestrians may need extra time to safely cross a street. Traffic signals can be retrofitted to allow pedestrians to increase the crossing time by pressing the push button a bit longer.

OPERATIONAL MEASURES

Changes to a signalized intersection's operations can often be made inexpensively without making physical changes to the intersection.

Short Cycle Lengths

Long cycle lengths at signalized intersections result in long pedestrian wait times to cross a street. By shortening an intersections cycle length, pedestrians do not have to wait as long to cross after pushing the button to request a "Walk" signal.

Longer crossing times at crosswalks ensure that all pedestrians are safely able to cross the street within the allotted time. Previous to 2009, crossing time for crosswalks at signalized intersections was based on an average walking speed of 4.0 feet per second. Guidance in the 2009 Manual on Uniform Traffic Control Devices specifies that a walking speed of 3.5 feet per second should be assumed to determine crossing times. A speed slower than 3.5 feet per second can be used where slower pedestrians routinely use the crosswalk, such as locations near schools, hospitals, or senior centers. Additionally, where a crosswalk's concurrent green vehicle phase is greater than the minimum phase for pedestrians, the duration of the pedestrian phase can be increased to be the same as the concurrent vehicle phase.

Leading Pedestrian Interval

A leading pedestrian interval illuminates the "Walk" signal for a few seconds prior to stopped through-vehicles receiving a green light. Allowing pedestrians a head start into the intersection can reduce conflicts between pedestrians and turning vehicles and makes crossing pedestrians more visible. The Manual on Uniform Traffic Control Devices recommends that leading pedestrian intervals be at least three seconds in duration.

Pedestrian Scramble Phase

Pedestrians usually have to cross two roadways to get from one corner of an intersection to the opposite corner. A scramble phase allows pedestrians to cross in all directions, including diagonally. Right-turn on red for vehicles must be restricted during the walk phase to ensure pedestrian safety.

No Right-Turn on Red

When attempting to turn right on red, vehicles must look left to see if the road is clear; drivers often forget to look right before turning and may not see pedestrians to their right. Restricting right-turns on red can reduce conflicts between vehicles and pedestrians. Blank out turn restriction signs are more effective than conventional "No Right Turn on Red" signs. "No Right Turn on Red" signs that specify time-of-day restrictions or "When Pedestrians are Present" are confusing to motorists and are often disregarded.

Pedestrian Recall

Pedestrian recall gives pedestrians a "Walk" signal at every cycle. No push-button or detection is necessary since a "Walk" signal will always be given. Pedestrian recalls are useful in areas with high levels of pedestrian activity. They demonstrate that an intersection is meant to serve both vehicles and pedestrians. In general, pedestrian recall should be used if pedestrians actuate a "Walk" signal 75 percent of the time during three or more hours per day.

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MEMORANDUM

Date: June 11, 2009

To: Mark Hoffheimer

From: Jane Bierstedt
Joe Fernandez

Subject: ***Pedestrian Bridge over El Camino Real in Downtown Menlo Park***

SJ09-1089

This memorandum discusses whether a pedestrian bridge would be a good option to improve pedestrian crossing of El Camino Real in downtown Menlo Park. Currently, pedestrians wishing to cross El Camino Real do so at one of several signalized intersections located at Oak Grove Road, Santa Cruz Avenue, and Menlo/Ravenswood Avenue. The City has received complaints of long wait times at the pedestrian signals and a less-than-pleasant pedestrian environment due to the high traffic volumes and vehicle speeds on El Camino Real. For these reasons, a pedestrian bridge has been discussed as a potential improvement to the current pedestrian crossing conditions. This memorandum discusses the circumstances where pedestrian bridges are appropriate and their applicability to El Camino Real in downtown Menlo Park.

SITUATIONS WHERE PEDESTRIAN BRIDGES ARE APPROPRIATE

Pedestrian bridges are needed in locations where there are physical or operational issues that prohibit at-grade pedestrian crossings. These include:

1. Across freeways where road bridges are far apart. An at-grade crossing is not possible because freeway vehicles cannot be stopped. (Examples include the pedestrian bridges over US 101 in Palo Alto at The Embarcadero/Oregon Expressway and in Sunnyvale at Borregas Avenue.)

2. Across railroad yards with multiple tracks and/or electrified third rails. An at-grade-crossing would be difficult to control and would degrade train service for multiple track locations and is too dangerous with electrified rails. (An example is the pedestrian bridge over the Caltrain and LRT tracks in Mountain View.)

3. Across a natural feature such as a river or ravine where an at-grade crossing is not physically possible.

EL CAMINO REAL

El Camino Real does not fall into any of the categories identified in the previous section. Therefore, other factors need to be considered before a pedestrian bridge can be recommended. These factors are:

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1. Is the roadway in a depression such that the pedestrian bridge is at grade level and therefore more convenient to use than walking down to the roadway and crossing it?

2. Is there enough right-of-way (land) to construct ramps on both ends of the bridge?

    a. Are the ramps compatible with adjacent land uses?

3. If land is not available for ramps, are elevators with stairs a viable solution?

    a. Would elevators have sufficient capacity for their demand?

    b. Will people feel safe in the elevators?

    c. Is it acceptable to not provide ADA-compliant access when the elevators are not working?

4. Would the pedestrian bridge be more convenient to use than an at-grade crossing?

    a. Will the crossing time be shorter?

    b. Will people be willing to walk up and down the ramps or stairs or wait to use the elevator?

5. Will a fence in the median and signage be needed to force pedestrians to use the bridge?

    a. Will the fence and signage meet the aesthetic requirements of the community?

El Camino Real is not below grade so the pedestrian bridge would be an overhead structure.

The ramps would be a minimum of 8 feet wide and they would be approximately 350-feet long to meet Americans with Disabilities Act (ADA) requirements. Alternatively, a wide spiral ramp would be needed. There is insufficient right-of-way to accommodate ramps at any of the potential downtown crossing locations. Plus the ramps would be obtrusive to adjacent business owners.

There is also insufficient room for the stairs and elevators, unless they can be incorporated into a new building to be built on a redeveloped site.

El Camino Real at Santa Cruz Avenue is approximately 90 feet wide. The pedestrian crossing time is 26 seconds, based on an average walking speed of 3.5 feet per second. The maximum amount of waiting time for the pedestrian signal to turn on is 160 seconds, although the average wait time is lower. Therefore the total crossing time under existing conditions, including waiting for the pedestrian signal, can range from 26 seconds to 186 seconds.

If there was room for ramps, the walking distance across El Camino Real using a bridge would be approximately 790 feet, which includes two 350-foot ramps and the overhead span of 90 feet. At an average walking speed of 3.5 feet per second, this corresponds to a walking time of 226 seconds to cross the street. The crossing time with a bridge and ramps is longer than the current at-grade crossing time.

The crossing time with an elevator is estimated to be 60 to 120 seconds (depending on the wait time for the elevator).

Fencing in the median of El Camino Real would be required to direct pedestrians to use the bridge. However, since the median does not extend through the intersections, pedestrians could still cross El Camino Real at grade; and unsafe situation.

CONCLUSIONS

A pedestrian bridge over El Camino Real would not be an appropriate solution to provide improved pedestrian crossing and should not be considered. Improving the at-grade crossings would provide more overall benefit at a much lower cost. This conclusion is based on the following:

1. There is insufficient room for the bridge's ramping system or elevator and stairs, unless the elevator and stairs can be incorporated into a new building to be built on a redeveloped site.

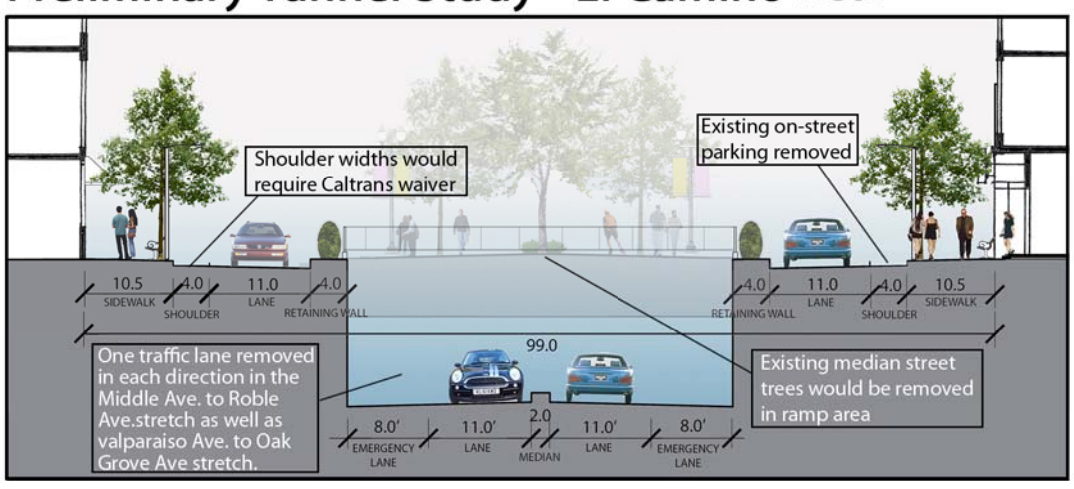
2. The pedestrian crossing time with the bridge and ramps would be 226 seconds, compared to the 26 to 186 second at-grade crossing time. Therefore the pedestrian bridge would be less convenient and people would not be inclined to use it.

3. The crossing time with an elevator would be shorter than with the ramps, but not always shorter than the at-grade crossing time. Elevators have other disadvantages, including unavailability during breakdowns and maintenance checks and security.

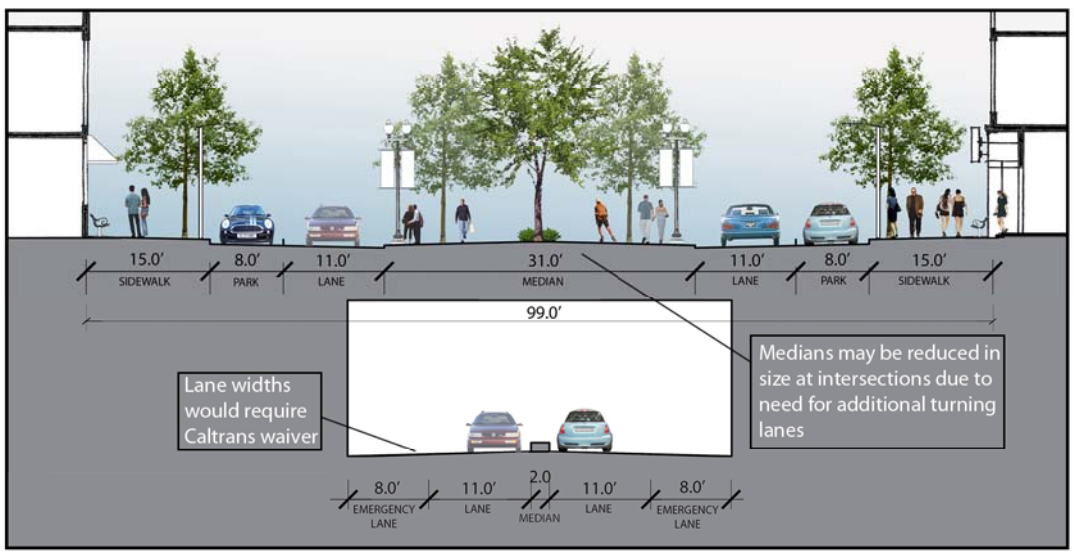
4. If the bridge were constructed, people would continue to cross El Camino Real at grade. The crosswalk and pedestrian signals would be removed at the bridge location thus creating an unsafe situation.

5. Measures to reduce pedestrian waiting times, decrease pedestrian crossing distances, and slow traffic speeds on El Camino Real would be less costly and more beneficial and therefore should be considered instead of a pedestrian bridge.

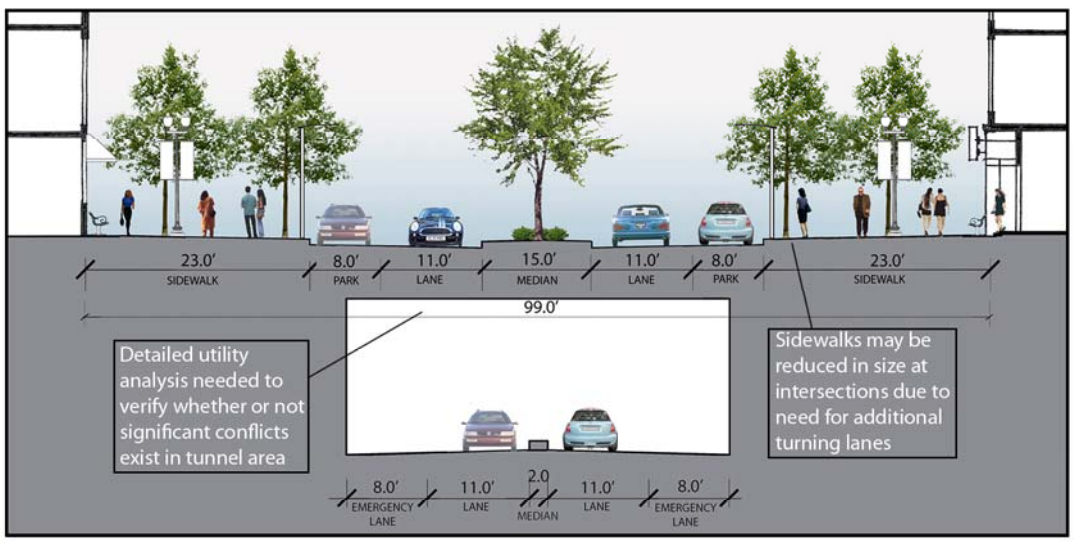
Preliminary Tunnel Study - El Camino Real



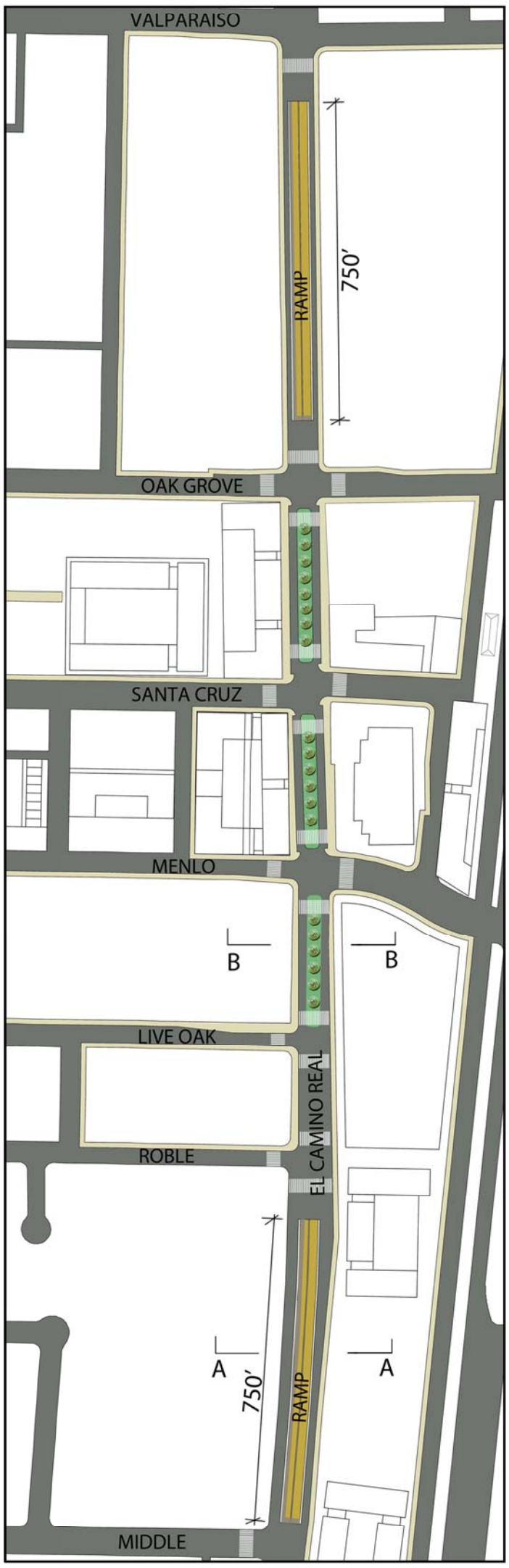
A SECTION - RAMP CONDITION



B SECTION ALTERNATIVE #1- TUNNEL CONDITION WITH WIDE MEDIAN ABOVE



B SECTION ALTERNATIVE #2- TUNNEL CONDITION WITH WIDE SIDEWALK ABOVE



DOWNTOWN TUNNEL PLAN

Preliminary Findings

- The existing El Camino Real right-of-way constrains the amount of space available for ramp infrastructure, travel lanes, parking lanes, and sidewalks, particularly where ramp conditions are proposed.
- The preliminary traffic analysis results indicate the concept may work technically, with through traffic (approximately 50% of traffic flow) and primary turning movements accommodated. However, a detailed traffic analysis would need to be conducted to understand the full impacts and it could result in the need for additional turn lanes and other improvements that minimize the potential aesthetic impacts discussed below.
- The primary benefits would be seen in the stretch between Roble and Oak Grove Avenues, where two lanes of through traffic (one in each direction) would be fully underground. In this area, significant aesthetic and pedestrian/bicycle connectivity improvements would be possible through widened sidewalks/medians and reduced automotive traffic.
- Between Middle and Roble Avenues and Oak Grove and Valparaiso Avenues, two 750-foot-long open ramps would present significant challenges with poor aesthetics, loss of existing street trees, removal of on-street parking, removal of two traffic lanes (in the stretch between Middle and Roble Avenues), and impacts to existing business with loss of access.
- Costs would clearly be significant, with no likely funding sources identified. There are still many unknowns at this point, including location and potential impediments from underground utilities and potential objections or concerns from Caltrans.
- Construction would require delays and/or rerouting over an extended period.
- From a business perspective, the tunnel could send a message that Menlo Park is a market to be bypassed, with the gains from an improved visual character and pedestrian/bicycle connectivity in the central area offset by a loss of visibility and unclear access.

Assumptions (based on typical Caltrans standards)

- Ramp slope: 5%
- Ramp length: 750 feet, inclusive of vertical approach
- Vertical clearance: 16.5 feet
- Tunnel cover: 6 feet
- Travel line widths: 11 feet (with require Caltrans waiver)
- Shoulder widths: 8 feet in tunnel and 4 feet at-grade (latter of which would require Caltrans waiver)