Appendix M

Comment Letter 10 Attachment

National Center for Sustainable Transportation

POLICY BRIEF

Increasing Highway Capacity Unlikely to Relieve Traffic Congestion

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Issue

Reducing traffic congestion is often proposed as a solution for improving fuel efficiency and reducing greenhouse gas (GHG) emissions. Traffic congestion has traditionally been addressed by adding additional roadway capacity via constructing entirely new roadways, adding additional lanes to existing roadways, or upgrading existing highways to controlled-access freeways. Numerous studies have examined the effectiveness of this approach and consistently show that adding capacity to roadways fails to alleviate congestion for long because it actually increases vehicle miles traveled (VMT).

An increase in VMT attributable to increases in roadway capacity where congestion is present is called "induced travel". The basic economic principles of supply and demand explain this phenomenon: adding capacity decreases travel time, in effect lowering the "price" of driving; and when prices go down, the quantity of driving goes up.[1] Induced travel counteracts the effectiveness of capacity expansion as a strategy for alleviating traffic congestion and offsets in part or in whole reductions in GHG emissions that would result from reduced congestion.

Key Research Findings

The quality of the evidence linking highway capacity expansion to increased VMT is high. All studies reviewed used time-series data and sophisticated econometric techniques to estimate the effect of increased capacity on congestion and VMT. All studies also controlled for other factors that might also affect VMT, including population growth, increases in income, other demographic factors, and changes in transit service.[2]

Increased roadway capacity induces additional VMT in the short-run and even more VMT in the long-run. A capacity expansion of 10% is likely to increase VMT by 3% to 6% in the short-run and 6% to 10% in the long-run. Increased capacity can lead to increased VMT in the short-run in several ways: if people shift from other modes to driving, if drivers make longer trips (by choosing longer routes and/or more distant destinations), or if drivers make more frequent trips.[3,4,5] Longer-term effects may also occur if households and businesses move to more distant locations or if development patterns become more dispersed in response to the capacity increase. One study concludes that the full impact of capacity expansion on VMT materializes within five years[6] and another concludes that the full effect takes as long as 10 years.[7]

Capacity expansion leads to a net increase in VMT, not simply a shifting of VMT from one road to another. Some argue that increased capacity does not generate new VMT but rather that drivers simply shift from slower and more congested roads to the new or newly expanded roadway. Evidence does not support this argument. One study found "no conclusive evidence that increases in state highway lane-miles have affected traffic on other roads"[8] while a more recent study concluded that "increasing lane kilometers for one type of road diverts little traffic from other types of roads".[9]

Increases in GHG emissions attributable to capacity expansion are substantial. One study predicted that the growth in VMT attributable to increased lane miles would produce an additional 43 million metric tons of CO_2 emissions in 2012 nationwide.[10]

Capacity expansion does not increase employment or other economic activity. Economic development and job creation are often cited as compelling reasons for expanding the capacity of roadways. However, most studies of the impact of capacity expansion on development in a metropolitan region find no net increase in employment or other economic activity, though investments do influence where within a region development occurs.[11, 12]

Conversely, reductions in roadway capacity tend to produce social and economic benefits without worsening traffic congestion. The removal of elevated freeway segments in San Francisco coupled with improvements to the at-grade Embarcadero and Octavia Boulevards has sparked an on-going revitalization of the surrounding areas while producing a significant drop in traffic.[13] Many cities in Europe have adopted the strategy of closing streets in the central business district to vehicle traffic as an approach to economic revitalization,[14] and this strategy is increasingly being adopted in cities the U.S., from New York City to San Francisco.

Further Reading

This policy brief is drawn from the "Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions" policy brief and technical background memo prepared for the California Air Resources Board (CARB) by Susan Handy (University of California, Davis) and Marlon Boarnet (University of Southern California), which can be found on CARB's website along with briefs and memos on 22 other land use and transportation strategies that impact vehicle use and GHG emissions. Website link: http://arb.ca.gov/cc/sb375/policies/policies.htm

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[1] Noland, R.B. and L.L. Lem. (2002). A review of the evidence for induced travel and changes in transportation and environmental policy in the US and the UK. *Transportation Research* D, 7, 1-26. http://bit.ly/1jZbl1E

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[8] Hansen and Huang. (1997).

[9] Duranton and Turner. (2011).

[10] Handy, S. (2005). Smart Growth and the Transportation-Land Use Connection: What Does the Research Tell us? International Regional Science Review, 28(2): 1-22. http://bit.ly/1NCeeSP

[11] Handy, S. (2005).

[12] Funderberg, R., H. Nixon, M. Boarnet, and G. Ferguson. (2010). New Highways and Land Use Change: Results From a Quasi-Experimental Research Design. Transportation Research A, 44(2): 76-98. http://bit.ly/1LqYhfD

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Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions

Policy Brief

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September 30, 2014

Policy Brief:
http://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf

Technical Background Document:
http://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_bkgd.pdf

California Environmental Protection Agency
Air Resources Board

Policy Brief on the Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions

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Marlon G. Boarnet, University of Southern California

Policy Description

Because stop-and-go traffic reduces fuel efficiency and increases greenhouse gas (GHG) emissions, strategies to reduce traffic congestion are sometimes proposed as effective ways to also reduce GHG emissions. Although transportation system management (TSM) strategies are one approach to alleviating traffic congestion,[1] traffic congestion has traditionally been addressed through the expansion of roadway vehicle capacity, defined as the maximum possible number of vehicles passing a point on the roadway per hour. Capacity expansion can take the form of the construction of entirely new roadways, the addition of lanes to existing roadways, or the upgrade of existing highways to controlled-access freeways.

One concern with this strategy is that the additional capacity may lead to additional vehicle travel. The basic economic principles of supply and demand explain this phenomenon: adding capacity decreases travel time, in effect lowering the “price” of driving; when prices go down, the quantity of driving goes up (Noland and Lem, 2002). An increase in vehicle miles traveled (VMT) attributable to increases in capacity is called “induced travel.” Any induced travel that occurs reduces the effectiveness of capacity expansion as a strategy for alleviating traffic congestion and offsets any reductions in GHG emissions that would result from reduced congestion. If the percentage increase in VMT matches the percentage increase in capacity, congestion (a function of the ratio of VMT to capacity) is not alleviated at all.

Conversely, some communities have decreased roadway capacity, in part motivated by the goal of reducing VMT. While temporary reductions in highway capacity are common (e.g. through the closure of lanes for construction or emergencies), permanent reductions are relatively rare. San Francisco eventually removed two elevated freeway segments damaged in the 1989 Loma Prieta earthquake, replacing them with street-level boulevards. Many European cities have closed selected streets in their

[1] See the separate policy brief on traffic incident clearance programs: http://arb.ca.gov/cc/sb375/policies/policies.htm

commercial cores to car traffic. This strategy is less common in U.S. cities, but one notable example is the recent elimination of vehicle traffic in Times Square in New York City. Increasingly common in the U.S. are “road diet” projects that re-allocate a portion of the public right-of-way for modes other than cars, though such projects do not necessarily decrease the capacity of the roadway as measured by vehicle throughput.

Impacts of Highway Capacity Expansion

Increased highway capacity can lead to increased VMT in the short run in several ways: if people shift from other modes to driving, if drivers make longer trips (by choosing longer routes and/or more distant destinations), or if drivers make more frequent trips (Noland and Lem, 2002; Gorham, 2009; Litman, 2010). Longer-term effects may also occur if households and businesses move to more distant locations or if development patterns become more dispersed in response to the capacity increase. Capacity expansion can lead to increases in commercial traffic as well as passenger travel (Duranton and Turner, 2011).

The induced-travel impact of capacity expansion is generally measured with respect to the change in VMT that results from an increase in lane miles, determined by the length of a road segment and its number of lanes (e.g. a two mile segment of a four-lane highway equates to eight lane miles). Effect sizes are usually presented as the ratio of the percent change in VMT associated with a one percent change in lane miles. The expectation is that this ratio, also called an “elasticity,” will be positive: an increase in lane miles will lead to an increase in VMT. An elasticity of 1 or greater means that the new capacity is entirely filled by additional VMT, producing no reduction in congestion or GHG emissions; for elasticities between 0 and 1, the closer the elasticity is to zero, the smaller the increase in VMT relative to the increase in capacity, and thus the greater the reduction in congestion and GHG emissions.

Impacts are also sometimes measured as the change in VMT associated with the change in travel time (that results from the change in highway capacity). Many studies analyze the change in the number of vehicles per day on that road segment (a metric called “average daily traffic”). No studies focused on travel time or average daily traffic are included here.

Effect Size

Studies consistently show that increased capacity induces additional VMT. Elasticity estimates of the short-run effect of increased highway capacity range from 0.3 to 0.6, though one study produced a lower estimate of 0.1 (Table 1). Estimates of the long-run effect of increased highway capacity are considerably higher, mostly falling into the range from 0.6 to just over 1.0. The more recent studies have produced the highest estimates of long-run elasticities using more sophisticated methodologies that are better able to illuminate the impact of highway capacity on VMT (as discussed in the accompanying Technical Background Document). Thus, the best estimate for the long-run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG in the long-run.

Table 1. Impact of Capacity Expansion on VMT

Study	**Study location**	**Study year(s)**	**Results**	
			Change in VMT/ change in lane miles	*Time period*
Duranton and Turner, 2011	U.S.	1983 - 2003	1.03	10 years
Cervero, 2003	California	1980 - 1994	0.10	Short term
			0.39	Long term
Cervero and Hansen, 2002	California	1976 - 1997	0.59	Short term (1 year)
			0.79	Intermediate term (5 years)
Noland, 2001	U.S.	1984 - 1996	0.30 to 0.60	Short term
			0.70 to 1.00	Long term
Noland and Cowart, 2000	U.S.	1982 - 1996	0.28	Short term
			0.90	Long term
Hansen and Huang, 1997	California	1973 - 1990	0.20	Short term
			0.60 to 0.70	Long term – counties
			0.90	Long term – metro areas

Even the earlier studies were skeptical about the potential of capacity expansion to reduce VMT, particularly in the long-run. In 1997, Hansen and Huang found that population growth is the most consistent contributor to VMT growth, but that the contribution from increases in lane miles is significant: "…Our results suggest that the urban [state highway lane miles] added since 1970 have, on the whole, yielded little in the way of level of service improvements." Noland (2001) concluded that "Increased capacity clearly increases vehicle miles of travel beyond any short run congestion relief

that may be obtained." More recently, Duranton and Turner (2011) echoed these earlier studies: "We conclude that increased provision of roads… is unlikely to relieve congestion."
The effect size appears to depend on the size (whether in terms of population or geographic extent) of the metropolitan area. On a percentage basis, the effects are larger for smaller areas (Schiffer, et al. 2005), likely for a number of reasons. In smaller areas, capacity increases are likely to represent larger percentage increases in total capacity, which then produce larger percentage increases in VMT (Noland and Cowart, 2000). Note that the amount (rather than the percentage) of induced travel is likely to be greater in larger areas than in smaller areas (Hansen and Huang, 1997).

Other factors may also influence the effect size. As noted above, the effect is larger in the long-run than in the short-run, with one study concluding that the full impact of capacity expansion on VMT materializes within five years (Hansen and Huang, 1997) and another concluding that the full effect takes as long as ten years (Durantan and Turner, 2011). The level of congestion is important, as capacity expansion will produce a larger reduction in travel time and thus a larger increase in VMT when congestion is high than when it is low and driving speeds are unconstrained (Schiffer, et al. 2005). In addition, the effect size may depend on fuel prices: when fuel prices are lower, the induced travel effects of expanded capacity tend to be higher, as travel time is a greater share of the cost of travel in this situation (Noland and Lem, 2002). Whether the form of capacity expansion (i.e. new roads or expanded roads) matters is not clear (Schiffer, et al., 2005).

An important question is whether increased VMT on highways following capacity expansion is partially offset by decreases in VMT on other roads. This would be the case if drivers shifted from slower and more congested roads to the new or newly expanded highways. However, Hansen and Huang (1997) found "no conclusive evidence that increases in state highway lane-miles have affected traffic on other roads," while more recently Duranton and Turner (2011) concluded that "increasing lane kilometers for one type of road diverts little traffic from other types of road." In other words, capacity expansion leads to a net increase in VMT, not simply a shifting of VMT from one road to another.

Another important question is whether increased highway capacity impacts public transit ridership, or vice versa. The potential interactions are complex. Increased highway capacity could lead public transit riders to shift to driving, thereby contributing to the induced travel effect. Conversely, increased public transit service could entice drivers to replace some driving with public transit, thereby reducing highway traffic and in effect freeing up additional capacity that could then lead to induced traffic. Duranton and

Turner (2011) found no evidence that public transit service affects VMT, suggesting that whatever interactions do occur tend to cancel each other out. In other words, adding transit capacity does not help to reduce congestion, as any freed up capacity is consumed by additional driving.

As noted, some communities have decreased roadway capacity, in part motivated by the goal of reducing VMT. Evidence on the effects of roadway removals or capacity decreases is sparse, however. A 1998 study of 60 locations where road space was taken away from cars in the UK, Canada, Tasmania, and Japan found that, on average, 25 percent of VMT seemed to go away, though the effect size varied widely (Goodwin, et al. 1998). A study of a fourteen-month closure of an important bridge in Calgary, Canada found only a small reduction in trips and little change in behavior with respect to mode (Hunt et al., 2001). Researchers also found limited changes in behavior during the temporary closing for construction of a stretch of Interstate 5 through downtown Sacramento in 2008 (Ye et al., 2012). Studies of the removal of the Central Freeway in San Francisco documented a significant drop in traffic: counts on the boulevard that replaced the freeway were roughly 50 percent less than counts on the freeway (Cervero et al., 2009). Effects on VMT rather than traffic counts have not been assessed.

Evidence Quality

The quality of the evidence linking highway capacity expansion to VMT increases is relatively high, although tying changes in VMT to changes in capacity is challenging. The cited studies use time-series data and sophisticated econometric techniques to estimate the effect size. These studies control for other factors that might also affect VMT, including population growth, increases in income, other demographic effects, and changes in transit service (Noland and Lem, 2002).

Although these studies show a strong correlation between capacity increases and increases in VMT, the direction of causality is an important question in that the anticipation of growth in VMT is generally the rationale for capacity expansion. One study showed that a 10 percent increase in VMT is associated with a 3.3 percent increase in lane-miles (Cervero and Hansen, 2002). However, Fulton, et al. (2000) found that growth in lane-miles precedes growth in VMT, and Duranton and Turner (2011) concluded that “roads are assigned to [metropolitan areas] with little or no regard for the prevailing level of traffic.” The cited studies have found a significant influence of capacity expansion on VMT even after accounting for the reverse effect.

Caveats

Many of the studies focus on California, and the results for these studies are similar to those for the national studies, suggesting that the effects are relatively uniform across the U.S. However, as noted above, the effect size may depend on size of the metropolitan area, existing levels of congestion, and fuel prices, and it is likely to be higher in the long run than in the short run.

GHG Emissions

The effect of capacity expansion on GHG emissions depends on two competing effects: the increase in VMT (which increases GHG emissions), and the reduction in traffic congestion (which tends to decrease GHG emissions). As noted above, any induced travel that occurs reduces the effectiveness of capacity expansion as a strategy for alleviating traffic congestion and offsets any reductions in GHG emissions that would result from improved traffic flow. Noland (2001) predicted that the growth in VMT attributable to increased lane miles would produce an additional 43 million metric tons of CO_2 emissions in 2012 nationwide. Conversely, any reductions in VMT resulting from reductions in capacity will reduce GHG emissions, though if traffic congestion increases as a result of the capacity reduction, the benefits will be offset to some degree.

Co-benefits

Given the induced travel effect, capacity expansion has limited potential as a strategy for reducing congestion. The additional vehicle travel induced by capacity expansion increases GHG emissions as well as other environmental effects, including increased air, water, and noise pollution. On the other hand, capacity expansion potentially generates economic and social benefits, at least in the short run, even if the new capacity is completely filled by induced travel. The additional benefits derive from the fact that the expanded highway is carrying more people, each of whom benefits from his or her travel. However, most studies of the impact of capacity expansion on development in a metropolitan region find no net increase in employment or other economic activity, though highway investments do influence where within a region development occurs (Handy, 2005; Funderberg et al., 2010).

In addition, the construction process itself generates both positive and negative effects. Most obviously, highway construction projects create jobs that can boost the local economy. On the other hand, highway construction projects often have substantial negative effects on the communities through which they are sited, particularly if construction necessitates the removal of homes or businesses. Historically, low-income and/or minority communities were and continue to be disproportionately affected by such projects.

In contrast, reductions in road capacity tend to produce positive social and environmental effects, and they can also generate economic benefits. For example, many cities in Europe have adopted the strategy of closing streets in the central business district to vehicle traffic as an approach to economic revitalization (Hajdu, 1988; Rodriguez, 2011). Road diet projects are becoming increasingly popular in California and elsewhere in the U.S. as a way to support modes other than driving and enhance the local environment, though their economic impacts have not yet been systematically documented.

Examples

California continues to expand its highway system, though at a far slower rate than during the era of interstate highway construction. According to the national Bureau of Transportation Statistics, California had 31,435 miles of freeways, highways, and arterial roadways in 2010, a 1.6 percent increase from 2005.

As noted above, San Francisco removed two segments of elevated freeway damaged in the 1989 Loma Prieta earthquake. The Central Freeway was replaced with Octavia Boulevard, while the removal of the Embarcadero Freeway enabled substantial improvements to the at-grade Embarcadero Boulevard. Both projects sparked an on-going revitalization of their surrounding areas (Cervero, et al. 2009).

The strategy of closing central business district streets to car traffic is uncommon in California but not unknown. Cities in California that have or have had “pedestrian malls” include Burbank, Oxnard, Pomona, Redding, Redlands, Sacramento, and Santa Cruz. The Fulton Mall in downtown Fresno, closed to traffic in the 1960s, has struggled, despite several revitalization efforts. In contrast, Santa Monica’s Third Street Promenade, closed to traffic in the 1960s, is widely seen as a success in promoting economic activity and creating a thriving community core.

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Generated Traffic and Induced Travel

Implications for Transport Planning

27 January 2015

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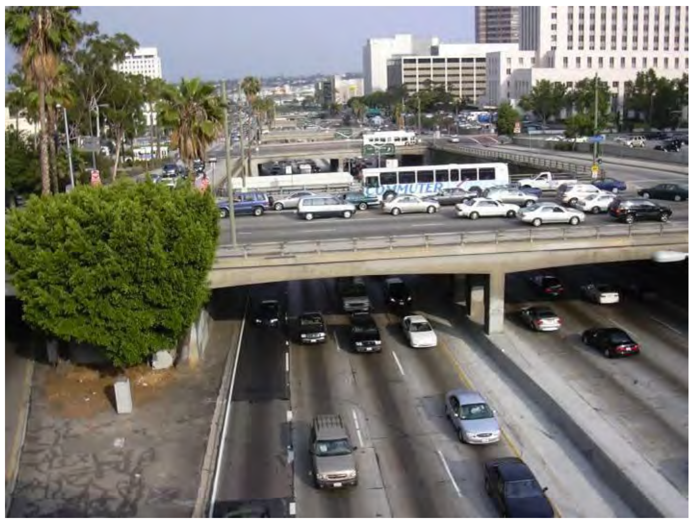

Abstract

Traffic congestion tends to maintain equilibrium. Congestion reaches a point at which it constrains further growth in peak-period trips. If road capacity increases, the number of peak-period trips also increases until congestion again limits further traffic growth. The additional travel is called "generated traffic." Generated traffic consists of diverted traffic (trips shifted in time, route and destination), and induced vehicle travel (shifts from other modes, longer trips and new vehicle trips). Research indicates that generated traffic often fills a significant portion of capacity added to congested urban road.

Generated traffic has three implications for transport planning. First, it reduces the congestion reduction benefits of road capacity expansion. Second, it increases many external costs. Third, it provides relatively small user benefits because it consists of vehicle travel that consumers are most willing to forego when their costs increase. It is important to account for these factors in analysis. This paper defines types of generated traffic, discusses generated traffic impacts, recommends ways to incorporate generated traffic into evaluation, and describes alternatives to roadway capacity expansion.

A version of this paper was published in the *ITE Journal*, Vol. 71, No. 4, Institute of Transportation Engineers (www.ite.org), April 2001, pp. 38-47.

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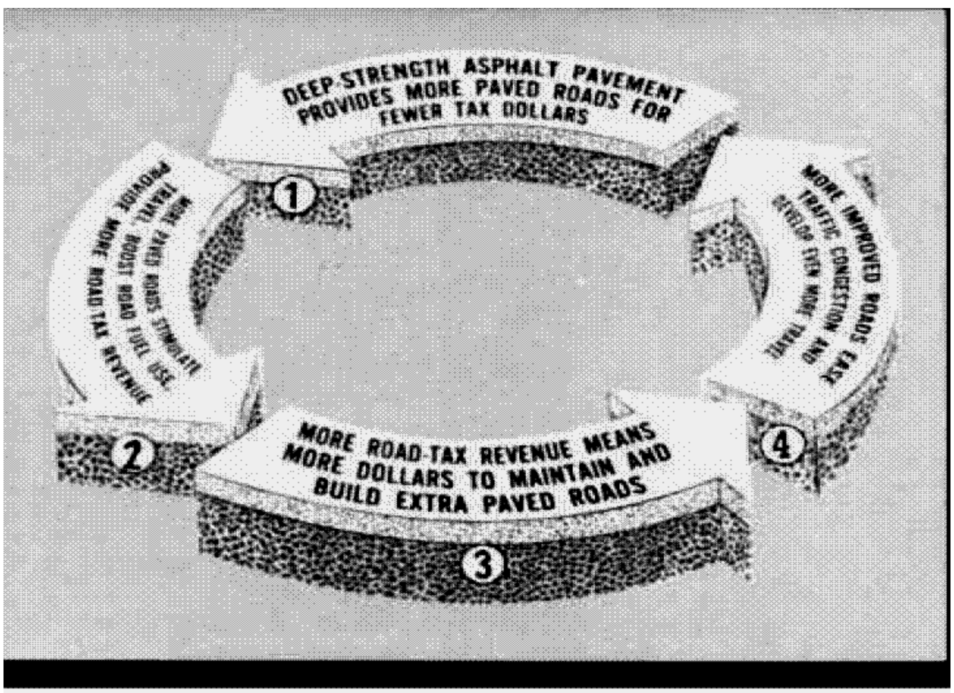


Roads beget roads: From the cover of *Asphalt Bulletin*, April 1966.

This illustration from ***Asphalt Bulletin*** *magazine shows how roadway expansion tends to stimulate automobile travel and the need for more roads.*

Introduction

Traffic engineers often compare traffic to a fluid, assuming that a certain volume must flow through the road system. But urban traffic may be more comparable to a gas that expands to fill available space (Jacobsen 1997). Road improvements that reduce travel costs attract trips from other routes, times and modes, and encourage longer and more frequent travel. This is called *generated traffic*, referring to additional vehicle traffic on a particular road. This consists in part of *induced travel*, which refers to increased total vehicle miles travel (VMT) compared with what would otherwise occur (Hills 1996).

Generated traffic reflects the economic "law of demand," which states that consumption of a good increases as its price declines. Roadway improvements that alleviate congestion reduce the generalized cost of driving (i.e., the price), which encourages more vehicle use. Put another way, most urban roads have *latent travel demand*, additional peak-period vehicle trips that will occur if congestion is relieved. In the short-run generated traffic represents a shift along the demand curve; reduced congestion makes driving cheaper per mile or kilometer in terms of travel time and vehicle operating costs. Over the long run induced travel represents an outward shift in the demand curve as transport systems and land use patterns become more automobile dependent, so people must drive more to maintain a given level of accessibility to goods, services and activities (Lee 1999).

This is not to suggest that increasing road capacity provides no benefits, but generated traffic affects the nature of these benefits. It means that road capacity expansion benefits consist more of increased peak-period mobility and less of reduced traffic congestion. Accurate transport planning and project appraisal must consider these three impacts:

1. Generated traffic reduces the predicted congestion reduction benefits of road capacity expansion (a type of *rebound* effect).
2. Induced travel imposes costs, including downstream congestion, accidents, parking costs, pollution, and other environmental impacts.
3. The additional travel that is generated provides relatively modest user benefits, since it consists of marginal value trips (travel that consumers are most willing to forego).

Ignoring these factors distorts planning decisions. Experts conclude, "…*the economic value of a scheme can be overestimated by the omission of even a small amount of induced traffic. We consider this matter of profound importance to the value-for-money assessment of the road programme*" (SACTRA 1994). "*...quite small absolute changes in traffic volumes have a significant impact on the benefit measures. Of course, the proportional effect on scheme Net Present Value will be greater still*" (Mackie, 1996) and "*The induced travel effects of changes in land use and trip distribution may be critical to accurate evaluation of transit and highway alternatives*" (Johnston, et al. 2001)

This paper describes how generated traffic can be incorporated into transport planning. It defines different types of generated traffic, discusses their impacts, and describes ways to incorporate generated traffic into transport modeling and planning, and provides information on strategies for using existing roadway capacity more efficiently.

Defining Generated Traffic

Generated traffic is the additional vehicle travel that results from a road improvement, particularly expansion of congested urban roadways. Congested roads cause people to defer trips that are not urgent, choose alternative destinations and modes, and forego avoidable trips. Generated traffic consists of *diverted travel* (shifts in time and route) and *induced travel* (increased total motor vehicle travel). In some situations, highway expansion stimulates sprawl (automobile-dependent, urban fringe land use patterns), further increasing per capita vehicle travel. If some residents would otherwise choose less sprawled housing locations, their additional per capita vehicle travel can be considered to be induced by the roadway capacity expansion.

Below are examples of decisions that generate traffic:

- Consumers choose closer destinations when roads are congested and further destinations when traffic flows more freely. "*I want to try the new downtown restaurant but traffic is a mess now. Let's just pick up something at the local deli.*" This also affects long-term decisions. "*We're looking for a house within 40-minute commute time of downtown. With the new highway open, we'll considering anything as far as Midvalley.*"
- Travelers shift modes to avoid driving in congestion. "*The post office is only five blocks away and with congestion so bad this time of day, I may as well walk there.*"
- Longer trips may seem cost effective when congestion is light but not when congestion is heavy. "*We'd save $5 on that purchase at the Wal-Mart across town, but it's not worth fighting traffic so let's shop nearby.*"

Travel time budget research indicates that increased travel speeds often results in more mobility rather than saving time. People tend to average about 75 minutes of daily travel time regardless of transport conditions (Levinson and Kumar 1995; Lawton 2001). National data indicate that as freeway travel increases, average commute trip distances and speeds increase, but trip time stays about constant (Levinson and Kumar 1997). As a result, traffic congestion tends to maintain a self-limiting equilibrium: once congestion becomes a problem it discourages further growth in peak-period travel. Road expansion that reduces congestion in the short term attracts additional peak-period trips until congestion once again reaches a level that limits further growth. It may therefore be incorrect to claim that congestion reductions save travel time.

Definitions

Generated Traffic: Additional peak-period vehicle trips on a particular roadway that occur when capacity is increased. This may consist of shifts in travel time, route, mode, destination and frequency.

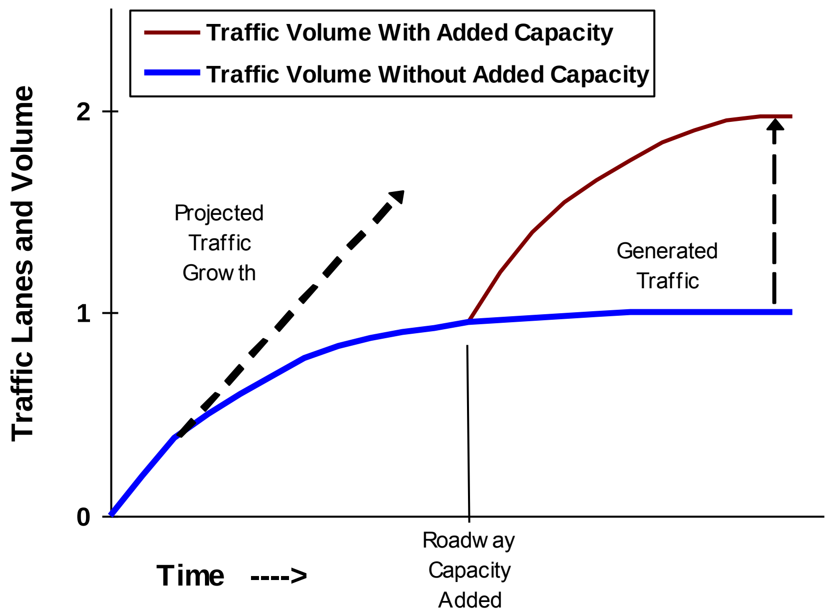
Induced travel: An increase in total vehicle mileage due to roadway improvements that increase vehicle trip frequency and distance, but exclude travel shifted from other times and routes.

Latent demand: Additional trips that would be made if travel conditions improved (less congested, higher design speeds, lower vehicle costs or tolls).

Triple Convergence: Increased peak-period vehicle traffic volumes that result when roadway capacity increases, due to shifts from other routes, times and modes.

Figure 1 illustrates this pattern. Traffic volumes grow until congestion develops, then the growth rate declines and achieves equilibrium, indicated by the curve becoming horizontal. A demand projection made during this growth period will indicate that more capacity is needed, ignoring the tendency of traffic volumes to eventually level off. If additional lanes are added there will be another period of traffic growth as predicted.

Figure 1 **How Road Capacity Expansion Generates Traffic**



Traffic grows when roads are uncongested, but the growth rate declines as congestion develops, reaching a self-limiting equilibrium (indicated by the curve becoming horizontal). If capacity increases, traffic grows until it reaches a new equilibrium. This additional peak-period vehicle travel is called "generated traffic." The portion that consists of absolute increases in vehicle travel (as opposed to shifts in time and route) is called "induced travel."

Generated traffic can be considered from two perspectives. Project planners are primarily concerned with the traffic generated *on the expanded road segment*, since this affects the project's congestion reduction benefits. Others may be concerned with changes in *total vehicle travel* (induced travel) which affects overall benefits and costs. Table 1 describes various types of generated traffic. In the short term, most generated traffic consists of trips diverted from other routes, times and modes, called *Triple Convergence* (Downs 1992). Over the long term an increasing portion is induced travel. In some situations, adding roadway capacity can reduce the network's overall efficiency, a phenomena called *Braess's Paradox* (Youn, Jeong and Gastner 2008).

Highway capacity expansion can induce additional vehicle travel on adjacent roads (Hansen, et al. 1993) by stimulating more dispersed, automobile-dependent development. Although these indirect impacts are difficult to quantify they are potentially large and should be considered in transport planning (Louis Berger & Assoc. 1998).

Table 1 **Types of Generated Traffic**

Type of Generated Traffic	Category	Time Frame	Travel Impacts	Cost Impacts
Shorter Route Improved road allows drivers to use more direct route.	Diverted trip	Short term	Small reduction	Reduction
Longer Route Improved road attracts traffic from more direct routes.	Diverted trip	Short term	Small increase	Slight increase
Time Change Reduced peak period congestion reduces the need to defer trips to off-peak periods.	Diverted trip.	Short term	None	Slight increase
Mode Shift; Existing Travel Choices Improved traffic flow makes driving relatively more attractive than other modes.	Induced vehicle trip	Short term	Increased driving	Moderate to large increase
Mode Shift; Changes in Travel Choice Less demand leads to reduced rail and bus service, less suitable conditions for walking and cycling, and more automobile ownership.	Induced vehicle trip	Long term	Increased driving, reduced alternatives	Large increase, reduced equity
Destination Change; Existing Land Use Reduced travel costs allow drivers to choose farther destinations. No change in land use patterns.	Longer trip	Short term	Increase	Moderate to large increase
Destination Change; Land Use Changes Improved access allows land use changes, especially urban fringe development.	Longer trip	Long term	More driving and auto dependency	Moderate to large increase, equity costs
New Trip; No Land Use Changes Improved travel time allows driving to substitute for non-travel activities.	Induced trip	Short term	Increase	Large increase
Automobile Dependency Synergetic effects of increased automobile oriented land use and transportation system.	Induced trip	Long term	Increased driving, fewer alternatives	Large increase, reduced equity

Some types of generated traffic represent diverted trips (trips shifted from other times or routes) while others increase total vehicle travel, reduce travel choices, and affect land use patterns.

What constitutes *short*- and *long-term* impacts can vary. Some short term effects, such as mode shifts, may accumulate over several years, and some long term effects, such as changes in development patterns, can begin almost immediately after a project is announced if market conditions are suitable. Roadway expansion impacts tend to include:

- *First order.* Reduced congestion delay, increased traffic speeds.
- *Second order.* Changes in travel time, route, destination and mode to take advantage of the increased speeds.
- *Third order.* Land use changes. More dispersed, automobile-oriented development.
- *Fourth order*. Overall increase in automobile dependency. Degraded walking and cycling conditions (due to wider roads and increased traffic volumes), reduced public transit service quality (due to reduced demand and associated scale economies, sometimes called the *Downs-Thomson paradox*), and social stigma associated with alternative modes (Noland and Hanson 2013, p. 75).

Such impacts can also occur in reverse: if urban roadway capacity is reduced a portion of previous vehicle traffic may disappear altogether (Cairns, Hass-Klau and Goodwin 1998; Cervero 2006; CNU 2011; ITDP 2012; Miller 2006) which is sometimes called *traffic evaporation* (EC 2004).

Measuring Generated Traffic

Several studies using various analysis methods have quantified generated traffic and induced travel impacts (Handy and Boarnet 2014; Noland and Hanson 2013). Their findings are summarized below:

- Cervero (2003a & b) used data on freeway capacity expansion, traffic volumes, demographic and geographic factors from California between 1980 and 1994. He estimated the long-term elasticity of VMT with respect to traffic speed to be 0.64, meaning that a 10% increase in speed results in a 6.4% increase in VMT, and that about a quarter of this results from changes in land use (e.g., additional urban fringe development). He estimated that about 80% of additional roadway capacity is filled with additional peak-period travel, about half of which (39%) can be considered the direct result of the added capacity.

- Duranton and Turner (2008) investigate the relationship between interstate highway lane-kilometers and highway vehicle-kilometers travelled (VKT) in US cities. They found that VKT increases proportionately to highways and identify three important sources for this extra vehicle travel: increased driving by current residents, an inflow of new residents, and more transport intensive production activity. They find aggregate city-level VKT demand to be elastic and so conclude that, without congestion pricing, increasing road or public transit supply is unlikely to relieve congestion, and current roadway supply exceeds the optimum.

- Handy and Boarnet (2014) performed a critical evaluation of various induced travel studies. They found *short-run* elasticity effects of increased highway capacity generally range from 0.3 to 0.6, although one study produced a lower estimate of 0.1. Estimates of the *long-run* effect of increased highway capacity are considerably higher, mostly falling into the range from 0.6 to just over 1.0. The more recent studies have produced the highest estimates of long-run elasticities using more sophisticated methodologies that are better able to illuminate the impact of highway capacity on VMT. They therefore conclude that the best estimate for the long-run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited access highways is unlikely to reduce congestion or associated GHG in the long-run.

- Time-series travel data for various roadway types indicates an elasticity of vehicle travel with respect to lane miles of 0.5 in the short run, and 0.8 in the long run (Noland 2001). This means that half of increased roadway capacity is filled with added travel within about 5 years, and that 80% of the increased roadway capacity will be filled eventually. Urban roads, which tend to be most congested, had higher elasticity values than rural roads, as would be expected due to the greater congestion and latent demand in urban areas.

- The medium-term elasticity of highway traffic with respect to California state highway capacity was measured to be 0.6-0.7 at the county level and 0.9 at the municipal level (Hansen and Huang 1997). This means that 60-90% of increased road capacity is filled with new traffic within five years. Total vehicle travel increased 1% for every 2-3% increase in highway lane miles. The researcher concludes, "it appears that adding road capacity does little to decrease congestion because of the substantial induced traffic" (Hansen 1995). Mokhtarian, et al (2002) applied a different statistical technique (matched-pairs) to the same data and found no significant induced travel effect, but that technique does not account for additional traffic on other roads or control for other factors that may affect vehicle travel.

- Leading U.K. transportation economists concludes that the elasticity of travel volume with respect to travel time is -0.5 in the short term and -1.0 over the long term (SACTRA 1994). This means that reducing travel time on a roadway by 20% typically increases traffic volumes by 10% in the short term and 20% over the long term.

- The following are elasticity values for vehicle travel with respect to travel time: urban roads, short-term -0.27, long term –0.57; rural roads, short term –0.67, long term –1.33 (Goodwin 1996). These values are used in the FHWA's SMITE software program described below.

- A Transportation Research Board report based finds consistent evidence of generated traffic, particularly with respect to travel time savings (Cohen 1995).

- National Highway Institute concludes that the elasticity of highway travel with respect to users' generalized cost (travel time and financial expenses) is typically -0.5 (NHI 1995).

- Analysis of traffic conditions in 70 metropolitan areas finds that regions which invested heavily in road capacity expansion fared no better in reducing congestion than those that spent far less (STPP 1998). The researchers estimate that road capacity investments of thousands of dollars annually per household would be needed achieve congestion reductions.

- Noland and Mohammed A. Quddus (2006) found that increases in road space or traffic signal control systems that smooth traffic flow tend to induce additional vehicle traffic which quickly diminish any initial emission reduction benefits.

- Cross-sectional time-series analysis of traffic growth in the U.S. Mid-Atlantic region found an average elasticities of VMT with respect to lane miles to be 0.2 to 0.6 (Noland and Lem 2002).

- The USDOT Highway Economic Requirements System (HERS) investment analysis model uses a travel demand elasticity factor of –0.8 for the short term, and –1.0 for the long term, meaning that if users' generalized costs (travel time and vehicle expenses) decrease by 10%, travel is predicted to increase 8% within 5 years, and an additional 2% within 20 years (Lee, Klein and Camus 1998; FHWA 2000).

- Cervero and Hanson (2000) found the elasticity of VMT with respect to lane-miles to be 0.56, and an elasticity of lane-miles with respect to VMT of 0.33, indicating that roadway capacity expansion results in part from anticipated traffic growth.

- A comprehensive study of the impacts of urban design factors on U.S. vehicle travel found that a 10% increase in urban road density (lane-miles per square mile) increases per capita annual VMT by 0.7% (Barr 2000).

- In a study of eight new urban highways in Texas over several years, Holder and Stover (1972) found evidence of induced travel at six locations, estimated to represent 5-12% of total corridor volume, representing from a quarter to two-thirds of traffic on the facility. Henk (1989) performed similar analysis at 34 sites and found similar results.

- Yao and Morikawa (2005) develop a model of induced demand resulting from high speed rail service improvements between major Japanese cities. They calculate elasticities of induced travel (trips and VMT) with respect to fares, travel time, access time and service frequency for business and nonbusiness travel.

- Modeling analysis indicates that adding an urban beltway can increase regional VMT by 0.8-1.1% for each 1.0% increase in lane capacity (Rodier, et al. 2001).

Table 2 Portion of New Capacity Absorbed by Induced Traffic

Author	Short-term	Long-term (3+ years)
SACTRA		50 - 100%
Goodwin	28%	57%
Johnson and Ceerla		60 - 90%
Hansen and Huang		90%
Fulton, et al.	10 - 40%	50 - 80%
Marshall		76 - 85%
Noland	20 - 50%	70 - 100%

- Odgers (2009) found that traffic speeds on Melbourne, Australia freeways did not decline as predicted following new urban highway construction, apparently due to induced traffic. He concludes that, "major road infrastructure initiatives and the consequent economic investments have not yet delivered a net economic benefit to either Melbourne's motorists or the Victorian community."

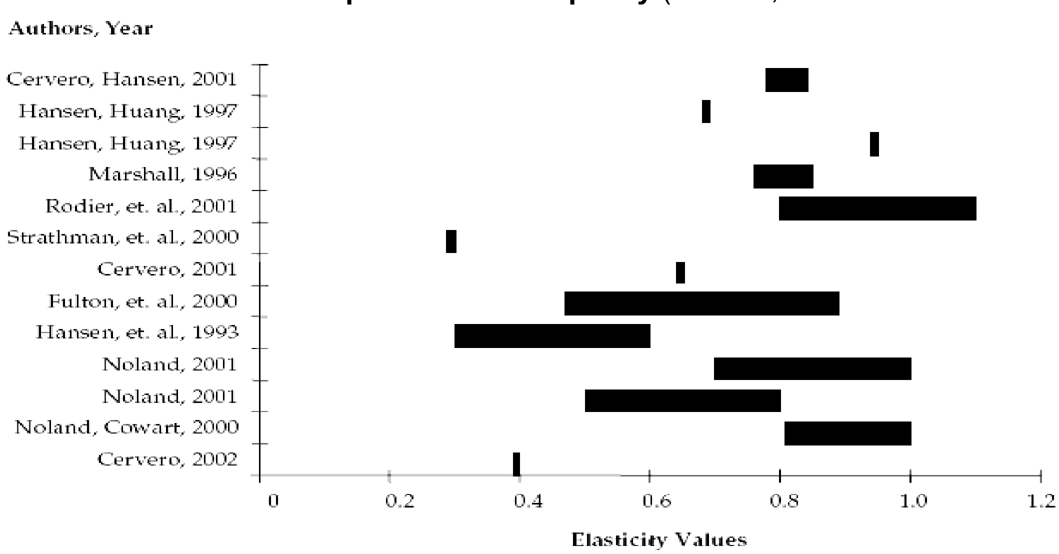
- Burt and Hoover (2006) found that each 1% increase in road lane-kilometres per driving-age person increases per capita light truck travel 0.49% and car travel 0.27%, although they report that these relationships are not statistically significant, falling just outside the 80% confidence interval for cars and the 90% confidence interval for light trucks.

- Hymel, Small and Van Dender (2010) used U.S. state-level cross-sectional time series data for 1966 through 2004 to evaluate the effects of various factors including incomes, fuel price, road supply and traffic congestion on vehicle travel. They find the elasticity of vehicle travel with respect to statewide road density (based on 2004 vehicle ownership rates and incomes) is 0.019 in the short run and 0.093 in the long run (a 10% increase in total lane-miles per square mile increases state vehicle mileage by 0.19% in the short run and 0.93% in the long run), and with respect to total road miles is 0.037 in the short run and 0.186 in the long run (a 10% increase in lane-miles causes state VMT to increase 0.37% in the short run and 1.86% over the long run), and the elasticity of vehicle use with respect to congestion is -0.045 (a 10% increase in total regional congestion reduces regional mileage 0.45% over the long run), but this increases with income, assumedly because the opportunity cost of time increases with wealth, and so is estimated to be 0.078 at 2004 income levels (a 10% increase in total regional congestion reduces regional mileage by 0.78% over the long run). Their analysis indicates that long-run travel elasticities are typically 3.4–9.4 times the short-run elasticities.

- The *Handbook of Transportation Engineering* urban highway capacity expansion often fails to significantly increase travel times and speeds due to latent demand (Kockelman 2010). A review of published literature indicates long-run elasticities of demand for roadspace (vehicle miles traveled) are generally 0.5 to 1.0 after controlling for population growth and income, with values of almost 1.0 (suggesting that new roadspace is almost precisely filled by generated traffic where congestion is relatively severe.

- Schiffer, Steinvorth and Milam (2005) perform a meta-analysis of induced travel studies to identify short- and long-term elasticities of VMT with respect to changes in traffic lane-miles and other variables, as summarized in Figure 2, and applied the results in to highway expansions in the Salt Lake City region. They reached the following general conclusions:
    - *Induced travel effects exist* – The elasticity of VMT with respect to added lane-miles or reductions in travel time is generally greater than zero and the effects increase over time.
    - *Short-term induced travel effects are smaller than long-term effects* – As measured by the increase in VMT with respect to an increase in lane-miles, short-term effects have an elasticity range from near zero to about 0.40, while long-term elasticities range from about 0.50 to 1.00. This means that a 10% increase in lane-miles can cause up to a 4% increase in VMT in the short term and a 10% increase in the long term.
    - *Induced travel effects for constructing new roadways versus widening existing roadways were not definitive* – The research included no examples that isolated the effects of constructing new roadways versus widening existing roadways. However, somewhat higher elasticities where found when "new roadways and widenings" were compared to "widenings only."
    - *Induced travel effects generally decrease with the size of the unit of study* – Larger effects are measured for single facilities while smaller effects are measured for regions and subareas. This is mainly due to diverted trips (drivers changing routes) causing more of the change on a single facility, whereas, at the regional level, diverted trips between routes within the region are not considered induced travel unless the trips become longer as a result.
    - *Traditional four-step travel demand models do not fully address induced travel or induced growth* – Land use allocation methods overlook accessibility effects, trip generation often fails to account for latent trips (potential trips constrained by congestion), many models overlook time-of-day shifts, and static traffic assignment algorithms may not account for queuing impacts on route shifts. Errors tend to be greatest when there is more or users are more responsive to travel costs.

Figure 2 **VMT With Respect to Road Capacity** (Schiffer, Steinvorth and Milam 2005)



This figure summarizes long term vehicle travel elasticities with respect to roadway capacity.

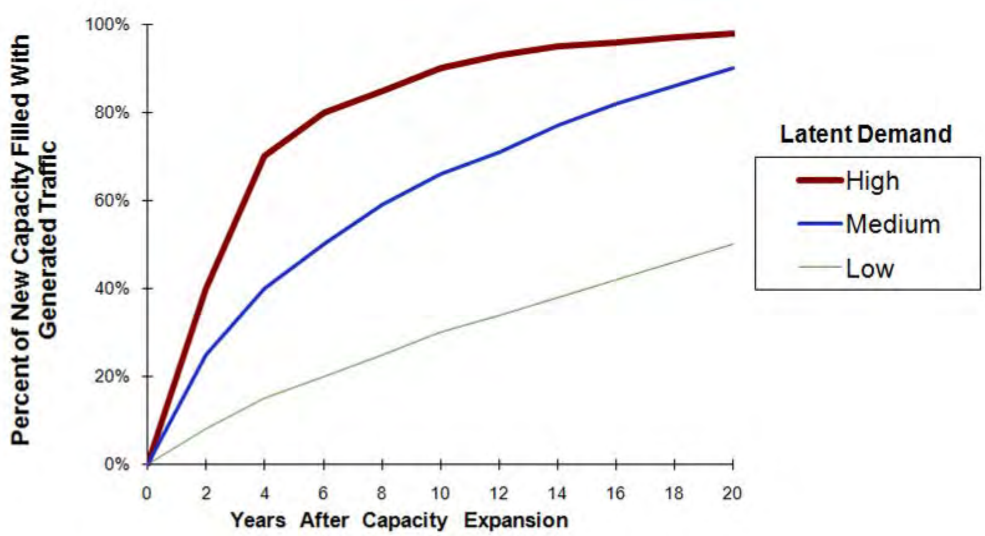
- Melo, Graham and Canavan (2012) found a positive relationship between urban highway expansion and vehicle travel in the U.S. between 1982 and 2009.

Gridlock?
People sometimes warn that roads will soon reach *gridlock* unless some recommended action is taken, such as roadway expansion. Such claims are usually exaggerated because they ignore traffic congestion's tendency toward equilibrium. Gridlock is a specific condition that occurs when backups in a street network block intersections, stopping traffic flow. Gridlock can be avoided with proper intersection design and traffic law enforcement. Increasing regional highway capacity tends to increase this risk by adding more traffic to surface streets where gridlock occurs.

The amount of traffic generated by a road project varies depending on conditions. It is not capacity expansion itself that generates travel, it is the reduction in congestion delays and therefore per-mile travel costs. Expanding uncongested roads will generate no traffic, although paving a dirt road or significantly raising roadway design speeds may induce more vehicle travel. In general, the more congested a road, the more traffic is generated by capacity expansion. Increased capacity on highly congested roads often generates considerable traffic (Marshall 2000). Older studies of the elasticity of VMT growth with respect to increased roadway lane-miles performed during the early years of highway building (during the 1950s through 1970s) have little relevance for evaluating current urban highway capacity expansion. In developed countries, where most highway expansion now occurs on congested links, such projects are likely to generate considerable amounts of traffic, providing only temporary congestion reduction benefits.

Generated traffic usually accumulates over several years (Goodwin 1998). Under typical urban conditions, more than half of added capacity is filled within five years of project completion by additional vehicle trips that would not otherwise occur, with continued but slower growth in later years. Figure 3 shows typical generated traffic growth indicated by various studies. Techniques for modeling these impacts into account are described in the next section (Dargay and Goodwin 1995).

Figure 3 **Elasticity of Traffic Volume With Respect to Road Capacity**



This illustrates traffic growth on a road after its capacity increases. About half of added capacity is typically filled with new traffic within a decade of construction. (Based on cited studies)

Modeling Generated Traffic

To predict generated traffic, transport models must incorporate "feedback," which reflects the impacts congestion has on travel behavior, and long-term changes in transport and land use patterns. This recognizes that congestion diverts traffic to other routes, times and modes, and reduces trip length and frequency, while reduced congestion has the opposite effects. Because of non-linear speed flow relationships, and typically small net differences between large costs and large benefits, a small amount of induced traffic can have a disproportionately large effect on the cost effectiveness of a roadway project.

Most current traffic models can predict route and mode shifts, and some can predict changes in scheduling and destination, but few adjust trip frequency and most ignore the effects transport decisions have on land use development patterns (Beimborn, Kennedy and Schaefer 1996; Ramsey 2005; Næss, Nicolaisen and Strand 2012). For example, they do not recognize that highway capacity expansion encourages more automobile-dependent urban fringe development. As a result, current models recognize diverted traffic but do not account for most forms of long term induced vehicle travel, and thus underestimate the amount of traffic likely to be generated when congested roads are expanded.

In one exercise, Ramsey (2005) found that the net benefits of a suburban highway capacity expansion project declined by 50% if the project caused 60,000 residents (about 2% of the regional population) to move from urban to suburban locations, thereby increasing traffic congestion on that roadway link. In a case study of a proposed roadway expansion project in Copenhagen, Denmark, Næss, Nicolaisen and Strand (2012) found that ignoring a portion of induced traffic effects significantly affected cost-benefit results: results show lower travel time savings, more adverse environmental impacts and a considerably lower benefit-cost ratio when induced traffic is partly accounted for than when it is ignored. They conclude that, "By exaggerating the economic benefits of road capacity increase and underestimating its negative effects, omission of induced traffic can result in overallocation of public money on road construction and correspondingly less focus on other ways of dealing with congestion and environmental problems in urban areas."

Analysis of urban highway expansion impacts on total emissions by Williams-Derry (2007) indicates that emissions from construction and additional vehicle traffic quickly exceed any emission reductions from reduced congestion delays.

Transportation modelers have developed techniques for incorporating full feedback (Harvey and Deakin 1993; SACTRA 1994; Loudon, Parameswaran and Gardner 1997; Schiffer, Steinvorth and Milam 2005). This recognizes that expanding the capacity of congested roads increases the number and length of trips in a corridor (DeCorla-Souza and Cohen 1999). Henk (1989) used analysis of vehicle traffic growth rates at 34 urban highways in Texas to develop a model which predicts the amount of latent demand, and therefore future traffic volumes from highway capacity expansion, taking into account the type of facility, the Volume/Capacity ratio, and local population densities. Even more accurate are integrated models that incorporate interrelationships between transport and land use patterns (Rodier, et al. 2001). Federal clean air rules require that these techniques be used in metropolitan transportation models to evaluate the effects transport system changes have on vehicle emissions, but many metropolitan planning organizations have yet to comply, and few models used in medium and small cities have full feedback.

Full feedback is necessary to accurately predict future traffic congestion and traffic speeds, and the incremental costs and benefits of alternative projects and policy options. Models without full feedback tend to overestimate future congestion problems and overestimate the benefits of roadway capacity expansion. In one example, modeling a congested road network without feedback underestimated traffic speeds by more than 20% and overestimated total vehicle travel by more than 10% compared with modeling with feedback (Comsis 1996). Models that fail to consider generated traffic were found to overvalue roadway capacity expansion benefits by 50% or more (Williams and Yamashita 1992). Another study found that the ranking of preferred projects changed significantly when feedback is incorporated into project assessment (Johnston and Ceerla 1996). Ignoring generated traffic tends to skew planning decisions toward highway projects and away from No Build and mobility management alternatives such as road pricing, transit improvements and commute trip reduction programs (Boarnet 1995).

UK Department For Transport's *Transport Analysis Guidance* (DfT 2007), includes a section on *Variable Demand Modelling* (www.dft.gov.uk/webtag/documents/expert/unit3.10.1.php) which describes methods for incorporating induced travel demand into project appraisal.

The FHWA *Spreadsheet Model for Induced Travel Estimation* (SMITE) was developed to predict the amount of traffic induced by road improvements and the effects on consumer welfare and vehicle emissions (DeCorla-Souza 2000). It is a relatively easy way to incorporate generated traffic impacts into road project assessments. Another approach involves integrated transport/ land use models (such as TRANUS and MEPLAN) that track transport benefits through their land value impacts (Abraham 1998).

Short Cut Methods of Incorporating Induced Demand
Based on comments in the *Transportation Model Improvement Program* listserve (TMIP-L@listserv.tamu.edu) by Phil Goodwin, 2001.

The easiest way to incorporate induced demand into conventional traffic models is to apply an overall demand elasticity to forecasted changes in travel speed, calculated either:

- Elasticities applied to generalized costs (travel time and financial costs) using a price elasticity (about -0.3 for equilibrium, less for short term), with monetized travel time costs. The time elasticity is generally about -0.5 to -0.8 or so, though this is highly dependent on context. Where to apply it depends on the model used. With a fixed trip matrix altered only by reassignment, apply elasticities to each separate cell, or the row and column totals, or the overall control total - depending on how short the short cut has to be. Or add a separate test at the end.

or

- Direct application of a 'capacity elasticity,' i.e. percent change in vehicle miles resulting from a 1% change in highway capacity, for which lane miles is sometimes used as a proxy, the elasticity in that case usually coming out at about -0.1. This will tend to underestimate the effect if the capacity increase is concentrating on bottlenecks.

Care is needed if the basic model has cost-sensitive distribution and mode split, as this will already make allowance for some induced traffic. Induced traffic consists of several types of travel changes that make vehicle miles "with" a scheme different from "without," including re-assignment to longer routes and some increased trip generation. Allowance for time-shifting, which is not induced traffic at all, is equally important because it has similar effects on calculation of benefits of reducing congestion, and is often a large response. Ideally you iterate on speed and allow for the effect from retiming of journeys, and separate the various behavioural responses which make up induced traffic. These short cuts are subject to bias, but less than the bias introduced by assuming zero induced traffic.

Land Use Impacts

An important issue related to generated and induced travel is the degree to which roadway improvements affect land use patterns, and in particular, whether highway capacity expansion stimulates lower-density, urban fringe development (i.e., urban sprawl), and the costs to society that result (Louis Berger & Assoc. 1998; USEPA 2001; ICF Consulting 2005). Land use changes are one category of induced travel. Such changes take a relatively long time to occur, and are influenced by additional factors, but they are durable effects with a variety of economic, social and environmental impacts.

Urban economists have long realized that transportation can have a major impact on land use development patterns, and in many situations improved accessibility can stimulate development location and type. Different types of transportation improvements tend to cause different types of land use development patters: highway improvements tend to encourage lower-density, automobile-oriented development at the urban fringe, while transit improvements tend to encourage higher-density, multi-modal, urban redevelopment, although the exact types of impacts vary depending on specific conditions and the type of transportation improvements implemented (Rodier, Abraham, Johnston and Hunt 2001; Boarnet and Chalermpong 2002; Litman 2002).

Some researchers claim that investing in road construction does not lead to the sprawl (Sen, et al. 1999; Hartgen 2003a and 2003b), although the evidence indicates otherwise. Even in relatively slow-growth regions with modest congestion problems, highway capacity expansion increases suburban development by 15-25%. These effects are likely to be much greater in large cities with significant congestion problems, where peak-period traffic congestion limits commute trip distances, and increased roadway capacity would significantly improve automobile access to urban fringe locations. This is particularly true if the alternative is to implement Smart Growth development policies and improved walking, cycling and transit transportation ("Smart Growth, VTPI 2006).

There has been considerable debate over the benefits and costs of sprawl and Smart Growth (Burchell, et al. 1998; Litman 2002). Table 2 summarizes some benefits that tend to result from reduced sprawl.

Table 2 **Smart Growth Benefits** ("Smart Growth, VTPI 2006)

Economic	Social	Environmental
Reduced development and public service costs. Consumer transportation cost savings. Economies of agglomeration. More efficient transportation.	Improved transportation choice, particularly for nondrivers. Improved housing choices. Community cohesion.	Greenspace and wildlife habitat preservation. Reduced air pollution. Reduce resource consumption. Reduced water pollution. Reduced "heat island" effect.

Costs of Induced Travel

Driving imposes a variety of costs, including many that are external, that is, not borne directly by users (Murphy and Delucchi 1998). Table 3 illustrates one estimate of the magnitude of these costs. Other studies show similar costs, with average values of 10-30¢ per vehicle-kilometer, and more under urban-peak conditions (Litman 2003).

Table 3 **Motor Vehicle Indirect and External Costs** (Delucchi 1996)

Cost Item	Examples	Vehicle-Year	Vehicle-Mile
Bundled private sector costs	Parking funded by businesses	$337-1,181	2.7-9.4 cents
Public infrastructure and services	Public roads, parking funded by local governments	$662-1,099	5.3-8.8 cents
Monetary externalities	External crash damages to vehicles, medical expenses, congestion.	$423-780	3.4-6.2 cents
Nonmonetary externalities	Environmental damages, crash pain.	$1,305-3,145	10.4-25.2 cents
Totals		*$2,727-6,205*	*22-50 cents*

This table summarizes an estimate of motor vehicle indirect and external costs. (US 1991 Dollars)

Any incremental external costs of generated traffic should be included in project evaluations, "incremental" meaning the difference between the external costs of the generated travel and the external costs of alternative activities (NHI 1995). For diverted traffic this is the difference in external costs between the two trips. For induced travel this is the difference in external costs between the trip and any non-travel activity it replaces, which tends to be large since driving has greater external costs than most other common activities. Most generated traffic occurs under urban-peak travel conditions, when motor vehicle external costs are greatest, so incremental external costs tend to be high.

Incremental external costs depend on road system conditions and the type of generated traffic. Generated traffic often increases downstream congestion (for example, increasing capacity on a highway can add congestion on surface streets, particularly near on- and off-ramps). In some conditions adding capacity actually increases congestion by concentrating traffic on a few links in the network and by reducing travel alternatives, such as public transit (Arnott and Small 1994). Air emission and accident rates per vehicle-mile may decline if traffic flows more freely, but these benefits decline over time and are usually offset as generated traffic leads to renewed congestion and increased vehicle travel (TRB 1995; Shefer and Rietvald 1997; Cassady, Dutzik and Figdor 2004).

Table 4 compares how different types of generated traffic affect costs. All types reduce user travel time and vehicle costs. Diverted trips have minimal incremental costs. Longer trips have moderate incremental costs. Shifts from public transit to driving may also have moderate incremental costs, since transit service has significant externalities but also experiences economies of scale and positive land use impacts that are lost if demand declines ("Social Benefits of Public Transit," VTPI 2001). Induced trips have the largest incremental costs, since they increase virtually all external costs. Longer and induced vehicle trips can lead to more automobile dependent transportation and land use over the long term. These costs are difficult to quantify but are probably significant (Newman and Kenworthy 1998; Burchell, et al 1998).

Table 4 **Cost Impacts of Roadway Capacity Expansion**

Costs Reduced	Costs Increased		
	Diverted Trips	*Longer Trips*	*Induced Trips*
Travel Time Vehicle Operating Costs Per-mile crash rates (if implemented in conjunction with roadway design improvements, but these are often offset if traffic speeds increase). Per-mile pollution emissions (if congestion declines, but these may be offset if traffic speeds increase).	Downstream congestion	Downstream congestion Road facilities Traffic services Per-capita crash rates Pollution emissions Noise Resource externalities Land use impacts Barrier effect	Downstream congestion Road facilities Parking facilities Traffic services Per-capita crash rates Pollution emissions Noise Resource externalities Land use impacts Barrier effect Transit efficiency Equity Vehicle ownership costs

Increased roadway capacity tends to reduce two costs, but increases others.

The incremental external costs of road capacity expansion tend to increase over time as the total amount of generated traffic grows and an increasing portion consists of induced motor vehicle travel and trips.

Table 5 proposes default estimates of the incremental external costs of different types of generated traffic. These values can be adjusted to reflect specific conditions and analysis needs.

Table 5 **Estimated Incremental External Costs of Generated Traffic**

Type	Description	Cost Per Mile
Time and route shift	Trips shifted from off-peak to peak, or from another route.	5 cents
Transit-to-Auto mode shift, and longer trips	Trips shifted from transit to driving alone, and increased automobile trip lengths.	15 cents
Induced vehicle trip	Additional motor vehicle trip, including travel shifted from walking, cycling and ridesharing.	30 cents.

This table indicates the estimated incremental costs of different types of generated traffic.

There is considerable discussion of the emission impacts of roadway expansion (TRB 1995). Although expanding highly congested roadways may reduce emission rates per vehicle-kilometer, expanding moderately congested roads may increase traffic speeds to levels (more than 80 kms/hr) that increase emission rates, and by inducing total vehicle travel tends to increase total emissions, particularly over the long run. According to a study by the Norwegian Centre for Transport Research (TØI 2009):

> "Road construction, largely speaking, increases greenhouse gas emissions, mainly because an improved quality of the road network will increase the speed level, not the least in the interval where the marginal effect of speed on emissions is large (above 80km/hr). Emissions also rise due to increased volumes of traffic (each person traveling further and more often) and because the modal split changes in favor of the private car, at the expense of public transport and bicycling."

Table 6 summarizes roadway improvement emission impacts, including effects on emission rates per vehicle mile, increases in total vehicle mileage, and emissions from road construction and maintenance activities.

Table 6 **Roadway Expansion Greenhouse Gas Emission Impacts** (TØI 2009)

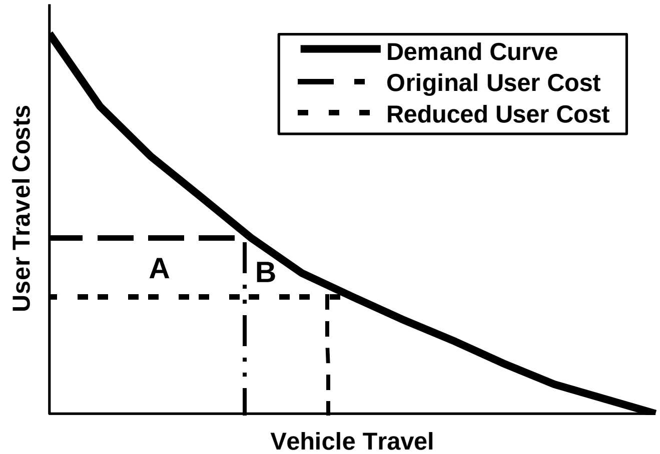
	General Estimates	Large Cities	Small Cities	Intercity Travel
Emission reductions per vehicle-kilometer due to improved and expanded roads.		Short term reductions. Stable or some increase over the long-term.	Depends on situation, ranging from no change to large increases.	Depends on situation. Emissions may decline or increase.
Increased vehicle mileage (induced vehicle travel), short term (under five years)	A 10% reduction in travel time increases traffic 3-5%	Significant emission growth	Moderate emission growth	Moderate emission growth
Increased vehicle mileage (induced travel), long term (more than five years)	A 10% reduction in travel time increases traffic 5-10%	Significant emission growth	Moderate emission growth	Moderate emission growth
Road construction and improvement activity	12 tonnes of CO_2 equivalent for 2-lane roads and 21 tonnes for 4-lane roads.	Road construction emissions are relatively modest compared with traffic emissions.		
Roadway operation and maintenance activity	33 tonnes of CO_2 equivalent for 2-lane roads and 52 tonnes for 4-lane roads.	Road operation and maintenance emissions are relatively modest compared with traffic emissions.		

This table summarizes roadway improvement emission impacts according to research by the Norwegian Centre for Transport Research.

Calculating Consumer Benefits

Generated traffic represents increased mobility, which provides consumer benefits. However, these benefits tend to be modest because generated traffic consists of marginal value trips, the trips that people are most willing to forego (Small 1998). To calculate these benefits economists use the *Rule of Half*, which states that the benefits of additional travel are worth half the per-trip saving to existing travelers, as illustrated in Figure 4 by the fact that B is a triangle rather than a rectangle (AASHTO 1977; Litman 2001a).

Figure 4 **Vehicle Travel Demand Curve Illustrating the Rule-of-Half**



Reduced user costs (downward shift on Y axis) increases vehicle travel (rightward shift on X axis). Rectangle A shows savings to existing trips. Triangle B shows generated travel benefits.

Because induced travel provides relatively small user benefits, and imposes external costs such as downstream congestion, parking costs, accident risk imposed on other road users, pollution emissions, sprawl and other environmental costs, the ratio of benefits to costs, and therefore total net benefits of travel, tend to decline as more travel is induced.

Failing to account for the full impacts of generated and induced travel tends to exaggerate the benefits of highway capacity expansion and undervalue alternatives such as transit improvements and pricing reforms (Romilly 2004). Some newer project evaluation models, such as the FHWA's SMITE and STEAM sketch plan programs, incorporate generated traffic effects including the Rule of Half and some externalities (FHWA 1997; FHWA 1998; DeCorla-Souza and Cohen 1998).

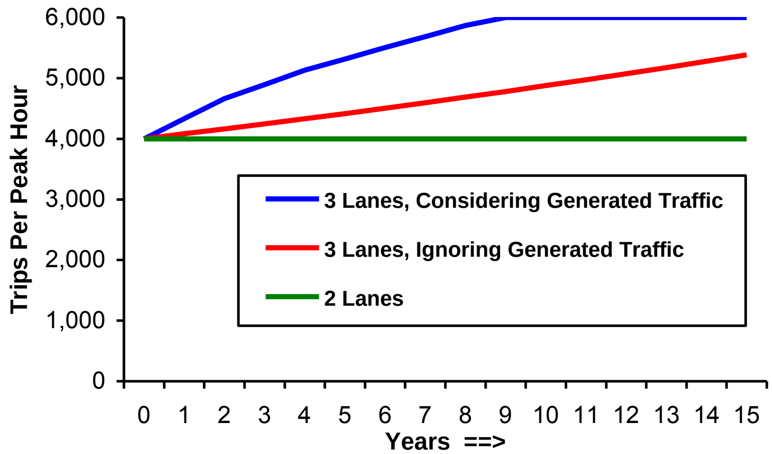
The benefits of increased mobility are often capitalized into land values. For example, a highway improvement can increase urban periphery real estate prices, or a highway offramp can increase nearby commercial land values (Moore and Thorsnes 1994). Because this increase in land values is an economic transfer (land sellers gain at the expense of land buyers), it is inappropriate to add increased real estate values and transport benefits, such as travel time savings (which represent true resource savings). This would double count benefits.

Example

A four-lane, 10-kilometer highway connects a city with nearby suburbs. The highway is congested 1,000 hours per year in each direction. Regional travel demand is predicated to grow at 2% per year. A proposal is made to expand the highway to six lanes, costing $25 million in capital expenses and adding $1 million in annual highway operating expenses.

Figure 5 illustrates predicted traffic volumes. Without the project peak-hour traffic is limited to 4,000 vehicles in each direction, the maximum capacity of the two-lane highway. If generated traffic is ignored the model predicts that traffic volumes will grow at a steady 2% per year if the project is implemented. If generated traffic is considered the model predicts faster growth, including the basic 2% growth plus additional growth due to generated traffic, until volumes levels off at 6,000 vehicles per hour, the maximum capacity of three lanes.

Figure 5 **Projected Traffic**

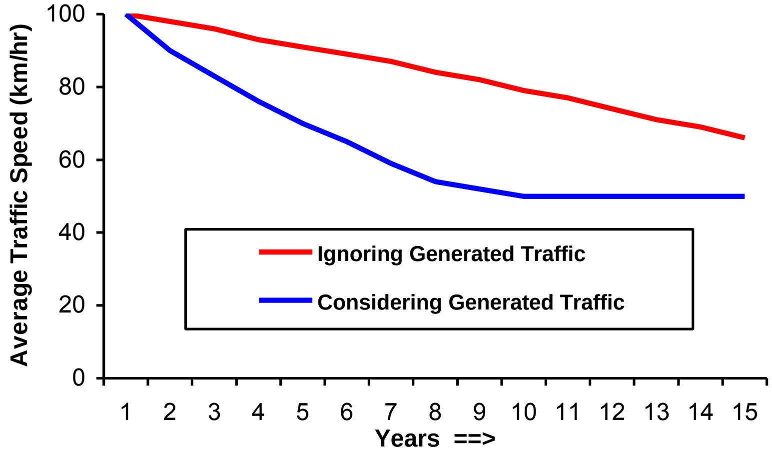


If generated traffic is ignored the model predicts that traffic volumes will grow at a steady 2% per year if the project is implemented. If generated traffic is considered the model predicts a higher initial growth rate, which eventually declines when the road once again reaches capacity and becomes congested. (Based on the "Moderate Latent Demand" curve from Figure 3)

The model divides generated traffic into diverted trips (changes in trip time, route and mode) and induced travel (increased trips and trip length), using the assumption that the first year's generated traffic represents diverted trips and later generated traffic represents induced travel. This simplification appears reasonable since diverted trips tend to occur in the short-term, while induced travel is associated with longer-term changes in consumer behavior and land use patterns.

Roadway volume to capacity ratios are used to calculate peak-period traffic speeds, which are then used to calculate travel time and vehicle operating cost savings. Congestion reduction benefits are predicted to be significantly greater if generated traffic is ignored, as illustrated in Figure 6.

Figure 6 **Projected Average Traffic Speeds**



Ignoring generated traffic exaggerates future traffic speeds and congestion reduction benefits.

Incremental external costs are assumed to average 10¢ per vehicle-km for diverted trips (shifts in time, route and mode) and 30¢ per vehicle-km for induced travel (longer and increased trips). User benefits of generated traffic are calculated using the Rule-of-Half.

Three cases where considered for sensitivity analysis. *Most Favorable* uses assumptions most favorable to the project, *Medium* uses values considered most likely, and *Least Favorable* uses values least favorable to the project. Table 7 summarizes the analysis.

Table 7 **Analysis of Three Cases**

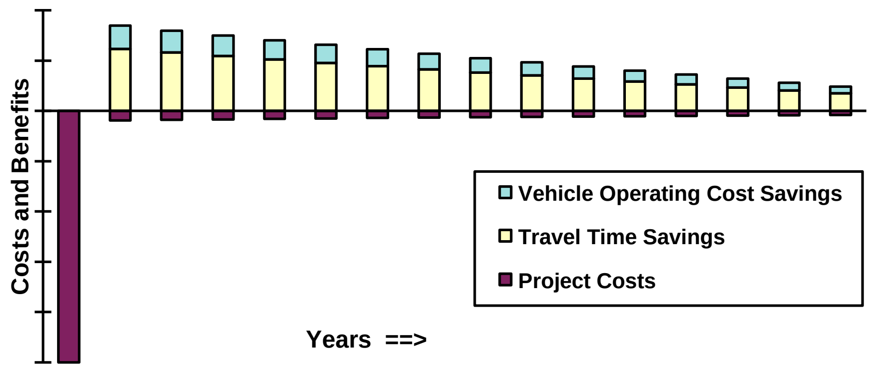
Data Input	Most Favorable	Medium	Least Favorable
Generated Traffic Growth Rate (from Figure 3)	L	M	H
Discount Rate	6%	6%	6%
Maximum Peak Vehicles Per Lane	2,200	2,000	1,800
Before Average Traffic Speed (km/hr)	40	50	60
After Average Traffic Speed (km/hr)	110	100	90
Value of Peak-Period Travel Time (per veh-hr)	$12.00	$8.00	$6.00
Vehicle Operating Costs (per km)	$0.15	$0.12	$0.10
Annual Lane Hours at Capacity Each Direction	1,200	1,000	800
Diverted Trip External Costs (per km)	$0.00	$0.10	$0.15
Induced Travel External Costs (per km)	$0.20	$0.30	$0.50
Net Present Value (millions)			
NPV Without Consideration of Generated Traffic	*$204.8*	*$45.2*	*-$9.8*
NPV With Consideration of Generated Traffic	*$124.5*	*-$32.1*	*-$95.7*
Difference	*-$80.3*	*-$77.3*	*-$85.8*
Benefit/Cost Ratio			
Without Generated Traffic	*6.90*	*2.30*	*0.72*
With Generated Traffic	*3.37*	*0.59*	*0.11*

This table summarizes the assumptions used in this analysis.

The most favorable assumptions result in a positive B/C even when generated traffic is considered. The medium assumptions result in a positive B/C if generated traffic is ignored but a negative NPV if generated traffic is considered. The least favorable assumptions result in a negative B/C even when generated traffic is ignored. In each case, considering generated traffic has significant impacts on the results.

Figure 7 illustrates project benefits and costs based on "Medium" assumptions, ignoring generated traffic. This results in a positive NPV of $45.2 million, implying that the project is economically worthwhile.

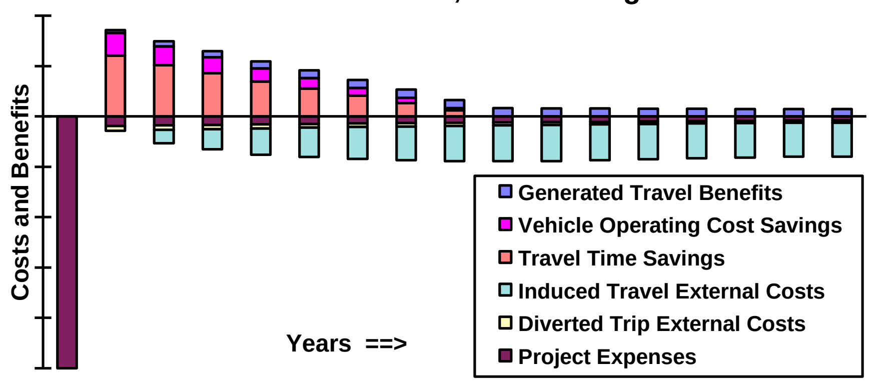
Figure 7 **Estimated Costs and Benefits, Ignoring Generated Traffic**



This figure illustrates annual benefits and costs when generated traffic is ignored, using "Medium" assumptions. Benefits are bars above the baseline, costs are bars below the baseline. Project expenses are the only cost category.

Figure 8 illustrates project evaluation when generated traffic is considered. Congestion reduction benefits decline, and additional external costs and consumer benefits are included. The NPV is –$32.1 million, indicating the project is not worthwhile.

Figure 8 **Estimated Costs and Benefits, Considering Generated Traffic**

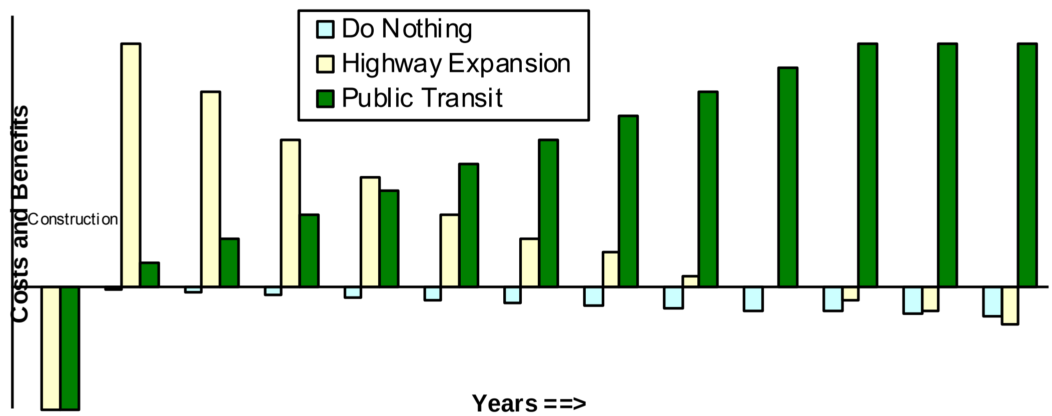


This figure illustrates benefits and costs when generated traffic is considered, using medium assumptions. Benefits are bars above the baseline, costs are bars below the baseline. It includes consumer benefits and external costs associated with generated traffic. Travel time and vehicle operating cost savings end after about 10 years, when traffic volumes per lane return to pre-project levels, resulting in no congestion reduction benefits after that time.

This analysis indicates how generated traffic can have significant impacts on project assessment. Ignoring generated traffic exaggerates the benefits of highway capacity expansion by overestimating congestion reduction benefits and ignoring incremental external costs from generated traffic. This tends to undervalue alternatives such as road pricing, TDM programs, other modes, and "do nothing" options.

For example, Figure 9 compares three possible responses to congestion on a corridor with increasing traffic demand. Do nothing causes traffic congestion costs to increase over time. Expanding general traffic lanes imposes large initial costs due to construction delays, but provides large short-term congestion reduction benefits. However, these decline over time, due to induced traffic, and the additional vehicle travel imposes additional external costs including downstream congestion, increased parking demand, accident risk and pollution emissions. Building grade-separated public transit (either a bus lane or rail line) also imposes short-run congestion delays, and the congestion reduction benefits are relatively small in the short term but increase over time as transit ridership grows, networks expand, and development becomes more transit-oriented.

Figure 9 **Road Widening Versus Transit Congestion Impacts**



A Do Nothing causes congestion costs to increase in the future. Highway expansion imposes short term construction delays, then large congestion reduction benefits, but these decline over time due to generated traffic. Grade-separated public transit provides smaller benefits in the short-term but these increase over time as public transit ridership grows.

Counter Arguments

"Widening roads to ease congestion is like trying to cure obesity by loosening your belt" Roy Kienitz, executive director of the Surface Transportation Policy Project

"Increasing highway capacity is equivalent to giving bigger shoes to growing children" Robert Dunphy of the Urban Land Institute

Some highway expansion advocates argue that generated traffic has minor implications for transport planning decisions. They argue that increased highway capacity contributes little to overall growth in vehicle travel compared with other factors such as increased population, employment and income (Heanue 1998; Sen 1998; Burt and Hoover 2006), that although new highways generate traffic, they still provide net economic benefits (ULI 1989), and that increasing roadway capacity does reduce congestion (TRIP 1999; Bayliss 2008).

These arguments ignore critical issues, and are often based on outdated data and inaccurate analysis. Overall travel trends indicate little about the cost effectiveness of particular policies and projects. For example, studies which indicate that, in the past, increased lane-miles caused minimal growth in vehicle travel (Burt and Hoover 2006), provide little guidance for future planning, since, in the past, much of the added highway lane-miles occurred on uncongested rural highways while most future highway expansion occurs on congested urban highways. Strategies that encourage more efficient use of existing capacity, such as commute trip reduction programs and road pricing, may provide greater social benefits, particularly considering all costs (Goodwin 1997).

Highway expansion advocates generally ignore or severely understate generated traffic and induced travel impacts. For example, Cox and Pisarski (2004) use a model that accounts for diverted traffic (trips shifted in time or route) but ignores shifts in mode, destination and trip frequency. Hartgen and Fields (2006) assume that generated traffic would fill just 15% of added roadway capacity, based on generated traffic rates during the 1960s and 1970s, which is unrealistically low when extremely congested roads are expanded. They ignore the incremental costs that result from induced vehicle travel, such as increased downstream traffic congestion, road and parking costs, accidents and pollution emissions. They claim that roadway capacity expansion reduces fuel consumption, pollution emissions and accidents, because they measure impacts per vehicle-mile and ignore increased vehicle miles. As a result they significantly exaggerate roadway expansion benefits and understate total costs.

Debates over generated traffic and its implications often reflect ideological perspectives concerning whether automobile travel (and therefore road capacity expansion) is "good" or "bad". To an economist, such arguments are silly. Some automobile travel provides large net benefits (high user value, poor alternatives, low external costs), and some provides negative net benefits (low user value, good alternatives, and large external costs). The efficient solution to congestion is to use pricing or other incentives to test consumers' willingness to pay for road space and capacity expansion.

If consumers only demand roadway improvements when they are shielded from the true costs, such projects are likely to be economically inefficient. Only if users are willing to pay the full incremental costs their vehicle use imposes can society be sure that increased road capacity and the additional vehicle travel that results provides net benefits. Travel demand predictions based on underpriced roads overestimate the economically optimal level of roadway investments and capacity expansion. Increasing capacity in such cases is more equivalent to loosening a belt than giving a growing child larger shoes (see quotes above), since the additional vehicle travel is a luxury and economically inefficient.

Some highway advocates suggest there are equity reasons to subsidize roadway capacity expansion, to allow lower-income households access to more desirable locations, but most benefits from increased roadway capacity are captured by middle- and upper-income households (Deakin, et al. 1996). Improving travel choices for non-drivers tends to have greater equity benefits than subsidizing additional highway capacity since physically and economically disadvantaged people often rely on alternative modes.

Although highway projects are often justified for the sake of economic development, highway capacity expansion now provides little net economic benefit (Boarnet 1997). An expert review concluded, “The available evidence does not support arguments that new transport investment in general has a major impact on economic growth in a country with an already well-developed infrastructure” (SACTRA 1997). Melo, Graham and Canavan (2012) found a positive relationship between U.S. urban highway expansion and economic output between 1982 and 2009, but conclude that other types of transportation system improvements could provide greater net benefits.

Alternative Transport Improvement Strategies

Since roadway capacity expansion provides smaller net benefits than is often recognized, due to the effects of generated traffic, other solutions to transportation problems may provide relatively more benefits. A "No Build" option may become more attractive since peak-period traffic volumes will simply level off without additional capacity. This can explain, for example, why urban commute travel times are virtually unchanged despite increases in traffic congestion, and why urban regions that have made major investments in highway capacity expansion have not experienced significant reductions in traffic congestion (Gordon and Richardson 1994; STPP 1998).

Consideration of generated traffic gives more value to transportation systems management and transportation demand management strategies that result in more efficient use of existing roadway capacity. These strategies cannot individually solve all transportation problems, but a package of them can, often with less costs and greater overall benefit than highway capacity expansion. Below are examples (VTPI 2001):

- Congestion pricing can provide travelers with an incentive to reduce their peak period trips and use travel alternatives, such as ridesharing and non-motorized transport.

- Commute trip reduction programs can provide a framework for encouraging commuters to drive less and rely more on travel alternatives.

- Land use management can increase access by bringing closer common destinations.

- Pedestrian and cycle improvements can increase mobility and access, and support other modes such as public transit (since transit users also depend on walking and cycling).

- Public transit service that offers door-to-door travel times and user costs that are competitive with driving can attract travelers from a parallel highway, limiting the magnitude of traffic congestion on that corridor.

Legal Issues

Environmental groups successfully sued the Illinois transportation agencies for failing to consider land use impacts and generated traffic in the Environmental Impact Statement (EIS) for I-355, a proposed highway extension outside the city of Chicago (Sierra Club 1997). The federal court concluded that the EIS was based on the "implausible" assumption that population in the rural areas would grow by the same amount with and without the tollroad, even though project was promoted as a way to stimulate growth. The court concluded that this circular reasoning afflicted the document's core findings. The judge required the agencies to prepare studies identifying the amount of development the tollroad would cause, and compare this with alternatives. The Court's order states:

> Plaintiffs' argument is persuasive. Highways create demand for travel and expansion by their very existence…Environmental laws are not arbitrary hoops through which government agencies must jump. The environmental regulations at issue in this case are designed to ensure that the public and government agencies are well informed about the environmental consequences of proposed actions. The environmental impact statements in this case fail in several significant respects to serve this purpose. (ELCP)

In 2008 the California Attorney General recognized that regional transportation plans must consider induced travel impacts when evaluating the climate change impacts of individual projects to meet California Environmental Quality Act (CEQA) requirements (Brown 2008). CEQA requires that "[e]ach public agency shall mitigate or avoid the significant effects on the environment of projects that it carries out or approves whenever it is feasible to do so." The state Attorney General recognizes that transportation planning decisions, such as highway expansion projects, can have significant emission impacts due to induced vehicle travel.

Conclusions

Urban traffic congestion tends to maintain equilibrium. Congestion reaches a point at which it discourages additional peak-period trips. Increasing road capacity allows more vehicle travel to occur. In the short term this consists primarily of generated traffic: vehicle travel diverted from other times, modes, routes and destinations. Over the long run an increasing portion consists of induced vehicle travel, resulting in a total increase in regional VMT. This has several implications for transport planning:

- Ignoring generated traffic underestimates the magnitude of future traffic congestion problems, overestimates the congestion reduction benefits of increasing roadway capacity, and underestimates the benefits of alternative solutions to transportation problems.
- Induced travel increases many external costs. Over the long term it helps create more automobile dependent transportation systems and land use patterns.
- The mobility benefits of generated traffic are relatively small since they consist of marginal value trips. Much of the benefits are often capitalized into land values.

Ignoring generated traffic results in self-fulfilling *predict and provide* planning: Planners extrapolate traffic growth rates to predict that congestion will reach *gridlock* unless capacity expands. Adding capacity generates traffic, which leads to renewed congestion with higher traffic volumes, and more automobile oriented transport and land use patterns. This cycle continues until road capacity expansion costs become unacceptable.

The amount of traffic generated depends on specific conditions. Expanding highly congested roads with considerable latent demand tends to generate significant amounts of traffic, providing only temporary congestion reductions.

Generated traffic does not mean that roadway expansion provides no benefits and should never be implemented. However, ignoring generated traffic results in inaccurate forecasts of impacts and benefits. Road projects considered cost effective by conventional analysis may actually provide little long-term benefit to motorists and make society overall worse off due to generated traffic. Other strategies may be better overall. Another implication is that highway capacity expansion projects should incorporate strategies to avoid increasing external costs, such as more stringent vehicle emission regulations to avoid increasing pollution and land use regulations to limit sprawl.

Framing the Congestion Question
If you ask people, *"Do you think that traffic congestion is a serious problem?"* they frequently answer yes. If you ask, *"Would you rather solve congestion problems by improving roads or by using alternatives such as congestion tolls and other TDM strategies?"* a smaller majority would probably choose the road improvement option. This is how transport choices are generally framed.

But if you present the choices more realistically by asking, *"Would you rather spend a lot of money to increase road capacity to achieve moderate and temporary congestion reductions and bear higher future costs from increased motor vehicle traffic, or implement other types of transportation improvements?"* the preference for road building might disappear.

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COUNTYWIDE TRAFFIC FEE PROGRAM SCHEDULE

July 2016

ITE 8th Edition

Department of Public Works and Facilities
Transportation Division

www.placer.ca.gov/departments/works/trafficfee

PLACER COUNTY
Countywide Traffic Fee Program

BACKGROUND/PURPOSE

In April 1996, the Placer County Board of Supervisors adopted the Countywide Traffic Fee Program, requiring new development within the County to pay traffic impact fees. The fees collected through this program, in addition to other funding sources, allow the County to construct transportation facilities needed as a result of new development.

COUNTYWIDE BENEFIT DISTRICTS

For purposes of assessing and collecting fees, the unincorporated portions of Placer County are divided into eleven (11) benefit districts. Exhibit A depicts the general limits of each benefit district boundary.

Traffic mitigation fees for the same land use types are determined uniformly throughout a benefit district. For example, a single-family residential home is charged the same fee regardless of where it is within a benefit district. Traffic mitigation fees for the same type of land use within separate benefit districts do not result in the payment of the same fee. For example, a residential home in one benefit district is not charged the same fees as a residential home in another benefit district.

CAPITAL IMPROVEMENT PROGRAMS

The fees collected through the Traffic Fee Program are used, in addition to other funds, to construct roadway improvements within the benefit districts.

Separate Capital Improvement Programs have been developed within each of the eleven benefit districts of the County. Each Capital Improvement Program identifies a list of transportation projects that are needed to serve future development. Funding sources are also identified for each roadway improvement, including the amounts to be collected through the Traffic Impact Fee Program.

A complete listing of the various capital improvement programs is contained in a separate document (Placer County Capital Improvement Programs) available from the Placer County Public Works and Facilities Department - *Transportation Division*.

Dwelling Unit Equivalence (DUE)

Within each benefit district, a fee is assessed to new development based on its Dwelling Unit Equivalent (DUE). DUE is a term used to compare the trip-making characteristics of various land uses to that of a single-family residential dwelling unit. The DUE factor for a particular land use category accounts for the number of trips made within the p.m. peak hour, average trip length, and percentage of trips that are new to the roadway system as a result of the subject land use.

DUEs are expressed in terms of units of development. For example, residential land uses are typically stated in terms of DUEs per dwelling unit. Non-residential uses are typically expressed in terms of DUEs per 1,000 square feet of building construction.

Exhibit B identifies the DUE per unit of development for typical residential and non-residential land use categories. Exhibit B is merely a guide for standard types of land use categories. DPW Engineers will determine the appropriate land use category and corresponding trip generation rate upon review of a proposed development. Staff may rely on additional published trip generation rates and standards, which may not be contained in this handout when determining the appropriate DUE factor. It is often the case that a particular proposed use does not fit neatly into these categories. In these cases, staff will determine the appropriate DUE factor, in conjunction with published trip generation standards and information supplied by the applicant.

Exhibit C identifies the fee per DUE charged within each benefit district.

Fee Calculation

The traffic mitigation fees for a project are determined as follows:

1) Determine the Benefit District the project is within (Exhibit A)

2) Determine the appropriate DUE per unit (Exhibit B)

3) Identify the fee per DUE within the benefit district (Exhibit C)

4) Determine the number of units of the project (dwelling units, 1,000 s.f.)

Fee Payment

Fees are collected prior to issuance of building permits.

Updates/Adjustments

These fees are subject to annual adjustments every July based on the Construction Cost Index as published in the Engineering News Record. Periodic updates may also occur as conditions change to account for new approvals to major land use projects as well as roadway improvements that have been completed.

OTHER FEE PROGRAMS

In addition to the above-described Countywide Traffic Fee Program, the County also participates in four other traffic fee programs. These fee programs were developed for the purpose of funding transportation improvements that benefit multiple jurisdictions within Placer County. They are:

1. **SPRTA: South Placer Regional Transportation Authority (a joint powers authority)**
   Jurisdictions: Placer County, City of Roseville, City of Rocklin, and the City of Lincoln

   The SPRTA Capital Improvement Program focuses on regional transportation needs for long-term projected growth within Placer County and associated traffic effects that cross over jurisdictional boundaries. The SPRTA Fee Program and CIP are governed by a Board of elected officials representing each jurisdiction.

2. **"Bizz Johnson" Highway Interchange Joint Powers Authority – (aka: Hwy 65 JPA)**
   Jurisdictions: Placer County, City of Roseville, and the City of Rocklin

   The Hwy 65 JPA Fee Program was created to fund interchange improvements along Hwy 65 in the area of Rocklin, Roseville and unincorporated Placer County with the projected growth in traffic. The Hwy 65 JPA is governed by a Board made up of elected officials from the above jurisdictions.

3. **Placer County/City of Roseville Joint Fee Program**
   Jurisdictions: Placer County and the City of Roseville

   The Placer County/City of Roseville (PC/CR) Fee Program was developed as a result of a cross-jurisdictional impact of traffic between Placer County and the City of Roseville in the area of Baseline Road, Fiddyment Road and Walerga Road. The Capital Improvement Program associated with this Fee Program includes only the capital improvements that require agency cooperation and joint funding.

4. **Tier 2**
   Jurisdictions: Placer County, City of Roseville, City of Rocklin, and City of Lincoln

   The Tier 2 Fee Program applies to development within the following SPRTA fee districts only: Placer

Vineyards, Curry Creek, Roseville MOU, Regional University, Placer Ranch and Lincoln Villages. This program has been developed to accommodate future roadway capacity requirements as a result of the above projected growth in Southern Placer County. A Capital Improvements Program (CIP), which outlines the improvements to be constructed under the program, is currently being developed and is projected to take effect prior to construction of the above listed development.

Exhibit A attached identifies the Countywide Fee districts as well as the SPRTA and PC/CR funding district areas. The Hwy 65 JPA district boundary map can be obtained by contacting the City of Roseville.

Fee calculation method and DUE rates (Exhibit B), as outlined above, are consistent among the fee programs. A complete listing of these various Capital Improvement Programs is contained in a separate document (Placer County Capital Improvement Programs) and can be obtained from Placer County Department of Public Works - Transportation Division and/or corresponding jurisdiction.

Contact: Amber Conboy (530) 745-7512

This information is available on-line at:
www.placer.ca.gov/departments/works/trafficfee

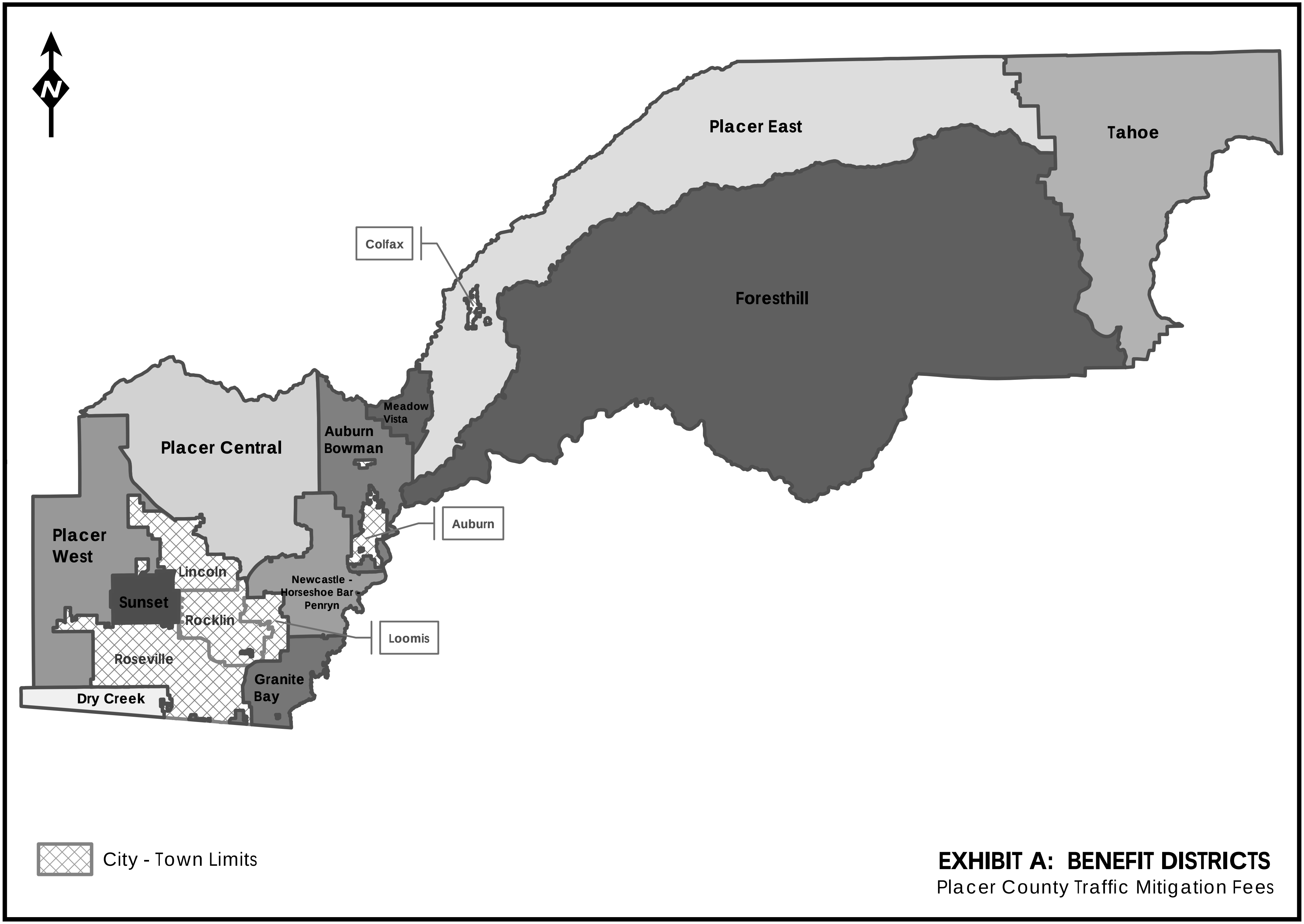


EXHIBIT A: BENEFIT DISTRICTS
Placer County Traffic Mitigation Fees

July 2016

EXHIBIT B: **DUE (Dwelling Unit Equivalent) and Fee Calculations**

Countywide Fee Program and SPRTA, County/City of Roseville, Hwy 65 JPA Programs

FEE = $/DUE (*From Ex. C*) x DUE Per Unit (*From Ex. B*) x No. of Units (*From Project*)

ITE Code	LAND USE CATEGORY	UNIT	PM PEAK RATE/unit [1]	TRIP LENGTH (MILES)	% NEW TRIPS	VMT PER UNIT	DUE PER UNIT
210	SINGLE FAMILY	Dwelling Unit	1.01	5.0	100%	5.05	1.000
220	SECOND RESIDENTIAL UNIT [4]	Dwelling Unit	0.62	5.0	100%	3.10	0.614
	DUPLEX	Dwelling Unit	0.84	5.0	100%	4.20	0.832
220	MULTI-FAMILY/APARTMENT	Dwelling Unit	0.62	5.0	100%	3.10	0.614
231	CONDOMINIUM/TOWNHOUSE	Dwelling Unit	0.78	5.0	100%	3.90	0.772
240	MOBILE HOME PARK	Dwelling Unit	0.59	5.0	100%	2.95	0.584
251	Senior Adult Housing - detached	Dwelling Unit	0.27	5.0	100%	1.35	0.267
252	Senior Adult Housing - attached	Dwelling Unit	0.16	5.0	100%	0.80	0.158
253	CONGREGATE CARE FACILITY	Dwelling Unit	0.17	2.8	74%	0.35	0.070
260	Recreational Home	Dwelling Unit	0.26	2.8	75%	0.55	0.108
110	LIGHT INDUSTRIAL	1,000 S.F.	0.97	5.1	92%	4.55	0.901
120	HEAVY INDUSTRIAL	1,000 S.F.	0.19	5.1	92%	0.89	0.177
130	INDUSTRIAL PARK	1,000 S.F.	0.86	5.1	92%	4.04	0.799
140	MANUFACTURING	1,000 S.F.	0.73	5.1	92%	3.43	0.678
150	WAREHOUSE	1,000 S.F.	0.32	5.1	92%	1.50	0.297
151	MINI-STORAGE	1,000 S.F.	0.26	3.1	92%	0.74	0.147
710	Office - Up to 10,000 s.f.	1,000 S.F.	4.27	5.1	92%	20.03	3.967
	Office 10,001 - 50,000 s.f.	1,000 S.F.	4.27	5.1	92%	20.03	3.967
	Office 50,001 - 150,00 s.f.	1,000 S.F.	1.91	5.1	92%	8.96	1.775
	Office 150,001 - 300,000 s.f.	1,000 S.F.	1.47	5.1	92%	6.90	1.366
	Office 300,001 - 500,00 s.f.	1,000 S.F.	1.32	5.1	92%	6.19	1.226
	Office 500,001 - 800,000 s.f.	1,000 S.F.	1.24	5.1	92%	5.82	1.152
	Office > 800,001 s.f.	1,000 S.F.	1.21	5.1	92%	5.68	1.124
770	BUSINESS PARK	1,000 S.F.	1.29	5.1	92%	6.05	1.199
720	MEDICAL/DENTAL OFFICE	1,000 S.F.	3.46	5.1	77%	13.59	2.691
310	Hotel	Room	0.59	6.4	71%	2.68	0.531
311	All Suites Hotel	Room	0.40	6.4	71%	1.82	0.360
312	Business Hotel	Room	0.62	6.4	71%	2.82	0.558
320	Motel	Room	0.47	6.4	59%	1.77	0.351
430	GOLF COURSE	HOLE	2.78	7.1	90%	17.76	3.518
431	MINIATURE GOLF COURSE	HOLE	0.33	7.1	90%	2.11	0.418
435	MULTIPURPOSE REC. FACILITY	Acre	5.77	7.1	90%	36.87	7.301
444	Movie Theater	1000 S.F.	3.80	2.3	85%	7.43	1.471
492	Health/Fitness Club	1000 S.F.	3.52	3.0	75%	7.92	1.568
493	Athletic Club	1000 S.F.	5.96	3.0	75%	13.41	2.655
495	Recreational Community Center	1000 S.F.	1.45	3.0	75%	3.26	0.646
520	Elementary School	1000 S.F.	1.21	4.3	80%	4.16	0.824
530	High School	1000 S.F.	0.97	4.3	90%	3.75	0.743
536	Private School (K-12)	1000 S.F.	1.70	4.3	80%	5.85	1.158
560	Church [2]	1000 S.F.	0.55	3.9	90%	1.93	0.382
565	DAY CARE CENTER (s.f.)	1,000 S.F.	12.46	2.0	74%	18.44	3.652
565	DAY CARE CENTER (students)	Student	0.82	2.0	74%	1.21	0.240
610	Hospital	1,000 S.F.	1.14	6.4	77%	5.62	1.112
620	NURSING/CONVALESCENT HOMES	1,000 S.F.	0.74	2.8	75%	1.55	0.308
630	Clinic	1,000 S.F.	5.18	4.8	92%	22.87	4.530
640	Animal Hospital/Veterinary Clinic	1,000 S.F.	4.72	4.8	92%	20.84	4.127
812	Building Materials & Lumber Yard < 25Ksf	1,000 S.F.	4.49	1.7	36%	2.75	0.544
813	DISCOUNT SUPERSTORE	1,000 S.F.	4.61	3.6	78%	12.94	2.563
814	SPECIALTY RETAIL Center	1,000 S.F.	2.71	3.6	78%	7.61	1.507
815	DISCOUNT STORE - No Grocery	1,000 S.F.	5.00	1.8	57%	5.13	1.016
816	HARDWARE/PAINT STORE	1,000 S.F.	4.84	1.7	36%	2.96	0.587
817	NURSERY	1,000 S.F.	3.80	1.7	36%	2.33	0.461
818	NURSERY - WHOLESALE	Acre	0.45	1.7	36%	0.28	0.055
820	LOCAL SHOPPING CENTER (≤200 Ksf)	1,000 S.F.	6.36	1.8	59%	6.75	1.337
	SHOPPING CENTER (200,001 - 500 Ksf)	1,000 S.F.	4.21	2.3	76%	7.36	1.457
	Shopping Center (500,001 - 1,000,000 S.F.)	1,000 S.F.	3.27	3.0	78%	7.65	1.515
	Shopping Center (>1,000,000 S.F.)	1,000 S.F.	2.88	3.6	78%	8.09	1.601
823	FACTORY OUTLET	1,000 S.F.	2.29	3.6	78%	6.43	1.273
880	Pharmacy/Drugstore w/o Drive-thru	1,000 S.F.	8.42	1.8	47%	7.12	1.411
881	Pharmacy/Drugstore w/ Drive-thru	1,000 S.F.	10.35	1.8	51%	9.50	1.881

ITE Code	LAND USE CATEGORY	UNIT	PM PEAK RATE/unit [1]	TRIP LENGTH (MILES)	% NEW TRIPS	VMT PER UNIT	DUE PER UNIT
931	QUALITY RESTAURANT	1,000 S.F.	7.49	2.5	79%	14.79	2.929
932	HIGH TURNOVER RESTAURANT	1,000 S.F.	11.15	1.9	76%	16.10	3.188
933	FAST FOOD w/o Drive Thru	1,000 S.F.	26.15	1.7	49%	21.78	4.313
934	FAST FOOD w/ Drive Thru	1,000 S.F.	33.84	1.7	49%	28.19	5.582
936	Coffee/Donut Shop w/o Drive Thru	1,000 S.F.	40.75	1.5	22%	13.45	2.663
937	Coffee/Donut Shop w/ Drive Thru	1,000 S.F.	42.93	1.5	22%	14.17	2.805
938	Coffee/Donut Shop w/ Drive Thru & No Seats	1,000 S.F.	75.00	1.5	22%	24.75	4.901
939	Bread/Bagel Shop w/o Drive Thru	1,000 S.F.	28.00	1.5	22%	9.24	1.830
940	Bread/Bagel Shop w/ Drive Thru	1,000 S.F.	19.56	1.5	22%	6.45	1.278
841	AUTO DEALER - NEW	1,000 S.F.	2.59	2.4	76%	4.72	0.935
	AUTO DEALER - USED	1,000 S.F.	1.40	2.4	76%	2.55	0.506
	TRAILER SALES & REPAIR SHOP	1,000 S.F.	0.84	2.4	76%	1.53	0.303
843	Automobile Parts Sales	1,000 S.F.	5.98	3.6	78%	16.79	3.325
848	TIRE STORE	1,000 S.F.	4.15	2.2	80%	7.30	1.446
941	QUICK LUBE VEHICLE SHOP	Stall	5.19	2.2	83%	9.48	1.877
942	AUTOMOBILE CARE CENTER	1,000 S.F.	3.38	2.2	83%	6.17	1.222
944	Gas Station	Fuel Position	13.87	1.9	20%	5.27	1.044
945	Gas Station w/Conv. Market	Fuel Position	13.38	1.9	20%	5.08	1.007
946	Gas Station w/Conv. Mkt./Wash	Fuel Position	13.94	1.9	20%	5.30	1.049
850	SUPERMARKET	1,000 S.F.	10.50	1.7	48%	8.57	1.697
851	CONVENIENCE MARKET - 24 hours	1,000 S.F.	52.41	1.5	22%	17.30	3.425
852	CONVENIENCE MARKET < 24 hours	1,000 S.F.	34.57	1.5	22%	11.41	2.259
853	CONVENIENCE MARKET w/Gas Pumps	1,000 S.F.	59.69	1.5	22%	19.70	3.901
861	DISCOUNT CLUB	1,000 S.F.	4.24	2.3	79%	7.70	1.526
862	Home Improvement Superstore	1,000 S.F.	2.37	1.8	52%	2.22	0.439
863	Electronics Superstore	1,000 S.F.	4.50	1.8	60%	4.86	0.962
864	Toy/Children's Superstore	1,000 S.F.	4.99	1.8	59%	5.30	1.049
890	FURNITURE	1,000 S.F.	0.45	3.6	78%	1.26	0.250
911	WALK-IN-BANK	1,000 S.F.	12.13	1.6	77%	14.94	2.959
912	DRIVE-IN-BANK	1,000 S.F.	25.82	1.6	57%	23.55	4.663

Notes:

[1] ITE Trip Generation Manual, 8th Edition

[2] A church may include a sanctuary/assembly hall, parsonage, and/or meeting rooms

[4] For the purposes of this Ordinance, a secondary dwelling, as defined in Section 17.56.200 of the current Zoning Ordinance, is considered a multi-family residence.

Exhibit C
Traffic Mitigation Fees
Fees per DUE by Benefit District

Benefit District	County Fee per DUE	Hwy. 65 JPA Fee Per DUE	SPRTA Regional Fee Per DUE	PC/CR Fee Per DUE	Total Fee Per DUE
Auburn/Bowman	$4,911	$0	$0	$0	**$4,911**
Dry Creek	$3,094	$0	$624	$756	**$4,474**
Foresthill (Residential)	$4,549	$0	$0	$0	**$4,549**
Foresthill (Non-Residential)	$2,365	$0	$0	$0	**$2,365**
Granite Bay	$6,094	$0	$620	$0	**$6,714**
Meadow Vista	$4,999	$0	$0	$0	**$4,999**
Newcastle/Horseshoe Bar/Penryn	$4,764	$0	$1,524	$0	**$6,288**
Placer Central	$2,051	$0	$1,920	$0	**$3,971**
Placer East	$3,317	$0	$0	$0	**$3,317**
Placer West	$2,540	$0	$1,467	$165	**$4,172**
Sunset	$1,645*	$1,451	$1,280	$246	**SEE BELOW***
Tahoe	$4,846	$0	$0	$0	**$4,846**

Notes:

County fees effective 12/2014

SPRTA fees effective 7/2016

Hwy 65 JPA fees effective 7/2016

Placer County/City of Roseville (PC/CR) Fee Program, updated, effective 12/2014

See Exhibit A for Benefit District Map

See Exhibit B for Dwelling Unit Equivalent (DUE) Factors

* Sunset Countywide Fees only apply to new SF (enclosed and/or outdoor uses); County Fee = $1645/1000sf of new SF. If project only includes existing SF = $0 Countywide Fee
Sunset Fees for other fee programs are calculated per DUE for any change in use and/or new use; Sunset Fees = Hwy 65 Fee (per DUE) + SPRTA Fee (per DUE) + PC/CR Fee (per DUE)

COUNTYWIDE
CAPITAL IMPROVEMENT PROGRAMS

Placer County
Department of Public Works

Transportation Division

Exhibit A, D of Article 15.28, Section 15.28.030 of Chapter 15 of the Placer County Code

December 2014

PLACER COUNTY

Countywide Capital Improvement Program

BACKGROUND/PURPOSE

In April 1996, the Placer County Board of Supervisors adopted the Countywide Traffic Mitigation Fee Program, requiring new development within the County to pay traffic impact fees. The fees collected through this program, in addition to other funding sources, provide the funds for the County to construct transportation facilities identified as needed to serve future development. The improvements identified in the Capital Improvement Programs (CIPs) are listed in this booklet.

For purposes of assessing and collecting traffic mitigation fees, the unincorporated Placer County is divided into benefit districts. Exhibit A depicts the general limits of each benefit district boundary.

CAPITAL IMPROVEMENT PROGRAMS

The Placer County Department of Public Works (DPW) developed a separate CIP within each benefit district in the county. Each CIP identifies roadway improvements needed to serve the future transportation demands on the roadway system.

Only projects that are listed in the various CIPs can be funded in whole or partially with fees collected though the County's traffic fee program. The Placer County Board of Supervisors sets priorities for the construction of the CIP projects within each benefit district.

FUNDING CATEGORIES

Funding sources are identified for each roadway improvement, including the amounts to be collected through the Countywide Traffic Mitigation Fee Program. A brief description of each of the funding categories corresponding to the columns in the CIP listings follows:

Frontage Improvements
Development projects are conditioned to fund and construct improvements for the portion of a public road on which they front. This generally requires the construction of the equivalent of up to one lane and shoulder. Concrete curb, gutter and sidewalk improvements are also required within the urban areas of the County.

Existing Deficiencies
The improvement of existing deficiencies is not the responsibility of new development. Existing deficiencies represent those improvements needed to bring the transportation system up to a minimum acceptable standard.

Other
Where applicable, other sources or local funding have been identified for roadway improvements. Typical sources include past programs with fund balances, contributions or participation from federal, state, city or redevelopment programs.

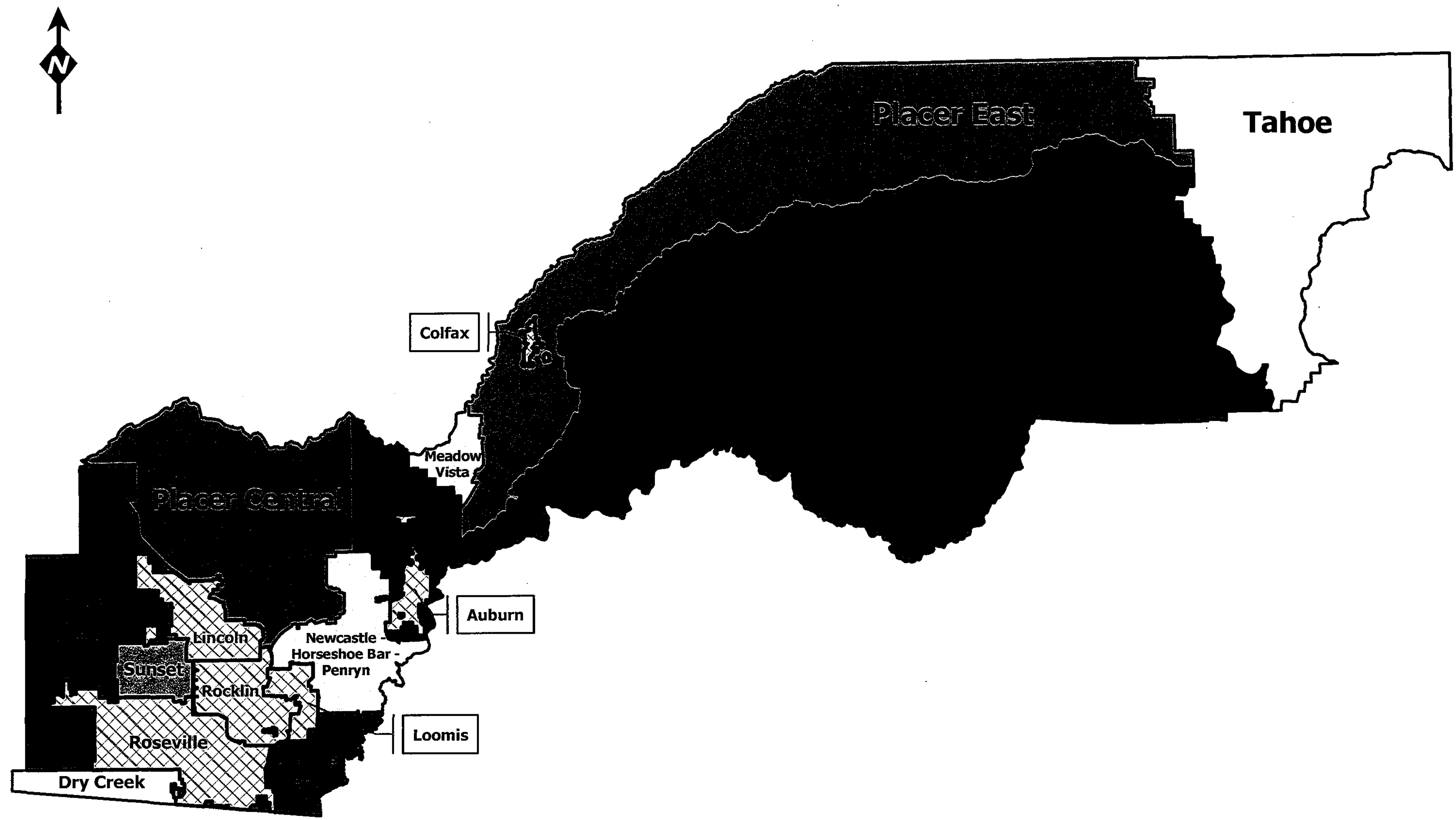
Countywide Traffic Mitigation Fee Program
All new development projects within the unincorporated portions of Pacer County that result in an increase in traffic are subject to the payment of traffic impact fees. These fees are based on the anticipated impact that development will have on the transportation system. Construction of improvements to County-maintained roadways needed to serve future development relies significantly on this funding source.

The "Placer County Traffic Fee Program" is a separate document that explains the traffic mitigation fee program. It is available from the DPW - *Transportation Division.*

Updates/Adjustments
The cost estimates in the CIPs are subject to annual adjustments by the Board of Supervisors effective every July 1st based on the Construction Cost Index as published in the Engineering News Record. They could be updated periodically to account for approvals to major land use projects or with significant update to community plans/specific plans.

Contact:
Amber Conboy (530) 745-7512

This information is available on-line at:
www.placer.ca.gov/departments/works/trafficfee



City - Town Limits

EXHIBIT A: BENEFIT DISTRICTS

Placer County Traffic Mitigation Fees

July 2014

PLACER COUNTY

COUNTYWIDE CAPITAL IMPROVEMENT PROGRAMS

Table of Contents

Auburn/Bowman Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Atwood Road	Richardson Drive to 1st Street	Widen/ CGS infill	$579.4					$579.4
	Richardson to Mt Vernon	Widen and realign	$1,506.6					$1,506.6
	at 1st Street	Signalization/ improvements	$200.0	$100.0				$100.0
Auburn-Folsom Rd.	City of Auburn to Shirland Tract Rd.	Shoulder Widening	$627.8					$627.8
Auburn Ravine Rd.	I-80 overcrossing	Widen to 4 lanes/ construct ramps	$2,952.2				$1,513.1	$1,439.1
	SPRR to Auburn limits	Bikelane	$59.0			$59.0		
Bancroft Rd.	Winchester Connector to Christian Valley Rd.	Shoulder Widening	$88.6					$88.6
Bell Road	Tahoe to Deseret	Shoulder widening	$23.6		$23.6			
	at 1st St./Blue Oaks	Signalization/ improvements	$350.0					$350.0
	I-80 to SR49	Widen to 4 lanes	$500.0					$500.0
	at I-80	Widen to 4 lanes+ Signalization	$2,524.7					$2,524.7
	at New Airport Rd	Widen to 6 lane thru intersection	$2,249.9					$2,249.9
	at Richardson Drive	Signalization/ improvements	$350.0					$350.0
Bowman UC Interchange Imp.	Bowman Rd. to Lincoln Way	Widen to 4 lanes Signalization	$738.1			$73.8		$664.3
Bowman Road	Auburn Ravine to Luther Road	Improve existing 2 lanes	$354.2					$354.2
Christian Valley Road	Misc. Locations	Realign reverse curves	$166.1		$166.1			
Dry Creek Road	State Route 49 to Lake Arthur	Widen and realign	$2,399.1		$1,476.1			$923.0
Education Street	End to Richardson Dr.	Construct 40' Roadway	$667.6	$667.6				
	at Richardson Drive	Signalization/ improvements	$350.0	$350.0				
	SR49 to Professional	Improve existing 2 lanes	$200.8					$200.8
	SR49 to Quartz Dr	Construct 40' Roadway	$3,140.8	$1,570.4				$1,570.4

Auburn/Bowman Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Galena Drive	Quartz Dr. to Education	Construct 2 lanes	$233.3	$73.8		$37.0		$122.5
Indian Hill Road	Auburn-Folsom Road to Newcastle Road	Widen to 4 lanes	$4,924.4			$3,939.8		$984.6
Lincoln Way	at Auburn Ravine Road	Improve Intersection	$221.4					$221.4
	Silver Bend to Sylvan Vista	Widen to 4 lanes	$354.2					$354.2
	Sylvan Vista to Bowman	Improve existing 2 lanes	$507.8	$253.9				$253.9
Luther Road	Bowman Rd. to Carriage Lane	Widen to 4 lanes	$271.6	$135.8				$135.8
	at Bowman Road	Signalization/ improvements	$350.0					$350.0
	at Canal Street	Signalization/ improvements	$350.0					$350.0
	Bowman Rd to State Route 49	Shoulders/ bike lane	$885.7		$295.2			$590.5
	SR 49 to Canal St.	Widen to 4 lanes	$1,565.2	$295.2				$1,270.0
Mt. Vernon Road	Auburn city limit to Joeger Road	Improve two lanes	$1,136.7	$147.6				$989.1
		Shoulder Widening	$751.3					$751.3
New Airport Road	at Bell Rd	Northbound separated left/thru/right	$500.0					$500.0
	at Bell Rd	Southbound separated left/thru/right	$500.0					$500.0
	Bell Rd to Airport	Improve two lanes	$815.0	$203.7	$113.6	$407.4		$90.3
	Bell Rd. to SR 49	Widen/rehabilitate pavement	$844.3	$147.6		$177.1		$519.6
Ophir Road	at Wise Road	Reconstruct intersection	$442.8					$442.8
Parallel Road	Dry Creek to Quartz (east of SR49)	Construct 40' Roadway	$11,142.8	$5,571.4				$5,571.4
Professional Dr/1st Street	1st to Atwood	Construct 40' Roadway	$2,727.2	$1,363.6				$1,363.6
Quartz Drive	extension to Richardson	Construct 2 lanes	$233.3			$37.0		$196.3
	at Education extension	Roundabout/ Signalization	$500.0	$100.0				$400.0
	State Route 49 to Bell Road	Construct 40' Roadway	$6,281.6	$3,140.8				$3,140.8

Auburn/Bowman Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Richardson Drive	Dry Creek to Bell	Construct 40' Roadway	$5,681.6	$4,261.2				$1,420.4
	Atwood to Mt. Vernon	Construct 2 lanes	$1,712.4	$856.2				$856.2
Rock Creek Road	SR 49 to KOA/Quartz Dr. Extension	Improve 2 lanes	$177.6	$88.8				$88.8
Shale Ridge	SR 49 to Parallel Road	Improve existing 2 lanes	$377.9	$147.6				$230.3
Shirland Tract Road	south of Auburn City limits	Improve curve	$19.2		$19.2			
	Auburn City limits to Auburn-Folsom Road	Widen and realign	$311.5		$163.8			$147.7
Willowcreek Road	State Route 49 to Third Street	Construct 4 lanes	$873.8	$392.6		$88.6		$392.7
Safety Improvements	Various Locations	Various	$500.0					$500.0
State Route 49	at Bell Rd	NB right turn/NB acceleration lane	$1,022.7	$100.00				$922.7
	Dry Creek Road to Bell Road	Widen to 6 lanes	$15,624.4	$3,906.10		$1,375.0	$5,000.0	$5,343.3
	Luther Road to Nevada Street	Widen to 6 lanes	$8,976.9	$2,244.2		$1,000.0	$5,000.0	$732.7
	at Hulbert	2nd SB left turn + signal mod.	$1,022.7	$1,022.7				
	SR49 Bypass	ROW and Studies	$5,904.5			$4,404.5		$1,500.0
	Bell, Atwood, New Air-port, Luther, Live Oak, Florence, Dry Creek, Quartz, Willowcreek, Edgewood, Nevada	Intersection imps, Signalization	$2,730.8	$147.6		$295.2	$442.8	$1,845.2
State Route 49	Education St.	Signal Modification	$177.1					$177.1
	Auburn City Limits to El Dorado County	Shoulder Widening/ Improvements	$383.9					$383.9
Auburn/Bowman Fee District Totals:			**$101,064.1**	**$27,288.3**	**$2,257.5**	**$11,894.5**	**$11,955.9**	**$47,667.9**

Dry Creek Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	Highway Bridge Program	County Traffic Impact Fee
16th Street	Sacramento County to Baseline Road	Construct 4 Lanes	$13,318.6	$6,659.3				$6,659.3
Contributions to Sutter County Improvements			$3,084.0					$3,084.0
Cook-Riolo Road	PFE Road to Baseline Road	Traffic Calming/Safety Measures (Includes modification of signal and diverter at Baseline Rd)	$1,840.5					$1,840.5
	at Dry Creek	New Bridge	$9,402.2				$8,323.7	$1,078.5
Dyer Lane	Baseline Road to 16th Street	Construct 4 Lanes	$18,758.5	$9,379.3				$9,379.3
Locust Road	Sac. County Line to 18th Street *	Widen to 4 lanes	$1,353.4	$180.4				$1,172.9
North Antelope Road	Sacramento County to PFE Road	Widen to 4 lanes	$1,594.4	$797.2				$797.2
	at PFE Road	Signalization	$464.0					$464.0
Palladay Road	Sac. County Line to Dyer Lane *	Construct 4 Lanes	$3,867.5	$1,933.8				$1,933.8
PFE Road	North Antelope Road to Roseville City limits	Widen to 4 lanes	$2,277.1	$1,138.6				$1,138.6
	Walerga Road to Cook-Riolo Road	Traffic Calming/Control	$873.8					$873.8
	Watt Avenue to Walerga Road *	Construct 4 Lanes	$11,580.0	$5,790.0				$5,790.0
Sierra Vista Specific Plan Contribution			$4,026.5			$4,026.5		
Vineyard Road	Crowder Lane to Foothills Blvd.	Safety Measures	$514.0					$514.0
Walerga Road	Baseline Road to Sacramento County Line *	Widen to 6 lanes	$12,633.9	$6,317.0				$6,317.0
	at E. Town Center Drive	Signal and Intersection Improvements	$2,583.9	$1,291.9				$1,291.9
	at PFE Road	Signal and Intersection Improvements	$1,912.1	$956.0				$956.0

Dry Creek Benefit District

All Costs in Thousands $

Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Funding Source: Frontage Impr. Funding	Local/Misc Programs: Existing Deficiencies	Local/Misc Programs: Other	Highway Bridge Program	County Traffic Impact Fee
Watt Avenue	Just South of Sac. Cty. Line to Baseline Road *	Construct 6 Lanes	$20,463.6	$6,821.2				$13,642.4
	at Dry Creek	New Bridge (Two Phases)	$13,878.0					$13,878.0
	Baseline Road to University Blvd.**	Construct 4 Lanes	$3,084.0					$3,084.0
	at A Street	Signal and Intersection Improvements	$2,724.2	$1,362.1				$1,362.1
	at Dyer Lane	Signal and Intersection Improvements	$3,158.5	$1,579.3				$1,579.3
	at E. Town Center Drive	Signal and Intersection Improvements	$2,583.9	$1,291.9				$1,291.9
	at Oak St	Signal and Intersection Improvements	$2,214.7	$1,107.4				$1,107.4
	at PFE Road	Signal and Intersection Improvements	$2,214.7	$1,107.4				$1,107.4
West Town Center Drive	Pleasant Grove Road to RR spur	Construct 2 Lanes	$1,250.6					$1,250.6
Dry Creek Fee District Totals:			**$141,656.7**	**$47,712.7**	**$0.0**	**$4,026.5**	**$8,323.7**	**$81,593.8**

* Funding included for right-of-way acquisition

** Regional University Improvements - Not in Boundaries of Dry Creek Community Plan

Foresthill Benefit District			All Costs in Thousands $						
				Funding Source				
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Local/Misc Programs: Existing Deficiencies	Local/Misc Programs: Other	State	County Traffic Impact Fee
Foresthill Road	Bridge to Spring Garden Road	Add 0.2 miles WB Passing Lane	$1,028.0					$1,028.0
Foresthill Road	Spring Garden Road to Todd Valley Road	Add 0.2 miles WB Passing Lane	$1,028.0					$1,028.0
Foresthill Road	Entire Length	Safety Improvements	$514.0					$514.0
Foresthill Road	Auburn Ravine/Lincoln Way	Add EB RTL Add 2nd NB LTL	$3,084.0			$709.3		$2,374.7
Auburn Ravine Road (Fair Share Contribution to AB Fee District)	I-80 Overcrossing	Widen to 4 Lanes	$20,560.0			$18,195.6		$2,364.4
Foresthill Fee District Totals (1):			**$26,214.0**	**$0.0**	**$0.0**	**$18,904.9**	**$0.0**	**$7,309.1**

(1) Foresthill District not annually adjusted for 08-09

Granite Bay Benefit District			All Costs in Thousands $							
				Funding Source						
					Local/Misc Programs					
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Improvements	Existing Deficiencies	Redevelop-ment	Other		State	County Traffic Impact Fee
Auburn-Folsom Road	Sacramento County Line to 500 ft n/o Douglas Blvd (1)	Widen to 4 Lanes w/ Class II Bikeway	24,281.5				18,200.0	(1)		6,081.5
	Douglas Blvd to Joe Rodgers Rd	Class II Bikeway								
	At Cavitt-Stallman Rd	New Signal (3-way approach) realignment at Laird								
	Joe Rodgers Rd to Dick Cook Rd	traffic flow improvements (e.g. left turn pockets)								
Barton Road	Sacramento County Line to Loomis Town Limit	Widen Pavement, Class II Bikeway	1,431.7							1,431.7
	At Douglas Blvd	Additional Turn Lanes on Barton	114.8							114.8
	At East Roseville Pkwy	New Signal (3-way approach)	203.3							203.3
Berg Street	Olive Ranch to Douglas Blvd	Widen Pavement	195.3	44.9						150.4
Cavitt-Stallman Road	Cavitt-Stallman South Rd to Barton Rd	Widen Pavement, Class II Bikeway	931.2	139.6						791.6
	Barton Rd to Auburn-Folsom Rd	Widen Pavement, Class II Bikeway	553.2	105.2						448.0
	at Laird Rd	Realign Intersection, ROW	227.8	24.5						203.3
Dick Cook Road	Val Verdi Rd to Auburn-Folsom Rd	Widen Pavement (Per Com. Plan)	276.6	69.1						207.6
Douglas Boulevard	Cavitt-Stallman South Rd to Sierra College Blvd	Widen to 6 Lanes w/ Class II Bikeway frontage imp. are completed	382.7							382.7
	At Sierra College Blvd (Max. conventional intersection - 6 lanes)	Additional Turn Lanes on Douglas (Dual lefts all approaches)	2,144.6				1,900.0	(6)		244.6
East Roseville Pkwy	At Wellington Way	New Signal (3-way approach)	203.3							203.3
Eureka Road	Sierra College Blvd to Wellington Way	Widen to 4 Lanes[2] w/ Class II Bikeway	956.7	382.7						573.9
	At Barton Rd	Roundabout or New Signal (4-way approach)	203.3							203.3
	At Wellington Way	New Signal (3-way approach)	203.3							203.3
	Wellington Way to Auburn-Folsom Road	Widen Pavement, Class II Bikeway	855.8							855.8
Laird Road	Cavitt-Stallman Rd to Loomis Town Limit	Widen Pavement, Curve Improvement, Class II Bikeway	794.0	63.5						730.5
Laird to Val Verdi Connector	Connector Between Laird Road & Val Verdi Road (4)	Construct New 2 Lane Roadway w/ Shoulders	918.4				815.6	(5)		102.8
Old Auburn Road	Sierra College Blvd to Roseville City Limit	Complete North Side of Roadway	918.4	73.5			813.3	(5)		31.7
Olive Ranch Road	Cavitt-Stallman Rd to Barton Rd	Widen Pavement/Reconstruct	598.7	101.8			188.5	(5)		308.4

Granite Bay Benefit District			All Costs in Thousands $							
				Funding Source						
					Local/Misc Programs					
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Improvements	Existing Deficiencies	Redevelop-ment	Other		State	County Traffic Impact Fee
Sierra College Blvd	Sacramento County Limit to Old Auburn Rd (East Side Only)	Widen to 6 Lanes w/ Class II Bikeway	459.2							459.2
	Old Auburn Rd to Roseville Pkwy (3)	Sidewalk, Curb & Gutter	211.6					(3)		211.6
	Eureka Rd to Cavitt-Stallman Rd (3)	Sidewalk, Curb & Gutter	1,086.0				822.4	(7)		263.6
Val Verde Road	Wells Avenue to Dick Cook Rd (4)	Widen Pavement	253.9				151.1	(5)		102.8
Wells Avenue	Laird Rd to Val Verde Rd	Widen Pavement	84.6							84.6
	Loomis Town Limit to Laird Rd	Widen Pavement	84.6							84.6
Minor Safety and Operation Improvements	Fee District	Minor Improvements required due to increased traffic	102.8							102.8
Granite Bay Fee District Totals (8):			**$38,574.7**	**$1,004.8**			**$22,890.9**		**$0.0**	**$14,781.8**

Footnotes

(1) $8,000,000 funding from SPRTA, $7,700,000 funding from fees collected to date (11/2006)

(2) Broken Down into Single Lane Lengths Since Varying Sections of Roadway Lanes/Widths Currently Exist

(3) SPRTA fee program to fund additional lanes, County/Development to fund sidewalks, curb & gutter, and landscaping costs

(4) Rocklin Road Extension Functional Equivalent

(5) Other Funding Not Identified

(6) City of Roseville funding

(7) CMAQ

(8) Granite Bay District not annually adjusted 08-09

Meadow Vista Benefit District			All Costs in Thousands $						
				Funding Source					
					Local/Misc Programs				
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Bancroft Rd.	Winchester Connector to Plan boundary	Shoulder widening	$20.2		$13.9			$6.3
Combie Road	Placer HIlls Rd. to Lakeview Hills Rd.	Shoulder widening	$227.3		$149.9			$77.3
Lake Arthur Road	Lake Arthur north to Pinewood	Shoulder widening	$77.2		$51.0			$26.2
Meadow Vista Rd.	Placer Hills Road to McElroy Road	Shoulder widening	$233.5		$164.0			$69.5
Placer Hills Rd.	at Meadow Vista Road	Left turn lane and signalization	$201.0					$201.0
	I-80 to 0.25 miles no. of Sugar Pine Road	Widen to 3 lanes	$4,638.8	$4,542.7				$96.1
	.25 miles no. of Sugar Pine to Meadow Vista Rd.	Widen to 3 lanes	$1,484.5					$1,484.5
	Meadow Vista Road to north of Combie Road	Widen to 3 lanes	$2,048.8	$369.5				$1,679.3
	Combie Road to Coyote Mountain Road	Shoulder widening	$383.4		$225.7			$157.7
Old County Rd.	Sugar Pine to Bancroft	Construct 2 lanes	$341.7	$189.0				$152.7
Road adjacent trails	various locations	Minor grading	$289.0	$24.7		$171.6		$92.7
Meadow Vista District Totals:			**$9,945.6**	**$5,125.9**	**$604.5**	**$171.6**	**$0.0**	**$4,043.5**

Newcastle/Horseshoe Bar/Penryn Benefit District			All Costs in Thousands $					
				Funding Source				
				Frontage	Local/Misc Programs			County
Street/ Intersection	**Segment**	**Description of Improvements**	**Est. Total Cost**	**Frontage Impr. Funding**	**Existing Deficiencies**	**Other**	**State**	**County Traffic Impact Fee**
Auburn-Folsom Road	at King Rd	Signalize/ Intersection Improv.	$491.2					$491.2
	at Horseshoe Bar Rd	Signalize/ Intersection Improv.	$331.4					$331.4
Bald Hill Road	Mt. Vernon Rd to Lozanos Rd	Widen/ Reconstruct	$3,068.9		$347.9			$2,721.0
Brennans Road	at Rock Springs Rd	Improve sight distance	$154.7					$154.7
Crater Hill Road	at Chili Hill Rd	Realign Intersection	$147.0		$147.0			
Chili Hill Road	west of Lozanos Rd	Realign horizontal curve	$38.8		$38.8			
Dick Cook Road	Auburn-Folsom Rd to Val Verde Rd	Widen/ reconstruct curves	$2,067.3					$2,067.3
English Colony Road	at Taylor Rd	Signalize	$491.2					$491.2
	Sierra College Blvd to Taylor Rd	Realign/widen for Shoulders/bike lanes	$2,986.0					$2,986.0
Gilardi Road	at I-80	Bridge Modifications	$3,092.7				$3,092.7	
Horseshoe Bar Road	Loomis Town Limits to Placer School Rd	Construct bike lanes/shoulders	$832.4					$832.4
	La Playa Ct to Auburn-Folsom Rd	Construct bike lanes/shoulders	$165.3					$165.3
Horseshoe Bar Road	Auburn-Folsom Rd to Folsom Lake Park	Shoulder widening	$334.7					$334.7
King Road	at Val Verde Rd	Improve sight distance	$193.4		$193.4			
	Loomis Town limits to Auburn-Folsom Rd	Construct bike lanes/shoulders	$1,081.9					$1,081.9
	at I-80	Bridge Modifications	$3,092.6				$3,008.4	$84.2
Lozanos Road	at Auburn Ravine	Replace bridge	$703.6			$616.7		$86.8
	Ophir Rd to Wise Rd	Shoulder Widening	$545.0					$545.0

Newcastle/Horseshoe Bar/Penryn Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	**Segment**	**Description of Improvements**	**Est. Total Cost**	**Frontage Impr. Funding**	**Existing Deficiencies**	**Other**	**State**	**County Traffic Impact Fee**
Newcastle Road	at I-80	Bridge Modifications	$5,412.0				$5,412.0	
	Indian Hill Rd to Rattlesnake Rd	Shoulder Widening	$1,031.8					$1,031.8
Penryn Road	I-80 to King Rd	Realign/widen for shoulders and bike lanes	$1,248.6					$1,248.6
	at Boyington Rd/I-80	Signalize/ Intersection Improv.	$568.4					$568.4
	at Boulder Creek/I-80	Signalize/ Intersection Improv.	$568.4					$568.4
	at King Rd	Signalize/ Intersection Improv.	$397.7					$397.7
	at Taylor Rd	Signalize/ Intersection Improv.	$491.2					$491.2
	at I-80	Bridge Modifications	$3,092.7				$3,092.7	
Rattlesnake Road	Shirland Tract Rd to Park	Repair shoulders and culverts	$568.3		$568.3			
Sierra College Boulevard	at Del Mar	Signalize	$491.2					$491.2
	Rocklin Rd to I-80	Widen to 4 lanes						
	King Rd to English Colony Rd	Widen to 4 lanes						
Taylor Road	Loomis Town limits to Plan boundary	Construct bike lanes/shoulders	$247.4			$247.4		
Wise Road	Ophir Rd to Crater Hill Rd	Shoulder Widening	$590.2					$590.2
State Route 193	Taylor Rd to Gold Hill Rd	Shoulder widening	$1,546.2				$773.1	$773.1
Newcastle/Horseshoe Bar/Penryn District Totals:			**$ 36,072.0**	**$0.0**	**$1,295.3**	**$864.2**	**$15,378.9**	**$18,533.7**

Placer Central Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	**Segment**	**Description of Improvements**	**Est. Total Cost**	**Frontage Impr. Funding**	**Existing Deficiencies**	**Other**	**State**	**County Traffic Impact Fee**
Gladding Road	at Coon Creek	Replace bridge	$1,520.6			$1,216.3		$304.3
Mt. Vernon Road	at Ayres Holmes Rd	Improve sight distance	$123.8		$61.9			$62.0
	at Mt. Pleasant Rd	Reconstruct Intersection	$193.4		$100.4			$92.9
Riosa Road	State Route 65 to Andressen Road	Shoulder widening	$153.0					$153.0
Sierra College Boulevard	English Colony Way to SR 193	Widen to 4 lanes	$1,541.4					$1,541.4
State Route 193	Gold Hill Rd to Sierra College Blvd	Shoulder widening	$782.4				$391.2	$391.1
	Lincoln City limit to Sierra College Blvd	Widen to 4 lanes	$4,638.8			$773.1	$2,319.4	$1,546.3
Placer Central District Totals:			**$8,953.3**	**$0.0**	**$162.3**	**$1,989.4**	**$2,710.6**	**$4,091.0**

Placer East Benefit District			All Costs in Thousands $					
				Funding Source				
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Local/Misc Programs		State	County Traffic Impact Fee
					Existing Deficiencies	Other		
Applegate Road	Clipper Gap Rd to Giesendorfer Rd	Shoulder widening	$233.5					$233.5
Bonnynook Road	Ridge Rd to Baxter Rd	Shoulder widening	$103.6					$103.6
Canyon Way	Weimar Cross Rd to Colfax	Shoulder widening	$170.2					$170.2
Crother Road	at Wooley Creek	Replace Bridge	$541.2			$487.1		$54.1
	at Placer Hills Rd	Repair bridge/ intersection	$541.2			$487.1		$54.1
	Placer Hills Rd to Lake Arthur Rd	Shoulder widening	$77.2					$77.2
Donner Summit Road	I-80 to Donner Summit	Shoulder widening	$92.7					$92.7
Giesendorfer Road	Applegate Rd to Paoli Lane	Shoulder widening	$72.7					$72.7
Gold Run Road	Magra Rd to Lincoln Rd	Shoulder widening	$47.9					$47.9
Hampshire Rocks Road	Cisco Rd to Donner Pass Rd	Shoulder widening	$167.0					$167.0
Lincoln Road	Gold Run Rd to Ridge Rd	Shoulder widening	$98.9					$98.9
Magra Road	Rollins Lake Rd to Gold Run Rd	Shoulder widening	$239.7					$239.7
Paoli Lane	Giesendorfer Rd to Ponderosa Way	Shoulder widening	$26.3					$26.3
Placer Hills Road	Crother Rd to Tokayana Way	Shoulder widening	$312.4					$312.4

Placer East Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Ponderosa Way	Paoli Way to Weimar Cross Rd	Shoulder widening	$30.9					$30.9
Ridge Road	Lincoln Rd to Bonnynook Rd	Shoulder widening	$119.1					$119.1
Rollins Lake Road	State Route 174 to Magra Rd	Shoulder widening	$242.8					$242.8
Tokayana Way	Placer Hills Rd to Church St	Shoulder widening	$92.7					$92.7
Weimar Cross Road	Placer Hills Rd to I-80	Shoulder widening	$86.6					$86.6
State Route 174	Colfax City limit to Rollins Lake Rd	Shoulder widening	$46.4					$46.4
Placer East District Totals:			**$3,343.1**	**$0.0**	**$0.0**	**$974.3**	**$0.0**	**$2,368.8**

Placer West Benefit District			All Costs in Thousands $					
				Funding Source				
					Local/Misc Programs			
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Frontage Impr. Funding	Existing Deficiencies	Other	State	County Traffic Impact Fee
Brewer Road	at Curry Creek	Replace bridge	$541.2			$432.9		$108.3
Fiddyment Road	Moore Rd to City Limit	Shoulder widening	$157.1					$157.1
Moore Road	at Fiddyment Rd	Improve sight distance	$115.9		$21.7			$94.2
Nicolaus Road	at Coon Creek	Replace Bridge	$426.9			$337.9		$88.9
Placer West District Totals:			**$1,241.0**	**$0.0**	**$21.7**	**$770.8**	**$0.0**	**$448.6**

Sunset Benefit District			All Costs in Thousands $							
				Funding Source						
					Local/Misc Programs					
Street/ Intersection	**Segment**	**Description of Improvements**	**Est. Total Cost**	**Frontage Impr. Funding**	**Existing Deficiencies**	**Redevelop-ment[5]**	**Other**		**State**	**County Traffic Impact Fee**
Foothills Blvd.	City/County Line to Athens Ave	Construct 2 lanes	$7,907.2	$1,464.3						$6,442.8
	at Pleasant Grove Creek Athens Ave	Construct Bridge	$1,757.2				$439.3	(1)		$1,317.9
Industrial Ave.	City/County Line to S.R. 65	Shoulder Widening	$805.3	$366.1						$439.3
Sunset Boulevard	S.R. 65 to Cincinnati Ave	Widen to 4 lanes	$1,757.2							$1,757.2
	at UPRR/Industrial Ave	Overcrossing Structure	$11,880.0				$4,685.8	(4)		$7,194.2
	Cincinnati Ave to Foothills Blvd	Construct 2 Lanes	$1,610.7	$1,171.4						$439.3
ITS/Safety	Fee District	ITS and Safety Imp.	$616.8				$308.4	(4)		$308.4
Sunset Fee District Totals:			**$26,334.3**	**$3,001.8**	**$0.0**	**$4,000.0**	**$5,433.5**		**$0.0**	**$13,899.0**

(1) Other: City of Roseville
(2) Other: Highway 65 Joint Powers Authority (JPA)
(3) If the State fully funds the widening of S.R. 65 to 4 lanes, this amount will be redirected to the Sunset Boulevard interchange project.
(4) Other: To be determined
(5) Redevelopment Contribution to Disctrict, not specific projects. Amount deducted from total County TIF. Amount is not to be inflated annually

Tahoe Region Benefit District

All Costs in Thousands $

Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Funding Source: Frontage Impr. Funding	Local/Misc Programs: Existing Deficiencies	Local/Misc Programs: Other		State	County Traffic Impact Fee
Alpine Meadows Road	Various Locations	Traffic Flow Improvements	$616.2						$616.2
National Avenue	Kings Beach	Misc. Shoulder Improvements	$356.8						$356.8
Northstar Drive	Trimont Lane/Intercept Lot to Basque Road	Widening / Intersection Improvements	$3,595.7			$460.1			$3,135.6
North Tahoe	Stateline to Tahoe City	Traffic Flow/Safety Improvements	$892.1						$892.1
Squaw Valley Road	Squaw Valley Rd	Traffic Flow/Safety Improvements	$522.4			$118.0			$404.4
State Route 267	County Line to Brockway Summit	Widen to 4 lanes/intersections improvements	$32,433.7					$13,878.0	$18,555.7
	at Northstar Dr	Intersection Improvements	$514.0			$176.8			$337.2
	at Schaffer Mill/Airport	Intersection Improvements	$514.0			$158.6			$355.4
	SR 267	2 transit vehicles	$785.0						$785.0
	Various Locations	Left Turn/Accel. Lanes	$411.2					$205.6	$205.6
State Route 28	Tahoe City	Traffic Flow Improvements	$1,170.7					$142.7	$1,028.0
	Kings Beach	Bike lanes/Shoulder/CGS	$2,267.4					$926.6	$1,340.7
	Kings Beach	Improve 28/267 Intersection	$1,960.2					$1,603.4	$356.8
	Kings Beach	SR 28/Coon St. Intersection	$356.8					$178.4	$178.4
	Kings Beach	SR 28/Bear Street Intersection	$713.7					$356.8	$356.9
	Tahoe Vista	SR 28/ National Avenue	$921.8					$499.6	$422.2
	Intersection SR 267 and SR 28	ITS	$178.4					$160.6	$17.8

Tahoe Region Benefit District			All Costs in Thousands $						
				Funding Source					
				Frontage	Local/Misc Programs				County
Street/ Intersection	Segment	Description of Improvements	Est. Total Cost	Impr. Funding	Existing Deficiencies	Other		State	Traffic Impact Fee
State Route 89	West River St	Traffic Signal & Hwy. Improvements	$1,392.8		$702.9				$689.9
	SR 28 at Granlibakken Rd	Intersection Improvements	$713.7					$356.8	$356.9
	Truckee River Crossing	Realign/Improve Existing Route	$28,784.0			$26,728.0			$2,056.0
	SR 89 near Fairway Dr	ITS	$178.4					$160.6	$17.8
Tahoe City	Tahoe City	Tahoe City Transit Improvements	$237.8						$237.8
West Shore	Tahoe City to Eldorado County Line	Traffic Flow/Safety Improvements	$892.1						$892.1
N/A	Cabin Creek	CNG Improvements	$416.3						$416.3
N/A	Along Transit Routes	Transit Shelters/Park and Ride facilities	$523.4						$523.4
Tahoe Region District Totals:			**$81,348.3**		**$702.9**	**$27,641.6**		**$18,469.0**	**$34,534.8**

City of Palo Alto
Bicycle + Pedestrian Transportation Plan

Adopted July 2012

PREPARED BY:
Alta Planning + Design

PREPARED FOR:
City of Palo Alto

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The creativity, energy, and commitment of numerous residents and other stakeholders were the driving force behind this planning effort. In addition, the following residents, staff, and other agency and organization members contributed regularly to the *Bicycle + Pedestrian Transportation Plan.*

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List of Acronyms

ABAG	Association of Bay Area Governments
AC Transit	Alameda-Contra Costa Transit District
ADA	Americans with Disabilities Act
BAAQMD	Bay Area Air Quality Management District
BEP	Bicycle Expenditure Plan
BPTP	2012 Palo Alto Bicycle + Pedestrian Transportation Plan ("the Plan")
BRT	Bus Rapid Transit
Caltrans	California Department of Transportation
CBP	Santa Clara Countywide Bicycle Plan
CEQA	California Environmental Quality Act
CIP	Capital Improvement Project
CMAQ	Congestion Mitigation and Air Quality
CPP	2007 Palo Alto Climate Protection Plan
CSTSC	City/School Traffic Safety Committee
CTC	California Transportation Commission
FHWA	Federal Highway Administration
GHG	Greenhouse Gasses
MTC	Metropolitan Transportation Commission
NACTO	National Association of City Transportation Officials
PABAC	Palo Alto Bicycle Advisory Committee
PAMF	Palo Alto Medical Foundation
PAUSD	Palo Alto Unified School District
PTOD	Pedestrian and Transit Oriented Development
SamTrans	San Mateo County Transit
SCVWD	Santa Clara Valley Water District
SWITRS	Statewide Integrated Traffic Records System
TDM	Transportation Demand Management
TLC	Transportation for Livable Communities
VERBS	Vehicle Emissions Reduction Based at Schools
VMT	Vehicle Miles Travelled
VTA	(Santa Clara) Valley Transportation Authority

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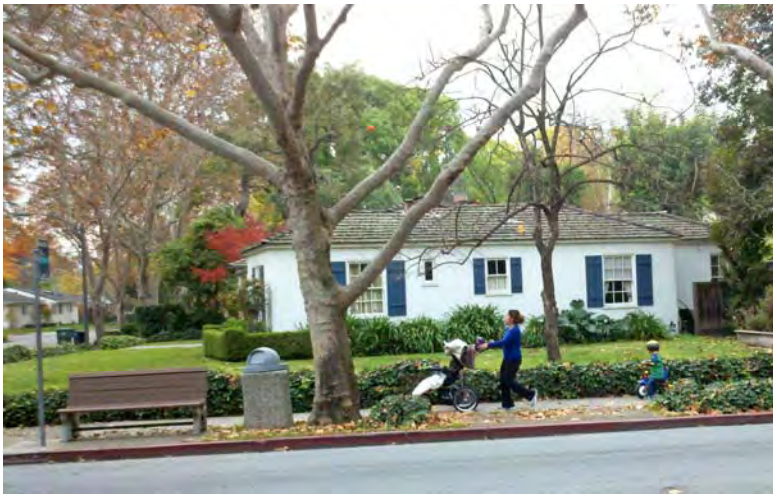
1 Introduction

Palo Alto has been at the forefront of bicycle and pedestrian planning since the early 1980's, when the City developed the nation's first bicycle boulevard on Bryant Street. Combined with a lively and historic downtown, and great connections to Stanford University and regional transit, the city attracts commuters, students, and visitors alike to bicycle or walk at much higher rates than other South Bay Area communities. Palo Alto can build upon this history and demand for bicycling and walking to solidify its status as one of the most bicycle friendly communities in California, if not the country.



Palo Alto has many residents and visitors who walk and bicycle, both recreationally and to access work, shopping, and transit.

This Plan builds upon extensive planning and design efforts already underway by the City of Palo Alto, including the implementation of the *2003 Bicycle Transportation Plan*, Safe Routes to School improvements, and creative land use planning. The Plan was developed through collaboration with the City, the Palo Alto Bicycle Advisory Committee (PABAC), the City/School Traffic Safety Committee (CSTSC), and the community. It strives to address the unmet needs of existing and future Palo Alto bicyclists and pedestrians by identifying a network for all types of bicycle travel and recommending other key improvements – including education and encouragement programs – to make non-polluting travel a viable, everyday option for more people.

1.1 Purpose

The *2012 City of Palo Alto Bicycle + Pedestrian Transportation Plan* (BPTP 2012) strategically guides public and private investments in non-motorized transportation facilities and related programs.[1] The Plan complies with state eligibility requirements for Bicycle Transportation Account (BTA) funds, as well as updates citywide priorities within the Valley Transportation Authority (VTA) Bicycle Expenditure Plan (BEP).

The BPTP 2012 expands the *2003 Bicycle Transportation Plan* to include coverage of pedestrian issues, priorities, and design standards in addition to revising the proposed bikeway network and design guidelines. It will also be adopted as part of the City's revised *Comprehensive Plan Transportation Element*, which is undergoing an update process in 2012. From planning citywide networks to reviewing private development proposals, the BPTP 2012 contains the policy vision, design guidance, and specific recommendations to increase walking and biking rates to ambitious (yet achievable levels) over the next

[1] *For the purposes of this Plan, "non-motorized" transportation includes pedestrians and bicyclists, including those using electric assists, such as e-bikes and motorized wheelchairs.*

decade and beyond – rates that will be instrumental in helping achieve local and regional targets for accommodating new growth, maintaining mobility, and reducing overall environmental impacts.

1.2 Setting

The City of Palo Alto is a community with an estimated 64,500 residents (a 10 percent increase from 2000) located between the open space preserves of the foothills and the tidal flats of San Francisco Bay. With an established grid network of streets, vibrant business districts, a well-known park and trail system, and direct proximity to Stanford University, much of Palo Alto is highly walkable. Flat terrain, tree-lined streets, and a temperate climate also make Palo Alto a relatively easy place to bicycle. Two U.S. Interstate highways, a major rail corridor, and one county expressway divide the city into several distinct communities with unique circulation patterns.

1.3 Benefits of Bicycling and Walking

Bicycling and walking are low-cost and healthy transportation options that provide economic and livability benefits to communities. When residents and visitors bicycle or walk for a trip, it alleviates congestion, minimizes greenhouse gas emissions, and helps extend and improve the quality of people's lives. Below is a brief overview of the benefits of greater investments in walking and bicycling.

The Palo Alto Caltrain station has the rail line's second most daily passenger boardings and bicycle boardings.

1.3.1 Environmental Benefits

Due to emissions from "cold starts" (i.e., when a car hasn't been driven in a few hours and the engine is cool), a one-mile automobile trip emits up to 70 percent as much pollution as a 10-mile excursion. This means that when people decide to bicycle or walk even just for very short trips, they are still significantly reducing their environmental footprint.[2] From reducing local levels of harmful pollutants that cause asthma and other respiratory illnesses to addressing global climate change, higher rates of bicycling and walking provide tangible, significant air quality benefits.

Bicycling and walking also do not pollute water as driving an automobile does. Cars leak oil, petroleum products and other toxins onto road surfaces that eventually make their way to storm drains, creeks, and large bodies of water. This "non-point source" pollution is a major threat to urban aquatic habits, contaminates drinking water, and can cause major illness. Some toxins and metals accumulate in sea life and cause medical problems to people when eaten. Others cause explosive growth of algae, which depletes water of oxygen, killing fish and aquatic life.[3] Every bicycle and walking trip is one less

[2] *Bay Area Air Quality Management District. (2007). Source Inventory of Greenhouse Gas Emissions.*
[3] *City and County of Honolulu Department of Environmental Services*

opportunity for these toxins to enter the environment, which on a large scale can make the difference in the health of local water ways and aquatic systems.

1.3.2 Economic Benefits to Cities

Multiple studies have shown that walkable, bikeable neighborhoods are more livable and attractive, helping increase home values[4] and retain a more talented workforce that result in higher property tax revenues and business competitiveness. Similarly, bike lanes can improve retail business directly by drawing customers and indirectly by supporting the regional economy. Patrons who walk and bike to local stores have been found to spend more money to visit local businesses than patrons who drive.[5]

The League of American Bicyclists reports that bicycling makes up $133 billion of the US economy, funding 1.1 million jobs.[6] The League also estimates bicycle-related trips generate another $47 billion in tourism activity (of which Palo Alto has opportunities to capture an ever increasing share). Many communities have enjoyed a high return on their investment in bicycling. For example, the Outer Banks of North Carolina spent $6.7 million to improve local bicycle facilities, and reaped a reported benefit of $60 million of annual economic activity associated with bicycling.[7]

Walkable, bikeable downtowns attract residents and visitors to spend money at local businesses while reducing household transportation costs when families can own fewer automobiles and reduce their driving trips.

1.3.3 Benefits to Households and Individuals

Walking and biking are not just forms of travel, they are important forms of exercise. Many public health experts associate the rising and widespread incidence of obesity with automobile-dominant development patterns and lifestyles that limit such daily forms of physical activity.[8] This association is perhaps most apparent, and acute, with respect to children and school travel. After decades of declining rates of walking and biking – from roughly half of all non-high school students in 1968 to just 14% in 2009 - obesity among youth has become an epidemic. [9] In California, one in three kids age 9-17 are now at risk of becoming or are already overweight.[10]

For children, the Center for Disease Control and Prevention recommends 60 minutes of daily aerobic exercise. The CDC recommends 75 to 150 minutes of vigorous exercise, in combination with muscle strengthening exercises, for adults on a weekly basis. For many adults and children, walking or biking to work or school is a viable - if not the only – option for achieving these recommended exercise regimens.

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[4] *Cortright, Joe for CEOs for Cities. (2009). Walking the Walk: How Walkability Raises Home Values in U.S. Cities.*

[5] *The Clean Air Partnership. (2009). Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighborhood.*

[6] *Flusche, Darren for the League of American Bicyclists. (2009). The Economic Benefits of Bicycle Infrastructure Investments.*

[7] *N.C. Department of Transportation, Division of Bicycle and Pedestrian Transportation. (No Date). The Economic Impact of Investments in Bicycle Facilities.* atfiles.org/files/pdf/NCbikeinvest.pdf

[8] *October 27, 1999 issue of the JAMA*

[9] *United States Department of Transportation, National Household Travel Survey*

[10] *The California Endowment. (No Date). Fighting California's Childhood Obesity Epidemic.* http://www.calendow.org/article.aspx?id=348

Pedestrian and bicycle infrastructure also provides transportation choices to those who cannot or do not drive, including people with disabilities, youth, seniors, and people with limited incomes. Families that can replace some of their driving trips with walking or bicycling trips spend a lower proportion of their income on transportation,[11] freeing additional income for local goods and services. Pedestrians with mobility, vision, or hearing impairments particularly depend on high-quality, well-maintained infrastructure as a basis for travel, from audible signals and curb ramps that indicate safe crossings to separated bike lanes that discourage bicyclists from riding on the sidewalk. For others who cannot afford to live near employment centers or who work away from transit, bicycling may provide the only affordable and reliable means of commuting.

1.4 Relation to Other Plans

Several key planning efforts directly influenced the development of the *Bicycle + Pedestrian Transportation Plan*. **Appendix E** of this Plan provides a more detailed review of existing plans and policies.

1.4.1 State and Regional Planning Initiatives

At the state level, the passage in 2008 of Assembly Bill 32 and Senate Bill 375 – which together require a statewide reduction of greenhouse gas emissions (GHG) to 1990 levels by 2025, among other mandates – has propelled a number of regional planning initiatives that positively influence the BPTP 2012 and transportation investments in Palo Alto. Within the regional framework established by the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC), new programs and funding sources are being developed that emphasize:

- **"Complete" streets and the routine accommodation of bicyclists and pedestrians in all projects.** The *California Complete Streets Act* (AB 1358) requires all cities and counties, when they update their general plan circulation element, to identify how the city or county will provide for routine accommodation of all roadway users including motorists, pedestrians, bicyclists, people with disabilities, seniors, and users of public transportation – or to design 'complete streets' for all users.
- **Climate action and reduction targets for greenhouse gas (GHG) emissions**. MTC's *Transportation 2035 Plan*, the regional blueprint for transportation investment, includes a new $400 million Climate Action Campaign to reduce the region's carbon footprint and complement established programs such as the Transportation for Livable Communities (TLC) and Regional Bicycle Program. The Climate Action Campaign includes funding for the Safe Routes to School and Safe Routes to Transit programs and an $80 million Climate Initiatives Program that aims to test new strategies to reduce transportation-related emissions and vehicle miles traveled, such as a regional Bike Share Program organized around the Caltrain corridor that will include Palo Alto.
- **The integration of land use and transportation planning to support livable, walkable, transit-oriented communities.** More than ever, the viability of transportation planning is viewed in the context of its ability to shape and serve compact neighborhoods and mixed-use centers that help reduce average trip lengths, promote transit patronage, and encourage more active and healthy lifestyles.

[11] *Center for Neighborhood Technology. (2005). Driven to Spend: Pumping Dollars out of Our Households and Communities.*

While these ideas are not new, their widespread adoption in recent years has brought meaningful progress toward policy goals and targets with "teeth" and improved practices and funding opportunities for non-motorized facility planning and design.

1.4.2 Valley Transportation Plan (VTP 2035/2040)

The *Valley Transportation Plan* (VTP) 2035 is Santa Clara County's long-range planning document that feeds into (and is consistent with) MTC's *Regional Transportation Plan*, and incorporates specific needs identified by the Valley Transportation Authority (VTA) and individual municipalities, including Palo Alto. The VTP 2035 considers all travel modes and addresses the linkages between transportation and land use planning, air quality, and community livability.

The *Santa Clara Countywide Bicycle Plan* (CBP) is an element of the VTP that guides the development of bicycle facilities to serve trips of countywide or intercity significance. The CBP identifies over $330 million in bicycle capital project needs, which include major Cross-County Bicycle Corridors (CCBC's), 24 On-Street Bicycle Routes, 17 Trail Networks, and over 100 Across Barrier Connections (ABC) project concepts. The large-scale projects identified for Palo Alto include the Adobe Creek/Highway 101 Bicycle/Pedestrian Grade Separation project.

The Bicycle Expenditure Plan (BEP) of the VTP 2035 seeks to fund the Tier 1 projects in the *Countywide Bicycle Plan* in the next ten years. The BEP is funded from the 1996 Measure B Sales Tax Bicycle Program, Transportation Development Act Article 3, the Transportation Funds for Clean Air Program, and the Transportation Equity Act for the 21st Century Transportation Enhancement. Palo Alto received $1 million for the Homer Avenue undercrossing project under this program.

1.4.3 City of Palo Alto Comprehensive Plan

The *City of Palo Alto Comprehensive Plan* establishes clear support and priority for investing in non-motorized transportation, improving access to transit, and reducing dependence on single-occupant vehicles to improve the overall efficiency of the transportation system. The existing *Comprehensive Plan*, which is under revision at the time of this planning effort, includes a vision statement and variety of goals that strongly influence and reflect the values of the *Bicycle and Pedestrian Transportation Plan*.

Comprehensive Plan goals include:

- Goal T-1: Less Reliance on Single-Occupant Vehicles
- Goal T-3: Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling
- Goal T-6: A High Level of Safety for Motorists, Pedestrians, and Bicyclists on Palo Alto Streets
- Goal C-5: Equal Access to Educational, Recreational, and Cultural Services for All Residents

To harmonize with the *Comprehensive Plan Transportation Element* revision process, the BPTP 2012 proposes no new goal statements. Instead, this Plan presents a manageable set of objectives, key strategies, and benchmarks to guide plan implementation, along with recommended policies and programs for consideration within the *Comprehensive Plan* update process. More detail on the relationship with the existing and future revised Palo Alto *Comprehensive Plan* is provided in **Appendix E.**

1.4.4 Palo Alto Climate Protection Plan

The *2007 Palo Alto Climate Protection Plan* (CPP) targets a 15 percent reduction in greenhouse gas emissions from 2005 levels by 2020 to comply with state reduction goals. Recognizing that automobile travel comprises 36 percent of total GHG emissions within Palo Alto, the CPP recommends providing a transportation demand management (TDM) coordinator position. Medium-term recommendations are to expand pedestrian-friendly zoning regulations and to complete transit projects on El Camino Real and the Palo Alto Intermodal Transit Center. Unfortunately, the CPP does not make extensive reference to the *2003 Bicycle Transportation Plan* or efforts to accelerate its implementation – despite the fact that 83 percent of auto-related emissions are from discretionary, non-commute trips within Palo Alto (i.e., a significant percentage of these trips could be converted to zero-emission walking or biking trips). The *2012 Bicycle + Pedestrian Transportation Plan* incorporates recommendations and, consistent with the CPP, targets increased funding for bicycle and pedestrian projects and programs.

1.4.5 2003 Bicycle Transportation Plan

The 2003 *Bicycle Transportation Plan* identifies existing bikeways; analyzes bicycle and pedestrian accident data; and recommends new bikeways, bicycle education and safety programs, and bicycle support facilities (including bike parking). The recommended bikeway network features bicycle boulevards, bike lanes on arterial streets, new bicycle/pedestrian grade separations, and spot improvements at key intersections. The 2003 Plan also details recommended best practices for bicycle education and outreach programs, bicycle facilities design and maintenance, and enforcement.

Notwithstanding the inclusion of a new pedestrian component, the BPTP 2012 is in many respects an update of the 2003 Plan, which remains a valuable reference document for bicycle planning in Palo Alto. The BPTP 2012 updates the 2003 *Bicycle Transportation Plan* to include a new policy framework, innovative facility design strategies (such as green bike lanes, cycletracks, and intersection through-markings), and a revised bikeway network and priority project list, among other changes.

The BPTP 2012 maintains many of the 2003 Plan recommendations and provides additional project recommendations including Pedestrian facilities to help better integrate facilities such as parks and community trails. The BPTP 2012 Plan provides project recommendations by categories to help prioritize implementation over the next five years, by which time another BPTP planning effort should occur.

1.5 Public Outreach Summary

The 2012 *Bicycle + Pedestrian Transportation Plan* development process included two public open houses and an online survey to solicit input from the general public. Members of the public attended an initial open house in March 2011 to review early project ideas and focus areas. Over 500 respondents completed the online survey, providing significant feedback on a number of bicycle and pedestrian topics. A second open house outreach effort occurred in July 2011 to receive public comment on the Draft BPTP 2012.

A community open house at Terman Middle School solicited public input on a range of topics from trails and innovative bicycle striping to school commute issues and priorities.

The BPTP was developed in coordination with the Palo Alto Bicycle Advisory Committee (PABAC), an 11-member citizen advisory committee with particular knowledge of and interest in non-motorized issues and conditions. In addition to PABAC, two meetings each were held with the City/School Traffic Safety Committee (CSTSC) and the Planning & Transportation Commission. The CSTSC is a partnership between community leaders at each of the public schools in the City, Palo Alto Unified School District (PAUSD) administrators, and City staff. The Planning & Transportation Commission is an appointed commission that provides policy recommendations on development and transportation projects to the City Council. A bicycle tour of one of the City's new planned bicycle boulevards was held prior to a Study Session of the City Council halfway through the BPTP 2012 development process. Presentation materials from these meetings were made available online via the City Planning Department's bicycle and pedestrian webpage.

A more detailed summary of the online survey results and public comments can be found in **Appendix D.** Additional outreach will be conducted during the implementation of this Plan.

1.6 Plan Organization

The remainder of the City of Palo Alto *Bicycle + Pedestrian Transportation Plan* is organized as follows:

Chapter 2 – Objectives, Key Strategies, and Guiding Principles

This chapter provides details on the policy and strategic frameworks that guided the Plan development and will ultimately be used to measure progress and build accountability into the Plan implementation. The chapter presents an assessment of *Comprehensive Plan* policies and programs to assist in incorporating this Plan's recommendations into a future revised *Transportation Element.*

Chapter 3 – Existing Facilities and Programs

This chapter documents the main existing walking and bicycling infrastructure in Palo Alto, including the existing pedestrian and bikeway network, as well as the programs that help deliver and promote both infrastructure and non-infrastructure non-motorized solutions. The programs are organized according to the five "E"s of transportation planning – Engineering, Education, Encouragement, Enforcement, and Evaluation.

Chapter 4 – Travel Demand and Collision Analysis

This chapter summarizes available travel data, distinguishes types of trips made by walking and biking, and assesses the collision history for both pedestrians and bicycles between 2004 and 2009.

Chapter 5 – Needs Analysis and Recommended Programs

This chapter synthesizes existing conditions, recommends focus areas, and identifies new programs and strategies to support specific infrastructure investments.

Chapter 6 – Recommended Facilities and Conditions

This chapter introduces the recommended bikeway network and priority pedestrian areas, and details existing and recommended conditions by sub-area.

Chapter 7 – Implementation and Funding

This chapter proposes a prioritization strategy and list of priority projects to consider for implementation and further analysis in the coming years. This chapter also documents planning level costs associated with each project and/or facility type along with a short list of potential funding sources and a note on the Plan's environmental analysis.

Appendix A – Design Guidelines and Standards

This section provides facility design guidelines as a reference toolkit for implementing key projects and facilities.

Appendix B – Municipal Code Bicycle Parking Recommendations

This appendix presents recommended insertions and deletions to Palo Alto's Municipal Code bicycle parking requirements and design guidelines to encourage the provision of an appropriate type and quantity of parking for bicyclists.

Appendix C – BTA Requirements Checklist

This section identifies the location of information and analysis required for Bicycle Transportation Account Compliance and presents a demand and benefits model for existing and future bicycling and walking.

Appendix D – Public Survey Summary

This section summarizes public outreach efforts and documents the results of the Plan's online public survey conducted in Spring 2011.

Appendix E – Policy and Plan Framework

This section is a detailed reference summary of federal, state, regional, county, and local plans and programs that influence the 2012 *Bicycle + Pedestrian Transportation Plan*, including a table summary of all relevant *Comprehensive Plan* Goals, Policies, and Programs.

Appendix F – Funding

This section is a more detailed list of potential funding sources, including a summary of the City of Palo Alto's six-year Capital Improvement Project (CIP) Plan.

2 Objectives, Key Strategies, and Guiding Principles

As stated in Chapter 1, the 2012 *Bicycle + Pedestrian Transportation Plan* (BPTP) builds on existing goal statements from the *City of Palo Alto Comprehensive Plan* to provide direction and accountability for Plan implementation. The first section of this chapter outlines five objectives, each with key strategies and benchmarks. The second section introduces the adopted Plan guiding principles, which provide a strategic and interdisciplinary 'filter' to assist project development and prioritization. The last section summarizes relevant goals, policies, and programs from the existing *Comprehensive Plan Transportation Element* and offers recommendations for inclusion in the upcoming revision process.

2.1 Plan Objectives

The following Plan objectives support the goals identified in the *City of Palo Alto Comprehensive Plan* and reflect specific targets and mandates from the *Climate Action Plan*, the state Complete Streets Act and regional Sustainable Communities Initiative, and the December 2009 Palo Alto City Council Colleagues Memorandum outlining desired elements of the *2012 Bicycle + Pedestrian Transportation Plan.*

Objective 1: Double the rate of bicycling for both local and total work commutes by 2020 (to 15% and 5%, respectively).

Rationale

Work commute trips are the primary source of peak period congestion on local streets, and significant shifts to bicycling and walking can reduce the number of cars on streets and increase the efficiency of the existing roadway network. Transportation investments and policies contribute to bicycle commute demand by prioritizing development of commute-focused bicycling and walking routes and by encouraging employer transportation demand management (TDM) programs, among other ways.

Comprehensive Plan Consistency

Objective One supports the existing Transportation Element's *Goal T-1: Less Reliance on Single-Occupant Vehicles* by shifting daily trips to bicycling. Transportation Element Goal T-3: *Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling* supports this Objective, while *Program T-23* encourages the development of sidewalks and bicycle facilities in employment areas, specifically supporting this goal. This Plan recommends incorporating the specific targets of Objective One within the revised Transportation Element.

Key Strategies

- Target employment districts with enhanced bicycle facilities and improved connections to and across major barriers
- Improve planning coordination and physical connectivity with adjacent communities

- Support and expand large employer transportation demand management programs (including the City's and Stanford's) and enforce/update existing transportation management plans
- Implement and promote the Caltrain-focused bicycle share program and seek to expand elsewhere within the city
- Continue to promote Bike to Work Day and related activities

Benchmarks

- U.S. Census / American Community Survey: Mode of Transportation to Work
- Large employer TDM and/or business district surveys including Stanford University's General Use Permit cordon counts; Transportation Management Plan (TMP) reports
- Construction of new Across Barrier Connections within or near employment centers

Objective 2: Convert discretionary vehicle trips into walking and bicycling trips in order to reduce City transportation-related greenhouse gas (GHG) emissions 15% by 2020.

Rationale

The City has a goal to reduce all GHG emissions by 15% from 2005 levels in order to comply with statewide climate action targets. Since non-commute discretionary travel is the single largest source of GHG emissions within Palo Alto (see Chapter 4, **Figure 4-5**), and since the majority of trips tend to be only a few miles in length, conversion to non-polluting walking and biking trips is both a high priority and viable objective. This objective also helps directly link climate action priorities with future non-motorized funding levels and investments.

***Comprehensive Plan* Consistency**

Objective Two is broadly supported by Transportation Element *Goal T-1: Less Reliance on Single-Occupant Vehicles*. Transportation Element *Program T-19* encourages the development of bicycle and pedestrian facilities linking trips to parks, schools, retail, centers, and civic facilities, which enables and encourages residents and visitors to bicycle or walk for discretionary trips. *Programs T-25* and *T-26* also call for progress on trail development, which supports this objective.

This Plan suggests incorporation of a policy into the revised Transportation Element (in addition to potential policies in other *Comprehensive Plan* sections) that specifically targets GHG reductions through measures that reduce drive alone rates and improve walking and biking access for short discretionary trips.

Key Strategies

- Focus investments across and along the Residential Arterial and School Commute Corridor Network to support the Safe Routes to Schools program

- Develop and implement an expanded Safe Routes to School Program with bicycle and pedestrian school route maps and improved education programs
- Expand education and encouragement efforts to include more regularly scheduled street closure events, family bicycle outings, traffic skills training, "teaching rides," pedestrian safety campaigns, and innovative bicycle facility instruction
- Improve non-motorized access to shopping centers, mixed use districts, and grocery stores/farmer's markets; provide sufficient bicycle parking and 'placemaking' opportunities in these locations to support such activity
- Remove and/or upgrade substandard bike lanes and trail crossing barriers to improve safety and convenience

Benchmarks

- School commute mode share; Safe Routes to School (SR2S) hand tallies and parent surveys
- Annual pedestrian and bicycle counts
- Total annual vehicle miles travelled (VMT) and GHG emissions

Objective 3: Develop a core network of shared paths, bikeways, and traffic-calmed streets that connects business and residential districts, schools, parks, and open spaces to promote healthy, active living.

Rationale

Planners and public health officials consistently make the connection between better bicycling and walking facilities, increased physical activity and mental well-being, and reduced rates of obesity, diabetes, asthma, and other chronic diseases. In a related trend to encourage non-motorized travel, many cities are more actively managing their streets to include vehicular closures and special events outside of peak travel periods. Specific to Palo Alto, many school and open space areas are critical links in the (proposed) bicycle boulevard and off-street trail networks, which provide an opportunity to develop a more coherent recreational system for the growing youth and family populations.

Comprehensive Plan Consistency

Objective Three is most directly supported by Transportation Element Goal T-3: *Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling*. In particular, *Policy T-14* and *Program T-19* promote bicycle and pedestrian networks that connect to key destinations, including open space. Transportation Element *Program T-22* calls for the implementation of a bicycle boulevard network, while *Policy T-17* promotes the development of trails, both of which will help promote healthy, active lifestyles.

Key Strategies/Programs

- Prioritize enhancements to the Bay to Ridge Trail corridor; consider designating spur trails and secondary alignments that provide connecting off-street pathways
- Develop, sign, and promote a bicycle boulevard network that incorporates important linkages through and across school and park properties
- Encourage and support the development of neighborhood greenways, linear park features, and "Safe Routes to Parks" projects that utilize the designated bikeway network
- Promote regularly scheduled street closure events as a strategy to encourage physical activity and provide unique non-motorized travel opportunities
- Continue to support, and expand where possible, maintenance programs to repave existing trails and park programs to maintain walkways and perimeter landscaping
- Expand trail networks along creeks through partnership projects with regional agencies including the Santa Clara Valley Water District (SCVWD)
- Evaluate the feasibility of a future potential trail connection between El Camino Park and Caltrain/Palo Alto High School through the Transit Center and/or a pedestrian corridor connection to Stanford Medical and Shopping Center

Benchmarks

- Miles of bicycle boulevards, enhanced bikeways, and trails developed
- Numbers of pedestrians and bicyclists on key facilities, as determined by counts
- Number of annual street closure events

Objective 4: Plan, construct, and maintain 'Complete Streets' that are safe and accessible to all modes and people of all ages and abilities.

Rationale

Pedestrians – especially children, seniors, and the disabled – represent the most vulnerable users of the street network and have a civil right to be able to travel safely and conveniently in the public realm. While certain streets may be more important for regional mobility, all streets should accommodate non-motorized travel unless specifically prohibited under state law.

Comprehensive Plan Consistency

Objective Four supports and expands Transportation Element *Goal T-3: Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling* to include a specific reference to 'Complete Streets' for all users (including transit). This Objective should be considered for addition to the Transportation Element in the update to the *Comprehensive Plan*. Of the current Transportation Element, this Objective is directly related to *Program T-25*, "When constructing or modifying roadways, plan for usage of the roadway space by all users, including motor vehicles, transit vehicles, bicyclists, and pedestrians," and *Program T-19*, "Develop, periodically update, and implement a bicycle facilities improvement program and a pedestrian facilities improvement program that identify and prioritize critical pedestrian and bicycle links to parks, schools, retail centers, and civic facilities." In addition, the Objective discusses maintenance, supporting *Policy T-17* (related to trail maintenance) and *Policy T-20* (bicycle and pedestrian infrastructure).

Key Strategies

- Accelerate the installation of accessible curb ramps and pedestrian countdown signals in commercial centers, school zones, around senior centers and hospitals, and near key transit stops or stations
- Develop a Complete Streets checklist and formal approval process for all infrastructure projects, including major roadway maintenance, in order to identify and maximize pedestrian and bicycle improvement opportunities
- Improve top collision locations and other high volume pedestrian arterial crossings
- Study the feasibility of 'road diets' on all streets with two or more travel lanes per direction to allow for dedicated bikeways and safer, more frequent pedestrian crossings
- Target transit facilities to enhance mobility and access, especially for seniors and youth
- Develop a focused signage program accessible to seniors

Benchmarks

- Annual installation of Americans with Disabilities Act (ADA) compliant curb ramps and accessible pedestrian signals
- Top pedestrian and bicycle collision locations improved or studied
- Annual pedestrian and bicycle collisions
- Projects with Complete Street checklists completed and approved

Objective 5: Promote efficient, sustainable, and creative use of limited public resources through integrated design and planning.

Rationale

Calls for climate action and renewed fiscal discipline both help to prioritize integrated projects that meet a number of needs efficiently, as opposed to stand-alone single-purpose projects. To be sustainable (and increasingly to be competitive for outside grant opportunities), projects must achieve progress in multiple disciplines so that the whole is greater than the sum of its parts. Such an approach can leverage efficiencies of scale, while reducing construction impacts on neighborhoods and businesses.

***Comprehensive Plan* Consistency**

Objective Five has no direct parallel in the Transportation Element, although it is related to *Goal T-4: An Efficient Roadway Network for All Users*. Related policies include: *Program T-4*, "Consider the use of additional parking fees and tax revenues to fund alternative transportation projects," *Program T-25* "When constructing or modifying roadways, plan for usage of the roadway space by all users, including motor vehicles, transit vehicles, bicyclists, and pedestrians," and *Policy T-28*: "Make effective use of the traffic-carrying ability of Palo Alto's major street network without compromising the needs of pedestrians and bicyclists also using this network."

This Objective should be considered for inclusion in the updated *Comprehensive Plan* to underscore the need for creative thinking and accountability across departments for achieving integrated projects that address sustainability goals, reduce construction impacts, and leverage outside funding.

Key Strategies

- Regularly coordinate scopes and timelines of roadway maintenance, utility, and private development activities to identify potential collaboration opportunities on the bikeway network and within priority pedestrian areas
- Evaluate and develop transportation programs and facilities using the "Five I's" – Integration, Inclusion, Innovation, Investment, and Institutional Partnerships – in addition to the traditional "Five E's" framework (described in Chapter 3)
- Development of "Plan Line Studies" along residential and commute arterial streets to guide design of local projects and identify community improvements

Benchmarks

- Total grant funding awarded for bicycle- and pedestrian-related transportation improvements
- Projects completed involving multiple agency or departmental funding sponsors
- Pedestrian and bicycle facilities implemented by private development

2.2 Strategic Guiding Principles - The "Five I's"

The "Five I's" is a customized set of guiding principles developed for the 2012 *Bicycle + Pedestrian Transportation Plan* that helps strategically organize and focus transportation investments. Used to guide Plan development and prioritization, a brief description of the Five "I's" is presented below:

Integration

In addition to integrating pedestrian needs into the new transportation plan, this principle seeks the integration of non-motorized accommodation into the regular decision-making processes of Palo Alto. It also serves to align the Plan with sustainability and climate action goals that increasingly call for shared accountability and the avoidance of planning "silos" and single-purpose projects. At the project scale, seek integrated design solutions that achieve multiple benefits (e.g., a sidewalk extension that also provides landscaping or stormwater management opportunities) and avoid or improve abrupt transitions in the public realm.

Inclusion

Acknowledging that the "strong and fearless" cyclists (i.e., adult commuter and recreationists) are reasonably well-served by the existing bicycle network, the principle of inclusion strives for actions and projects that meet the needs of more novice bicyclists and reach a broad spectrum of non-motorized users in Palo Alto. This principle also speaks to the concept of "access for all" for those with mobility impairments or without access to motor vehicles.

Innovation

This principle highlights the role of Palo Alto (and Stanford) as a national leader in good ideas with a historic commitment to experimentation (i.e., learning by doing). These notions are crucial to advancing non-motorized design, where lengthy approval processes and other constraints can unnecessarily hold up the most trivial of advances. With innovation also comes the need for additional education and outreach, which will be especially important as the City introduces types of pedestrian and bicycle facilities/designs that are new to Palo Alto residents.

Institutional Partnerships

Build and utilize relationships with Stanford University, adjacent jurisdictions, the Santa Clara Valley Water District, major employers (such as Space Systems/Loral Inc., Hewlett-Packard, AOL, and Facebook), and the Palo Alto Unified School District to realize the plan's success. Explore private/public partnerships and ways to extend the sense of accountability beyond and across public agencies.

Investment

Attract, leverage, and commit to a fair share of resources for bicycle and pedestrian facilities and programs. Seek to use these resources efficiently, but understand that the quality of the facilities and programs often correlates with the level of investment. As a Plan strategy, maximize the competitiveness of the City of Palo Alto to receive outside grant funding.

A detailed discussion of how these strategic guiding principles are used to help evaluate and prioritize projects is located in Chapter 7.

2.3 *Comprehensive Plan* Policies and Programs Assessment

The 2012 BPTP was developed, and is supported, by numerous goals, policies, and programs within the existing *Transportation Element* of the *City of Palo Alto's Comprehensive Plan*. At the same time, the BPTP responds to and incorporates a number of policies and issues that are not yet included within the *Comprehensive Plan* but may be established with the planned update of the *Transportation Element* in 2012.

Table 2-1 documents the relationship between the existing Comprehensive Plan and suggests where recommendations from this Plan may be incorporated into a future revised Transportation Element.

Table 2-1. *Comprehensive Plan* Policies and Programs Assessment

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
Transportation Element		
Goal T-1:	***Less Reliance on Single-Occupant Vehicles***	
	Policy T-1: Make land use decisions that encourage walking, biking, public transit use.	This policy supports BPTP development. The BPTP includes recommendations for pedestrian districts and design guidelines that can be used to help guide development review. This policy could be strengthened slightly by revising to "Make integrated land use and transportation decisions that help reduce average trip distances and support walking, biking, and public transit."
	Policy T-2: Consider economic, environmental, and social cost issues in local transportation decisions.	This policy provides high-level support for the BPTP's integrated planning approach and inclusion of climate action goals. This policy may be modified or complemented by including specific language from Objectives 1 and 2.
	Program T-4: Consider the use of additional parking fees and tax revenues to fund alternative transportation projects.	Appendix F of the BPTP summarizes ways to fund projects and programs that improve biking and walking, including potential parking management and pricing strategies.
	Program T-5: Work with private interests, such as the Chamber of Commerce and major institutions, to develop and coordinate trip reduction strategies.	The BPTP highlights public/private partnerships as a key implementation strategy, and includes a recommendation to provide enhanced transportation demand management programs that coordinate trip reduction strategies.
	Program T-8: Create a long-term education program to change the travel habits of residents, visitors, and workers by informing them about transportation alternatives, incentives, and impacts. Work with the Palo Alto Unified School District and with private interests, such as the Chamber of Commerce, to develop and implement this program.	The BPTP evaluates existing education and encouragement programs and makes recommendations for new and improved initiatives. This program may benefit from additional references to encouragement efforts, which are critical to developing a culture of biking and walking.
Goal T-2:	***A Convenient, Efficient, Public Transit System that Provides a Viable Alternative to Driving***	
	Policy T-5: Support continued development and improvement of the University Avenue and California Avenue Multi-modal Transit Stations and the San Antonio Road Station as important transportation nodes for the City.	The BPTP includes and prioritizes recommendations within these station areas. Within this goal, a new reference to supporting and expanding the future bicycle share program is recommended as a way to provide "last mile" connections to transit services in Palo Alto.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
	Program T-14: Pursue development of the University Avenue Multi-modal Transit Station conceptual plan based on the 1993-1994 design study.	The BPTP references the conceptual plan and proposed design, and identifies potential funding sources for improving the station area.
	Program T-15: Improve the environment at the University Avenue Multi-modal Transit Station, including connecting tunnels, through short-term improvements and regular maintenance.	The BPTP recommends roadway and intersection improvements that enhance access to the existing station facilities, including widened underpasses along University Avenue.
	Policy T-9: Work towards integrating public school commuting into the local transit system.	The BPTP prioritizes the School Commute Traffic Corridors Network for improvements and makes recommendations to support the Safe Routes to School program.
Goal T-3:	***Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling***	
	Policy T-14: Improve pedestrian and bicycle access to and between local destinations, including public facilities, schools, parks, open space, employment districts, shopping centers, and multi-modal transit stations.	The BPTP recommends refinements to the bicycle network and prioritizes pedestrian facilities that link schools, parks, open spaces, transit stations and stops, and commercial uses. This is supported by the City's new focus on multi-modal level of service in the pending update to the Comprehensive Plan.
	Program T-18: Develop and periodically update a comprehensive bicycle plan.	This policy directly supports BPTP development; the BPTP recognizes the update process and focuses on developing projects to support strategic near- and medium-term priorities.
	Program T-19: Develop, periodically update, and implement a bicycle facilities improvement program and a pedestrian facilities improvement program that identify and prioritize critical pedestrian and bicycle links to parks, schools, retail centers, and civic facilities.	The BPTP includes bicycle/pedestrian facility improvement programs, and prioritizes them based on proximity to these features and to the relationship with other capital improvement programs.
	Program T-20: Periodically produce a local area bicycle route map jointly with adjacent jurisdictions.	The BPTP includes a revised map of existing conditions to support future updates to the Mid-Peninsula Bike Map.
	Program T-21: Study projects to depress bikeways and pedestrian walkways under Alma Street and the Caltrain tracks and implement if feasible.	The BPTP recommends improvements to existing plans for bicycle/pedestrian underpasses at Alma Street and identifies potential funding sources for implementation. The future Transportation Element should integrate recommendations from this Plan with those from the Joint Rail Corridor Task Force effort taking place concurrent with this Plan.
	Program T-22: Implement a network of bicycle boulevards, including extension of the southern end of the Bryant Street bicycle boulevard to Mountain View.	The BPTP expands the bicycle boulevard program to include a revised network and comprehensive wayfinding protocol. The Plan also prioritizes the extension of the Bryant Street bicycle boulevard route into Mountain View at Mackay Drive/Nita Ave.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
	Program T-23: Develop public sidewalks and bicycle facilities in Stanford Research Park and other employment areas.	The BPTP recommends working with the Stanford Research Park owners and leaseholders to identify ways of linking the Bol Park Path with Hansen Way among several significant shared use trail and bikeway recommendations. This program could be updated to include these specific recommendations in addition to opportunities for closing sidewalk gaps.
	Policy T-15: Encourage the acquisition of easements for bicycle and pedestrian paths through new private developments.	The BPTP identifies high-priority opportunities that would require an easement through private land, including Stanford Research Park and Palo Alto Unified School District (PAUSD) properties and frontages.
	Policy T-16: Create connecting paths for pedestrians and bicycles where dead-end streets prevent through circulation in new developments and in existing neighborhoods.	The BPTP continues support for this policy and identifies several locations where connecting paths may improve circulation within the bikeway network.
	Policy T-17: Increase cooperation with surrounding communities and other agencies to establish and maintain off-road bicycle and pedestrian paths and trails utilizing creek, utility, and railroad rights-of-way.	The BPTP cites the Santa Clara County Park District's *Countywide Trails Master Plan* (1995) and the *Uniform Interjurisdictional Trail Design, Use, and Management Guidelines,* as well as the Santa Clara Valley Water District (SCVWD) 's *Guidelines and Standards for Land Use Near Streams* (2006). The BPTP also actively pursues trail development opportunities along creeks and utility rights-of-way.
	Program T-25: Evaluate the design of a Bay-to-Foothills path	The BPTP prioritizes the existing Bay to Ridge Trail concept and includes specific recommendations and general design guidance for providing enhanced bikeways and greater separation of traffic along the route. The *Comprehensive Plan* language should be updated to reflect the BPTP recommended design guidelines and the "Bay to Ridge Trail" name.
	Program T-26: Complete development of the Bay Trail and Ridge Trail in Palo Alto.	The BPTP highlights portions of the Bay Trail that remain incomplete or require maintenance and makes specific recommendations to further develop the Bay to Ridge trail concept.
	Policy T-19: Improve and add attractive, secure bicycle parking at both public and private facilities, including multi-modal transit stations, on transit vehicles, in City parks, in private developments, and at other community destinations.	The BPTP supports the continuance of this policy and provides guidance for the placement of bicycle parking facilities, as well as design of on-street bicycle parking corrals.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
	Policy T-20: Improve maintenance of bicycle and pedestrian infrastructure.	This policy supports BPTP development and implementation, which includes a category of priority projects dedicated to rehabilitation and maintenance of bicycle facilities. This policy could be strengthened by including more specific definition of "improved" maintenance.
	Program T-28: Adjust the street evaluation criteria of the City's Pavement Management Program to ensure that areas of the road used by bicyclists are maintained at the same standards as, or at standards higher than, areas used by motor vehicles.	The BPTP continues support for this policy and has worked with the Pavement Management Program to coordinate priority pavement locations.
	Policy T-21: Support the use of Downtown alleyways for pedestrian- and bicycle-only use.	The BPTP incorporates existing pedestrian and bicycle-friendly alleys into the existing network and prioritizes further development of such facilities in both Downtown and the California Avenue Business Districts.
	Program T-31: Test the Downtown Urban Design Guide emphasis on the use of alleyways for pedestrian- and bicycle-only use. Allow controlled vehicle access for loading and unloading where no alternatives exist.	The BPTP supports the use of alleyways for pedestrian- and bicycle-only use and acknowledges the need for further evaluation and improvement of alleys within both the Downtown and California Avenue Business Districts.
	Policy T-22: Improve amenities such as seating, lighting, bicycle parking, street trees, and interpretive stations along bicycle and pedestrian paths and in City parks to encourage walking and cycling and enhance the feeling of safety.	The BPTP heavily promotes opportunities to integrate connections and investment along and between bikeways, pedestrian paths, and parks, and includes recommendations for improved pathway lighting and a "Safe Routes to Parks" program.
	Policy T-23: Encourage pedestrian-friendly design features such as sidewalks, street trees, on-street parking, public spaces, gardens, outdoor furniture, art, and interesting architectural details.	The BPTP continues support for this policy and includes revised design guidelines for bicycle and pedestrian facilities.
	Program T-32: Improve pedestrian crossings with bulbouts, small curb radii, street trees near corners, bollards, and landscaping to create protected areas.	The BPTP includes a recommendation to develop a formal pedestrian countdown signals and crossings program that supports this program. Consider revising T-32 to include reference to high visibility crosswalks, pedestrian countdown signals, and other pedestrian-oriented traffic control devices.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
Goal T-4:	***An Efficient Roadway Network for All Users***	
	Policy T-25: When constructing or modifying roadways, plan for usage of the roadway space by all users, including motor vehicles, transit vehicles, bicyclists, and pedestrians.	The BPTP supports the "routine accommodation" of bicyclists and pedestrians in all phases, as proscribed by the California Complete Streets Act. Specific reference to "Complete Streets" is recommended within the revised Transportation Element.
	Program T-33: Develop comprehensive roadway design standards and criteria for all types of roads. Emphasize bicycle and pedestrian safety and usability in these standards.	The BPTP includes a set of innovative design standards/guidelines (Appendix A) to enhance bicycle and pedestrian safety for a variety of roadway conditions and types.
	Program T-34: Establish procedures for considering the effects of street modifications on emergency vehicle response time.	Appendix A of this Plan notes the need to work with emergency service providers when considering traffic calming or street closures/diverters.
	Policy T-27: Avoid major increases in street capacity unless necessary to remedy severe traffic congestion or critical neighborhood traffic problems. Where capacity is increased, balance the needs of motor vehicles with those of pedestrians and bicyclists.	The BPTP assumes no major increases in capacity except as identified in local and regional plans. Although this policy generally supports alternative modes, a revised Transportation Element should consider more specific guidance for when (and/or where) reduced vehicle level-of-service is acceptable to implement priority non-motorized projects.
	Policy T-28: Make effective use of the traffic-carrying ability of Palo Alto's major street network without compromising the needs of pedestrians and bicyclists also using this network.	The BPTP supports the "routine accommodation" of bicyclists and pedestrians in all phases, as is proscribed by the California Complete Streets Act.
Goal T-5:	***A Transportation System with Minimal Impacts on Residential Neighborhoods***	
	Policy T-30: Reduce the impacts of through-traffic on residential areas by designating certain streets as residential arterials.	The BPTP includes several recommendations for residential arterials that are consistent with this policy.
	Program T-41: The following roadways are designated as residential arterials. Treat these streets with landscaping, medians, and other visual improvements to distinguish them as residential streets, in order to reduce traffic speeds. • Middlefield Rd (between San Francisquito Creek and San Antonio Rd) • University Ave (between San Francisquito Creek and Middlefield Rd) • Embarcadero Rd (between Alma St and West Bayshore Rd) • Charleston/Arastradero Rs (between Miranda Ave and Fabian Way)	The BPTP recommends bicycle and pedestrian improvements on these street segments as part of the bicycle network and pedestrian priority areas.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
	Policy T-31: Evaluate smoothing and slowing traffic flow in commercial areas by reducing through-traffic lanes and trading the area for improved turning lanes, landscaping, and bicycle lanes.	The BPTP recommends further study of bike lanes and enhanced Class II bikeways that may reduce travel lanes and/or traffic speeds in commercial areas to accommodate improved bicycle and pedestrian access.
	Policy T-32: Design and maintain the City street network to provide a variety of alternate routes, so that the traffic loads on any one street are minimized.	Bicycle boulevard and other BPTP recommendations recognize the importance and efficiency of an interconnected, grid-like street network.
	Policy T-33: Keep all neighborhood streets open unless there is a demonstrated safety or overwhelming through-traffic problem and there are no acceptable alternatives, or unless a closure would increase the use of alternative transportation modes.	The BPTP recommendations for bicycle boulevards note the conditions where street closures or partial diverters may be appropriate. The BPTP recommends additional planning with neighborhood involvement prior to implementing any street closures.
	Policy T-34: Implement traffic calming measures to slow traffic on local and collector residential streets and prioritize these measures over congestion management. Include traffic circles and other traffic calming devices among these measures.	This policy supports BPTP recommendations on these streets, particularly for bicycle boulevards where slower traffic speeds are necessary for improved bicycle and pedestrian conditions. Appendix A presents traffic calming treatments, including speed humps/tables/raised intersections, chicanes, and traffic circles.
	Program T-43: Establish a Neighborhood Traffic Calming Program to implement appropriate traffic calming measures. Consider using development fees as a funding source for this program.	The recommendations in Appendix A and the bicycle boulevard network provide support for a Neighborhood Traffic Calming Program.
	Program T-44: Evaluate changing Homer and Channing Avenues to two-way streets with or without redevelopment of the Palo Alto Medical Foundation campus.	The BPTP designates Homer and Channing Avenues as enhanced bikeways, and provides options for developing them with or without conversion to two-way operation. This program should be updated to remove the Palo Alto Medical Foundation (PAMF) language and include reference to the enhanced bikeway designation.
	Policy T-35: Reduce neighborhood street and intersection widths and widen planting strips as appropriate.	Recommendations for bike lanes and enhanced bikeways, as well as bicycle boulevards and intersection improvements, may require lane reductions and/or curb extensions where feasible.
	Policy T-36: Make new and replacement curbs vertical where desired by neighborhood residents.	The BPTP generally supports replacing rolled curbs with vertical curbs, but provides guidance to retrofit existing rolled curbed streets for greater accommodation of pedestrians and bicycles.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
	Policy T-37: Where sidewalks are directly adjacent to curbs and no planting strip exists, explore ways to add planting pockets with street trees to increase shade and reduce the apparent width of wide streets.	The BPTP recommends curb extensions and potential "bicycle chicanes" that may create space for additional street trees and reduce the width of streets.
	Policy T-38: Continue the current "guard and go" system of having stop signs approximately every other block on local residential streets to discourage through-traffic.	This Plan does not support the use of regular stop signs on identified bicycle boulevard streets. Consider revising this policy to encourage greater use of alternative traffic calming devices (e.g., traffic circles) to develop bicycle boulevards as priority bicycle streets.
Goal T-6:	***A High Level of Safety for Motorists, Pedestrians, and Bicyclists on Palo Alto Streets***	
	Policy T-39: To the extent allowed by law, continue to make safety the first priority of citywide transportation planning. Prioritize pedestrian, bicycle, and automobile safety over vehicle level-of-service at intersections.	This policy provides a high level of support for the BPTP. The BPTP recommendations focus on enhancing safety for all road users and utilize an updated collision analysis to identify top collision locations.
	Program T-45: Provide adult crossing guards at school crossings that meet adopted criteria.	The BPTP supports the crossing guard program as part of the Safe Routes to School program.
	Program T-46: Encourage extensive educational programs for safe use of bicycles, mopeds, and motorcycles, including the City-sponsored bicycle education programs in the public schools and the bicycle traffic school program for juveniles.	The BPTP reviews existing educational programs and recommends additional programs that would support this program.
	Policy T-40: Continue to prioritize the safety and comfort of school children in street modification projects that affect school travel routes.	BPTP recommendations focus on the identified school commute corridors for bicycle and pedestrian recommendations, and prioritize routes to school.
	Policy T-41: Vigorously and consistently enforce speed limits and other traffic laws.	The BPTP notes the importance of enforcement to improve safety and encourage residents and visitors to walk and bicycle more often.
Goal T-7:	***Mobility For People With Special Needs***	
	Policy T-42: Address the needs of people with disabilities and comply with the requirements of the Americans with Disabilities Act (ADA) during the planning and implementation of transportation and parking improvement projects.	This Plan highlights the needs of pedestrians with disabilities, and innovative design guidelines presented in **Appendix A** note ADA requirements where appropriate.

Goals	Policies and Programs (edited for relevancy)	Plan Relationship/Recommendation
Goal T-8:	***Attractive, Convenient Public and Private Parking Facilities***	
	Policy T-45: Provide sufficient parking in the University Avenue/Downtown and California Avenue business districts to address long-range needs.	The BPTP recommends several alternative uses of on-street parking spaces, including bicycle parking corrals and temporary "parklets." A revised set of these policies should, at minimum, further define parking to include bicycle parking. Transportation demand management (TDM) and other recommendations also reduce parking demand in support of this policy.
	Policy T-46: Minimize the need for all-day employee parking facilities in the University Avenue/Downtown and California Avenue business districts and encourage short-term customer parking.	
Goal T-9:	***An Influential Role in Shaping and Implementing Regional Transportation Decisions***	
	Policy T-51: Support the efforts of the Metropolitan Transportation Commission (MTC) to coordinate transportation planning and services for the Mid-Peninsula and the Bay Area that emphasize alternatives to the automobile. Encourage MTC to base its Regional Transportation Plan (RTP) on compact land use development assumptions.	The BPTP's goals promote regional coordination as well as coordination between transportation and land use to support and prioritize bicycle and pedestrian facilities.
Goal T-10:	***A Local Airport with Minimal Off-site Impacts***	
	Program T-57: Provide a planting strip and bicycle/pedestrian path adjacent to Embarcadero Road that is consistent with the open space character of the Baylands.	The BPTP recommends a Class I Multi-Use Path along Embarcadero Road from E. Bayshore Rd toward the airport driveway and Byxbee Park.

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3 Existing Facilities and Programs

3.1 Existing Pedestrian Facilities

The City of Palo Alto, in combination with the Stanford University campus and related properties, includes a wide range of pedestrian conditions. Below are short descriptions of existing facility types and select assets, some of which are depicted in **Map** 3-1.

3.1.1 Dedicated Facilities

Sidewalks

Pedestrian activity is most often accommodated with dedicated facilities separated from motor vehicle traffic (i.e., sidewalks). The majority of Palo Alto contains a connected network of sidewalks, the main exceptions being southwest Palo Alto and other select corridors where residents do not desire them or where feasibility is extremely limited. In some locations, such as along El Camino Real, existing sidewalks are narrow and are in poor condition. In addition to sidewalks, 15 miles of Class I facilities and park paths offer additional separation from traffic.

The new sidewalk constructed along Stanford Avenue adjacent to a faculty housing development includes both a paved and unpaved surface to support utilitarian and recreational (jogging) pedestrian activity. This hybrid walkway extends from Hanover Street to El Camino Real along the Bay to Ridge Trail.

Unpaved Trails and Private Paths

Distinct from sidewalks and shared use paths, many unpaved trails exist both in the regional open space areas and within larger private developments and parcels. These facilities include an extensive trail network opposite the Bol Park Path and VA Medical Center in the Stanford Research Park as well as planned trail connections in and around Sterling Creek. Both areas are shown on Map 3-2 as private paths but are not distinguished from other paved surfaces. Stanford University recently completed an unpaved pedestrian-only path from Page Mill/Deer Creek to the Arastradero Trail.

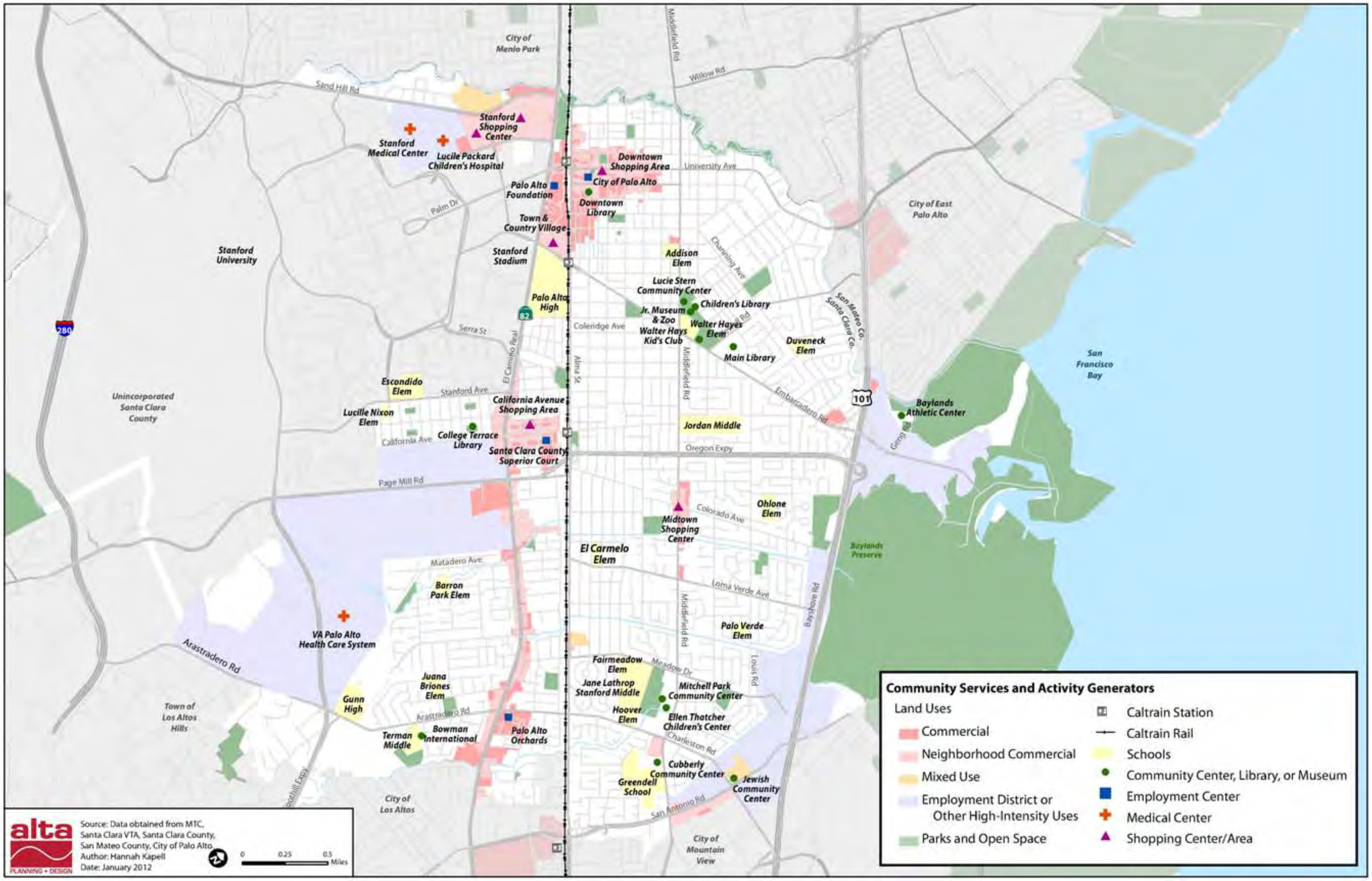
Courtyards, Pedestrian Alleys/Pass-Throughs, and Parks

Courtyards and pedestrian alleys/pass-throughs interior to city blocks also provide important dedicated space for pedestrian refuge and activity. Several well-executed examples are located in Downtown, including the Ramona Plaza development and the Scott Street connection to Heritage Park, while additional pedestrian cut-throughs are located in the California Avenue Business District. Plazas, parks, and other semi-private open spaces (including school grounds) are also particularly important for neighborhood connections and pedestrian activity in Palo Alto.

Several pedestrianized alleys in downtown help maintain an intimate scale while offering refuge and private outdoor spaces away from arterial traffic.

Stanford Pedestrian Zone and Temporary Street Closures

Stanford University's central campus restricts motorized vehicles (except in limited circumstances) to maintain a pedestrian- and bicycle-friendly network of street malls and paths. While several visions have been proposed for a similar pedestrian mall/zone in or near downtown Palo Alto without success, it is worth noting that temporary (and less controversial) dedications of pedestrian space are often made during parades, street festivals, farmer's markets, and other events.



Map 3-1: Existing Community Services and Activity Generators

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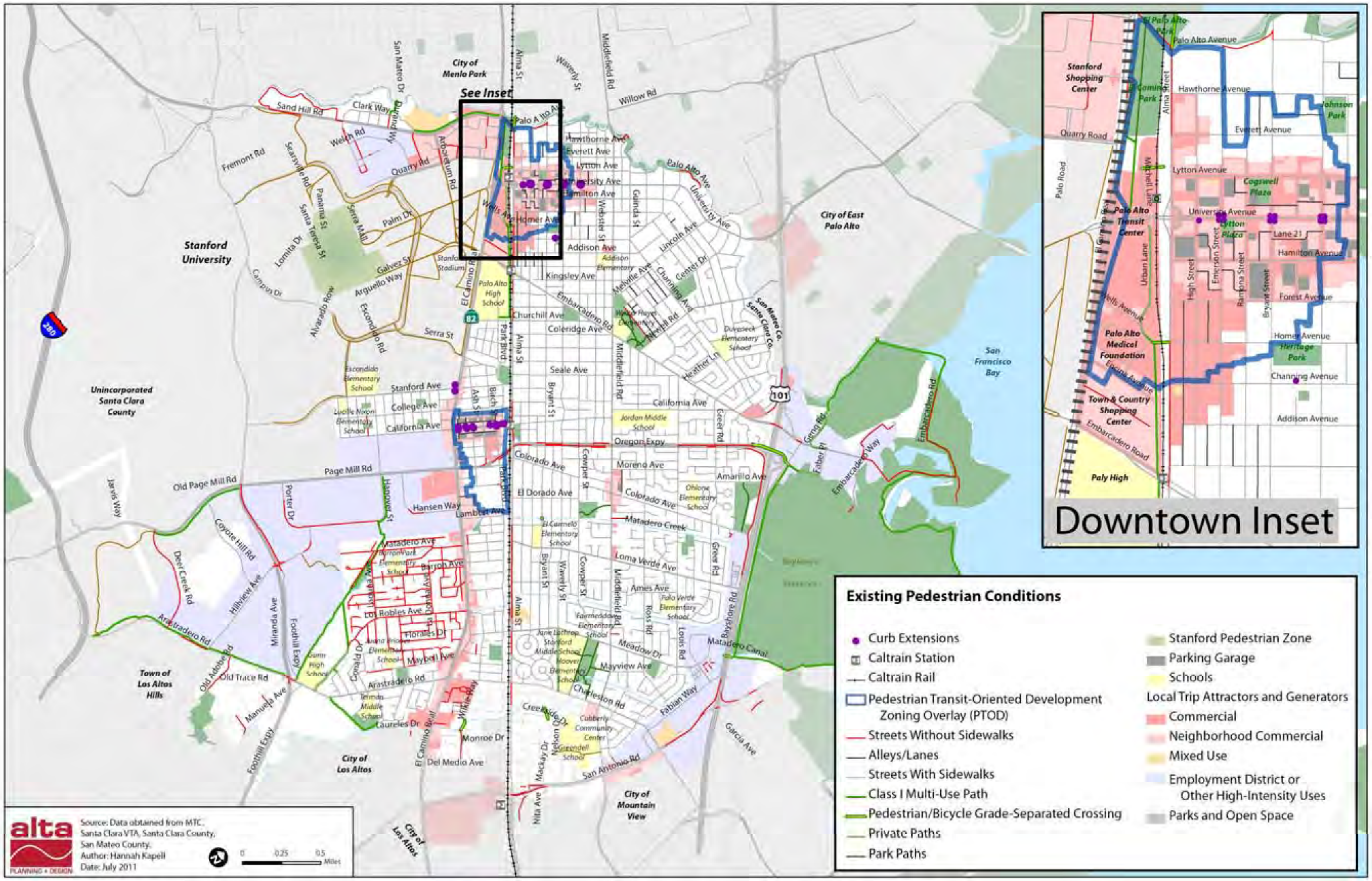

Map 3-2: Existing Pedestrian Conditions

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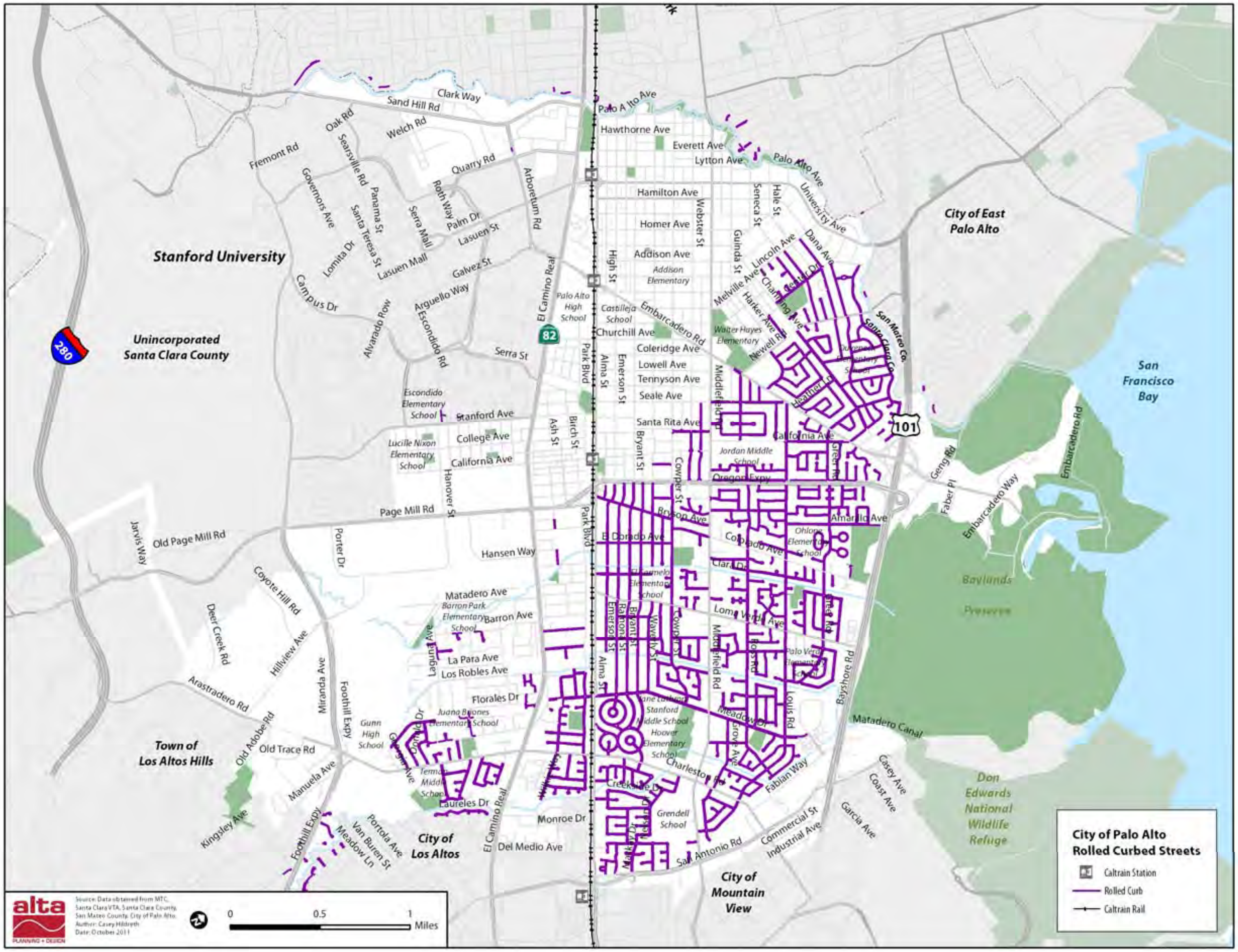

Map 3-3: Streets with Rolled Curbs

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3.1.2 Shared Facilities

Shared-Use Paths and Barrier Crossings

As the name implies, shared-use paths are off-road facilities where bicycle and pedestrian traffic mixes, which at times may cause conflict where bicycle speeds and/or peak volumes are high or where visibility is restricted. These potential conflict conditions are exacerbated where there is insufficient width to meet Caltrans Class I path standards (see **Figure 3-1** on page 3-14), such as in older parks and barrier crossings, and on several Stanford perimeter paths. In these locations barrier devices and/or signage may exist to force bicycles to dismount or take extra precautions.

Laguna Avenue at Matadero Creek, Barron Park Neighborhood.

Streets Without Sidewalks

Despite much of the city having a network of interconnected sidewalks, there are a few significant exceptions. As shown in **Map 3-3** the majority of streets in the Barron Park and Monroe Park neighborhoods have unimproved roadway edges or valley gutters without sidewalks due to the preference for maintaining a distinct rural character. Although in some instances a soft shoulder is available for pedestrian travel, most of these streets lack sufficient width for continuous facilities of any kind outside the travel way. Sidewalks are also not a preferred option for many residents concerned with maintaining neighborhood character, impacting creek riparian areas, or spending significant public resources in low-volume residential areas. Additional streets with significant sidewalk gaps on at least one side of the street include Alma Street (Caltrain side, which has no pedestrian destinations), Oak Creek and Palo Alto Avenues (along San Francisquito Creek), Oregon Expressway, San Antonio Road approaching Highway 101, and several streets within Stanford Research Park.

Service Alleys / Public Parking Lots

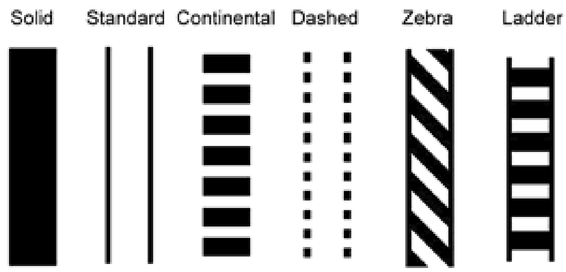
Most service alleys and publicly owned surface parking lots require pedestrians and vehicles to share the travel way. Distinct from streets without sidewalks, these facilities are typically narrower (alleys), next to commercial activity centers, and prone to safety concerns (sight distance issues, personal security) if not well lit or if accompanied by blank facades. Although not typically thought of as pedestrian facilities, the predominance of these features in both the Downtown and California Avenue Business Districts makes them especially relevant to existing conditions and as future improvement opportunities.

3.1.3 Intersection Facilities

Technically, intersection crossings are instances of shared space between motorists and vehicles. Temporary separation is achieved only through careful signing, striping, and/or signalization along with state and local laws that require motorists to yield for pedestrians. While inventory data was not available, specific locations and frequencies of the most prevalent intersection devices and controls are discussed below.

Unmarked Crossings

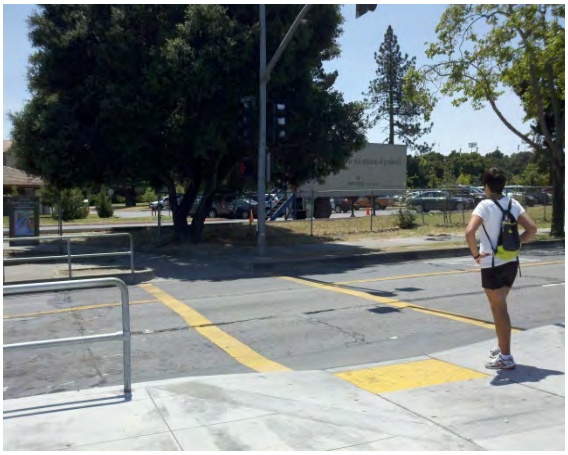
In California, it is legal for pedestrians to cross where any two streets intersect, except at unmarked, uncontrolled locations between adjacent signalized crossings or where crossing is expressly prohibited. In Palo Alto, the most common unmarked crossings are at stop-controlled intersections and between signals along arterial roadways where traffic control and pedestrian markings are not provided at minor street intersections.



Of the major types of crosswalk striping, the "Standard" crosswalk is most prevalent in Palo Alto.

Crosswalks

Marked crossings (crosswalks) reinforce the location and legitimacy of pedestrian crossing activity, and may be provided at either signalized or unsignalized intersections. Marking crosswalks at unsignalized locations with more than one lane of traffic per direction is discouraged without additional treatments. This is due to the "double threat" collision scenario where a near-lane vehicle whose driver yields to the pedestrian hides a far-lane vehicle whose driver does not see or anticipate the pedestrian. Only a handful of such crossings exist in Palo Alto, and several existing locations will be removed/improved with upcoming capital projects. Despite the limited number of multi-lane crossings, there are a number of unsignalized crosswalks across two-lane arterials where motorist compliance remains low (such as at the Churchill Avenue and Castilleja Avenue intersection).



In California, it is a standard that crosswalks are marked in yellow adjacent to school grounds.

The vast majority of crosswalks in Palo Alto are the "standard" parallel transverse stripes. Other less frequent striping patterns include "high visibility" zebra style crosswalks (an example of which is currently at Alma Street and Hamilton Avenue) and ladder striping (Arastradero Road at Terman Middle School and Gunn High School). In most new installations, an advance limit line (a solid stripe similar to those used at stop signs, set back four feet from the crosswalk) has been provided to limit encroachment by stopped vehicles.

Pedestrian Countdown Signals

A pedestrian countdown signal integrates a separate display for pedestrians that uses three phases: "walk," flashing "don't walk" with a countdown, and "don't walk." Pedestrian signals provide additional information regarding the amount of remaining time during the flashing "don't walk" pedestrian interval; the countdown displays may improve pedestrians' judgment about whether is safe to cross the intersection. Legally, pedestrians are prohibited from beginning to cross an intersection when the flashing "don't walk" display is initiated, although in practice this provision is consistently ignored or misunderstood by pedestrians and is rarely enforced. As a peripheral benefit, pedestrian countdown signals can aid bicyclists approaching an intersection in deciding whether or not to speed up to clear an intersection before the light changes.

Pedestrian countdown signals have been installed at various signal locations in Palo Alto, with the majority in commercial areas and business districts and on major arterials. The City has initiated a citywide replacement program. Completed in Fall 2011, the first phase replaced approximately one third of the City's traffic signals. Phase 2 is scheduled for Summer 2012. In addition, many downtown signals do not yet have a pedestrian signal.

Pedestrian Advance Lead and Scramble Signal Phases

Pedestrian Lead phases (a.k.a. "Leading Pedestrian Interval") and "All Pedestrian" phases (a.k.a. "Pedestrian Scrambles" or pedestrian-only phases) are signal options that allow staggered or exclusive pedestrian and vehicle movements to limit conflict at high volume intersections.

"Pedestrian Lead" phases begin the walk phase several seconds before adjacent motor traffic receives a green light, enabling pedestrians to occupy the crosswalk and improving their visibility to motorists preparing to turn. A leading pedestrian interval is deployed by the City of Palo Alto at the intersection of Alma Street and Homer Street, adjacent to the Homer Tunnel. Leading pedestrian intervals should be considered along high-vehicle volume corridors such as Embarcadero Road and San Antonio Road, and on Oregon Expressway-Page Mill Road with coordination from the County of Santa Clara.

"All Pedestrian" phases prohibit all vehicle movements while pedestrians cross, allowing for diagonal walking movements if desired. Targeted to improve safety, these phases can result in longer

University Avenue is one of the only Palo Alto roadways that has multiple curb extensions, among other unique features.

wait times for all modes, including pedestrians. Examples of this treatment currently exist at select intersections along Suggested Routes to School in Palo Alto, including Arastradero Road at Donald Drive-Terman Road and Embarcadero Road at Middlefield Road.

Future traffic signal timing should carefully consider All Pedestrian phases on University Avenue in the Downtown during peak hours, as well as in new streetscape projects to improve pedestrian crossings and maintain vehicle progression.

Curb Ramps

Curb ramps are transitions between the sidewalk and legal roadway crossings that provide a smooth grade change for pedestrians – in particular patrons with disabilities and other wheeled devices – and for bicyclists dismounting or reaching a nearby parking spot. An intersection corner may contain one or two curb ramps depending on the location of signal poles, traffic controller cabinets, drainage inlets, private property boundaries, and other potential complicating factors. Generally speaking, curb ramps must be 'readily accessible to and usable by' persons with disabilities in order to comply with the intent of the Americans with Disability Act (ADA), although best practice guidelines provide specific designs for various curb ramps. Such guidance includes FHWA's *Designing Sidewalks and Trails for Access, Part II* (2001) as well as the pending *Public Rights-of-Way Accessibility Guidelines* from the Access Board (Draft 2011).

The series of non-conforming curb ramps and isolated islands across Palm Drive and the El Camino Real off ramps makes walking or biking to downtown or the transit center much less inviting.

Curb Extensions

Curb extensions, or "bulbouts," are extensions of the sidewalk into the adjacent parking lane(s) that help reduce pedestrian crossing distances and vehicular turning radii, which is a major factor in how fast vehicles are able to turn. Curb extensions also provide more sidewalk space for pedestrian queuing, landscaping, seating, and other amenities. Except along the University Avenue and California Avenue corridors, very few curb extensions exist in Palo Alto. Within these business district corridors, curb extensions exist along all four corners of University Avenue at Emerson Avenue, Bryant Street, Cowper Street,

Clockwise from top right: Pedestrian wayfinding in downtown; art, seating, and outdoor cafe along California Avenue; traffic control cabinet art.

and Waverly Street. A brick low-level wall separates the single curb bulb at the southeast corner of High Street. An additional four or five pairs of curb extensions are located on California Avenue, which will likely see an increase of curb bulbs with the upcoming streetscape design project.

Medians (Refuge Islands)

Center medians and pedestrian refuge islands enable pedestrians to wait after crossing one direction of motor traffic, which are especially valuable on long crossings of busy thoroughfares such as El Camino Real, Oregon Expressway, and San Antonio Road. According to the Department of Public Works, the City maintains 388 medians, islands, gateways, and traffic diverters. Many of these medians are landscaped for much of their length yet still allow pedestrians to wait safely before finding a gap in traffic or waiting for a green signal phase.

Channelized Right Turn, or "Pork Chop" Islands

Commonly referred to as "pork chop" islands due to their shape, these triangular medians separate right-turning traffic from through-traffic in an effort to accommodate pedestrians while maintaining high automobile levels of service. In older designs, narrow islands with curb ramps often force up-and-down movements that can be difficult for mobility-impaired persons. Newer designs provide smoother at-grade pedestrian cut-throughs yet still provide for fast-moving vehicle turns.

The conversion of pork chop islands to widened sidewalks with bulb-outs is an increasingly popular approach to improve the pedestrian realm and create "Complete Streets" for all users. The City of Palo Alto has an active demonstration project at the intersection of El Camino Real and Stanford Avenue that includes the conversion of two pork chop island facilities. Removal of these islands can result in increased delay to vehicles and impacts upon freight mobility where heavy right turn movements exist, and thus should be studied carefully before being implemented. Additional locations for consideration in Palo Alto can include intersections such as El Camino Real at Arastradero Road or Charleston Road.

Pedestrian "Support Facilities"

Trees and landscaping, shelter from rain and wind, wayfinding, public art, pedestrian-scale lighting, seating, newspaper-box corrals, sidewalk cafes, and many other interesting design features are all important components of the pedestrian realm in Palo Alto. These amenities are strongly encouraged in *Comprehensive Plan* policies and programs, many of which are enforced and/or encouraged through design guidelines in the Municipal Code.

3.2 Existing Designated Bikeways

In California, Caltrans designates three facility design types for bicyclists: Class I, II, and III Bikeways. **Figure 3-1** shows their general design standards. Palo Alto also has several enhanced Class III routes known as bicycle boulevards (including Bryant Street, the nation's first). These streets' distinctive characteristics are discussed separately below. In total, Palo Alto has nearly 65 miles of existing bikeways. **Map 3-4** illustrates the location of these bikeways.

The *Santa Clara Countywide Bicycle Plan* identifies Cross-Country Bicycle Corridors (CCBCs) in Palo Alto, which are routes that connect between jurisdictions in the county. The following tables indicate routes that are designated CCBCs.

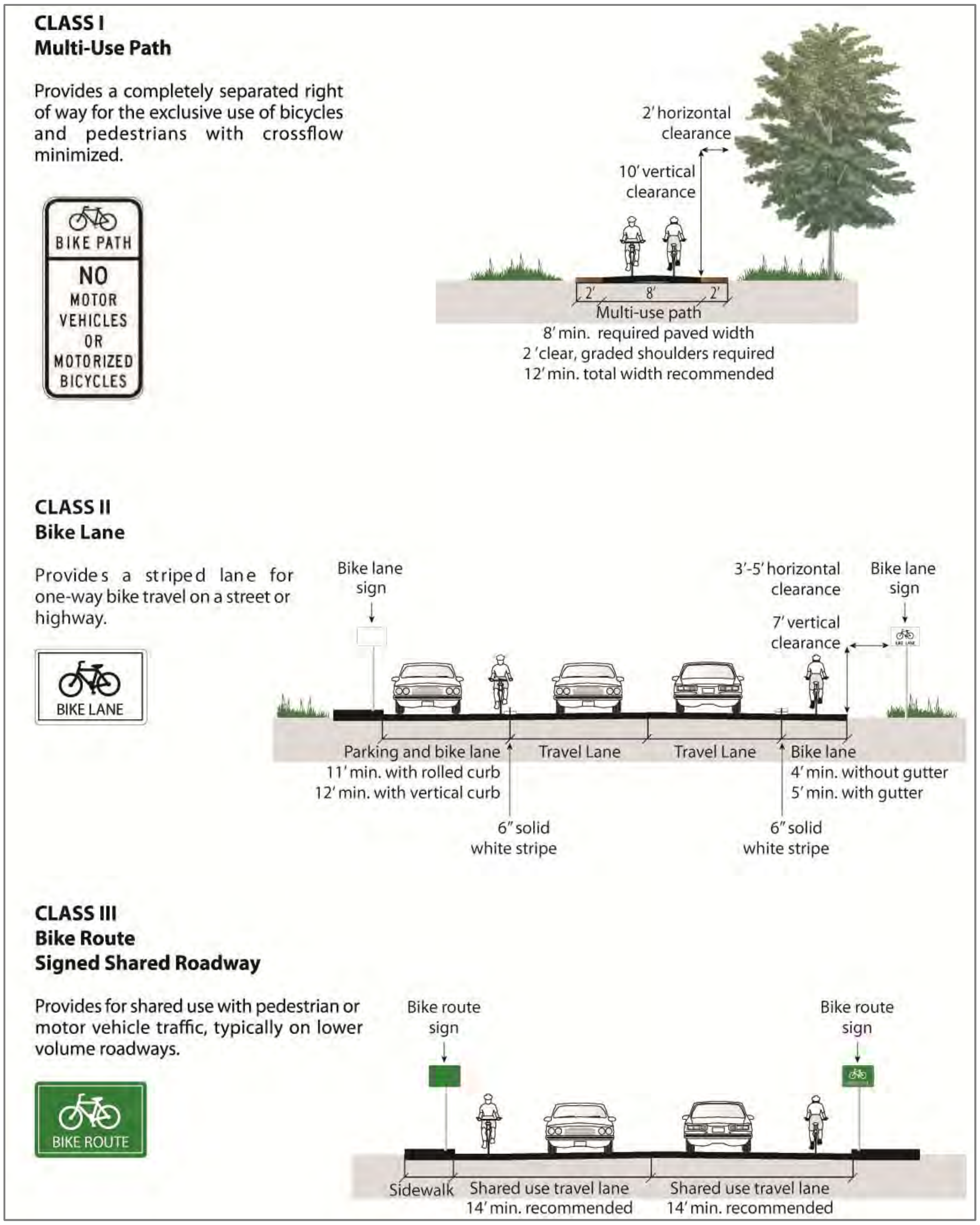


Figure 3-1: Caltrans Bikeway Classifications

Class I Bikeways/Multi-Use Paths

Class I bikeways are also referred to as multi-use or shared-use paths. They are physically separated from a roadway by either at least five feet of landscape or an impact barrier. Class I facilities are for exclusive use of non-motorized transportation modes and must have a minimum paved width of eight feet as well as two-foot wide graded shoulders. Palo Alto has 15.3 miles of Class I paths, as well as many additional paths that are physically separated from traffic but whose narrow widths and/or surface treatments do not meet Class 1 requirements. Many paths on the Stanford University campus also do not qualify as Class I facilities but are a significant component of the greater Palo Alto area's bicycle and pedestrian network. Although these "private paths" are not included in the existing bikeway table, every effort has been made to include them on the Existing (and Proposed) Bikeways Map.

The *Santa Clara County Trails Master Plan Update* (1995) designates three levels of trails: Regional, Subregional, and Connector, and the Plan discusses all regional and subregional trails. The only regional trail in Palo Alto is the San Francisco Bay Trail (R-4), which incorporates both the Baylands Preserve Path and East Palo Alto Baylands. Sub-regional trail routes provide recreation and transportation benefits, connecting to rail stations, bus routes, park-and-ride facilities, connecting between cities, and providing long-distance loop trail opportunities. The only proposed sub-regional trail in Palo Alto is the Matadero Creek/Page Mill Trail (S1). Finally, Connector routes provide convenient access from urban and developed areas and public lands to Regional and Sub-Regional trails. In Palo Alto, the San Francisquito/Los Trancos Creek trail (C1), Adobe Creek trail (C-2), and the Hetch-Hetchy trail (C-4) are designated Connectors.[12] **Table 3-1** lists the existing multi-use paths and park paths in Palo Alto.

Table 3-1: Existing Class I Multi-Use Paths/Park Paths *

Location	Extent	Mileage
Arastadero Road Path (CCBC 05C-17c/x)	Miranda Avenue - Los Altos Hills	1.3
Baylands Preserve Path	Faber Place - Don Edwards National Wildlife Refuge	1.9
E. Palo Alto Baylands	Santa Clara County Line - Weeks Street	5.5
El Camino Park Path (CCBC 02-2a)	Quarry Road - University Circle	0.2
Caltrain Bike Path (CCBC 02-2b)	University Avenue - Churchill Avenue	0.9
Gunn High School Eastside Path	Gunn High School Path - Arastradero Road	0.7
Bol Park Path	Hanover Street - Arastradero Road	1.2
Hanover Street	Page Mill Road - Gunn High School Path	0.3
JLS and Hoover School MUP	Meadow Drive - Charleston Road	0.4
Page Mill-Arastradero Connector**	Junipero Serra Boulevard - Arastradero Road	1.0
San Mateo Drive Path	San Mateo Drive - Clark Way	0.1
Sand Hill Road Path	El Camino Real - Clark Way	0.6
Terman Park Path	Arastradero Road - Glenbrook Drive	0.4
Total Class I Multi-Use Paths		***13.9***

** Some "park paths" and other trail segments may not conform strictly to Class I width standards, although generally they are of a higher quality than private paths and trails.*
*** Corridor is only partially in the City of Palo Alto.*

[12] *The Santa Clara County Trails Master Plan Update is available here:* *http://www.parkhere.org/portal/site/parks/parksarticle?path=%252Fv7%252FParks%2520and%2520Recreation%252C%2520Department%2520of%2520%2528DEP%2529&contentId=d6d18432dca3e210VgnVCM10000048dc4a92*

Class II Bikeways

Class II bikeways are striped lanes on roadways for one-way bicycle travel. Class II bike lanes on street segments without parking must be at least four feet wide including any concrete gutter, with at least three feet of asphalt. Bike lanes on streets with parallel parking must be at least five-feet wide, although many communities, including the Valley Transportation Authority's (VTA) Bicycle Technical Guidelines, have adopted wider minimum width standards to reduce potential conflict with the "door zone" and to encourage a wider range of bicyclists.

The City of Palo Alto has over 30 miles of Class II bike lanes, which exhibit a variety of widths and quality. Some of the City's bike lanes are time-restricted and revert to vehicle parking in the evenings and on weekends. More detail on time-restricted, buffered, floating, and green painted bicycle lanes are included in *Appendix A: Design Guidelines.*

Table 3-2: Existing Class II Bike Lanes in Palo Alto

Location	Start	Mileage
Alma Street	Palo Alto Avenue - Lytton Avenue	0.3
Bayshore Parkway	San Antonio Avenue - Garcia Avenue	0.3
California Avenue (CCBC 03-4a)	Middlefield Road - Alma Street	0.6
California Avenue (CCBC 03-4d)	El Camino Real - Hanover Street	0.5
Castilleja Avenue(CCBC 02-3)	Park Boulevard - El Camino Real	0.2
Channing Avenue/Addison Avenue	Bryant Street - St. Francis Drive	1.8
Charleston Road/Arastradero Road (CCBC 01-5/CCBC 05C-17a)	Foothill Expressway - El Camino Real	2.4
Churchill Avenue	Bryant Street - El Camino Real	0.5
Coleridge Avenue	Bryant Street - Middlefield/Embarcadero	0.4
Cowper Street	Loma Verde Avenue - East Meadow Drive	0.6
Deer Creek Road	Page Mill to Arastradero Road/Trail	0.7
East Bayshore Road	Embarcadero Road - San Antonio Avenue	1.9
Embarcadero Road (CCBC 03-1a/ CCBC T-R4-1y)	Embarcadero Way - East Bayshore Road	0.6
Foothill Expressway	Page Mill Road - Los Altos Line	2.4
Hanover Street	California Avenue - Hillview Avenue	0.7
Hansen Way	Page Mill Road - El Camino Real	0.6
Hillview Avenue	Hanover Street - Arastradero Road	1.1
Loma Verde Avenue	Louis Road - Bryant Street	0.9
Los Robles Avenue/El Camino Real	Meadow Drive - La Donna Avenue	0.4
Louis Road	Embarcadero Road - Charleston Road	2.3
Lytton Avenue	Middlefield Road - Alma Street	0.6
Meadow Drive	Fabian Way - El Camino Real	1.6

Location	Start	Mileage
Middlefield Road (CCBC 01-6)	Loma Verde Avenue - Keats Court	1.3
Miranda Avenue	Arastredero Road - Hillview Avenue	0.8
Newell Road	Edgewood Drive - California Avenue	1.1
Page Mill Road (CCBC 03-6)	El Camino Real - Berry Hill Court	1.4
Palo Alto Avenue	Alma Street - El Camino Real	0.1
Pasteur Drive	Sand Hill Road - Loop	0.5
Porter Drive	Page Mill Road - Hanover Street	0.4
Quarry Road	El Camino Real - Quarry Extension	0.7
Sand Hill Road	San Francisquito Creek - El Camino Real	1.6
St. Francis Drive	Channing Avenue - Embarcadero Road	0.1
Stanford Avenue	El Camino Real - Amherst Street	0.8
University Avenue	San Franciscquito Creek - Middlefield Road	1.0
Vineyard Lane	Sand Hill Road - Quarry Road	0.2
Welch Road	Quarry Road - Campus Drive	0.5
West Bayshore Road*	Amarillo Avenue - East Meadow Drive	1.3
Total Class II Bicycle Lanes:		***33.2***
Northbound Bicycle Lanes/Southbound Sharrows		
California Avenue	Louis Road - Middlefield Road	0.4
Colorado Avenue	Middlefield Road - Louis Road	0.4
Total Northbound Bicycle Lanes/Southbound Sharrows Class II Bicycle Lanes		***0.9***

** On W. Bayshore Road between Amarillo Avenue and Matadero Creek, there is no southbound bicycle lane.*

Table 3-3: Existing Class II Bike Lanes in Unincorporated Santa Clara County

Location	Start	Mileage
Campus Drive	Searsville Road - Sam MacDonald Mall	1.4
Escondido Road	Campus Drive - Stanford Avenue	0.4
Junipero Serra Boulevard	Alpine Road - Page Mill Road	2.4
Palo Road	Palm Dr - Quarry Road	0.2
Peter Coutts Road	Stanford Avenue - Page Mill Road	0.6
Serra Street	Galvez Street - Campus Drive	0.3
Total Class II Bicycle Lanes:		***5.3***

Class III Bikeways

Class III bikeways are signed bike routes where bicyclists share a travel lane with motorists. Typical applications for Class III bike routes include roadways with bicycle demand but without adequate space for Class II bike lanes, low-volume streets with slow travel speeds, especially those on which volume is low enough that passing maneuvers can use the full street width, and as "gap fillers" for breaks in Class II lanes.

Palo Alto has eight miles of Class III bicycle routes, most of which are signed routes only and do not contain shared lane marking ("sharrow") markings. Application of sharrows is discussed in the proposed design guidelines. High-demand Class III bikeway corridors under 2,000 vehicles per day (vpd) and over a half-mile in length may be considered for designation as bicycle boulevards.

Table 3-4: Existing Class III Bikeways

Location	Extent	Mileage
Armarillo Avenue	Bayshore Road - Louis Road	0.5
California Avenue (CCBC 03-4c)	Park Boulevard - El Camino Real	0.3
Campus Drive	Junipero Serra Boulevard - Arguello Mall	0.7
Clark Way	Vineyard Lane - Pasteur Drive	0.6
Colorado Avenue	Cowper Street - Middlefield Road	0.2
Cowper Street	Coleridge Avenue - Loma Verde Avenue	1.4
Cowper Street	Colorado Avenue - El Dorado Avenue	0.1
Durand Way	San Mateo Drive - Sand Hill Road	0.1
Hanover Street (CCBC 03-5)	Stanford Avenue - California Avenue	0.3
Lomita Drive	Santa Teresa Street - Mayfield Avenue	0.2
Mayfield Avenue	Lomita Drive - Campus Drive	0.3
Nelson Drive/Mackay Drive	Adobe Creek - San Antonio Road	0.5
Oregon Avenue	Sierra Court - St. Francis Drive	0.1
Redwood Circle/Carlson Circle/Duncan Place	Bryant Street - Adobe Creek	0.4
San Antonio Road (CCBC 05C-13)	Byron Street - Alma Street	0.5
Santa Teresa Street	Campus Drive - Lomita Drive	0.5
Serra Mall	Via Ortega - Galvez Street	0.6
St. Francis Drive	Embarcadero Road - Oregon Avenue	0.3
Via Ortega	Serra Mall - Campus Dr	0.0
Waverly-Lathrop Connector	Waverly Street - Lathrop Middle School Path	0.1
Wilkie Way*	Charleston Road - Wilkie-Miller Bridge	0.3
Total Class III Bikeways (excluding bicycle boulevards)		8.0

** Wilkie Way lacks signs and pavement markings along this section.*

Bicycle Boulevards

Bicycle boulevards are signed, shared roadways with especially low motor vehicle volume, such that motorists passing bicyclists can use the full width of the roadway. Bicycle boulevards prioritize convenient and safe bicycle travel through traffic calming strategies, wayfinding, and other measures. One key feature is that unwarranted stop signs are "turned" - removed from the boulevard and placed on cross streets, improving bicyclists' average speed by minimizing unneeded stops. Palo Alto's Bryant Street was the first bicycle boulevard created in the U. S. The Bryant Street Bicycle Boulevard was recently renamed the Ellen Fletcher Bicycle Boulevard, after the former Vice Mayor, a local bicycle activist and Holocaust survivor.

Palo Alto defines a bicycle boulevard as a local street with low traffic speeds and volumes that contains several of the following key elements:

- Motor vehicle through-traffic is made aware of bicyclists with shared lane markings and discouraged through traffic calming measures such as speed humps and traffic circles, as well as barriers and diverters.
- Free-flow travel for bicycles is promoted by assigning the right-of-way to the bicycle boulevard at most intersections. To achieve this, unwarranted stop signs are removed for vehicles traveling on the bicycle boulevard but retained for vehicles crossing the boulevard.
- Traffic signals and other crossing enhancements are used at intersections with arterial streets, and wait times for bicyclists are minimized through the use of signal actuators that enable bicyclists to trigger the signal.
- Bridges, tunnels, or bike paths are used along a segment of the bicycle boulevard and may not allow motor vehicles to pass through.
- Reasonably continuous streets with few jogs composed primarily of straight segments at least a half mile in length.

The Bryant Street Bicycle Boulevard is exemplary, as it contains all of the elements of a bicycle boulevard. A 1982 study found that motor vehicle volumes remained consistently under 1,000 vpd along the Bryant Street corridor, despite reorientation of stop signs that also removed restrictions on through-movement for automobiles. In addition to turning stop signs, other common measures in Palo Alto to slow traffic and prioritize bicycle travel include traffic diverters, speed humps, traffic circles, and pedestrian/bicycle-only creek bridges.

Palo Alto currently has 4.2 miles of bicycle boulevards, with another 2.5 miles planned for official designation in 2011 along the Castilleja-Park-Wilkie corridor.

Table 3-5: Existing Bicycle Boulevards

Location	Extent	Mileage
Bryant Street	Redwood Circle - Palo Alto Avenue (CCBC 01-3)	3.8
Maybell Avenue	El Camino Real – Donald Drive	0.6
Total Bicycle Boulevards		***4.2***

3.2.1 Neighboring Community Bikeway Connections

Both the Santa Clara County Valley Transportation Authority (VTA) and San Mateo County have designated bikeways of regional significance that traverse or connect to the City of Palo Alto. Additionally, local bikeways in the cities of Menlo Park, East Palo Alto, Mountain View, and Los Altos/Los Altos Hills connect at the city border.

Table 3-6 lists bikeway connections from the City of Palo Alto to other Santa Clara County communities, ordered counterclockwise from the northern county line. **Table 3-7** lists the connections between San Mateo County bikeways of countywide significance and the City of Palo Alto, ordered from southwest to northeast. The table includes connections to recreational routes such as Page Mill Road and commute routes such as Middlefield Road and Willow Place Path.

Table 3-6: Connections between Palo Alto and Santa Clara County/Los Altos/Mountain View

Location	Adjacent Community Facility	Palo Alto Facility	Notes
Welch Road	Class II	Existing Class II	Connection to Stanford
Quarry Road	Private path	Existing Class II	Connection to Stanford
Park Boulevard/ Serra Street	Private path	Existing Class II	Connection to Stanford
Stanford Avenue	Private path	Existing Class II; proposed Class I	Bay to Ridge Trail segment
Page Mill Road	Class I and Class II	Existing Class I	Primarily recreational
Foothill Expressway (north)	Class II	Existing Class II	
Arastradero Road	Class I	Existing Class I	Primarily recreational
Hillview Avenue	No facility	Existing Class II	Connection to Los Altos Hills
Foothill Expressway (south)	Gap, then existing Class III	Existing Class II	Connection to Los Altos and Cupertino
Hetch Hetchy easement	Class III on Los Altos Avenue via Class I trail segment	Existing Class I (Palo Alto-Los Altos Bike Path)	Connects to Gunn High School
El Camino Real	Class II on San Antonio Road	Class III arterial bikeway	Adjacent private development may include Class I bikeway
Miller Avenue/ Monroe Drive	Proposed Class III on Del Medio Avenue; Existing Class II on California Street	Proposed bicycle boulevard	Connects north to Castilleja-Park-Wilkie Bicycle Boulevard; connection to Mountain View/San Antonio Road and to Los Altos via the Wilkie-Miller bridge and proposed path behind Palo Alto Bowl
Cesano Court / Palo Alto Bowl	Existing Class III designation along Los Altos Avenue	Proposed Bicycle Boulevard and Class I trail connection	School commute route into Los Altos across El Camino Real

Location	Adjacent Community Facility	Palo Alto Facility	Notes
Alma Street	Connects to Class II on Showers Drive via future Mayfield underpass	Proposed Class III arterial bikeway	CCBC 02-1
Mackay Drive	Gap on Nita Avenue, Class III on Laura Lane	Existing Class III; Proposed bicycle boulevard	Continues north as Bryant Street Bicycle Boulevard
Middlefield Road	Class II	Proposed Class III at San Antonio Road; Existing Class II	Mountain View connection; several block gap around San Antonio Road
Charleston Road	No facility	Gap; Existing Class II; Proposed enhanced bikeway; Proposed Class II from Fabian Way to Mountain View	Mountain View connection
Bayshore Parkway	Class II Bike Lanes	Class II Bike Lanes	Connection to Garcia Avenue

Table 3-7: Connections between Greater Palo Alto and San Mateo County

Location	San Mateo Facility	Palo Alto Facility	Notes
Page Mill Road	Proposed Class III	Existing Class II	Recreational
Sand Hill Road	Class I and II	Existing Class I and II	
San Mateo Drive	Class III	Clark Way Class III	Connects via existing overcrossing
El Camino Real	Proposed Class III	Existing private paths; No existing on-street facilities	Bicycle accommodation TBD
Alma Street	Class II	Existing Class I and II	Creek overcrossing with connecting paths (CCBC 02-1)
Willow Place Path	Class I	Palo Alto Avenue Class III; Bryant Street Bicycle Boulevard	Part of the North-South Bikeway identified by the Silicon Valley Bicycle Coalition
Middlefield Road	Class II	None; proposed Class III	Part of the North-South Bikeway identified by the Silicon Valley Bicycle Coalition
Pope Street	Class III	Proposed Chaucer-Boyce Bicycle Boulevard	Pope-Chaucer Bridge over San Francisquito Creek
University Avenue	Proposed Class II	Class II	Proposed Highway 101 overcrossing near University Avenue
East Bayshore Road	Proposed/ Existing Class II	Existing Class I and II	Bay Trail
Golf Course Path (Bay Trail)	Class I	Class I	Upgrade approaches to existing Highway 101 overcrossing at Oregon Expressway

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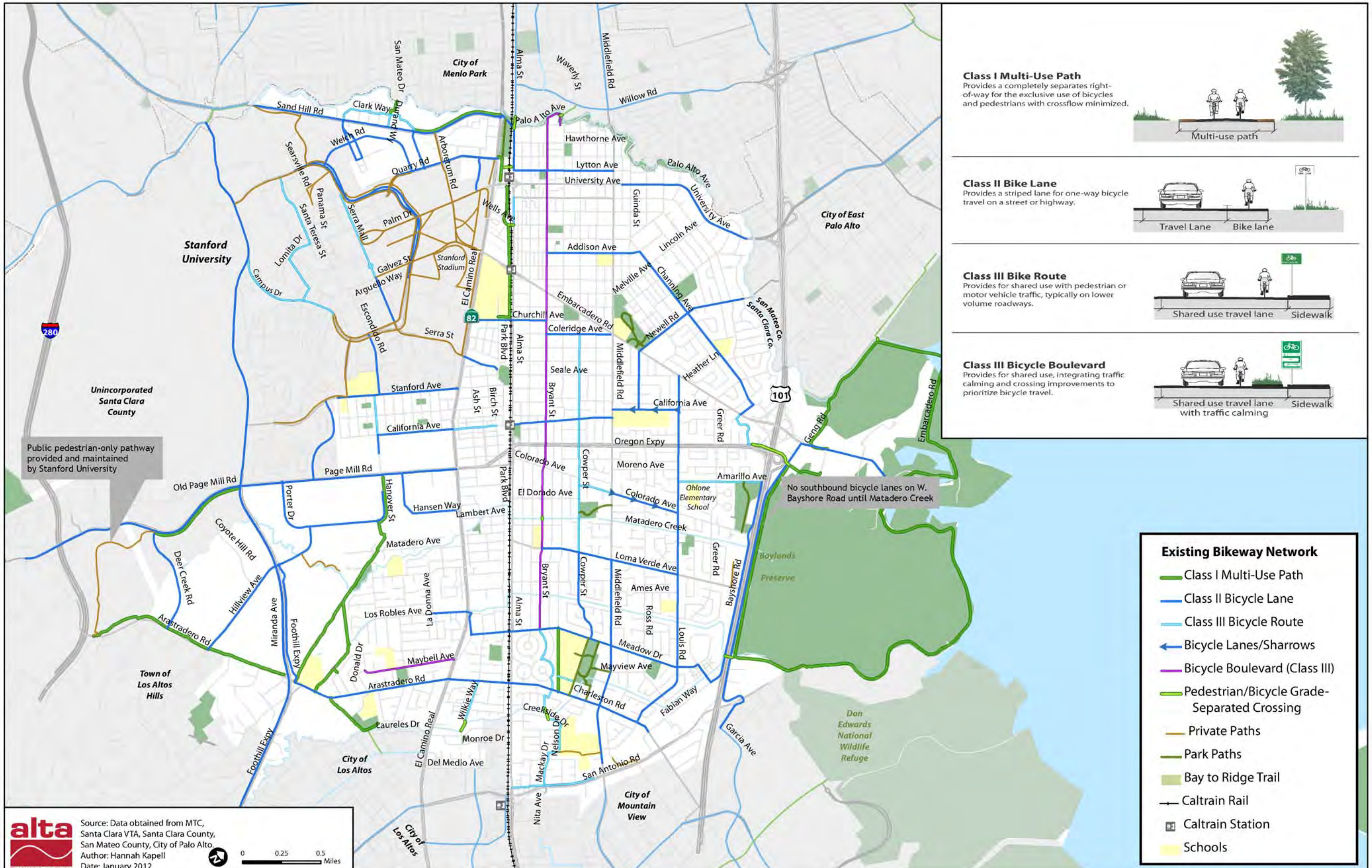

Map 3-4: Existing Bikeways

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3.3 Pedestrian and Bicycle across Barrier Connections

Non-motorized travel within Palo Alto is constrained by several key linear barriers. In the north-south direction these include El Camino Real (State Route 82), Highway 101, and the Caltrain/Alma Street corridors. In the east-west direction these include four creek corridors (San Francisquito, Matadero, Barron, and Adobe). The provision and location of barrier connections is a fundamental consideration for non-motorized travel, and there are currently long stretches where no such crossings exist. Below is a summary of existing pedestrian- and bicycle-only barrier connections. While Highway 280 is outside of the city boundary and is thus not listed as a City facility, the City strongly supports bicycle improvements and is working continually with the County to develop concept improvement plans.

3.3.1 Caltrain Undercrossings

Caltrain bisects Palo Alto in the north-south direction. While the train itself facilitates regional multimodal trips, the tracks and adjacent Alma Street corridor are a barrier to east-west bicycle and pedestrian circulation.

Homer Avenue

The Homer Avenue Caltrain undercrossing for pedestrians and bicyclists opened in 2004. Its well-designed tunnel enables bicyclists to ride their bikes separate from pedestrians between the South of Forest Area (SOFA) neighborhood to the east and the Palo Alto Medical Foundation (PAMF) and Caltrain corridor path to the west side. The structure is 18 feet wide and 70 feet long with lighting and two skylights. The undercrossing roughly aligns with the Palo Alto Medical Foundation signal at El Camino Real, whose western leg has a path connecting to Stanford's Lasuen Mall/path. Because of the potential importance of this axis as a Stanford non-motorized commute corridor, pedestrians and bicyclists would benefit from a more intuitive, signed connection between the undercrossing and signal. On the east side of the undercrossing, making Homer Avenue bidirectional for one or more blocks would create a direct bicycle connection to downtown and areas east of High Street.

The Homer Street Underpass is the most recent barrier crossing improvement in the City of Palo and accommodates both pedestrians and bicyclists.

Palo Alto Transit Center

Two undercrossings are located in the transit center at Palo Alto Station, one along the University Avenue sidewalks under Alma Street and the tracks, the other underneath and across the Caltrain station platforms approximately one block to the north. Because both tunnels are relatively narrow for the peak pedestrian volume they serve, bicyclists are required to walk bicycles through them, although two-way riding is common on the University Avenue sidewalks. Many short- and long-term improvements have been previously suggested in this area, including a wider sidewalk tunnel on the north side of University Avenue, a new undercrossing facility near Everett Avenue (at the north end of the station complex), and a transformative overhaul of the University Avenue interchanges with Alma Street, El Camino Real, Caltrain, and Palm Drive. The combined usage of the transit center undercrossings is almost certainly the highest among all barrier crossings in Palo Alto, although specific figures are not available.

California Avenue

The California Avenue undercrossing is frequently used, but it is narrow andchallenging for pedestrians with disabilities.

The California Avenue undercrossing is located at Palo Alto's other Caltrain station and connects the California Avenue business district and Evergreen Park/Ventura neighborhoods with Old Palo Alto and Midtown. It is heavily used due to its central location and the long distances to the next closest surface crossings to the north (Churchill Avenue, 0.6 miles) and south (Meadow Drive, 1.3 miles). The current tunnel should be further evaluated for compliance with ADA standards. The City should pursue opportunities for future compliance such as California High Speed Rail or Caltrain Electrification projects. Because of unsafe speeding by bicyclists and skateboarders, two uninviting but effective "maze" railings force bicyclists to walk their bikes. These mazes render the undercrossing awkward for bicycles towing short cargo and child trailers, and impassible to long bicycle cargo trailers. Bicyclists are asked to walk their bikes, but they do not always do so, which makes the area challenging for pedestrians who are also negotiating through the railings with bicyclists.

Major connectivity and bicycle parking improvements are proposed and funded as part of the California Avenue streetscape project, with additional access from the west provided by the Castilleja-Park-Wilkie Bicycle Boulevard. Bicycle lanes and low traffic volumes on N. California Avenue provide good bicycle access from the east, while Jerry Bowden Park and the Oregon Expressway interchange at Alma Street provide mixed conditions for pedestrians. Santa Clara County intends to study the replacement of the Alma Street/Oregon Expressway bridge and should identify opportunities for improved connections from the southeast. The *Santa Clara Countywide Bicycle Plan* identifies the Alma Street Caltrain undercrossing as project 03-4b.

Embarcadero Road

Embarcadero Road's underpass of Alma Street and the Caltrain line has wide sidewalks on both sides. Over 1,600 bicyclists used these sidewalks during a 12-hour period in 1978. In part because of the addition of the Homer Avenue undercrossing, Embarcadero's sidewalks now see only a fraction of this activity, yet they remain an important connection for many residents. The sidewalks in this undercrossing are of a similar design quality to those at University Avenue and they provide direct access to the Town & Country Shopping Center, Palo Alto High School (usually referred to as "Paly High"), and the Caltrain Path. Connectivity on the east side is made especially difficult by the confluence of several skewed intersections, while high traffic volumes and speeds limit the overall comfort of the undercrossing, particularly from the west.

3.3.2 Highway 101 Over/Undercrossings

Adobe Creek Undercrossing

Despite being open only five months out of the year due to seasonal flooding, the Adobe Creek Underpass carries an estimated 43,000 annual users.

The undercrossing of Adobe Creek at Highway 101 is a popular access point for the Baylands and Shoreline Park levee trails and other destinations, including Twisters Sports Center. It is generally only open for six months (April 15 – October 15) because the path surface is only one foot above dry-season water level and is regularly covered with mud and debris by even moderate storm flows. The undercrossing can be open for only a few months during unusually wet years. In the 2011-12 winter season, the City worked with the Santa Clara Valley Water District (SCVWD) to better accommodate community use by extending the use period of the tunnel to align with weather conditions. This year the tunnel was open for an additional six weeks.

The underpass is accessible from the west side of the highway via Class II bicycle lanes on W. Bayshore Road and from the east via bike lanes on E. Bayshore Road as well as an extensive network of Class I trails that extend to East Palo Alto and Mountain View. Two sets of mazes – one at the E. Bayshore access point and one on the poorly-lit curve under the highway – create low-speed points intended to minimize conflicts between pedestrians and bicyclists, but which seriously deter bicycle trailers and persons with mobility assistance devices (e.g. wheelchairs). An estimated 40,000 bicyclists and 3,000 pedestrians use the underpass during each of its half-year open periods. The *Santa Clara Countywide Bicycle Plan* identifies the Adobe Creek undercrossing as project 02-6.

Embarcadero Road Overcrossing

The overpass at Embarcadero Rd is part of the Bay to Ridge Trail, which provides a connection from the open space preserves of the Foothills through Stanford University and California Avenue business district to the Bay Trail.

The pedestrian/bicycle overpass south of Embarcadero Road near Oregon Expressway spans over 1,000 feet between St. Francis Drive/Oregon Avenue and E. Bayshore Road. Part of the designated Bay to Ridge Trail, it is the only existing year-round non-motorized crossing of Highway 101 in Palo Alto. The bridge is narrower than current Class I standards and technically requires bicycles to be walked. The east and west approaches are both located in relatively isolated locations and are in need of comprehensive upgrades to improve accessibility, visibility, and wayfinding. A recent count effort identified 49 bicycles and 12 pedestrians using the overpass during a weekday evening peak period, which equates to nearly 100,000 estimated annual users according to a non-motorized travel demand model (Alta's Seamless Travel Demand Model) developed for and used by Caltrans. The *Santa Clara Countywide Bicycle Plan* identifies the Adobe Creek undercrossing as project 03-1b.

3.3.3 Non-Motorized Creek Bridges

Six pedestrian- and bicycle-only bridges help connect important bikeways and pathways within Palo Alto. Three are located along San Francisquito Creek – two at Palo Alto Avenue in Downtown North, and one west of El Camino at Clark Way/Durand Way connecting to San Mateo Drive in Menlo Park. One bridge each across Matadero and Adobe Creeks provides exclusive through-access for bicycles and pedestrians on the unofficial southern end of the Bryant Street Bicycle Boulevard. A second bridge across Adobe Creek connects Monroe Park to Wilkie Way and the soon-to-be upgraded Castilleja-Park-Wilkie Bicycle Boulevard. These bridges are identified on both the existing and future bikeway maps.

3.4 Bicycle Support Facilities

Bicycle Parking

Bicyclists, like motorists, need a place to store their vehicle, whether a sidewalk rack to grab a coffee or a more secure bicycle locker or cage for all-day parking near transit. Vandalism, theft, and inconvenience are all main concerns for bicyclists, who typically expect parking close to their destinations. Where adjacent parking facilities are not available, bicyclists tend to lock their bikes to street fixtures such as trees and sign poles. Use of street fixtures other than bicycle racks is problematic due to impacts to pedestrian facilities, instability of the locked bicycle, and deterioration of the streetscape and Complete Street concepts. Bicycle parking is classified as short- or long-term, each with distinct standards for type, capacity and placement:

The on-street bicycle parking "corral" at the Coupa Café provides bicycle parking without impeding the sidewalk for pedestrians.

- Short-term bike parking is usually a rack on the sidewalk or an on-street corral serving people bicycling for shopping, errands, eating, or recreation. Bicycle racks should support the bicycle at two or more points and should provide a moderate level of security by allowing the bike's frame to be locked with a U-lock without lifting a wheel over the rack.
- Long-term bike parking encloses the bicycle and its accessories, and protects it from precipitation. This category is further divided into "individual-secure" facilities (bike lockers) and "shared-secure" facilities such as bike enclosures ("cages") and bike stations. These facilities provide a high level of security but are often less convenient than racks for errands and shopping because it impractical to site them on public sidewalks.

Bicycle Parking and Shower Facility Development Requirements

Bicycle parking requirements for development ensure that bicyclists have somewhere secure and convenient to park their bicycles at newly constructed buildings. The City's current bicycle parking requirements do not provide clear guidance to developers in terms of design, and location, and the rates of required parking do not address the complexities of the street environment. Private development requirements for provision of bicycle parking facilities are found in Chapter 18.83 of the Municipal Code, "Off-Street Parking and Loading Regulations." Typically, the number of parking spaces required is 10 to 25 percent of the automobile parking requirement.

Wayfinding

Wayfinding signs can help guide casual bicyclists and other users who are unfamiliar with city destinations and can help them follow corridors involving multiple turns (common in Palo Alto). Although "Bike Route" signs are located on most of the existing bicycle network (including all Class III bikeways and the "Ellen Fletcher" Bryant Street Bicycle Boulevard), bicycle wayfinding signs are less comprehensive, located only at strategic places in the bikeway network such as creek bridges and on routes connecting to the Bryant Street Bicycle Boulevard.

Wayfinding signs direct bicyclists to key destinations and assist them with following the designated network.

Source: City of Palo Alto website

3.5 Existing Programs

To shift people to bicycling and walking from other modes, a community must consider not just infrastructure improvements but also programs that support and encourage the choice to bike or walk. Many programs can be categorized according to the "Five E's": Engineering, Education, Encouragement, Enforcement, and Evaluation. The "Five E's" are commonly used to structure Safe Routes to Schools programs and are considered in the League of American Bicyclists' Bicycle Friendly City application.

3.5.1 Safe Routes to School

The City, in collaboration with the Palo Alto Unified School District and parent volunteers from the Palo Alto Council of Parent/Teacher Associations (PTAs), began to coordinate efforts to reduce congestion and improve safety for students on their way to and from school in 1994, using the traditional three E's of engineering, education and enforcement. Since 2000, when this partnership was expanded to include the 4th 'E' of encouraging alternatives to single family driving to school, the City has seen a significant and on-going increase in biking and walking to school as a direct result of these efforts. Several schools now depend on maintaining high levels of non-motorized student commuting to keep their school zones from being overwhelmed by motor vehicle drop-off and pickup activity.

In Fall 2010, the Valley Transportation Authority (VTA) awarded Palo Alto a "Vehicle Emissions Reduction Based at Schools" (VERBS) grant. With this grant the City will increase the reach and content of its existing education, encouragement and evaluation programs by extending their efforts to four "Choice Program" schools and conduct direct outreach to Spanish and Chinese language families. Because the grant was funded through the Metropolitan Transportation Commission (MTC's) Climate Action Initiative, the 5th 'E' of evaluation will also include assessment of greenhouse gas emissions reductions. Each of the following 'E' categories offers additional highlights of the Safe Routes to School Program.

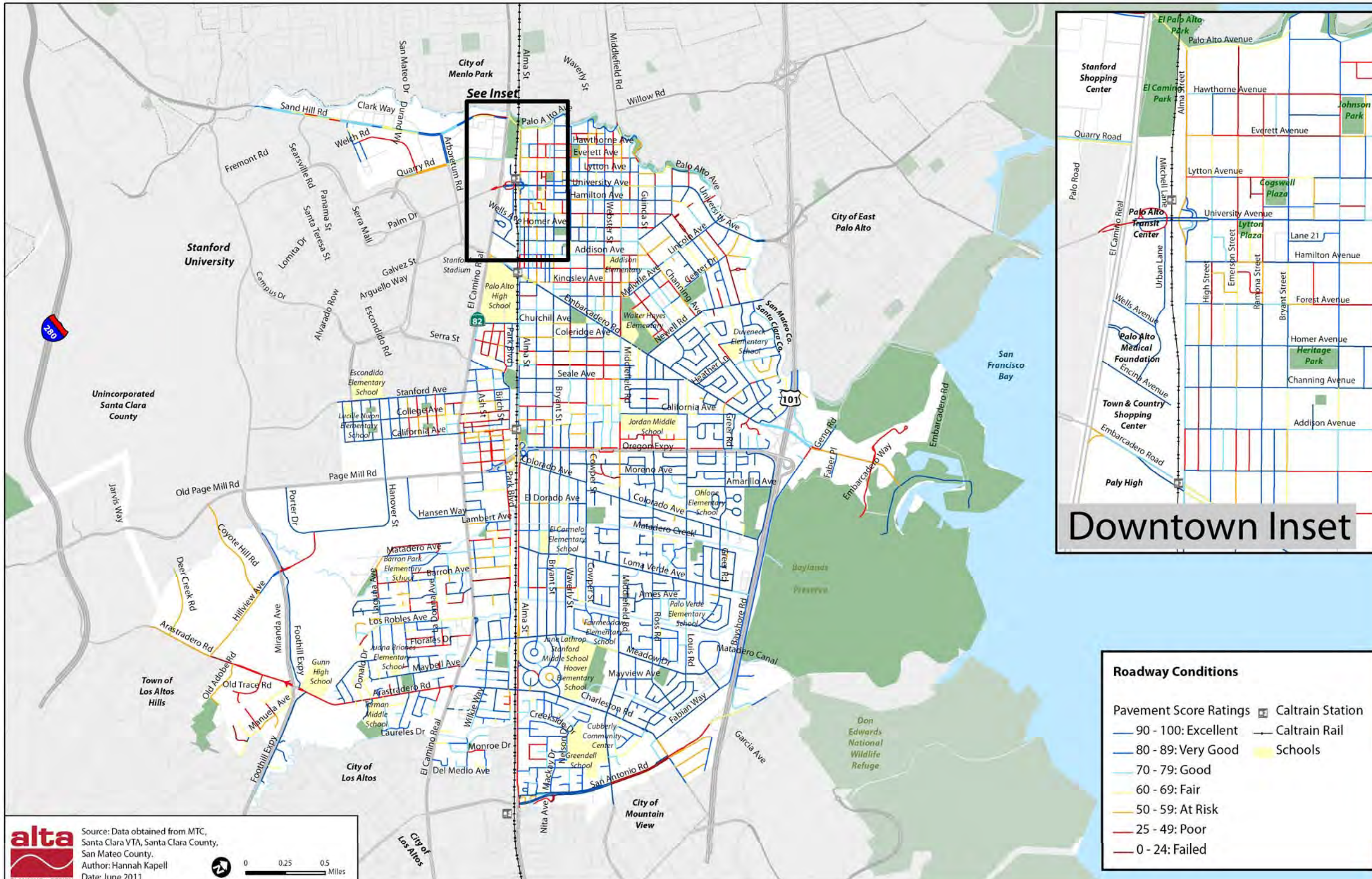
3.5.2 Engineering

Engineering strategies include City programs to provide high-quality infrastructure to support bicycling and walking. A majority of the BPTP includes discussion and recommendations pertaining to engineering strategies, although below is a select list of existing programs.

Pavement Management System (Maintenance Program)

Many bicyclists consider pavement condition when selecting travel route, which includes the quality of pavement markings, signal detection systems, and adjacent curb ramps. **Map 3-5** depicts the latest pavement quality information for Palo Alto streets, based on the Pavement Management System. Note that the map does not reflect recent improvements to Arastradero Road between El Camino Real and Gunn High School.

The pavement condition index report is updated every four years to refine the priority of future street resurfacing and surface treatment programs. Each winter, a list of streets for the annual resurfacing program is prepared with input from the Transportation Manager and Palo Alto Bicycle Advisory Committee (PABAC) to ensure that bicycle priority streets are included. Continued coordination with the resurfacing program provides a unique opportunity to implement recommendations of the BPTP 2012 and allows for efficient coordination of funding sources.



Map 3-5: Roadway Pavement Conditions

Note: map is from 2010 pavement analysis and does not reflect pavement projects from 2011

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Traffic Calming Program

Regardless of whether physical separation is provided for pedestrians and/or bicyclists, the speed and volume of motor vehicles plays an important role in providing a comfortable and safe environment. Palo Alto has specific warrants for implementation of traffic calming:[13] a neighborhood group requests the treatment, and City engineers work with the community to determine if the location is appropriate based on a checklist of factors. Speed humps and traffic circles are the City's most commonly used traffic calming devices, although these treatments are often not considered appropriate for collector arterial streets. Very few of the street closures and diverters that exist in Palo Alto residential neighborhoods were installed by the Traffic Calming Program, although these devices help prioritize certain streets for non-motorized travel and were especially popular among respondents to the BPTP online survey.

The Traffic Calming Program states that an increase of up to 25 percent of existing volumes on an adjacent local street, as motorists seek alternative routes, is an acceptable outcome of a traffic calming installation.[14] However, the resulting total traffic volume on the adjacent local street must not exceed 2,500 vpd. The City would also remove traffic calming treatments if they cause unacceptable delays to emergency services or have other unintended results as determined by City staff.

The City primarily considers traffic calming along designated school routes with 85th percentile speeds (the speed travelled by 85 percent of traffic) exceeding 32 mph. The practice of retaining stop signs at traffic circles should be discontinued (and remedied) along bicycle boulevards (if not at all traffic circle locations) due to the confusing effect of stop signs on all users and to improve local noise and air quality.

3.5.3 Education

Education programs are designed to improve safety and awareness of bicyclists and pedestrians and are geared toward all roadway users. They can include, but are not limited to, adult bicycle handling and traffic skills courses, school-based assemblies that teach children how to safely walk or ride a bike, and citywide education programs that target safety messages to all roadway users.

Youth Bicycle Education

Palo Alto schools currently offer bicycle and pedestrian safety education courses for grades K through three and in fifth and sixth grade. This program reaches over 5,000 students and includes instruction of all sixth graders by a League of American Bicyclists certified instructor (LCI). With the recently awarded Safe Routes to School VERBS grant, the City will update and expand this program.

Palo Alto has an active Safe Routes to School program that teaches students how to safely walk and bicycle.

The Parks and Recreation Department also provides youth bicycle education through the Enjoy Catalog,

13 Available online at: http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=6666
14 Based on the Traffic Infusion on Residential Environments (TIRE) index, which shows that most residents do not notice an increase of 25 percent.

which participants can register for online. One popular course provides 10-year-olds and their parents with on-bike instruction on neighborhood streets. A similar program will be included as part of the VERBS grant.

Adult Bicycle Education

Children mimic the behavior of their parents. Safe and lawful riding among children relies on parents modeling appropriate bicycling behavior. To ensure that parents know appropriate behavior, the Palo Alto Parent Teacher Association shows parents of elementary students how to teach bicycle riding skills to their children twice annually. In previous years, the program reached 120 parents annually, which will increase with the VERBS-funded expansion of the program.

Bicycle education for adults helps them communicate safe behaviors to their children and encourages bicycling for work, shopping, and other purposes.

3.5.4 Encouragement

Encouragement programs are essential to institutionalizing bicycling and walking as integral and widely adopted transportation modes. Encouragement programs are geared toward encouraging people to bicycle or walk more in their day-to-day life. They can include, but are not limited to, events such as Bike to Work Day, guided walking tours, school-based mileage contests, and bicyclist discount programs for local businesses.

Palo Alto sponsors Energizer Stations during Bike to Work Day, which provide information and incentives for people who commute by bicycle.

Bike to Work Day

The City currently encourages residents to bicycle and walk by participating in Bike to Work Day and supporting the school district programs, including Walk and Roll Days. Bike to Work Day includes Team Bike Challenges and a Pedaling for Prizes promotion at Gunn High School. The City of Palo Alto, Stanford University, and Hewlett Packard sponsor Energizer Stations, which provide information and encouragement. Many bicyclists cite Bike to Work Day as a key motivator that led them to begin commuting by bicycle.

Walk and Roll/International Walk to School Day

On International Walk to School Day, held on the first Wednesday in October, Palo Alto joins students from around the world in walking to school, with the intent of instilling a healthy commute habit for the remainder of the year. Activities such as Walking School Buses and Art Contests raise awareness about walking for transportation. Bicycling, skating, scootering, carpooling, and transit are all encouraged to help reduce the number of cars around schools.

Many Palo Alto schools also participate in a Walk and Roll Day for Earth Day every April. This event reminds students and parents that schools support and encourage walking and bicycling to school.

Walk and Roll to School Days provide encouragement for students to try walking and bicycling.

Source: Safe Routes to School Palo Alto

Way2Go Program

The City's Way2Go Program is the foundation for a variety of alternative commute programs at the City and school levels. In addition to encouraging carpooling, Way2Go programs engage City officials and staff to actively participate and provide focused programs aimed at reducing vehicle miles traveled in Palo Alto. The City currently supports school education and outreach programs through a 0.25 full-time equivalent (FTE) staff person, which will be doubled through the VERBS grant. Additional detail related to existing programs is provided in Appendix E. Policy and Plan Framework.

Bicycle Tours

In May 2011, the City hosted a tour of Park Boulevard Bicycle Boulevard with the Mayor and City Council. Community members were invited to ride the corridor and discuss potential improvements. This event was well-attended and allowed members of the public to engage with City Council on bicycle issues.

The Park Boulevard Bicycle Boulevard tour was well-attended and popular with community members.

Bike Palo Alto Event

The Palo Alto Neighborhood Green Teams host this annual family event, which includes local bicycling and safety information, helmet fitting, bicycle maintenance, and a group ride. Participants receive maps of a variety of routes with directions, while local vendors provide free treats. Some bicycle vendors provide bicycles for rent free of charge for the event. In 2011, Bike Palo Alto had over 500 participants.[15]

[15] More information: http://www.pagreenteams.org/bikepaloalto

3.5.5 Enforcement

Enforcement programs enforce legal and respectful use of the transportation network by all roadway users. They can range from formal targeted enforcement and warning stops led by police officers, to informal neighborhood-based signage programs to slow traffic.

Speed feedback signs inform drivers of their speed and encourage them to drive at the posted speed limit.

Speed Limits and Feedback Signs

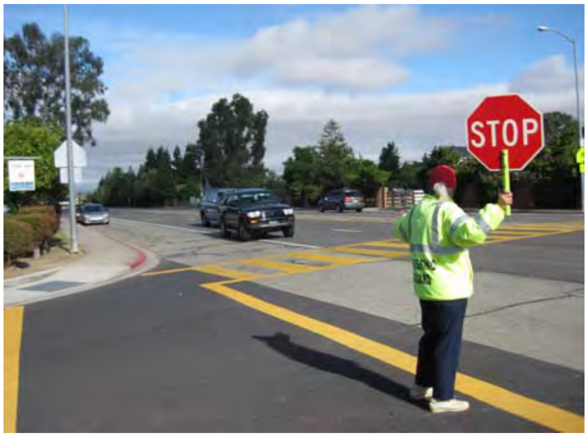
The Traffic Calming Program allows residents to request a mobile radar speed feedback trailer for qualifying streets. These trailers are mobile units that display a motorists' travel speed adjacent to a speed limit sign. Additional, permanent units have also been installed along the Residential Arterials Network, a series of 25 mph roadways that provide essential access through and across many neighborhoods.

Operation Safe Passage

The Police Department administers Operation Safe Passage, a program to enforce traffic violations committed by motorists, pedestrians, and bicyclists in and around all schools during peak commute hours. Among the violations targeted for enforcement include speeding, failure to yield to pedestrians, stop sign violations, and crossing downtown streets between closely-spaced traffic signals.

Crossing Guards

Crossing guards are critical to ensuring lawful use of roadway crossings by children and to engender respect and yield compliance by motorists. Twenty-nine locations in Palo Alto have crossing guards citywide during school commute periods.



Crossing guards direct traffic during student drop-off and pick-up times, improving safety for students.

Bicycle Licenses

The City of Palo Alto requires residents to license their bicycle. Bicycle licenses help the Police Department return stolen bicycles and identify victims of collisions.

The Fire Department and local bicycle shops issue bicycle licenses for two dollars, while Stanford University encourages all freshman to license their bicycles.

3.5.6 Evaluation

Evaluation programs measure the success of education, encouragement and engineering programs and projects. Evaluation tools may include analysis of collisions, facilities built, activity levels, utilization rates, funding, policy concurrence, and attitudinal surveys. Data collection is a key part of evaluation.

Student Hand Tallies and Parent Surveys

The City currently coordinates classroom tally counts by teachers in grades K-5 each fall to evaluate the effectiveness of its current education and outreach efforts. These tallies also allow a snapshot of mode share over time, which is graphically depicted in Section 4.1.2. Through evaluation of the VERBS grant, a parent survey will be distributed annually to help identify parents' perceptions of barriers to walking and/or bicycling to school, similar to surveys that have been implemented since 1994. Bicycle activity at the four middle and high schools is estimated by counting parked bicycles during the school day.

Bicycle and Pedestrian Counts

In 2010, the City purchased new automated counting equipment (Pyrex Eco-Counters) that will greatly expand the availability of non-motorized data to help track mode share progress and inform the design and priority of future projects. These units are stand-alone, mobile, infrared sensor-based boxes that are best applied along trails, non-motorized barrier crossings, and select screenlines.

Counting capacity will also increase as signals are upgraded to microwave detection, a technology that can distinguish bicycles from motor vehicles, and track bicycle and vehicle movements separately through intersections. A grant from the VTA's Transportation Development Act (TDA) program in 2011 will also fund the deployment of new microwave-based bicycle detection equipment at signalized intersections in the City; these new devices will also allow the City to collect bicycle count data. The City of Palo has dedicated funds to install these devices in future projects. Staff should work with PABAC to outline an implementation strategy that builds toward an annual or semi-annual counting effort consistent with the National Pedestrian and Bicycle Documentation Project guidelines.

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4 Travel Demand and Collision Analysis

This chapter provides background information related to the existing demand for bicycle and pedestrian facilities and conditions that impact bicycling and walking in Palo Alto. The first section addresses travel demand, presenting an overview of work, school, and discretionary trips, as well as transit connections, existing recent count data, and travel demand management strategies. The second section of this chapter presents an overview of collisions involving bicyclists and/or pedestrians, focusing on the causes of collisions and high-frequency locations to target improvements.

4.1 Travel Demand Overview

This section discusses the existing transportation patterns in Palo Alto and neighboring jurisdictions. The data informs recommendations by identifying opportunities to shift trips to walking or bicycling.

4.1.1 Work Commute Trips

Local Commuting within Palo Alto

U.S. Census data provides useful information for understanding bicycling and walking rates, particularly when assessing demographic trends and comparing jurisdictions. While Census data typically provides the best available snapshot of activity for most jurisdictions, it only reports the mode that residents use when commuting to work; the Census does not count trips taken for other purposes such as school trips and shopping. Thus, the Census underestimates the true number of people walking and biking in a community. For the City of Palo Alto, the most recent available Census data with detailed travel information comes from the 2006-2010 American Community Survey (ACS).

Palo Alto's bicycle commuting rate is higher than that of comparable communities and is significantly higher than the local transit commute rate – an unusual characteristic but consistent with other university-oriented communities. Walking rates are higher than other Santa Clara County communities but significantly less than the more transit-oriented City of Berkeley. Combined with work-at-home rates, approximately 21 percent of Palo Alto residents commute by means other than car or transit.

Table 4-1: Journey to Work Mode Split by Place of Residence

	Palo Alto	Berkeley	Mountain View	Santa Clara County	San Jose MSA	California	United States
Drove Alone	67.7%	40.6%	73.1%	77.1%	76.9%	73.2%	76.3%
Carpooled	6.3%	7.1%	9.6%	10.3%	10.5%	12.0%	10.4%
Transit	4.6%	17.8%	4.7%	3.3%	3.3%	5.1%	5.0%
Bike	6.9%	7.6%	3.4%	1.4%	1.4%	0.9%	0.5%
Walk	5.4%	16.5%	2.6%	2.2%	2.2%	2.8%	2.9%
Other/ Work at Home	9.2%	10.4%	6.6%	5.7%	5.7%	5.9%	5.0%

Source: American Community Survey, 2006-2010

Residents of Palo Alto generally have shorter commutes than residents of other cities in Santa Clara County and California. The sizable gap between walking and bicycling rates and the 31 percent of residents within 15 minutes of work suggests there are significant opportunities to increase non-motorized commuting rates of Palo Alto residents.

All Work Trips into Palo Alto

Palo Alto has approximately twice as many jobs as households. Thus, the travel patterns of workers from outside communities are a critical component of overall travel demand on Palo Alto roadways and non-motorized facilities. Just under two percent of all workers in Palo Alto (residents and non-residents) bicycle to work, while 1.3 percent walk.[16]

The vast majority of Palo Alto workers come from outside the city, with the majority coming from San Mateo County, as shown in **Table 4-2.** Nearly 15 percent of all workers have commutes of less than 15 minutes, and another 14 percent have commutes between 15 and 19 minutes.

Table 4-2: Origins to Work Trips in Palo Alto

From	Number	Percent of Total Palo Alto Commuters
Palo Alto	18,100	17%
Mountain View	8,100	8%
Los Altos/Los Altos Hills	3,900	4%
Sunnyvale, Cupertino	7,400	7%
San Jose	14,400	14%
Other Santa Clara County	7,000	7%
Santa Clara County Subtotal	**58,900**	**57%**
San Mateo County	23,600	23%
Alameda County	11,300	11%
San Francisco County	5,100	5%
Other Bay Area	1,700	2%
Bay Area Subtotal	**100,600**	**97%**
Non-Bay Area	3,400	3%
Total Palo Alto Commuters	**104,000**	**100%**

Source: Santa Clara Valley Transit Authority, 2007

[16] *Census Transportation Planning Package*

Nearly 30 percent of all workers live within 20 minutes of their work, despite only 17 percent living within the city limits. This data confirms that significant opportunities exist to encourage commuters living in adjacent communities to shift to bicycling to work. Additionally, improved pedestrian and bicycle access to and from major transit stops can encourage additional transit usage and transit-bicycle trip chaining for the high number of workers with commutes of 45 minutes or more.

4.1.2 School Trips

For Palo Alto, school commuting represents a significant and important component of overall travel patterns and issues. The Palo Alto Unified School District (PAUSD) serves approximately 11,000 students who mostly live in the City of Palo Alto, certain areas of Los Altos Hills and Portola Valley, as well as the Stanford University campus. The District includes 12 kindergarten-fifth grade elementary schools, three middle schools (grades 6-8) and two high schools (grades 9-12), as well as vocational and pre-school services at an additional campus (Greendell). Of the 12 elementary schools, two are currently "choice" schools that do not have enrollment boundaries. Expanding enrollment and upgrades to existing school campuses funded by the 2008 Strong Schools Bond continue to be priorities for the District.

Thanks to the City/School Traffic Safety Committee, in concert with a broader coalition that includes the City/School Liaison and Safe Routes to School Task Forces, data on student and family travel modes is available. The data, shown in **Figure 4-1** through **Figure 4-4**, indicate a clear trend toward more walking and biking to school.

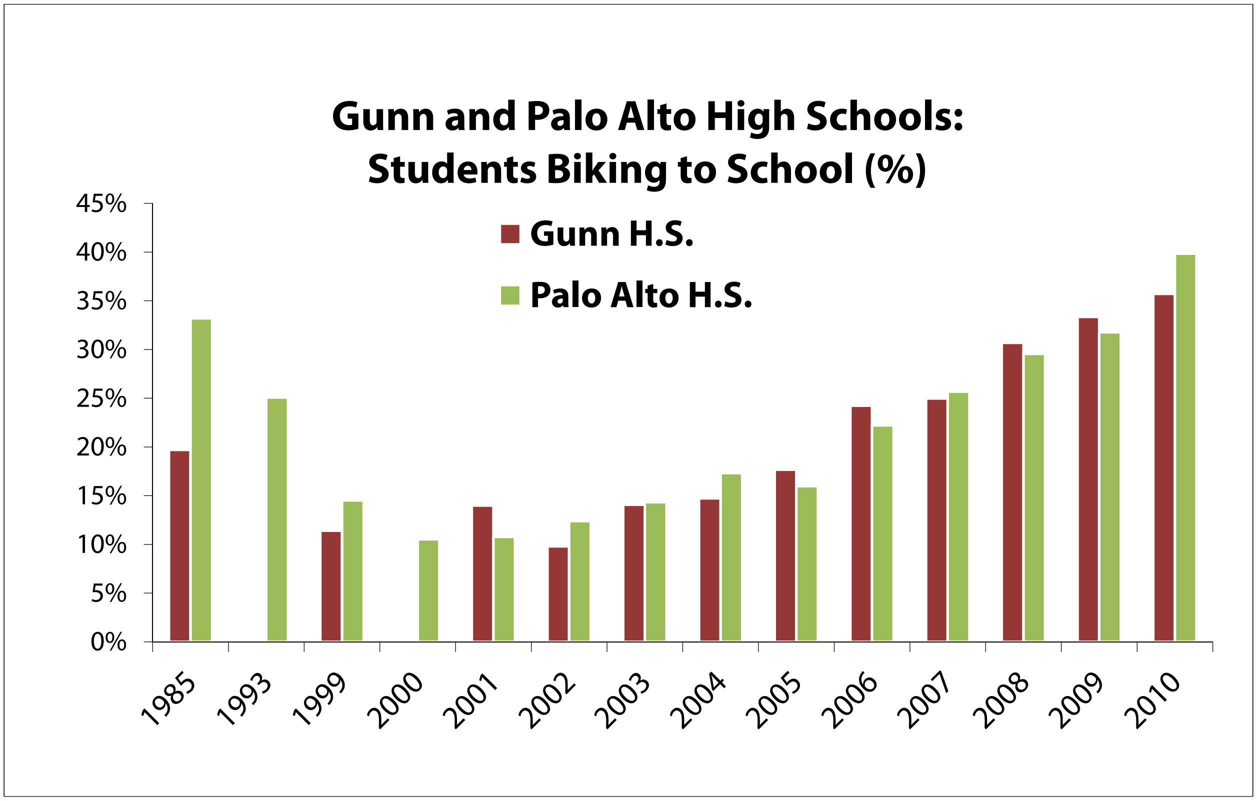


Figure 4-1: High School Bicycling Rates, 1985-2010

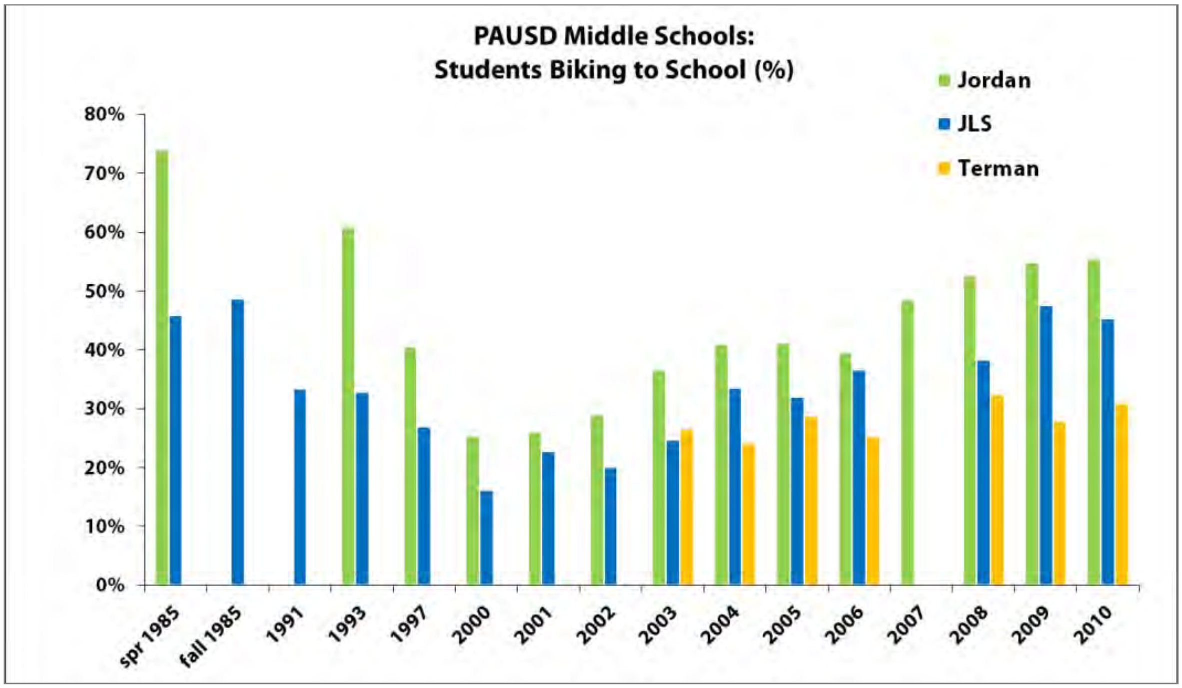


Figure 4-2: Middle School Bicycling Rates, 1985 – 2010

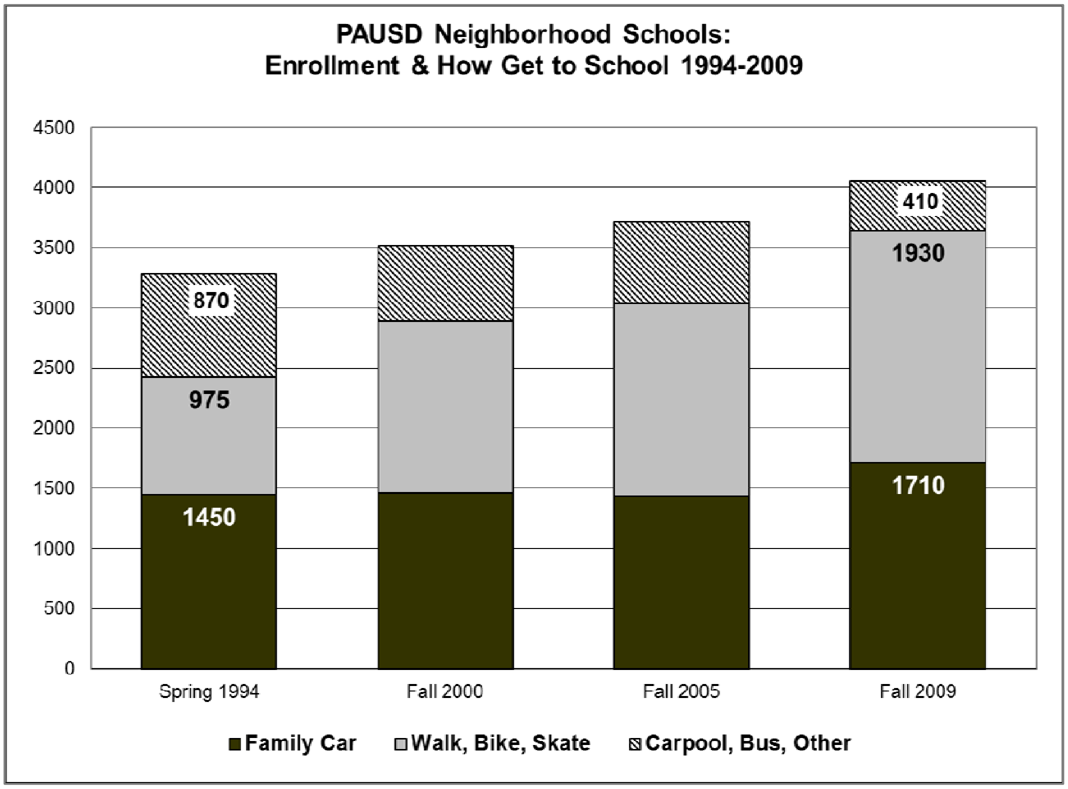


Figure 4-3: Travel Mode Snapshot and Trends, Neighborhood Elementary Schools

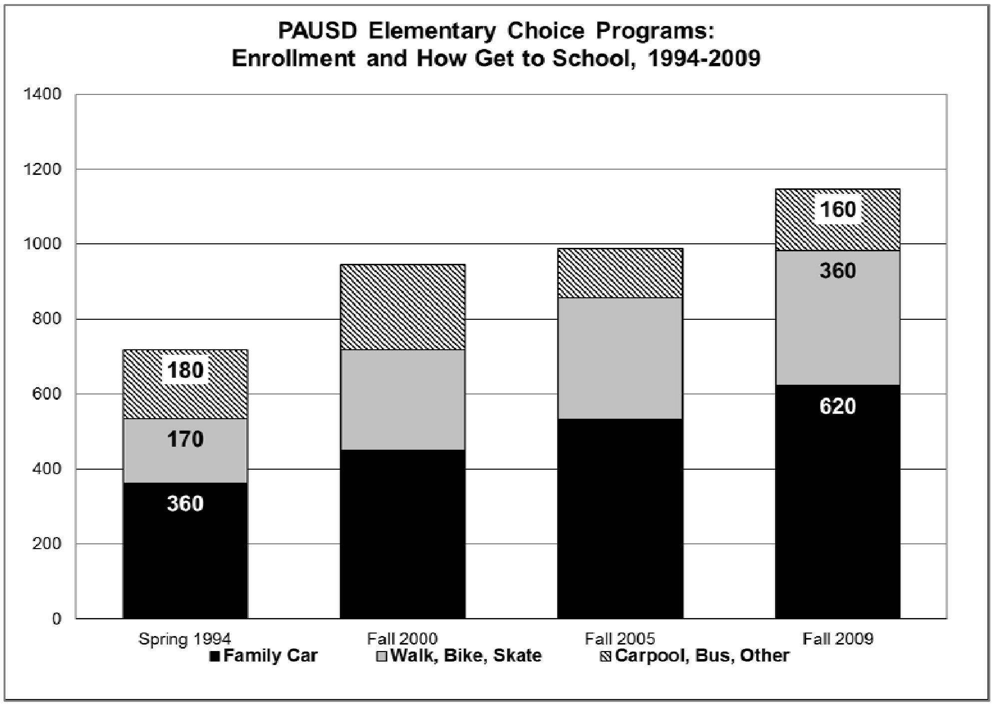


Figure 4-4: Travel Mode Snapshot and Trends, "Choice" Elementary Schools

4.1.3 Discretionary Trips

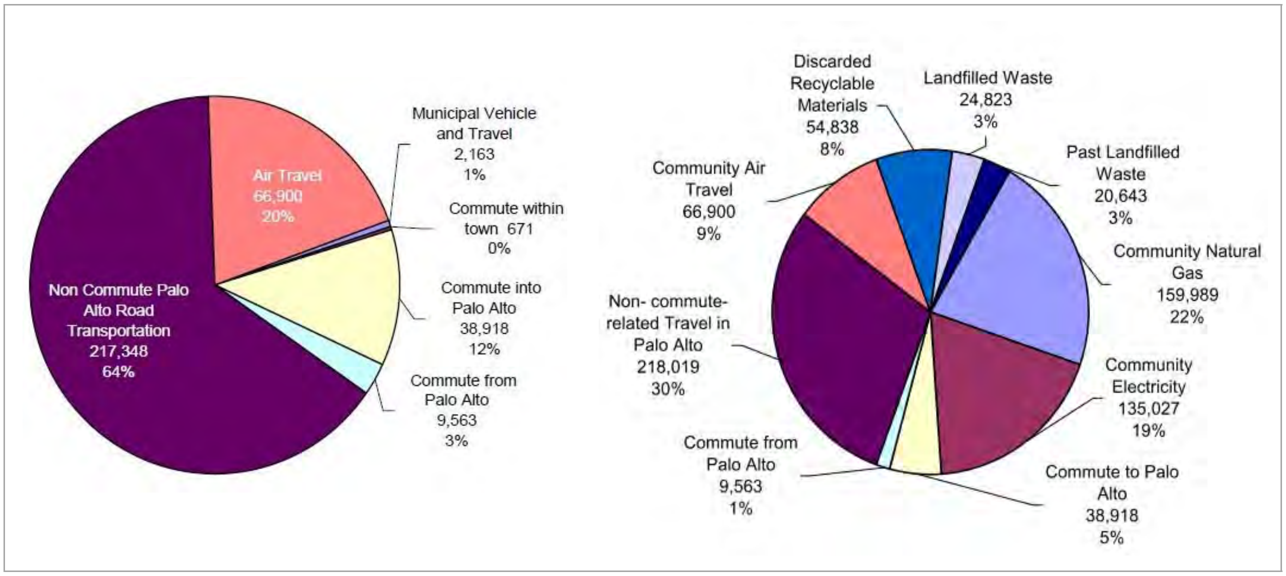
Discretionary trips are all trips that are not commute trips, including recreational and social trips as well as trips to the store, services, or other non-work or school purposes.

Discretionary Trip Generators

In addition to schools, regional commercial activity centers (like the Downtown and California Avenue Business Districts), neighborhood shopping centers, and public parks/community centers generate the majority of non-commute travel. These trips often differ from work commutes in that they are less routine and have more dispersed origins and destinations but also have a shorter average distance travelled. To encourage people to walk and bicycle more for discretionary trips, it is essential to provide targeted strategies for improving access to these discretionary trip generators. In particular, Foothills Park and Arastradero Preserve generate bicycle and pedestrian trips, but they are currently hard to access by bicycle or transit, as the main access road is Page Mill Road.

Greenhouse Gas Emissions

The City of Palo Alto 2007 *Climate Action Plan* provides information on travel-related greenhouse gas emissions (GHGs) that originate in Palo Alto. According to the *Climate Action Plan*, non-commute trips within the city account for roughly 30 percent of total emissions and nearly two-thirds of transportation–related GHGs (shown in **Figure 4-5**). Since nearly all of these trips are under a few miles in length, a significant number of them are targeted for conversion to walking and bicycling. As non-motorized improvements have a significant potential for reducing the single largest source of GHGs in Palo Alto, funding and planning for bicycle and pedestrian projects should receive greater attention as a primary climate action strategy in future plan revisions and City budgets.



Source: City of Palo Alto 2007 Climate Action Plan

Figure 4-5: Travel-Related Greenhouse Gas Emissions within Palo Alto

A Note on Discretionary Trip Needs

In order to carry family passengers or move possessions on a bicycle, people often must attach trailers, racks, and baskets or otherwise ride a larger "non-standard" bicycle. These bicycles require additional space to maneuver around obstacles and often have a larger turning radius than more traditional bicycles.

Bicycles such as tandems, tag-alongs, cargo bikes, recumbent bicycles, bicycles with trailers, or bicycles with long wheelbases are growing in popularity. In an effort to accommodate these vehicles, particularly for family travel, shopping, and other utilitarian trips where hauling and larger bicycles may be required, the City should prioritize the removal of outdated safety corrals and design for wider bicycles in future projects.

4.1.4 Transit Connectivity

While the City cannot directly improve bicycle accommodations on public transit vehicles, it can improve on-street access and recommend accommodations to transit agencies, as discussed below.

Caltrain

Palo Alto has two Caltrain stations at University and California Avenues, the first of which (Palo Alto Station) is the rail line's second busiest in terms of average daily passenger boardings and average bicycle boardings behind only the San Francisco station. A third Caltrain station just across the southern city limit in Mountain View near San Antonio Road also serves residents and workers in Palo Alto, albeit with much lower activity levels (Table 4-3). Caltrain currently runs 86 weekday trains plus weekend service. Service cuts are expected to help close a significant budget deficit; however, they will likely reduce this schedule as well as the number of trips serving the California and San Antonio Stations on weekends.

Table 4-3: Caltrain Ridership/Bicycle Counts, 2010

Station	Daily Passenger Boardings		Daily Bicycle Boardings		
	Total	*System Rank**	*NB*	*SB*	*System Rank**
Palo Alto	3905	2	209	113	2
California Avenue	891	12	76	38	8
San Antonio Road (Mountain View)	545	18	42	10	15

**29 Total Stations*

Source: Caltrain 2010 Annual Counts

The ability to accommodate more patrons with bicycles has been a focus issue for Caltrain, which allows bicycles on designated bicycle cars only. Most weekday trains have a single bicycle car with a capacity of 40 to 44 bicycles, and Caltrain tries to provide two bicycle cars (80 bicycle capacity) when rail car maintenance schedules allow. In 2008, Caltrain completed a *Bicycle Access & Parking Plan* that documents conditions at and around the Palo Alto Station area. Recommendations from that Plan include converting existing individual bicycle lockers to electronic, on-demand spaces; improved information and management of the Palo Alto Bikestation (described below); a widened tunnel underneath the tracks on University Avenue; and on-street bicycle facility improvements to Alma Street and Lytton Avenue.

At the California Avenue Station, the well-used pedestrian and bicycle underpass does not meet current ADA standards and people with bikes must dismount and walk around a safety corral. Class II bike lanes along California Avenue to the east provide good access, although the Oregon Expressway/Alma Street ramp area limits pedestrian access from the south. On the west side, Park Boulevard and the California Avenue business district generate strong pedestrian and bicycle demand. Both roadways are slated for improvements, with California Avenue set to receive a major overhaul that will include a reduced number of vehicle lanes, raised crosswalks, repaving, new bicycle parking, shared lane markings, and other improvements.

Palo Alto Transit Center

The Palo Alto Caltrain Station is part of a larger transit center that includes dedicated bus bays on the west side of the tracks north of University Avenue for the Valley Transportation Authority (VTA), San Mateo County Transit (SamTrans), the Alameda-Contra Costa Transit District (AC Transit), and local shuttle services. A Bikestation is located at the Palo Alto Caltrain Depot, which provides secure, long-term parking for 96 bicycles. As bicycles are not allowed on Caltrain cars when they are at capacity, the presence of the Bikestation enables transit riders to ride to the station and leave their bicycle at peak hours.

The transit center can be accessed via shared use trails from the north and south, as well as from bicycle lanes on Quarry Road and Palm Drive from Stanford University. Bicycle lanes on Alma Street and Lytton Avenue connect to the station from the east. The Palo Alto Bikestation provides long-term secured bicycle parking, individual bike lockers, and 61 "U-racks." Non-motorized connections within the transit center include an underpass beneath the platforms and on University Avenue, although the current configuration of on and off ramps (and insufficient lighting) limits the convenience of this connection. The long-range plan for the transit center calls for an ambitious $60+ million overhaul that would realign the interface of University Avenue, El Camino Real, the Caltrain tracks, and Alma Street and increase the separation between non-motorized and vehicular traffic.

Nearly all transit vehicles serving the station – including the free shuttles – are equipped with two-bike front-mounted racks that allow independent insertion and removal. VTA policy allows two additional bikes inside the bus subject to driver's discretion; this policy enables more bicyclists to use buses at times when the bus is partly empty but there are already two bicyclists aboard. SamTrans also allows two additional bikes aboard, space permitting. In all future fleet purchases and rehabilitation efforts by transit agencies, Palo Alto should support the procurement of three-bike front-mounted racks for additional transit-bicycle trip chaining capabilities. Such support may require advocacy to change existing state laws that limit the size and location of projections from bus vehicles (but that do not exist in other states).

El Camino Real Bus Service and Bus Rapid Transit (BRT)

VTA is currently planning upgrades to El Camino Real for the development of Bus Rapid Transit (BRT), "light rail-like" service from the Palo Alto Transit Center south and east to the HP Pavilion and Eastridge Transit Center in San Jose. To maintain fast, reliable service with buses every 10 minutes, a key component of the overall project is to revise the cross section of El Camino Real to include dedicated, center-running transit lanes with split island boarding. This treatment is known as the "4+2" option by VTA in reference to the remaining four travel lanes (not including turn lanes nor the proposed six-foot bike lanes). Service is expected to begin in 2016 with construction starting in 2014 and environmental review/preliminary engineering beginning in late 2011.

Due to a lack of expected travel time savings, the proposed "4+2" configuration will not likely extend into Palo Alto. Instead, VTA will retain the bus service in the outside travel lanes with mixed flow and upgrade the two bus stop pairs (at California Avenue and Charleston/Arastradero Road) that will service BRT. Upgrades will generally consist of "bus bulbs" that allow for in-lane stops that minimize delay and provide sufficient sidewalk width for related station amenities, including real-time information.

VTA projects that the enhanced service, in conjunction with forecasted development around the stations, will attract three to six times more passengers than the existing 522 Rapid (which BRT will replace). As such, pedestrian and bicycle improvements at and near the proposed BRT stations will be an important strategy for ensuring its success.

Stanford/Palo Alto Shuttles and 2008 Community Transit Study

The Palo Alto Shuttle is a free shuttle that runs approximately hourly on weekdays to connect residential neighborhoods, senior services, libraries, recreation centers, shopping districts, and Caltrain. There are two routes: the Crosstown shuttle runs from the University Avenue Station through downtown to the Stevenson House. The Embarcadero Shuttle runs from the University Avenue Station along Embarcadero Road to serve employers in the East Bayshore area. Stanford University also offers a free shuttle service to students, faculty, staff, and the general public. Its 15 routes serve destinations on campus and in nearby cities. Front-mounted racks accommodate two bicycles on both the City of Palo Alto and Stanford University shuttle services.

The *2008 Community Transit Study* identifies a high "brand value" of the Palo Alto and Stanford Marguerite shuttles. The Study also notes the poor transit demand and performance of the Stanford Research Park shuttle. The first finding contributes to the *Transit Study* recommendation for prioritizing pedestrian access upgrades at existing shuttle stops, while the latter finding suggests an opportunity for bicycles – especially as part of an expanded Caltrain-focused bicycle share program – to better serve Stanford Research Park commuters as part of a "last mile" solution.

Caltrain Corridor Bicycle Share Program

Bicycle share programs are essentially public transit programs aimed at providing "last mile" transit and other short connections for populations who may not otherwise choose to own or ride a bicycle. The Safe Routes to Transit (SR2T) program provided $500,000 to the VTA Pilot Bike Sharing program. In 2010, $4.3 million was secured through MTC's Climate Initiatives Program to develop an initial bike share program with 1,000 bicycles along the Caltrain corridor in the cities of San Francisco, Redwood City, Palo Alto, Mountain View, and San Jose. A hundred bicycles (out of 1,000) are earmarked for Palo Alto, which will consist of large "hub" stations at the Palo Alto Transit Center and California Avenue Caltrain stations. A small number of "pod" stations at select sites will be determined by the VTA and the City of Palo Alto.

4.1.5 Transportation Demand Management and Parking

While the bulk of transportation planning considers the "supply" of facilities and resources to accommodate existing travel demands, it is important to recognize that the "demand" for such facilities is also sensitive to fluctuation and outside factors. At a national level, this has been highlighted in recent years by the large spike in gas prices (which are again reaching their peak levels from 2008) and resultant decrease in total vehicle miles traveled and shift to transit, as well as by roadway pricing strategies and formal transportation demand management (TDM) programs. The latter are forms of encouragement and education aimed to assist individuals interested in shifting away from single-occupant vehicle use.

Transportation literature and analysis increasingly highlights the direct relationship between travel demand and the supply of parking. Although this is a famously sensitive subject throughout U.S. communities, it is important to recognize the policy and physical trade-offs between free and abundant parking availability and increasing pedestrian and bicycle demand and safety.

Beginning January 2012, employees of Stanford Hospital & Clinics and Lucile Packard Children's Hospital will receive free Caltrain passes through the Caltrain GO Pass program. New developments including Birch Plaza have also participated. TDM programs should continue in Palo Alto and, where possible, new developments should participate in the Caltrain GO Pass program.

4.1.6 Stanford University General Use Permit Agreement and Medical Center Expansion

Any discussion of travel demand in Palo Alto is not complete without reference to the enormous influence Stanford University has on all aspects of local travel. A General Use Permit (GUP) agreement with the County Development of University property essentially caps the number of peak period trips to and from campus at 2001 levels. As the campus has sought to expand, this agreement has helped focus new investments in transit (of which the Marguerite Shuttle is a highlight), bicycle facilities, and the development of a comprehensive and successful Transportation Demand Management (TDM) program with a half-time TDM coordinator for the Research Park area.

The agreement, however, does not include the Stanford Research Park or Stanford Medical Center, both of which generate high travel demand that is primarily auto-oriented. A traffic mitigation and public benefit package approved in May 2011 as part of the Stanford Medical Center expansion identifies nearly $5 million in direct spending on pedestrian and bicycle improvements. This amount does not include significant expenditures for the expansion of the Stanford TDM and Marguerite shuttle programs.

4.1.7 Existing Pedestrian and Bicycle Counts and Traffic Volumes

The City of Palo Alto does not regularly conduct bicycle or pedestrian counts nor are private developments or capital projects required to provide counts. As such, there is limited data on existing activity for particular streets or bikeway segments and on overall pedestrian or bicycle activity trends in the city. The recent purchase of electronic pedestrian counters and plans for the installation of "smart" signals that can detect bicycles will dramatically improve the City's ability to collect and analyze activity levels. However, these efforts are too recent to provide sufficient data for the *Bicycle and Pedestrian Transportation Plan* (BPTP) development process.

The *2003 Bicycle Transportation Plan* does provide a useful, but limited, snapshot of bicycle activity through historic counts at key over/underpasses and bridges along with a count map. The Plan shows the results of 12-hour bicycle counts in 1997 conducted at a larger set of screenline locations. The University and California Avenue undercrossings, along with the Bryant Street Bicycle Boulevard at California Avenue, exhibited the highest volumes in 1997 with between 830 and 898 total bicycles counted. San Francisquito Creek bridge crossings, the Bol Park Path at Arastradero, and Galvez Street at El Camino Real also stood out with between 411 and 543 bicyclists.

Additional activity assumptions and count information was derived from several other documents, including the *Stanford Hospital Expansion Environmental Impact Report* (EIR), the *South Palo Alto Safe Routes to School Plan*, the *El Camino Real Master Planning Study*, and City of Palo staff memos related to specific project studies. In helping identify, develop, and prioritize bicycle and pedestrian facilities and recommendations, the BPTP 2012 considers the City's traffic volume data map from 1999 **(Figure 4-6)**. Due to the age of this data, it is recommended that the City conduct counts and develop a new volume data map for future planning.

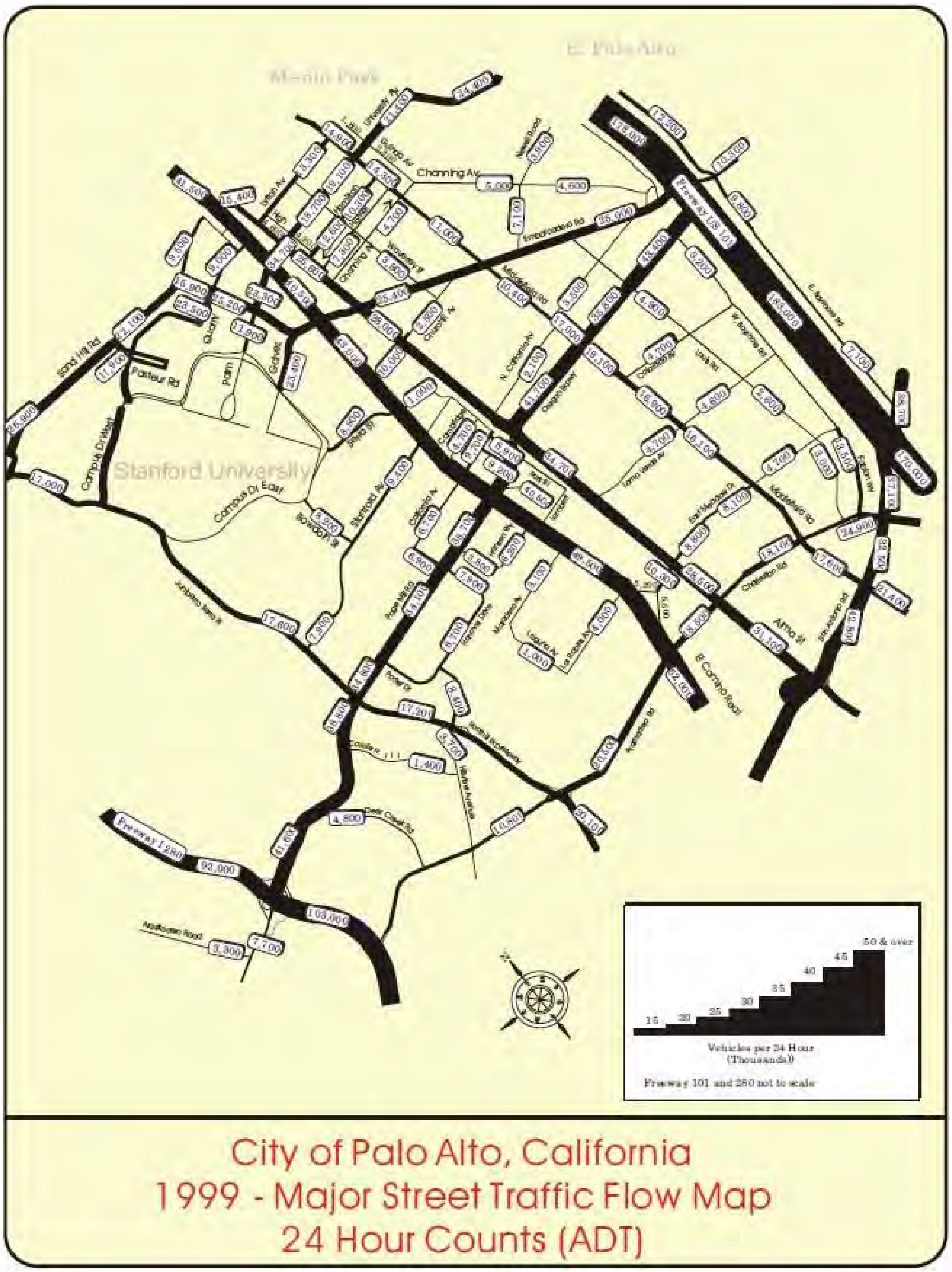


Figure 4-6: Citywide Traffic Volume Map

4.2 Collisions Documentation and Assessment

Analysis of bicycle and pedestrian collision data provides the City with a basis for infrastructure and programmatic recommendations that can improve safety of bicyclists and pedestrians. Collision data comes from the Statewide Integrated Traffic Records System (SWITRS). Because SWITRS is a repository for all police departments to submit traffic records, data is sometimes incomplete due to varying reporting methods. While collision data is sometimes incomplete and does not capture the safety performance of trails nor the frequency of "near misses," it does provide a general sense of the safety issues facing bicyclists and pedestrians in Palo Alto.

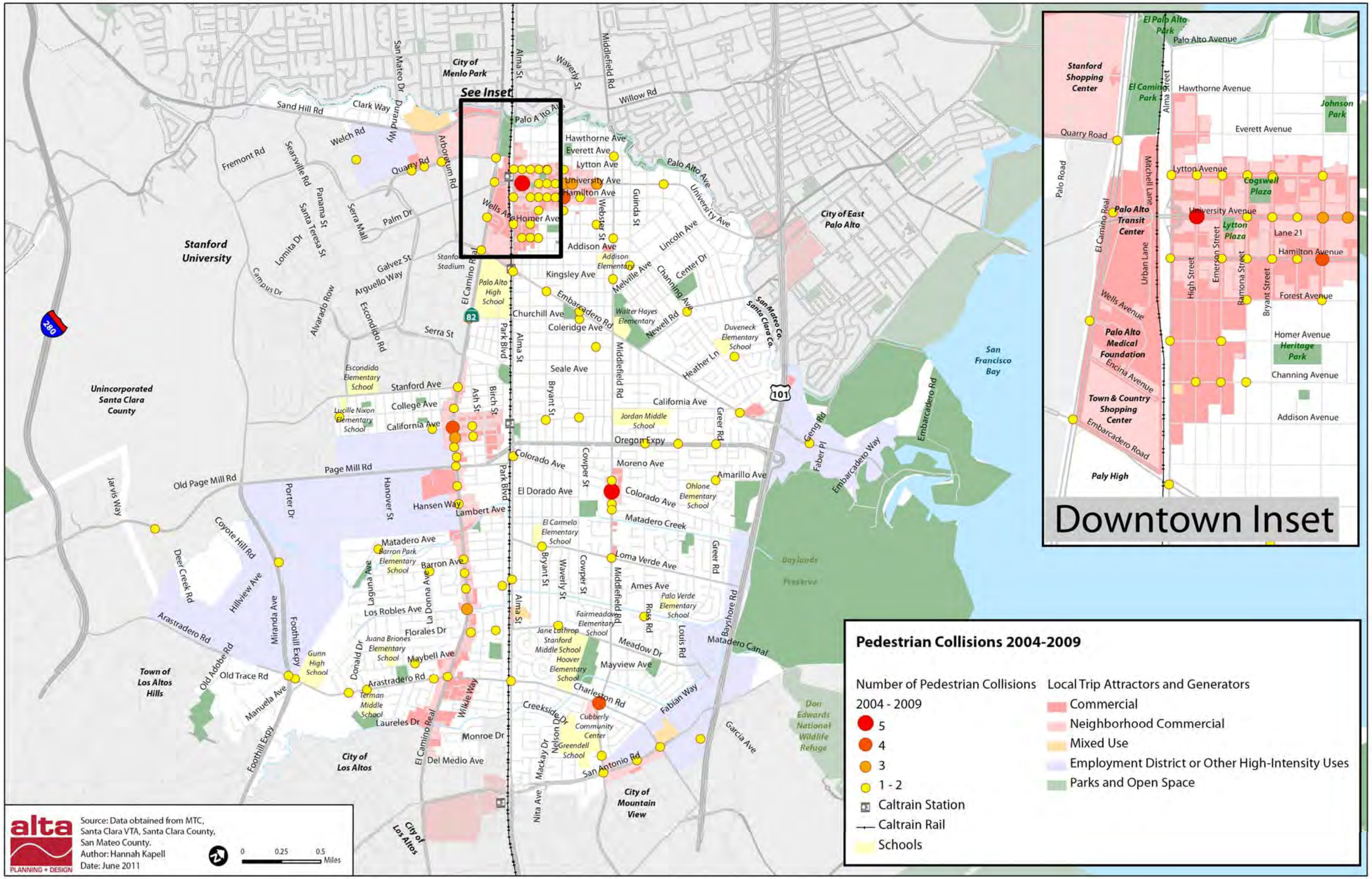
4.2.1 Annual Collision Totals

Analysis of bicycle and pedestrian related collisions for the 2004 through 2009 reveals the number of bicycle and pedestrian collisions remained relatively consistent, with a few exceptions. The number of collisions increased significantly in 2008 for pedestrians and in 2005 and 2009 for bicyclists. Without additional information concerning bicycle and pedestrian activity levels (i.e., count data), it is extremely difficult to distill any safety trends or risk.

Table 4-4 provides the annual totals for bicycle and pedestrian collisions in Palo Alto from 2004-2009. Map **4-1** and **Map 4-2** illustrate the locations and frequencies of these collisions. Note that the map orientation is tilted to simplify discussion of "N/S/E/W" bikeways and other linear features.

Table 4-4: Bicycle and Pedestrian Collisions by Year

Year	Pedestrian Collisions	Bicycle Collisions
2004	25	59
2005	21	92
2006	23	64
2007	26	67
2008	36	64
2009	14	80
Total	***156***	***420***



Map 4-1: Pedestrian Collisions 2004-2009

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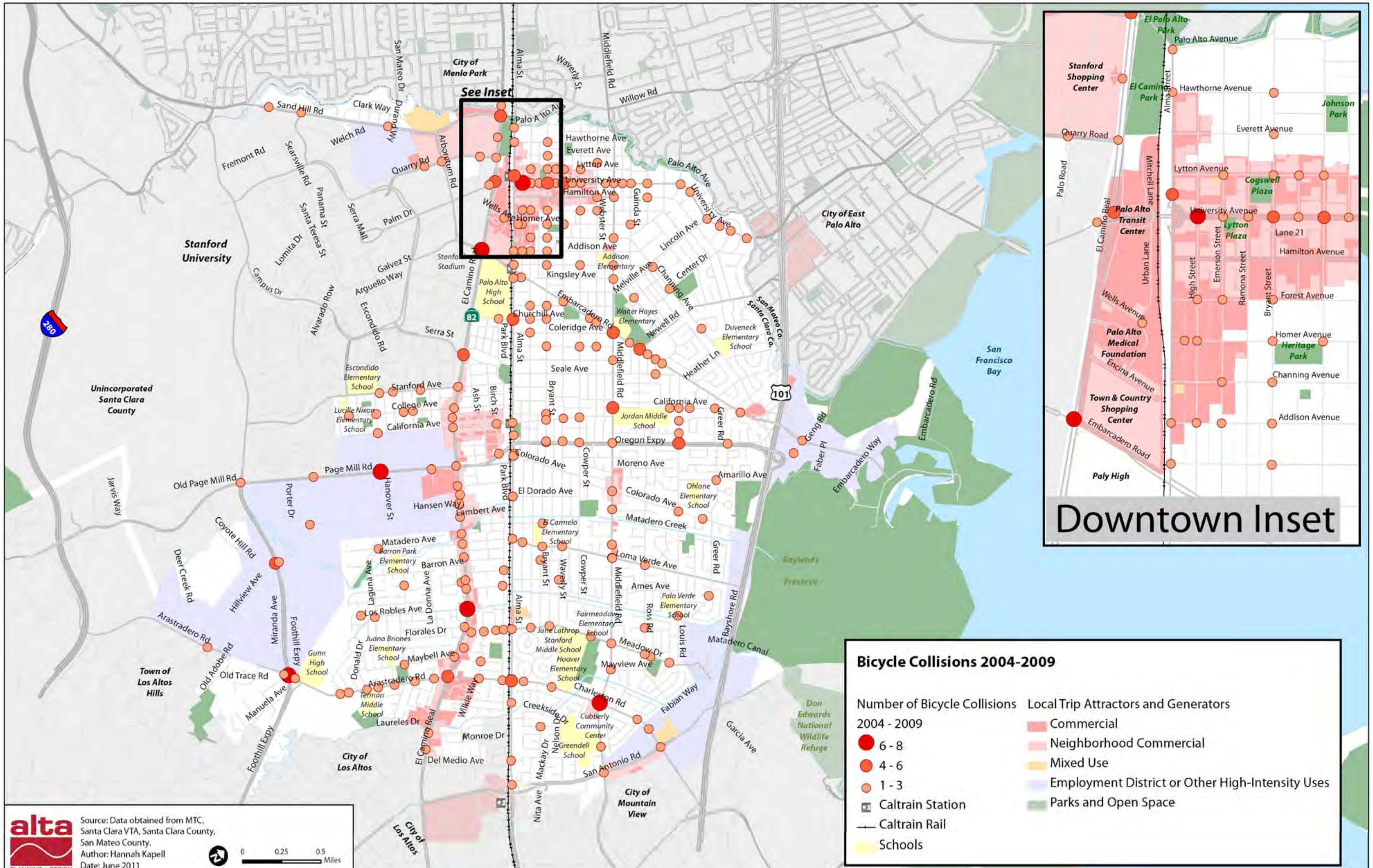

Map 4-2: Bicycle Collisions 2004-2009

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4.2.2 Trends in Bicycle and Pedestrian Collisions

Decline in Total Bicycle Collisions 1990's versus 2000's

The 2003 *Bicycle Transportation Plan* shows that the total number of bicycle collisions recorded for 2004-2009 (420) is significantly less than the total collisions from 1993-1998 (504). While a lack of count data makes comparing collision rates difficult, there is reason to believe that collision risk has also declined over the same period. This assessment is based on the increased rates of school commute bicycling documented in **Figure 4-1** (page 4-3) and **Figure 4-4** (page 4-5), and is consistent with findings from other cities where increases in bicycling and safety are associated with expanded installation of dedicated bicycle facilities.

Time of Day

Many collisions (one-third of the totals for both modes) occur between 2 pm and 6 pm, which is the peak travel time in the afternoon. This time period combines the afternoon school commute and job commute time periods, limiting further analysis regarding impact to school-age populations. There are significantly fewer pedestrian collisions in the morning peak as compared to the evening peak, while bicycle collisions are similar over the same time periods.

Party at Fault

The reporting officer determines the party at fault for bicycle and pedestrian collisions. Motorists were at fault for 44 percent of collisions, although 29 percent of collisions did not identify a party at fault. Motorists most commonly violated pedestrian right-of-way, while pedestrian collisions were most commonly categorized into "pedestrian violation," which likely includes pedestrians crossing at a location other than the crosswalk, against a light, or otherwise breaking the law.

No trend was apparent regarding party at fault for collisions involving bicyclists. Bicyclists were reported as being at fault for 39 percent of collisions, compared to motorists being at fault for 31 percent of collisions. Twenty-nine percent of collisions did not have an assigned party at fault. The data show a high rate of wrong-way riding. Variations in the quality of Class II bikeways may explain this finding, as well as lack of good connections to or from trails and the need for additional education for bicyclists and motorists of all ages.

Injury Severity

Pedestrians are the most vulnerable street users and are more at risk of suffering a severe injury during a collision. In Palo Alto, pedestrians most often suffer low-grade injuries (i.e., visible injury or complaint of injury) while walking in a crosswalk.

Unlike pedestrian-related collisions, where SWITRS records if a collision occurred in a crosswalk, SWITRS data does not record if bicycle related collisions occurred in bikeways, (e.g., if a collision occurred in a bike lane). However, SWITRS collects the action responsible for a bicycle related collision. At the top 10 collision locations, most bicycle-related collisions are broadside collisions, of which 91 percent resulted in injury and was the cause of one fatality.

High Frequency Collision Locations

Under the current protocol, the reporting officer estimates the nearest intersection to record the collision location. Locations with the highest frequency of collisions provide insight into problem areas and problematic behaviors. Cause of crashes at these locations indicates potential solutions that would decrease collisions involving bicyclists and pedestrians in Palo Alto both at these key locations and citywide. While these 'hot spots' are important for analysis and 2012 BPTP recommendations, it should be recognized that this is a relative term; one collision per year was the average for high pedestrian crash locations, while high bicycle crash locations had 1.6 collisions per year, on average.

El Camino/Los Robles Avenue at El Camino Real is a high-frequency pedestrian and bicycle crash location, likely due to its unusual geometric design and importance as a school commute and neighborhood route.

The vast majority of collisions that occurred at the locations with the highest frequency of pedestrian collisions were identified as motorist at-fault incidents. Almost half of these (45 percent) involved motorists colliding with a pedestrian in a crosswalk. The locations that experienced the most frequent **pedestrian** collisions include:

- University Avenue and High Street (5)
- Middlefield Road and Colorado Avenue (5)
- Charleston Road and Middlefield Road (4)
- California Avenue and El Camino Real (4)
- Hamilton Avenue and Waverley Street (4)

At high-frequency bicycle collision locations, three intersections had six collisions each with reported parties at fault. Broadside collisions accounted for 64 percent of collisions. Locations that experienced the most frequent collisions involving bicyclists include:

- Middlefield Road and Charleston Road (8)
- El Camino Real and Los Robles Road (8)
- El Camino Real and Embarcadero Road (8)
- University Avenue and High Street (7)
- Foothill Expressway and Arastradero Road (7)
- Page Mill Road and Hanover Street (7)
- El Camino Real and Charleston Road (6)
- El Camino Real and Sand Hill Road (6)
- Alma Street and Churchill Avenue (6)
- University Avenue and Bryant Street (5)
- Embarcadero Road and Middlefield Road (5)

5 Needs Analysis and Recommended Programs

This chapter outlines priority issues for improving bicycling and walking in Palo Alto based on analysis of existing conditions and key opportunities. The first section describes programs and project types that address deficiencies and/or result in benefits to both bicyclists and pedestrians. The subsequent two sections are organized according to specific mode, while the final section includes a summary of programmatic recommendations organized according to the "Five E's" as outlined in Chapter 3.

5.1 Promoting Nonmotorized Transportation

While bicyclists and pedestrians have different facility and support needs, several programs/projects can substantially benefit both modes. These include a robust data collection effort to support project evaluation; a "Complete Streets" planning and design process (checklist) to better integrate pedestrian and bicycle upgrades with street maintenance activities; new Across Barrier Connections (ABC's) that provide shared pathways over major facility gaps; additional urban design and placemaking strategies; and more regularly occurring temporary street closures and community events. Each of these is discussed in greater detail below.

5.1.1 Data Collection

Addressing the lack of existing bicycle and pedestrian count data and updating the citywide traffic volume data (the current map dates back to 1999) are two of the highest priority needs identified in this Plan. Regularly documenting and assessing actual bicycle/pedestrian activity will help Palo Alto target investments where they are most beneficial and measure progress towards achieving stated goals for bicycling and walking rates as established in Chapter 2. Where projects recommend potential significant changes to roadway configuration and/or circulation patterns, being able to assess specific traffic conditions (both general "screenline" volumes and key turning movement locations) for both modes is critical to final design and approval. Furthermore, having verified pedestrian and bicycle counts can make an important contribution for improving future activity level estimates (i.e., non-motorized demand modeling).

A quality data-monitoring program can also help Palo Alto obtain funding for new projects. Most grant programs require awardees to monitor the results of funded projects, including a baseline count and usage over time. Cities with established bicycle and pedestrian monitoring programs have an advantage over other cities when pursuing funding, especially where they are able to suggest a relationship between rising activity levels and new investment(s) over a substantial period of time. Data collection, including traffic speeds and volumes, crashes, compliance, delay, or other factors is also an essential tool for analyzing the success of any project, particularly projects that employ innovative or new treatments.

In addition, the pending update to Palo Alto's *Comprehensive Plan* includes a focus on Multi-Modal Level of Service (MMLOS), which is a tool for assessing how well a street serves the needs of all users, including automobiles, busses, bicycles, and pedestrians. This methodology requires considerable data about infrastructure and walking and bicycling activity, which can be collected as part of this effort.

As noted in Section 4.1.7, the City of Palo Alto has purchased (and plans to purchase additional) electronic pedestrian counters for trails and specific screenline locations; and has funding to install "smart" signals that can count bicyclists and pedestrians at key intersections. While the City will be strategically deploying these devices at school locations as part of the Safe Routes to School program, it should also develop a citywide program to collect baseline/trend line activity and begin requiring counts for new public and private projects. All regular (annual, semi-annual) citywide count efforts should be planned in accordance with the National Pedestrian and Bicycle Documentation Project methodology[17] and include organizing/training of local volunteers to help maximize the number of count locations. By establishing and dedicating staff resources to a formal count program or initiative, Palo Alto can begin to document progress on increasing walking and biking rates via a 'Report Card' and build community support and awareness for future projects.

5.1.2 Major Maintenance Projects and Complete Streets

Palo Alto's high expectation for the maintenance and preservation of existing assets helps keep many on-street bikeways, multi-use paths, and sidewalks in a reasonably safe and attractive condition. Particularly for bicyclists and other users of wheeled devices (i.e., wheelchairs and strollers), the presence of smooth and regular surface conditions can be a major factor in choosing one's route and reaching it comfortably. The City should thus continue to support, and expand where feasible, existing maintenance programs aimed at sidewalks, curb ramps, multi-use paths, and roadways.

Alma Street between the Mountain View border and El Dorado Avenue is tentatively planned for repaving in 2012. Future paving and bicycle/pedestrian priorities should be coordinated as far in advance as possible to maximize design and funding opportunities for new and improved facilities. (Image from Google Streetview)

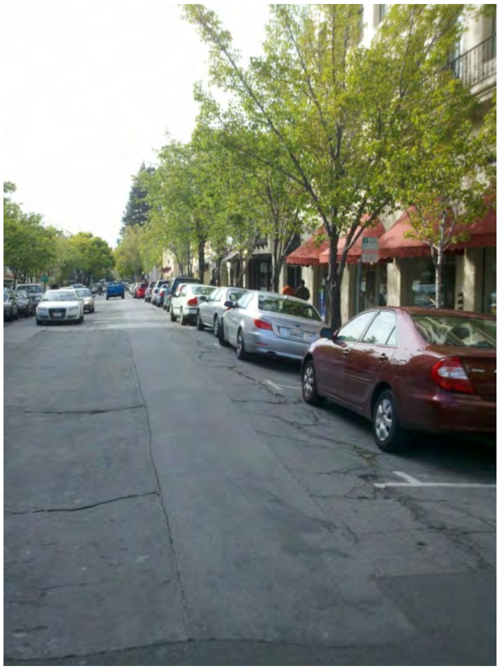
Roadway resurfacing and reconstruction projects provide special opportunities to reconfigure arterial and other roadways for improved pedestrian and bicycle facilities that may otherwise be infeasible due to their scale. Leveraging these opportunities requires significant planning and coordination years in advance of project implementation. This is due in part to the fact that large projects require multiple review cycles, but also because outside grant funding and/or traffic analysis is often necessary. A good example of project coordination is Santa Clara County's Oregon Expressway repaving project, to which the City of Palo Alto is contributing funding for the inclusion of a bicycle-only signal treatment at Ross Road (similar to those installed on the Bryant Street Bicycle Boulevard). Similar early coordination

[17] *The National Bicycle and Pedestrian Documentation Project Website has more information: http://bikepeddocumentation.org*

within the City has provided for a future bikeway facility on San Antonio Road between Charleston Road and Middlefield Road, planned for implementation in 2012. The City's on-going coordination efforts along the Caltrain corridor and with VTA's El Camino Real Bus Rapid Transit may also present opportunities to reconfigure multiple intersections and/or create new Across Barrier Connections by leveraging other projects to the benefit of non-motorized users.

Palo Alto has an aggressive paving schedule over the next several years, which includes significant stretches of the Lytton Avenue, Channing Avenue, California Avenue, Arastradero Road (west of Gunn High School), and Alma Street arterials. Although coordination between the Planning and Public Works Departments takes place on an annual basis to help prioritize on-street bicycle maintenance, it may be helpful to develop more explicit bicycle prioritization criteria and provide a three- to five-year tentative project list to maximize coordination opportunities. Other proposed bikeways planned or potentially eligible for paving priority in the near future (as identified by the pavement condition map in Chapter 3) include:

- Park Boulevard (multiple segments): proposed bicycle boulevard
- Emerson and Ramona Avenue (downtown): proposed Class III bikeways / "shared streets"
- Everett Avenue: proposed bicycle boulevard
- Webster Street and Kingsley Avenue (multiple segments): proposed bicycle boulevards
- Middlefield Road (segments): Class III shared arterial
- Embarcadero Road (east of 101): existing Class II bike lanes, potential buffered bike lanes and proposed trail maintenance/extension (Geng Rd, municipal golf course frontage)
- Laguna and Barron Avenue: Proposed Class III bikeways in the Barron Park neighborhood



This Plan identifies Ramona (above) and Emerson Streets as desirable shared (Class III) bikeways that should be high priority candidates for maintenance funding and Complete Streets planning in the near future.

To ensure compliance with both the letter and intent of the state's "Complete Streets" mandate, the City should also develop a project checklist for all significant capital and maintenance projects. While MTC has developed such a checklist and has made it a requirement for several grant programs[18], no form is currently required of locally funded projects to formalize a coordination and decision-making process. A customized Palo Alto Complete Streets Checklist might also request additional information and activities (such as conducting counts or reviewing utility and Parks Department *Capital Improvement Plan* priorities) that go beyond the minimum MTC requirements.[19]

[18] See http://www.vta.org/bike_information/library/btg/Update_07_Jan_11.pdf.
[19] Sample of a more comprehensive localized checklist: http://www.seattle.gov/transportation/docs/ctac/2011_04_19Final%20Draft%20Checklist.pdf

5.1.3 Interjurisdictional Connections

Due to the large number of commuters entering and leaving Palo Alto on a daily basis, as well as the major recreational opportunities afforded by nearby open spaces and trails, it is crucial for this Plan to address connections across the official City boundary. As pedestrians or bicyclists enter and leave Palo Alto, they should be able to ride on similar bicycle facilities and be directed toward activity centers, rather than having a bike lane or shared roadway connection end abruptly at the boundary without any sort of bikeway through the neighboring jurisdiction. **Table 3-6** and **Table 3-7**: Connections between Greater Palo Alto and San Mateo County document the existing and proposed bikeways that cross jurisdictional boundaries, both within Santa Clara County and between San Mateo County.

Key barriers between Palo Alto and neighboring jurisdictions include San Francisquito Creek to the north, San Antonio Road to the east/south, and Foothill Expressway/Highway 280 to the south and west. Some of these barriers are discussed in the following section. Other connections will require ongoing collaboration and coordination with neighboring jurisdictions.

5.1.4 Across Barrier Connections (ABC's)

Palo Alto has multiple linear barriers that present challenges for bicycling and walking, including Highway 101, Caltrain/Alma Street, and several creek water bodies. These barriers require large, expensive construction projects such as bridges or tunnels. The following is a short summary of the major barrier connection priorities and opportunities for the Palo Alto area, termed "ABC's" by the Santa Clara Valley Transportation Authority (VTA).

Photo simulation of the preferred conceptual design of a year-round overcrossing of Highway 101 at Adobe Creek (Image by Bellomo Architects)

Adobe Creek Highway 101 Overcrossing

The recent *City of Palo Alto Highway 101 Over/Undercrossing Feasibility Study* identifies a pedestrian and bicycle overcrossing at Adobe Creek as the preferred alternative for improving connections across Highway 101 from South Palo Alto to the Baylands and Bay Trail. Such a connection would provide a year-round alternative to the seasonal undercrossing and nearby San Antonio Avenue highway overpass (whose conditions are much less favorable to walking and bicycling). Based on the preliminary outcomes of the feasibility study, the City of Palo Alto is actively pursuing funds for the environmental review and permitting, design, and construction of the proposed structure. Total projected cost is estimated between $6 – $10 million. An estimated 100,000 bicyclists and pedestrians would use the bridge each year, a figure that would rise as adjacent bicycle connections improve and area land uses adapt.

Matadero Creek Caltrain/Alma Barrier Connection

The 1.3-mile distance between the existing Caltrain undercrossing at California Avenue and the surface crossing at Meadow Drive represents the longest stretch of track barrier in Palo Alto. The lack of east-west connectivity is a major issue for the Cal-Ventura area, a mixed-use neighborhood with potential for new residential and mixed-use development near the Fry's Electronics site and along El Camino Real. To the east of Caltrain lies the Matadero Creek maintenance road and proposed creek trail that extends through Midtown and eventually to the Baylands. This Plan recommends the City undertake a feasibility study to determine the specific alignment and phasing opportunities for the Matadero Creek Trail. The study's scope should include an alternatives analysis of the potential undercrossing options near the creek (or overcrossing compatibility pending Caltrain/High Speed Rail plans).

University Avenue/Palo Alto Transit Center Undercrossings (Enhanced)

The 2008 Caltrain Comprehensive Access Plan includes a recommendation to widen the sidewalk along the north side of University Avenue under Caltrain, an existing undercrossing that experiences high volumes of pedestrians and bicyclists. A wider undercrossing with better lighting would allow for safer passage by bicycle and for transit patrons coming to and from the staircase directly underneath the station. Despite a second non-motorized undercrossing approximately one block to the north within the transit center, improved University Avenue undercrossings (the other sidewalk undercrossing experiences similar demand) would yield a more visible and direct linkage for both transit and downtown-related trips. Likely competitive for federal and state funding, this medium-term improvement concept should be studied for its compatibility with the longer-term vision of a completely reconfigured Palo Alto Intermodal Transit Center in coordination with Caltrans.

The University Avenue/Palo Alto Transit Center undercrossing is narrow and has poor visibility.

California Avenue Caltrain/Alma Undercrossing (Rebuild or Retrofit)

Reconstruction of the existing tunnel to be more accommodating is a long-term citywide priority due to its importance as a regional transit and business district connection and proximity to expected growth. The location of existing underground utilities, unfortunately, would force a much deeper and more expensive tunnel than similar proposed facilities. In the short-term, the City will be improving lighting, signage, and bicycle access to the west entrance of the undercrossing as part of the upcoming California Avenue streetscape improvement project.

Matadero Creek Highway 101 Seasonal Undercrossing

The existing Santa Clara Valley Water District (SCVWD) maintenance road along Matadero Creek under Highway 101 is not a legal, bicycle and pedestrian undercrossing. With reconfiguration of the approaches and addition of lighting, railings and signage, however, this road could be upgraded to a seasonal public trail similar to the existing Adobe Creek undercrossing. The recent *Highway 101 Over/Undercrossing Feasibility Study* estimates the cost of these improvements at approximately $1 million in 2010 dollars. Public use of the facility, which could be further studied as part of a Matadero Creek Trail Feasibility Study, would require an approved joint use agreement between the City and SCVWD.

The existing SCVWD maintenance road along Matadero Creek could be upgraded to provide a seasonal undercrossing of Highway 101 toward the Baylands. Its design should be further explored as part of a Matadero Creek Trail Feasibility Study.

Page Mill Road/Interstate 280

While Page Mill Road and Highway 280 are technically under the purview of Santa Clara County and Caltrans, respectively, the City of Palo Alto strongly supports bicycle improvements in this area and is actively working with these agencies to improve access to the Arastradero Open Space Preserve and other recreational destinations west of Highway 280. This interchange has double (two lane) ramps both to and from the highway, and experiences particularly high vehicle volumes and speeds. Although Class II bicycle lanes are provided in the westbound direction along Page Mill Rd, bicycle and pedestrian crossings of these ramps can be dangerous and there is limited opportunity for improvement with the current lane and ramp configuration. Potential improvements include reconfiguring the highway ramps for slower speed, yet efficient, vehicle travel or grade separation of non-motorized and vehicle traffic.

Peers Park Caltrain/Alma Street Barrier Connection at Seale Avenue

This Plan proposes a new Caltrain barrier connection concept at Peers Park between the Churchill Road surface crossing and California Avenue undercrossing. This connection would link the Serra Street/Park Boulevard and Stanford Avenue east-west bikeways (along with the north-south Castilleja-Park-Wilkie Bicycle Boulevard) across Caltrain to Seale Avenue, a low-volume residential street. With direct access across Middlefield Road to the Community Center and Jordan Middle School complexes, such a route would provide an inviting alternative to the Churchill/Coleridge Avenue corridor for school commutes and other trips, and if established should trigger the implementation (or further development) of Seale Avenue as a bicycle boulevard.

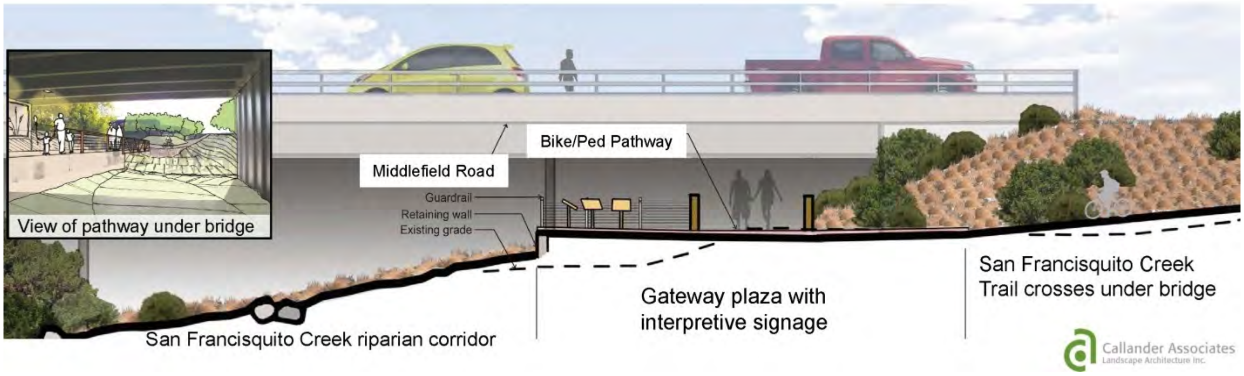


Figure 5-1: Concept for a pedestrian and bicycle path under Middlefield Road Bridge
(Source: San Francisquito Creek Joint Powers Authority).

El Camino Park Caltrain/Alma Barrier Connection at Everett Avenue

This undercrossing was proposed as part of the 2003 Bicycle Transportation Plan and potential (partial) funding for its construction was identified as part of the Stanford Medical Center expansion project. Further analysis through the 2012 BPTP has revealed significant utility conflicts and higher priority improvements to an adjacent facility (University Avenue undercrossing). Regardless, this connection would further reduce the barrier effect of the Caltrain corridor at a key location and should be considered a potential long-term ABC project.

Creek Barrier Crossings

Several additional barrier-crossings are proposed along or across creek corridors that are appropriate to highlight as ABC's. The first is under Middlefield Road at the border with Menlo Park, where the San Francisquito Creek Joint Powers Authority (SFCJPA) is championing a new bridge undercrossing as part of a shared-use creek path from Alma Street to East Palo (Woodland Avenue). Although not identified as a high priority for bicycle commuting, this project would nevertheless provide an attractive grade-separated crossing of a busy four-lane arterial (Middlefield Road) where there is a long stretch without a signal.

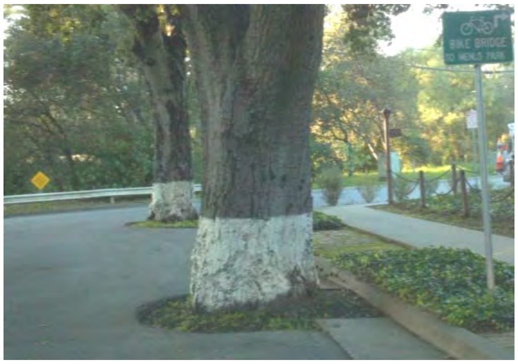
A second creek barrier crossing is at Newell Road bordering East Palo Alto, where the City has identified funding from Caltrans and the SFCJPA to replace the existing, narrow roadway bridge. Considered functionally obsolete and a flood hazard by these agencies, the new bridge is expected to include pedestrian and bicycle facilities but should be carefully studied for compatibility with the nearby Highway 101 overcrossing proposal (see above section) and enhanced bikeway opportunities identified by this Plan.

Two pedestrian-bicycle only creek bridges are also proposed as part of the Sterling Canal Trail concept just west of highway 101. These new crossings would connect Class I trail segments across Barron and Matadero Creeks to provide a continuous north/south recreational corridor from Greer Park to the fast-growing southeast corner of Palo Alto.

Other Jurisdiction Across Barrier Connections

Although not technically in Palo Alto or proposed as high priorities by City staff, two other planned barrier connections are important to document in this Plan. The first is a proposed overcrossing of Highway 101 in East Palo Alto, which was the highest bicycle priority identified in the City's *2012 Bicycle Transportation Plan*. With an option for a touchdown at Newell Road near Woodland Avenue, there is potential for direct linkage to the Gateway 101 Shopping Center and the Bay Trail from Palo Alto's Community Center and adjacent neighborhoods. The City of Palo Alto should support East Palo Alto's efforts to improve the creek and provide a crossing.

The other anticipated barrier connection is at the former Mayfield Mall site in Mountain View. The City recently approved a large residential development proposal that includes a dedicated bicycle and pedestrian undercrossing of the Central Expressway at the San Antonio Caltrain Station. This connection could directly improve connections for South Palo Alto residents headed to the transit station or San Antonio Shopping Center via the Miller Avenue and Mackay Drive proposed bicycle boulevard connections.



Streets without sidewalks or with rolled curbs can benefit from the use of shared space concepts. Trees or other strategically placed obstacles in the roadway, such as this example from the Bryant Street Bike Boulevard, communicate the need for drivers to slow down and may be an effective substitute for sidewalks where they are not desired or feasible.

A successful shared space application within a private shopping center in Marin County. Yellow ADA rumble strips differentiate travel lanes from exclusive walking areas for persons with sight impairments, while overhead catenary lighting helps maintain and enhance a pedestrian character.

5.1.5 Intentionally Designed Shared Spaces

Roadways and parking lots intentionally designed without curbs separating pedestrians and vehicular traffic are increasingly popular in the U.S. These may include slower-speed residential streets and private courts where sidewalks may not be desirable due to aesthetics (as with the Barron Park neighborhood). With the goal of making the street comfortable for living and playing (and uncomfortable to drive faster than 10-15 mph), shared space elements often include special roadway paving materials and intentional obstructions (e.g. trees, staggered parking stalls, etc.) to differentiate them from traditional roadways.

Shared space can also help define and activate public gathering spaces while retaining vehicular access. Many successful contemporary, or "lifestyle," shopping centers

Special treatments that visually knit together vehicle and pedestrian spaces can help calm traffic and distinguish areas for recurring events and closures.

(of which Town and Country is an example) employ this strategy for parking lots abutting retail services. In higher traffic commercial applications, color-contrasting detectable (a.k.a. rumble) strips are an important feature to ensure proper accommodation for sight-impaired users.

5.1.6 Temporary Spaces and Recurring Events

Festival Streets

Festival Streets are public places or a portion of a public roadway that are officially designated – and specifically designed – for repeated temporary closure to vehicular traffic and use by pedestrian-oriented special activities. Typically considered for non-arterial streets near parks, plazas, transit stations or commercial areas, festival streets might also include surface parking lots that have similar qualities and/or already host special events.

Palo Alto's collection of public parking lots, side alleys, and non-arterial streets in the California Avenue, Downtown, and Midtown commercial areas are all candidates for festival street designation. The blocks between University and Hamilton Avenues on Ramona and/or Emerson Street are especially intriguing since they are non-arterials that link downtown with the South of Forest Area; contain (virtually) contiguous surface parking, alley and plaza public spaces; and are proposed bikeways that could benefit from reduced weekend parking activity and recurring destination events. Also identified as a priority for maintenance, the City should explore in the short-term whether Ramona and Emerson Streets have future potential as festival and/or shared spaces.

Alternative Use of On-Street Parking Stalls (aka 'Parklets' or 'Flex Zones')

Several communities, including San Francisco and Mountain View, have unique streets or programs designed to provide flexible use of the parking areas adjacent to sidewalks for commercial or open space use. This strategy increases sidewalk width for amenities, improves the business environment, and provides intriguing and special experiences for pedestrians and passing observers. Often, these activities may be allowed under existing café permits or with minor changes to such regulations. Properly designed temporary structures, often referred to as 'parklets', can last for years and are low-cost alternatives to permanent bulb outs. Because they are temporary, cities can also remove or relocate unsuccessful uses with little consequence.

Other strategies to manage the right-of-way for pedestrian priority include permitting the alternative (temporary) use of on-street parking spaces, which can help provide amenities like café seating, landscaping, and bicycle parking while clearing up the sidewalk to provide a wide travel path relatively free of obstacles.

San Francisco's Pavement to Parks program recommends parklets only in areas that have limited public space, narrow sidewalks, or no parks. The areas should have existing conditions that attract people to the space, such as retail and high pedestrian activity. Generally, community benefit districts, storefront business owners, non-profit institutions, and community organizations sponsor and implement parklets.

'Ciclovias' or Sunday Streets

Sunday Streets events provide an opportunity for a community to come together around bicycling and walking.

"Ciclovía" is a term for temporary, recurring events in which multiple streets are closed to traffic and opened up for citizens of all ages and backgrounds to interact with each other through exercise, entertainment, and fun. Originally developed in Bogotá, Colombia, these events have quickly and recently spread throughout the U.S. as a strategy to promote active lifestyles, increase access to parks and recreation facilities, and celebrate/support local merchants and artists. Often customized with a more straightforward name such as "Sunday Streets", these events are free to the public and generally occur a handful of times over the summer (if rotating routes) or on a weekly/monthly basis if recurring on the same streets. Some of the proven benefits/successes of Ciclovía-style events include:[20]

- Focused public attention on active transportation and physical fitness
- Focused economic development that celebrates downtown and/or neighborhood eateries, merchants, and culture
- Opportunities for residents to explore areas of the City that they may not frequent, including areas that may otherwise be uncomfortable to walk/bike/jog during normal operation

5.1.7 Public/Private Partnerships

Cities throughout the country have utilized a variety of alternative partnerships with public organizations to develop facilities and encourage non-motorized transportation use. Whether with developers, planners, or individual members of the public, such partnerships could leverage City resources to promote bicycling and walking.

Bike Rack Program

The City currently offers free bike racks to businesses in Palo Alto. Businesses are responsible for installation of the racks. However, the program is not well-publicized and few businesses take advantage of it. This program should be better marketed to local businesses, potentially through brochures and/or information about the benefits of bicycle parking.

Development Certification Programs

The City could encourage designs that promote bicycling and walking by prioritizing or requiring that projects meet established standards in bikeability and walkability. One example is the Leadership in Energy and Environmental Design - Neighborhood Development (LEED-ND) program, which recognizes developments that are environmentally responsible and sustainable. To qualify for LEED-ND, the development's location and design must reduce environmental impacts and promote proximity between

[20] *From Ciclovias Recreativas of the Americas Fact Sheet, 2008.* http://cicloviarecreativa.uniandes.edu.co/english/index.html

housing and jobs, enabling alternative transportation choices. However, due to the extensive checklist of qualifications, few infill developments can meet the standards of LEED-ND.[21]

An alternative to the LEED-ND designation, the emerging Sustainable Transportation Analysis and Rating System (STARS) is a performance-based, agency-driven, and transportation-focused program. Projects can be certified for improving access to jobs/schools, housing and goods; reducing petroleum use and greenhouse gas emissions, and reducing transportation capital and operating costs. Palo Alto could require that plans meet one or more of STARS' "core credits," such as Access, Climate and Energy, and Innovation. Alternatively, for a particular project, the City could prioritize proposals that would meet one or more of these credits, or offer incentives to developments that meet the criteria.[22]

Parking District Fees

Palo Alto could consider developing a Community or Transportation Benefit District (TBD), which would implement a parking tax to fund transportation improvements within the district. The City would be required to develop a plan specifying the transportation improvements to be funded by the TBD. The plan should determine whether the funds will be used on an ongoing basis for smaller projects such as bicycle parking, or if they will be collected for a specified period to fully fund a large project or to serve as a match for state or federal grant funds.

A TBD can fund any transportation improvement that is necessitated by existing or reasonably foreseeable congestion levels. This can include maintenance and improvements to city streets, investments in transportation demand management, and other transportation projects identified in a regional transportation planning organization plan or state plan.

Palo Alto currently has two existing Parking Assessment Districts in the Downtown and California Avenue business districts. These are set up to repay previous bonds for garage projects and to fund on-going maintenance projects, but do not include bicycle facility improvements.

Volunteer Groups

Residents and community members are excellent resources for garnering support and enthusiasm for bicycle and pedestrian facility improvements. The City could work with volunteers to substantially reduce implementation and maintenance costs, particularly for unpaved paths on City-owned land. Local schools, community groups, or a dedicated neighbors group may help sponsor projects, possibly by working with a local designer or engineer. Work parties can be formed to help clear right-of-way where needed. Local construction companies can donate or discount services. Potential volunteers include neighborhood and other community groups, including Eagle Scouts for a community-service project. A great example of such a partnership is the SWTrails group in Portland, Oregon, who build and maintain trails, organize group hikes, and advocate for bicycling and walking resources.[23]

[21] *More information is available online at: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148*
[22] *Additional information is available at: http://www.portlandonline.com/transportation/index.cfm?a=319882&c=34749*
[23] *More information is available at: http://swtrails.org/*

Tourism Maps

The City could look into partnering with the Chamber of Commerce or the Palo Alto Downtown Business and Professional Association to print bicycle maps or walking maps of downtown. These could be funded by local businesses and include advertisements and coupons, as well as identifying shopping opportunities and other tourist destinations. Such maps are often made available free of charge at downtown businesses and transit centers, and they encourage tourism, walking, and bicycling. An example is a map made for St. Louis, Missouri, which uses symbols to indicate services and shows attractive illustrations of key destinations.[24]

Attractive walking and bicycling maps can be developed in coordination with downtown businesses or tourist services.

"Friends of" Groups

A "Friends of Palo Alto Bicycles" advocacy organization could be formed to ask local businesses for incentives or discounts to give to bicyclists or pedestrians at events. The group could help support and conduct outreach for bicycle-related projects, maximizing public-private funding opportunities. For trail projects, the group could hold a fundraiser in which individuals finance a small portion of the trail. Jackson County, Oregon had a "Yard Sale," in which the Bear Creek Greenway Foundation sold symbolic "yards" of the trail and placed donor's names on permanent markers that are located at each trailhead. At $40 a yard, the organization raised enough money in private cash donations to help match their $690,000 Transportation Enhancements program award.

One notable opportunity for public involvement is support for an Open Streets or Sunday Parkways type event (discussed in **Section 5.1.6**). While the City should lead programming for such an event due to the need for permitting, outreach, and other tasks, strong public support and volunteer availability will help make such an event a success. Information about such partnerships is available on the Open Streets Project website (openstreetsproject.org), including advocacy manuals and volunteer training.

5.2 Bicyclist Needs and Recommendations

The bicycle network should accommodate all types of bicyclists, from confident, experienced users who would rather ride in traffic and minimize travel time, to others who would rather travel a little out-of-direction or wait longer to cross a street in order to avoid riding on streets with large numbers of motor vehicles or high vehicular speeds. This section identifies types of bicyclists as well as specific bikeway facility and supporting facility types appropriate for different bicyclists.

Bicyclists' needs and preferences tend to vary by the purpose of their trip; utilitarian trips are made by commuter bicyclists going to and from work or school as well as by people who use bicycles to go shopping or run other errands, while recreational trips can range from a short family outing to a local park to a long distance group ride or something in between. Less-experienced recreational riders or riders with children tend to prefer riding on multi-use paths or on streets with low motor vehicle speeds

[24] *The map is available online at: http://www.smart-trips.org/downloads/smart_trips_highland_park_map.pdf*

and volumes. Other recreational riders may prefer riding on a major street that provides signalized street crossings, minimizing their need to stop.

Palo Alto has existing facilities for bicyclists making both recreational and utilitarian trips. While experienced bicyclists may not require significant infrastructure, providing high-quality off-street facilities and bicycle boulevards is likely to attract recreational bicyclists from around the Bay Area.

5.2.1 Accommodating "Interested but Concerned" Bicyclists

Recent developments in bicycle facility planning and design have focused largely on one principle: separating bicyclists – visually, psychologically, and physically – from automobile traffic, or on mixing bicyclists with low volumes of traffic traveling at low speeds. This focus stems from the popularity of national programs such as Rails to Trails, planning research of bicycle-friendly cities in Europe and Canada, and from the common finding that fear is the number one reason people do not bicycle more in the U.S.

According to the bicycle coordinator with the City of Portland, OR:

> "Riding a bicycle should not require bravery. Yet, all too often, that is the perception among cyclists and noncyclists alike… Survey after survey and poll after poll has found again and again that the number one reason people do not ride bicycles is because they are afraid to be in the roadway on a bicycle. They are generally not afraid of other cyclists, or pedestrians, or of injuring themselves in a bicycle-only crash. When they say they are "afraid" it is a fear of people driving automobiles."[25]

Based on a theory developed in Portland and corroborated elsewhere in the U.S., planners often refer to four types of bicyclists (and their general prevalence in society) when targeting bike facilities and programs aimed at reducing fear. As depicted in **Figure 5-2,** a majority of people are considered "interested but concerned" with respect to bicycling, a target audience that typically includes females, young families with children, and active seniors less confident at sharing the road with motor vehicle traffic. Cultivating these potential bicyclists demands both engineering solutions that reduce motor vehicle interactions and education/encouragement efforts to proactively engage and support reluctant populations.

By developing and sustaining a model Safe Routes to School program and inventing the prototype for a bicycle boulevard (Bryant Street), Palo Alto has made significant efforts to attract the "interested but concerned" demographic. Higher than average rates of bicycling – and increased rates of bicycling concurrent with new facilities and expanded programs – indicate these efforts have been successful. They will also be essential if the city is to double the share of work commutes by bicycle and convert a sufficient number of car trips into bicycle trips for reaching climate action targets. Like most other U.S. cities, however, existing design and funding constraints have thus far limited opportunities for substantially expanding trail and protected on-street networks (and education/encouragement programs) to attract even more bicyclists.

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[25] *Roger Geller, "Four Types of Cyclists," available at: www.portlandonline.com/transportation/index.cfm?a=237507&c=44671*

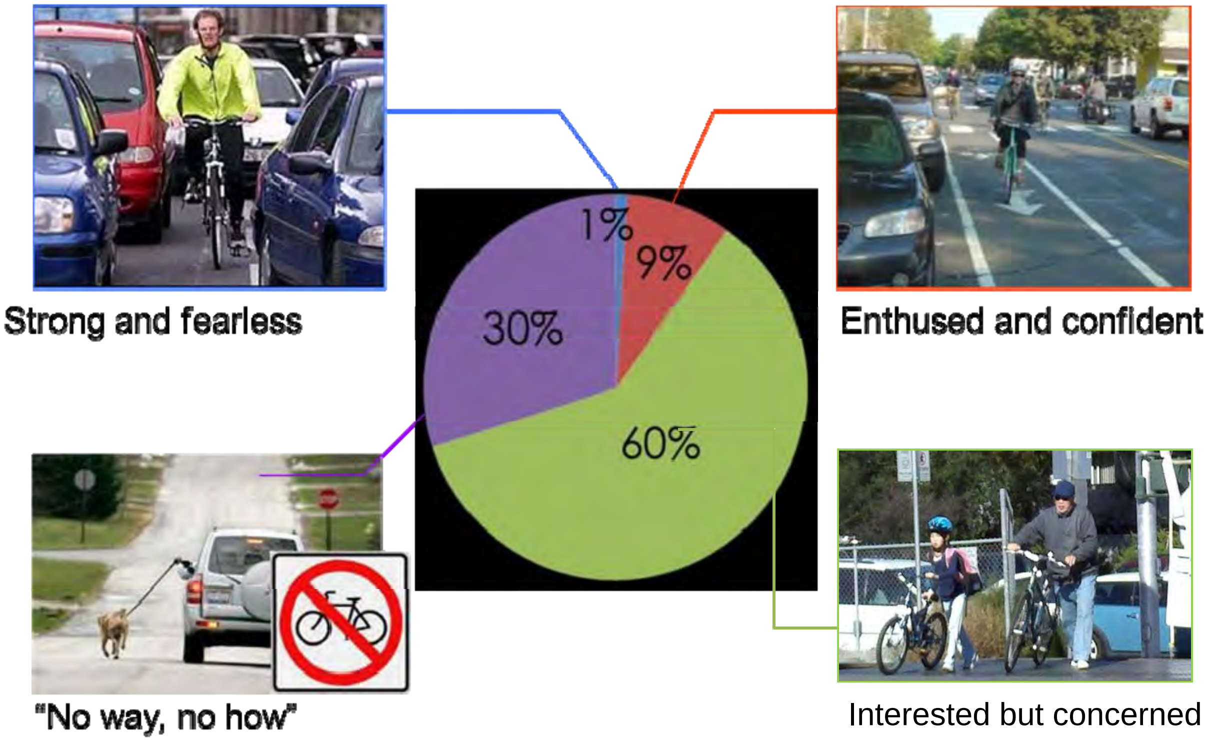


Figure 5-2: Four Types of Bicyclists

In response to the need for innovation and advocacy on behalf of cities, the National Association of City Transportation Officials (NACTO) recently developed the *Urban Bikeway Design Guide* (April 2011). This online resource includes strategies for increasing separation between motor vehicles and bicyclists and bicyclist visibility using relatively low-cost treatments such as colorized bike lanes, intersection markings, and physically separated bike lanes (e.g., cycletracks). These facilities represent the most recent treatments being implemented in cities throughout the U.S. and the NACTO guidance provides best practices and considerations for situations in which innovative or non-traditional facilities may be appropriate or beneficial.

All of the facilities included have been implemented in the U.S. and none are expressly prohibited under or contrary to the current versions of the American Association of State Highway and Transportation Officials (AASHTO) *Guide to Bikeway Facilities* or the California *Manual on Uniform Traffic Control Devices* (CAMUTCD). While none of these facilities are illegal, many state and federal funding sources cannot be used to fund their implementation, including the Bicycle Transportation Account (BTA) and Transportation Development Act (TDA) funds.

Customized guidance on relevant NACTO and other innovative treatments is included in this chapter and **Appendix A** of this Plan, while **Chapter 7** includes recommendations to utilize local spending for bikeway facilities not eligible for other funds. Another concern with implementing non-traditional facilities is the potential for additional liability. The City of Palo Alto has committed to following experimentation approval process for treatments that may be implemented in ways not specifically allowed by AASHTO or the CAMUTCD.

Along with Palo Alto Bicycle Advisory Committee (PABAC) and City/School Traffic Safety Committee (CSTSC) review, the City should consider updating existing bicycle facilities that do not meet NACTO and other state and local standards, including locations where a five-foot bike lane is adjacent to a seven-foot parking lane.

5.2.2 Defining a Core Network of Crosstown and Recreational Routes

To take full advantage of existing on-street facilities, off-road trail and park segments, and other strategic "cut-through" routes requires substantial prior knowledge of Palo Alto. This is due in part to numerous "T" intersections that require turns and the need for anticipating network barriers, although it is also inherent to a relatively dense and varied bikeway network. This is particularly true along shared lane bikeways and bicycle boulevards, which follow local streets and often "jog" or turn onto another street. At the same time, the most popular bike routes experience heavy usage during peak periods to the point that crowding is or will soon become an issue. As a method to improve existing legibility and future capacity of the system – particularly as the number of new and more casual users continues to grow – Palo Alto should begin to identify and improve a core network of bicycle facilities that includes the following:

- **Wayfinding**. Basic and enhanced wayfinding will help inform users of important destinations, facilitate route selection, and brand the core system. The *BPTP 2012* includes a custom signage and on-street markings package to help establish and more easily identify bicycle boulevards (see following section and **Appendix A** for more discussion).
- **Bay Trail and Bay to Ridge Trails**. An important component of wayfinding is hierarchy, or the clear relationship of regional, citywide, and local routes and destinations. Including and enhancing the Bay Trail and Bay to Ridge Trails as the backbone of a core Palo Alto network is an essential strategy for ensuring compatibility and hierarchy of regional and local facilities. The BPTP 2012 identifies California Avenue as a unique on-street component of the Bay to Ridge Trail that should be improved through further separation from traffic and/or increased visibility of roadway markings and signage.
- **The Civic Loop.** This loop concept would promote a continuous loop in the city's center, to help people navigate by bicycle. It would link the existing Embarcadero/Caltrain trail, the Castilleja-Park-Wilkie Bicycle Boulevard, and the California Avenue Enhanced Bikeway with consistent wayfinding.
- **Connectivity of On- and Off-Road Facilities**. Just as transit planners seek to build "seamless" connections where multiple transit modes and routes converge, so too must the bicycle network reduce conflicts and improve connectivity between trails, paths, and on-street facilities. This is especially important where barrier connections funnel and disperse a variety of routes.

5.2.3 Bicycle Boulevards

A network of bicycle boulevards is the most direct and cost-effective way to increase bicycle mode share, safety, and mobility. A well-connected, flat, and relatively dense street grid along with numerous pedestrian and bicycle–only barrier crossing opportunities makes Palo Alto an ideal setting to further develop the bicycle boulevard concept. This Plan proposes several new additions to the bicycle boulevard network and includes a design toolbox that emphasizes integrated wayfinding, speed limit reductions, actuated arterial crossings, and greater use of traffic circles as a replacement for stop signs (especially where bicycle boulevards intersect other bikeways). New "soft" innovative traffic calming tools such as bicycle-friendly chicanes and narrow queuing street segments (see **Appendix A**) are also provided where "hard" traffic diversion is not feasible or desirable. These latter features may be especially relevant for rolled curbed streets and streets without sidewalks to improve bicycle (and pedestrian) comfort and increase the potential for landscaping.

This Plan proposes a custom wayfinding protocol, including street signs and pavement markings, for an expanded network of bicycle boulevards in Palo Alto. ***Chapter 6*** *and* ***Appendix A*** *provide more details.*

It must be noted that Palo Alto has made very little progress outside of the Bryant Street corridor, which is problematic since bicycle boulevards work best as part of a system of bikeways. Although many proposed boulevard corridors function reasonably well today, they are not yet "implemented" and available for promotion. Significant plans to improve (implement) the Castilleja-Park-Wilkie corridor are actively moving forward concurrent with this Plan. As a tandem high priority strategy, the City should establish much of the network quickly without diluting the high standard of bicycle boulevards through the use of Bike Route signs. As physical traffic control improvements and more substantial spot upgrades are provided, streets can be formally designated bicycle boulevards, and distinct wayfinding signs can replace the Bike Route signs on the existing sign poles. To assist the pace of implementation, this Plan includes a customized signage and wayfinding protocol for bicycle boulevards. This recommendation is consistent with BPTP 2012 survey results that indicate strong support for expanding the bicycle network as the City's highest bicycle priority (see **Appendix D**).

(Above): Shared use path and roadway intersection with "cross bike" pavement markings and pedestrian lighting – Ohlone Greenway, Berkeley, CA. (Left): Urban trailhead, San Rafael, CA. Note high visibility signage, a lack of unnecessary barriers, and inclusion of a "mixing zone" gateway feature as elements of this successful path terminus.

5.2.4 Trail Crossings and Accessibility

Access to the existing trail network is poor in many locations throughout Palo Alto, including the Bol Park/Gunn High School paths as well as to/from important barrier crossings like the Embarcadero Highway 101 overpass. Many (not all) existing substandard barrier devices meant to block motorcycles and/or protect pedestrians have dubious safety benefits and overly impede existing user convenience and accessibility.

Standard or nonexistent roadway crossing treatments also limit visibility of the trail/path system and connectivity to on-street bikeways. The BPTP 2012 includes several project recommendations and design guidelines aimed at improving and extending trails and trail crossings. These include new pedestrian lighting and a series of trail connection enhancements along Bol Park path to increase school commute safety and general connectivity, as well as lighting the Lefkowitz Tunnel as a short-term improvement for park connectivity due to the Highway 101 skylight displacement.

Two of the proposed trail extensions will require extensive property owner coordination/support; the first is at the back entrance to the VA Medical Center parking lot, which would create a trail bypass route around the existing steep slopes and arterial bike lanes on Hillview Avenue within the outer Stanford Research Park Area; the second would extend Bol Park Path to Hansen Way (and El Camino Real) through the Research Park along an old railroad easement. More detail on the highest priority trail projects is located in **Chapter 6**.

Gunn High School Path at the terminus of Los Robles Avenue. This barrier design is typical of many existing trail intersections, and complicates use by people with disabilities, strollers, and bicycles with trailers.

5.2.5 Enhanced Bikeways

The BPTP 2012 generally identifies enhancements to existing corridors – in particular, bicycle stencil markings carried through intersections as described in the NACTO Urban Bikeway Design Guide – as the most effective strategy to improve arterial bicycling conditions in Palo Alto. Many existing bike lanes are dropped at approaches to major intersections, leaving bicyclists and motorists with little guidance at the points of greatest potential conflict. Such markings do not impact traffic capacity, are relatively inexpensive, and can be implemented throughout the city. Improved and comprehensive wayfinding signage as depicted in **Appendix A** should also be prioritized on enhanced bikeways, which together with bicycle boulevards and trails represent the core bicycle network.

Other recommended improvements to enhanced bikeway corridors include the use of green colorized pavement markings to denote potential conflict zones or exclusive bike facilities, improved bicycle detection, and the conversion of substandard bike lanes to well-designed shared roadways. For the latter, lead-in bicycle lanes with bicycle boxes (see **Appendix A**) are strongly encouraged to promote bicycle priority in locations with high numbers of bicycle left or vehicle right turn movements.

The enhanced bikeway designation also prioritizes corridors for potential conversion from time restricted bike lanes to two-way cycletracks and/or the addition of Class I sidepaths. These corridors and their issues are discussed in greater detail in the following sections.

Intersection through markings (far left) and colorized bike lanes (left) are two examples of potential enhancements to existing arterial facilities.

5.2.6 Time Restricted Bike Lanes

Palo Alto has many bike lanes that are possible only by restricting parking on one side of the roadway (typically from 7am-7pm). This practice results in the presence of bike lanes during the heaviest periods of use (morning and evening weekday commutes) while allowing homeowners the use of the public street for evening and weekend parking for themselves and their guests. Due to constrained roadway width, however, most of these facilities result in an imbalanced cross-section that forces bicyclists too close to the parking lane "door zone" and/or encourages wrong-way riding. As many are school commute corridors and important access routes to major civic destinations, the BPTP recommends improvements to these corridors as a high priority to help distinguish a core bicycle network.

At minimum, streets with existing conditions shown in **Figure 5-3** should be restriped to provide two 9.5-foot travel lanes and two 5-foot bike lanes. Additional enhancements such as green colorized lanes and intersection through-markings should also be considered. Despite helping reduce the potential for "dooring" where parking is permitted and increasing visibility, both the minimum bike lane widths described above and loss of the bicycle lane during evenings/weekends are not desirable conditions according to best practices. For this reason, the BPTP 2012 presents additional design options for existing time-restricted bike lane streets in **Chapter 6** and in **Appendix A**. These options include consideration of full-time parking restrictions in order to "stack" dedicated bicycle space to one side of the street (i.e., build cycletracks). These facilities are more attractive to novice bicyclists, can help develop a core bicycle network integrated with trails and barrier crossings, and, when properly designed, may reduce wrong-way and sidewalk riding. They also require a limited number of major intersections and careful design attention to reduce potential vehicle conflicts, and thus may be appropriate only for a small number of corridors.

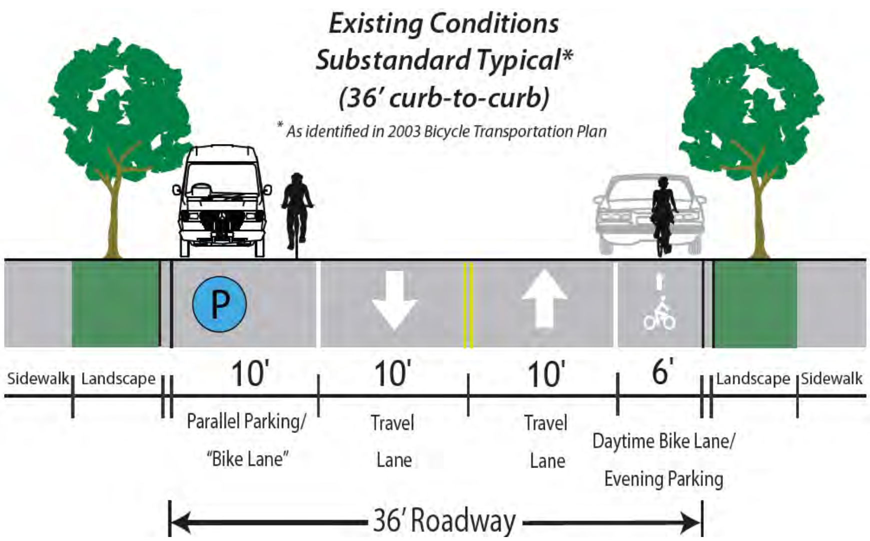
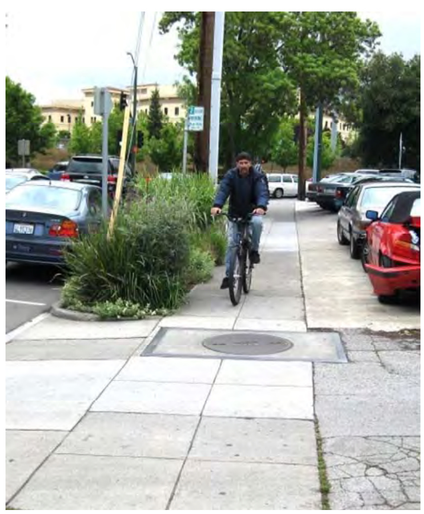


Figure 5-3: Typical Cross Section of Substandard Time Restricted Bicycle Lanes

5.2.7 Sidewalks vs. Sidepaths and Cycletracks

The *2003 Bicycle Transportation Plan* was instrumental in helping establish clear City policy prohibiting and/or discouraging riding bicycles on sidewalks in most situations (see also Chapter 10.64 of the Municipal Code). This policy is based in part on a 1994 Palo Alto study that concludes on-street bicycling is two times safer on average than sidewalk riding, as well as from similar findings/theories such as



Adult bicyclists should be discouraged from bicycling on sidewalks. However, well-designed separated facilities such as cycletracks and sidepaths can be appealing for a wide range of bicyclists.

John Forester's influential book "Effective Cycling." While this conclusion and the existing city policy remain valid, it is important to distinguish sidewalk riding from newer types of facilities recommended for consideration under this Plan. These include the potential provision of two-way cycletracks and conversion of existing sidewalks into Class I shared use paths (known as sidepaths when running parallel and adjacent to roadways).

The main issue identified with sidewalk riding, just as with cycletrack and sidepath design, is the identified safety risks at roadway crossings (intersections and to a lesser extent, driveways). Without proper geometric design standards, signal controls, signage, markings, or associated education and outreach to motorists, existing intersections where sidewalk riding occurs are often ill equipped to handle conflicts with turning vehicles. Modern guidance on the design of cycletrack and sidepath facilities considers a number of suitability criteria and includes measures that reduce potential intersection conflicts. More information on cycletrack and sidepath design guidance is provided in **Chapter 6** and in **Appendix A**.

In Palo Alto, sidewalk and wrong-way riding activities are due to a combination of factors, including the element of fear. Other factors include the presence of imbalanced bike lanes (mentioned previously), the need to access sidewalk parking, and barrier connections (under/overcrossings) that require access from one side of a street or crosswalk. Understanding reasons for sidewalk riding, as well as the differences between newer protected facility types, is important for developing community support for protected facilities – and ultimately, communicating their proper function to users and motorists. Where opportunities may exist to meet modern guidelines, the BPTP 2012 recommends consideration of sidewalk upgrades to Class I sidepaths and re-striping of roadways to include two-way cycletracks.

5.2.8 Arterial Bicycle Facilities

Arterial streets remain important routes for bicyclists because they are fast, direct, bridge many barriers, and serve many destinations. As with the 2003 Plan, this *Bicycle and Pedestrian Transportation Plan* did not conduct a Bicycle Level-of-Service or similar assessment, relying instead on existing plans (including the 2003 plan), near-term paving priorities, public input, and qualitative analysis to identify facility opportunities and their importance. The potential for bicycle and pedestrian "Complete Street" opportunities also greatly influences this Plan's assessment of arterial corridors.

Class III Arterial Shared Roadways

Some major arterial routes have high traffic speeds and volumes and may not be comfortable for 'interested but concerned' bicyclists even with shared lane marking treatments. Nevertheless, the 'strong and fearless' bicyclists prefer these routes because of their directness and signalized crossings. In order to accommodate this type of rider, "Share the Road" signage may be sufficient along with strategically located shared lane "sharrow" pavement markings.

These accommodating roadways include Alma Street, El Camino Real, Embarcadero Road, San Antonio Road, and Oregon Expressway. Several of these corridors are currently or likely to be the subject of separate corridor studies, which should consider bicycle and pedestrian access. For example, Embarcadero Road is the subject of a priority corridor study that will focus on safety and mobility improvements.

5.2.9 Improving Access to Neighborhood Commercial Centers

The City has placed a "dismount zone" stencil in front of City Hall to deter people from bicycling through commercial areas.

Outside of the two business districts, the remaining commercial centers are served primarily by arterial vehicle lanes and infrequent local bus service. Improving non-motorized access to these neighborhood centers is a key strategy for increasing bicycle commute rates and the share of discretionary trips made on foot or by bicycle.

As part of ongoing planning for Bus Rapid Transit (BRT) along El Camino Real, the City of Palo Alto, Caltrans, and the VTA should assess opportunities to provide bicycle lanes through the commercial area south of California Avenue and north of Charleston/Arastradero Roads, as well as connecting to the south. Such facilities were recommended for consideration by the 2003 *El Camino Real Master Schematic Design Study* and would greatly improve transit and commercial access in a dynamic, fast-growing area of the city.

Further east in Midtown, the City is actively seeking funds for a comprehensive study of Middlefield Road to identify Complete Street improvement opportunities. Recently added to the county's transportation plan (VTP 2035), this effort should assess (along with new potential crosswalk and curb extension locations) the feasibility of extending bike lanes north from Loma Verde Avenue into the Midtown Shopping Center. Additional opportunities to improve Midtown bicycle access include new potential east-west bicycle boulevard (Amarillo/Moreno Avenue) and trail (Matadero Creek) connections, upgrades and extensions of Colorado Avenue bike facilities, and design enhancements and programming of Midtown Court.

A more detailed account of proposed arterial improvements that contribute to better commercial access is provided in **Chapter** 6. It is important to note that all projects with potentially significant impacts on traffic service levels will be studied independently from this Plan.

5.2.10 Bicycle Parking

Additional, well-placed bike parking in combination with more visible on-street facilities (sharrows) may help reduce the frequency of sidewalk riding in business districts.

Bicycle parking and end-of-trip facilities can be a determining factor in whether someone decides to make a bicycling trip. A majority of respondents to the BPTP 2012 public survey indicated a desire for more bicycle parking in the California Avenue and Downtown business districts. Additional parking needs were also noted in the Midtown, Town and Country, and Stanford Shopping Centers. In response to demand, the City recently deployed new bike racks in Midtown and is actively planning and installing on-street bicycle corral and sidewalk rack facilities in Downtown. California Avenue will also receive significant bicycle parking facility improvements as part of the streetscape improvement project between El Camino Real and Park Boulevard.

Palo Alto Municipal Code requires that all new buildings, additions or enlargement of existing buildings, or change in a use that results in the need for additional vehicle parking provide bicycle parking. Section 18.54.060 discusses the design of bicycle parking facilities. The code specifies short- and long-term bicycle parking as follows:

- Short-term bicycle parking is intended for shoppers, customers, and visitors who require bicycle storage for us to several hours. Acceptable racks enable the bicyclist to lock the frame and one or both wheels with a user-provided U-lock or cable and support a bicycle by its frame in a stable upright position without damage to the bicycle or its finish.
- Long-term bicycle facilities are intended for bicyclists who need to park a bicycle and its components and accessories for extended periods during the day, overnight or for a longer duration. Long-term bicycle storage is typically for employees, students, residents and commuters. The facility frequently protects the bicycle from inclement weather. The four design alternatives are: bicycle lockers, restricted-area bicycle enclosure, multifamily dwelling unit storage locker, and school bicycle enclosure.

Locally designed Bike Arc bicycle racks as well as custom public art racks are planned for installation in Downtown. (Source: Bellomo Architects)

Lightning Bolt Racks are frequently used on Stanford campus and support the bicycle from the frame and the wheel.

The 2003 Plan conducted an inventory of existing bicycle parking facilities. The inventory found a considerable number of bicycle racks at major shopping areas, transit centers, public schools, and in other locations.

The provision of longer term, secured bike parking for major transit facilities (the Palo Alto Transit Center) and new development (including shower facilities for office/commercial) is addressed in detail within other existing documents. These include the 2008 *Caltrain Bicycle Access Study* and City of Palo Alto Municipal Code, Chapter 18.5.

Bicycle Parking Design

Well-designed bicycle parking provides the user with a secure and easy-to-use place to store his or her bicycle and helps prevent improperly parked bicycles from impeding pedestrian activity or obstructing the path of travel for persons with disabilities.

A conventional inverted-U style rack supports the bicycle on two points of contact and provides easy-to use bicycle parking.

The design of the rack itself should be intuitive to use and provide security against theft. Racks with moving parts or complicated designs may confuse users. Unacceptable racks include wheel benders, toaster racks, and wave racks, which do not support the bicycle at two points or allow for the frame and at least one wheel to be locked to the rack. A standard inverted-U style rack is recommended for Palo Alto, although post-and-loop racks are acceptable and artistic racks may be used but are subject to review and determined by zoning administration. The "Bike Arc" racks and other art racks will be installed in Downtown Palo Alto in 2011 and 2012. The shape of the Bike Arc rack is compatible with existing tree wells along University Avenue and limit intrusion on the existing sidewalk. See **Appendix A** for additional bicycle parking guidance.

Palo Alto's Municipal Code Section 18.54.060 discusses specific guidance for types of bicycle facilities, differentiating short-term and long term parking. Short term parking consists of bicycle racks, while long-term may include bicycle lockers or restricted-access enclosures. **Appendix B** suggests insertions and deletions to the Municipal Code in order to simplify the language and allow a variety of innovative bicycle parking types while specifying the key elements that are required for formal bicycle parking. For example, the current code does not specify that a rack should provide two points of contact with the bicycle, which is recommended by the Association of Pedestrian and Bicycle Professionals (APBP) in the 2010 *Bicycle Parking Guidelines* (2010).

Location and Placement of Bicycle Parking

Placement of bicycle racks determines how useful they are to bicyclists; if short term parking is not readily apparent at the entrance of the building, bicyclists may lock informally. Accessible and visible long term parking may make the difference between whether or not an employee bikes to work.

For short term parking, bicycle racks can be placed on the sidewalk (shown in **Figure 5-4**) or on-street, known as a bike 'corral' (see **Figure 5-5**). Palo Alto's first bicycle corral has been installed on Ramona Street and provides space for 10 bicycles in a single automobile stall. The provision of on-street bicycle "corrals" located at corner and midblock locations can be an effective strategy for efficiently using limited space where high parking demand and/or high demand for other sidewalk uses is clustered.

The Municipal Code outlines standards for bicycle parking location, layout, paving, lighting, and signage. **Appendix B** makes recommendations for updating the Municipal Code to require sufficient space for and between bicycle racks to allow access to the rack as well as maintaining pedestrian circulation. The text specifies how far from the building entrance short- and long-term parking may be, as well as placement of long term parking within a parking garage, and other recommendations.

A pilot installation of high visibility, well-located on-street bicycle "corrals," or grouped bicycle parking, took place in summer 2011 on Ramona Street at the Coupa Café. Up to ten additional corrals are planned for Downtown within the next year.

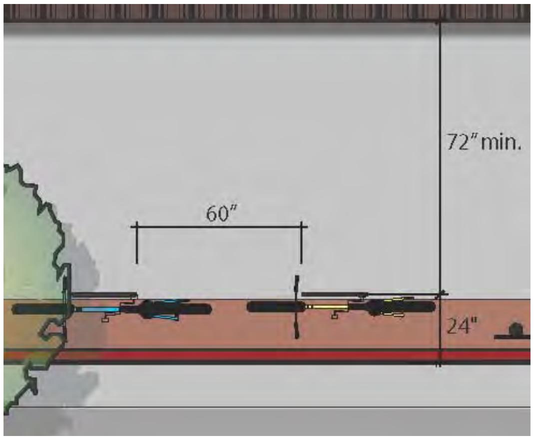


Figure 5-4. Recommended configuration of a staple bicycle rack on the sidewalk

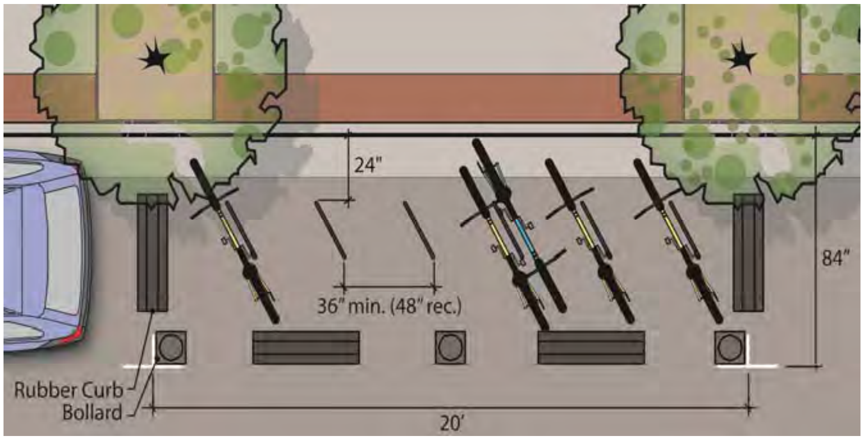


Figure 5-5. Recommended configuration of an on-street bicycle corral

Development Requirements

Because land use is closely linked to people's transportation decisions, promoting bicycle- and pedestrian-friendly infill development and new developments is a critical element of encouraging bicycling and walking. Palo Alto's Municipal Code requires bicycle parking based on land uses, to enable bicyclists to rely on suitable accommodation at all destinations. Table 1 of Palo Alto Municipal Code Section 18.52.040 presents the required quantity of bicycle parking by land use.

In general, a mix of short and long term parking is required at commercial and retail uses. Multiple family residential uses also require long-term parking. Spaces for schools should be identified as being enclosed in bike cages. In Community Commercial uses, employee shower facilities are required in new buildings and additions based on square footage, with no shower required below a certain area based on building use (18.43.070 [e]). The City's Context-Based Design Criteria also requires the provision of bicycle facilities and sidewalks in many types of development.

A number of incentives could further encourage improved bicycle parking and end-of-trip facilities:

- Providing motor vehicle parking relaxations where bicycle parking is provided beyond the minimum requirements.
- Providing motor vehicle parking relaxations where complete end-of-trip facilities are provided, e.g., long- and short-term parking coupled with showers, washrooms, and clothing lockers.
- In space-constrained applications, such as redevelopment of an existing building, allow for the conversion of motor vehicle parking spaces into long-term bicycle parking to meet the bylaw requirement (typically five bicycle parking spaces can be achieved per motor vehicle parking space).
- Extending or introducing payment-in-lieu of parking programs to allow funds to be collected in-lieu of vehicle parking and placed in a sustainable transportation infrastructure fund to fund active transportation projects, which may include a centralized bicycle parking and end-of-trip facility (e.g. a bike station). Note: this should not replace bicycle parking and end-of-trip facility requirements.

Palo Alto could also create a Bicycle Rack Program that works with interested land owners to supplement the existing supply of bicycle parking. The City could help pay for racks and/or installation costs for bicycle racks installed on private property. The program should provide information for businesses regarding the benefits of bicycle parking.[26]

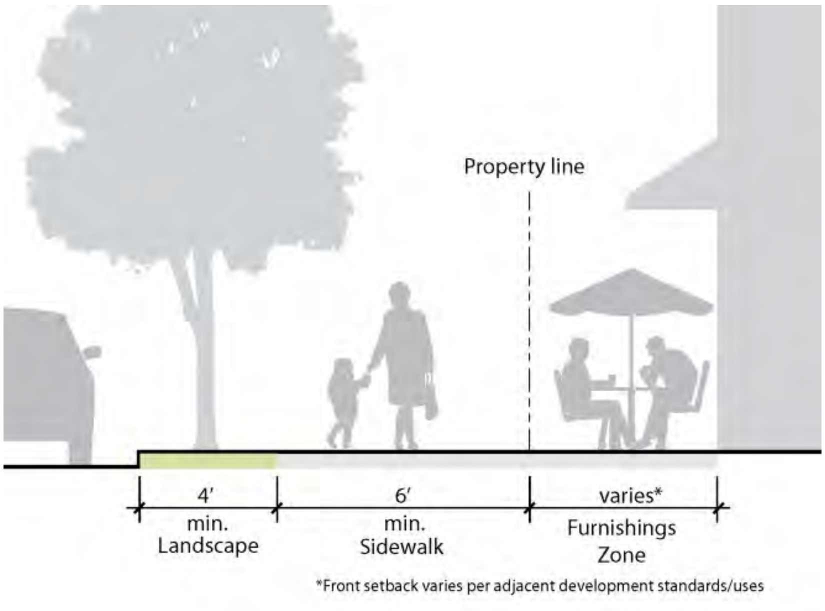
[26] *The 2010 report, Bike Corrals: Local Business Impacts, Benefits, and Attitudes found widespread support for bike corrals from local businesses, while The Employer Guide to Bicycle Commuting: Establishing a Bike-Friendly Workplace for your Baltimore Region Employees compares the initial cost of 12 automobile parking spaces ($40,000 to $100,000 USD) to the cost of 12 bike rack spaces and one automobile space ($4,600 - $9,600 USD).*

5.3 Pedestrian Needs and Recommendations

The following section describes relevant citywide issues pertaining to pedestrian travel and safety. Additional pedestrian facility recommendations for specific areas of the city are provided in **Chapters 6** and **7**.

5.3.1 Sidewalk Zones and Width

The 2003 VTA *Pedestrian Technical Guidelines* document contains an extensive discussion of sidewalk standards, promoting a minimum four-foot sidewalk width and the consolidation of driveway curb cuts to reinforce traffic separation. The City of Palo Alto standard is to build five-foot wide sidewalks and five-foot landscaping/furnishing zones where feasible. The BPTP 2012 proposes a new requirement that all new sidewalks include a minimum six feet of unobstructed, linear sidewalk space free of street furniture, street trees, planters, and other vertical elements such as utility poles, signs and fire hydrants. Segments less than six feet do not allow pedestrians to pass each other comfortably, particularly when mobility assistance devices and/or baby strollers are used. Additional width may be required and/or encouraged under the Municipal Code or through Architectural Review Board review.



Recommended widths for sidewalk "zones" or sections.

The VTA guidelines also recommend a landscape/furnishing/edge zone to limit walkway encroachment by trees, signs, poles, and other features and for added separation from traffic. This zone, where feasible, should be a minimum of four or five feet to accommodate roadway clearances and tree root growth. Exceptions to minimum roadway clearance standards should also be considered for constrained sites where pedestrian accommodation is a priority over the preferred placement of signs and poles.

Although artistic sidewalk designs are encouraged, weaving or irregularly patterned edges should be avoided due to their difficult navigation by persons with disabilities and approved wheeled devices.

Rolled Curbs

The widespread use of shallow 36-inch wide gutters with rolled curbs on arterial and residential streets complicates pedestrian separation and travel in Palo Alto. Parked vehicles commonly utilize all or portions of the gutter and sidewalk, encroaching upon what is already a limited space for walking (especially where private vegetation is adjacent). The integrated nature of the rolled curb/sidewalk also discourages landscaping elements or other buffers between the sidewalk and travel/parking lanes. The *Comprehensive Plan* includes specific policy language that encourages retrofitting streets and sidewalks with vertical face curbs where desired. The BPTP design guidelines for queuing streets in **Appendix A** include an alternative option to retrofit rolled curbed residential streets (in particular, bicycle boulevards) for improved pedestrian accommodation.

Sidewalk Gaps

Although much of the city contains adequate sidewalks where they are generally desired (i.e., outside of Barron Park and creek riparian corridors), a few significant sidewalk gaps remain. These include areas immediately fronting Rinconada, Robles, and Monroe Parks; the west side of Alma Street heading north from the Palo Alto Transit Center; portions of Hanover Street, Porter Drive, and Hansen Way in the Research Park; and the approach to the San Antonio overpass. Other notable sidewalk deficiencies include the El Camino Real approach from Matadero Avenue, and the west approach to Middlefield Avenue from Colorado Avenue.

Steps from the Palo Alto Transit Center, and with parking adjacent to the curb, Alma Street north of Lytton Avenue is a priority sidewalk (or shared use path) gap closure project.

5.3.2 Curb Ramps, Extensions, and Turn Radii

Most Palo Alto intersections with sidewalks provide curb ramps, typically a one-ramp or "diagonal" design that may or may not have ADA-compliant detectible warning strips, ramp slopes, landing area dimensions, and joint smoothness. Retrofitting curb ramps to ensure compliance with ADA requirements should be a high priority for high-volume locations and where requested by individuals with mobility impairments. It is also a requirement for all new roadway and development projects that affect intersections.

Major maintenance and spot improvement efforts should consider curb extensions to the maximum extent practical, namely where on-street parking and the lack of significant drainage infrastructure make them viable. (Note: The prevalence of curbside bike lanes makes curb extensions difficult in many areas.) Four out of the top five pedestrian collision locations appear to meet this standard and could each

In Palo Alto, El Camino Real BRT will not include center-running transit lanes, but instead utilize widened sidewalks at bus zones – or bus bulbs – to improve transit access, amenity space, and passenger comfort. In addition to the improvements at California Avenue (above), VTA is planning for bus bulbs at the Charleston/Arastradero intersection. (Source: VTA) benefit from new curb extensions that improve pedestrian visibility. New curb extensions should provide two-ramp or "perpendicular" configurations to facilitate more direct and convenient travel to/from crosswalks for wheelchair users, families with strollers, and persons with limited mobility.

Minimizing curb radii – or the angle at which a curb wraps into an intersecting roadway – is essential to reducing vehicle turn speeds and reducing pedestrian crossing distances. The removal or mitigation of high-speed channelized right turns, particularly along El Camino Real, remains a citywide priority. The Stanford/El Camino intersection – under construction during the development of this plan - will likely set the standard for similar reconfigurations at Charleston/Arastradero Road, Churchill Road, Hansen Way, and potentially Embarcadero Road. In other areas of the city, curb radii should be minimized to the maximum extent feasible, with 25-feet for residential arterials (actual radii) and 20-feet for non-arterial intersections used as a general standard except where specific truck or bus movements occur.

5.3.3 Traffic Calming and Speed Limits

Vehicular speeds have significant impacts on the pedestrian environment because of the likelihood of injury resulting from a crash, as well as turning, passing, and other potential conflicts with motor vehicles at intersections. **Figure 5-6** shows the impact of automobile speed on the likelihood a fatality will result from a crash.

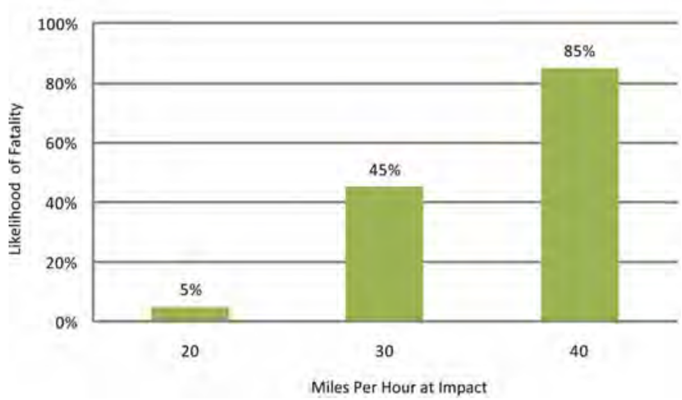


Figure 5-6. Likelihood of pedestrian fatality resulting from crash based on automobile speed.
(Source: U.K. Department of Transport)

In addition to traditional traffic calming, such as speed humps and traffic circles on neighborhood streets, many cities are protecting the most vulnerable road users by implementing strict speed limits around schools. San Francisco has designated 15 mile per hour speed limit zones within 500 feet of the City's elementary schools.

5.3.4 Signalized Crossings

Plan survey respondents overwhelmingly identified more visible crosswalks and pedestrian countdown signals as the highest priorities to improve walking conditions in business and commercial areas. Anticipated roadway projects along Lytton and California Avenues should increase the number and consistency of pedestrian countdown signals and high visibility crosswalks. Many other intersections, however, including those along University and Hamilton Avenues, could benefit from a targeted pedestrian crossing program.

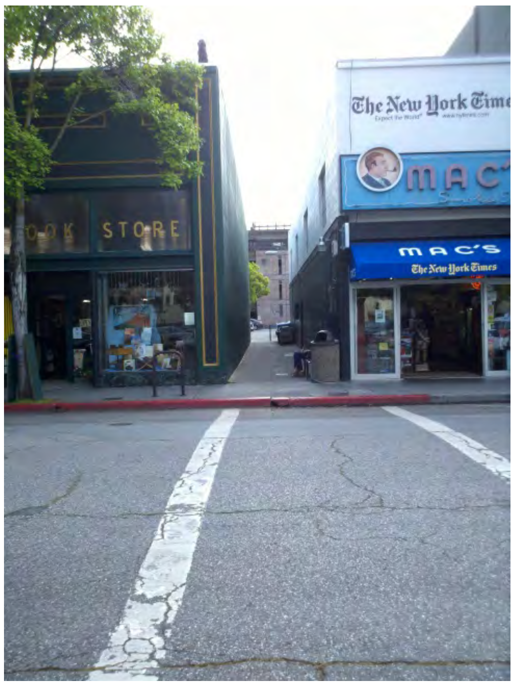
All new striping at signalized intersections should include an advanced limit line, or stop bar, set at least four feet back from the crosswalk to discourage vehicle encroachment. Both stop bars and bicycle boxes **(Appendix A)** may require relocation of in-pavement loops and/or utilization of remote sensors such as microwave detection.

A typical signalized crossing in Palo Alto (left) compared to. a best practice crossing treatment (right). Differences include a higher visibility "continental" striping pattern and "advance stop bar" to limit encroachment by vehicles; pedestrian countdown signals; curb extensions or "bulb outs" to reduce crossing distances and vehicle turn speeds; and curb ramps with color contrasting detectable warning strips. For more detail on specific pedestrian crossing treatments, see ***Appendix A.****A*

5.3.5 Midblock and Un-signalized Crossings

Marked, unsignalized crosswalks on roadways with two or more travel lanes per direction are generally discouraged, and few exist in Palo Alto. Capital projects on corridors that currently include such crossings, such as Oregon Expressway and California Avenue, are planning to remove and/or modify these facilities. The City is encouraged to identify all existing locations and conduct a similar assessment of improvement opportunities.

While promoting safe pedestrian crossings, this policy can also result in long distances between available arterial crossings. On Embarcadero Road between Waverly Avenue and Middlefield Road, for example, is an approximately 3,000-foot stretch without a marked crossing – despite four additional intersections. Locating a new marked crosswalk either with a new signal, protected center median, or pedestrian hybrid signal (see **Appendix A**), is a high priority for additional analysis. A new crossing of Embarcadero Road is also critical for establishing a successful Webster Street Bicycle Boulevard. Another location with a major crosswalk gap is along Middlefield between Colorado and Loma Verde Avenues, which is why consideration of a road diet should assess the potential benefits to both bicycles and pedestrians.



Improving midblock, un-signalized crossings is important for linking public parking lots, plazas, and pedestrian alleys in the business districts, such as between University and Hamilton Avenues across Emerson and Ramona Avenues.

Un-signalized crosswalks of roads with only one travel lane in each direction (not including a two-way left-turn lane) are an essential tool for pedestrian circulation in many locations in Palo Alto. This is true of stop-controlled intersections, certain residential arterial crossings, as well as important midblock pedestrian cut-throughs and alleys in the business districts.

Upgrading un-signalized crossings with curb ramps and extensions, high visibility and/or raised crosswalks, center medians, and rapid flashing beacons (at critical school commute crossings) is an identified need to improve pedestrian circulation in most parts of the city.

5.4 Recommended Programs and Policies Summary (Five E's)

The following program and policy actions are recommended for helping establish core concepts of the BPTP 2012 within the City's decision-making framework. Similar to the existing programs review, they are organized according to the 5 "E's for both consistency and consideration by the League of American Cyclists when Palo Alto chooses to apply for Bicycle Friendly City status.

5.4.1 Engineering

- Develop a Complete Streets Checklist for all major capital and maintenance projects and a review/approval process that ensures early coordination between City departments and outside agencies.
- Establish dedicated funding for a citywide pedestrian countdown signal and crossings program and a citywide bike parking program.
- Develop and adopt an official design standard and funding policy for the use of on-street parking spaces and/or red curb zones as 'parklets' and other non-traditional uses (e.g. bike corrals, bicycle stations). Consider the California Avenue and University Avenue business districts as priority locations for initial implementation.
- Support pilot/trial projects to test design recommendations from this Plan, including bicycle chicanes, queuing streets, and back-in angled parking (see Appendix A).
- Update the School Commute Corridor Network (used to prioritize school-related transportation investments) to consider recent land use changes and network recommendations from this Plan and to include Monroe Park travel to Los Altos Schools.
- Revise the land use code to establish a six-foot minimum sidewalk width standard where the current standard is five-feet.
- Evaluate the feasibility of a future potential trail connection between El Camino Park and Caltrain/Palo Alto High School through the Transit Center.

5.4.2 Education

- Expand the Safe Routes to School Program to all schools and continue to leverage outside grant funding to implement education and encouragement programs.
- Conduct innovative bicycle facility outreach and education campaign(s) to youth and adults as part of the Safe Routes to School curriculum and to the public as these facility types are implemented.

- Improve the City of Palo Alto online bicycle page as a community resource.
- Work with other jurisdictions to update the existing user bikeway map, including Monroe Park access to Mountain View and Los Altos. The City should work with MTC to incorporate existing and new facilities into the 511.org bike mapper application and the GoogleMaps bicycle layer where feasible.

5.4.3 Encouragement

- Establish a "Friends of Palo Alto Bicycles" advocacy organization to reach out to local businesses or groups to help support and promote bicycle-related projects and to maximize public-private funding opportunities such as development of bicycle or walking maps and/or path maintenance.
- Provide support and dedicated funding for a recurring Bike Palo! / Palo Alto Sunday Streets program of events, potentially in coordination with local business groups and/or a newly established "Friends of Palo Alto Bicycles" organization. A formal policy to support regularly occurring street closure events and programming – and the potential for designating specific roadway sections for such activities – is recommended for addition to the Comprehensive Plan Transportation Element, likely under *Goal T-3: Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling*
- Support and expand the existing Way 2Go program and other transportation demand management (TDM) efforts to encourage alternatives to driving for city employees and other major employers. This Plan recommends that additional funding and/or existing staff time focus on transit pass promotion, parking management, and bicycle share program expansion in addition to existing encouragement activities (such as Bike to Work Day). This recommendation is consistent with recommendations and policies from the 2007 *Climate Action Plan* and *Comprehensive Plan* that emphasize the importance of TDM initiatives for encouraging new bicycle and walking trips.

5.4.4 Enforcement

- Continue to support Operation Safe Passage and revise/expand where necessary to ensure appropriate emphasis on Safe Routes to School priority issues and campaigns.
- Consider a 20-mph zone speed limit for application in select school zones and along bicycle boulevards. Specific implementation of this recommendation will require stakeholder outreach and engineering analysis along the particular corridors.
- Conduct crosswalk violation 'stings' in areas with reported issues.
- Encourage safe and appropriate "Rules of the Road" for all roadway users through targeted enforcement and education.
- Develop a policy for establishing and expanding minimum red curb zone distances from marked and unmarked pedestrian crossings.
- Expand the existing crossing guard program and consider the potential for new protocol/locations where bicyclists may be assisted.

5.4.5 Evaluation

- Create a program to conduct regular pedestrian and bicycle data collection efforts at strategic screenlines (and locations identified for additional study) to assess activity level trends – both generally and for project before/after studies. Develop an annual report that documents and promotes findings from these data collection activities, and include a progress check on related benchmarks established in **Chapter 2** of this Plan.
- Consider building on the annual "Service Efforts and Accomplishments" survey to collect opinion data from a cross section of the public.
- Include an analysis of GHG emissions calculations for all major programs and projects (where practical) to understand the impacts of new investments on climate action goals and milestones.
- Update citywide traffic counts for all modes, including automobile counts, to assist the feasibility and design for including pedestrian and bicycle facilities in new projects as well as to analyze multi-modal level of service on Palo Alto streets.
- Consider prioritizing or requiring certification that encourages bicycle- and pedestrian-friendly developments, such as LEED-ND or STARS.

Chapter 6 Recommended Facilities and Conditions

This chapter presents an overview of recommended bicycle and pedestrian facilities and priority focus areas. The first section summarizes the recommended bikeway network and includes a review of changes from the 2003 Plan. The second section lists proposed new pedestrian and bicycle barrier crossings (called Across Barrier Connections), while the third section identifies priority pedestrian areas. The last section reviews existing and proposed conditions by sub-area and provides added context to many of the recommendations described throughout this *Bicycle + Pedestrian Transportation Plan* (BPTP 2012).

6.1 Bicycle Network Recommendations

Table 6-1 summarizes the bicycle network recommendations. The proposed network emphasizes bicycle boulevards, which accommodate all types of bicyclists. In addition, the Plan recommends improvements to several of the existing Class II bike lanes, which could include improving intersections, improving corridor visibility through use of coloration, and/or improving separation from traffic through the use of buffers and cycletracks. Additional sub-sections of this chapter provide a summary of specific recommendations by facility type, while a prioritized list of projects by category (with planning level cost estimates) is provided in Table 7-1 on page 7-3.

Table 6-1: Recommended Bikeway Network Class Mileage Totals

Facility Type	Total New or Enhanced Routes Recommended (miles)	Planning-Level Cost	Total Route Miles (Proposed Bicycle Network)
Class I Multi-Use Path*	7.06	$4,534,000	20.4
Class II Bike Lane	2.70	$140,000	44.3
Enhanced Bikeways (Class II and III)	15.34	$1,750,000	16.2
Class III Shared Lane	9.15	$75,000	17.5
Class III Bicycle Boulevard	18.20	$990,000	22.2
Across Barrier Connections	N/A	$17 - $27,000,000	N/A
Intersection Improvements	N/A	$1,250,000	N/A
Total	***52***	***$26-36,000,000***	***~120***

**Does not include barrier connections or the proposed trail project along San Francisquito Creek. Costs do not include potential future rights-of-way acquisition or easements.*

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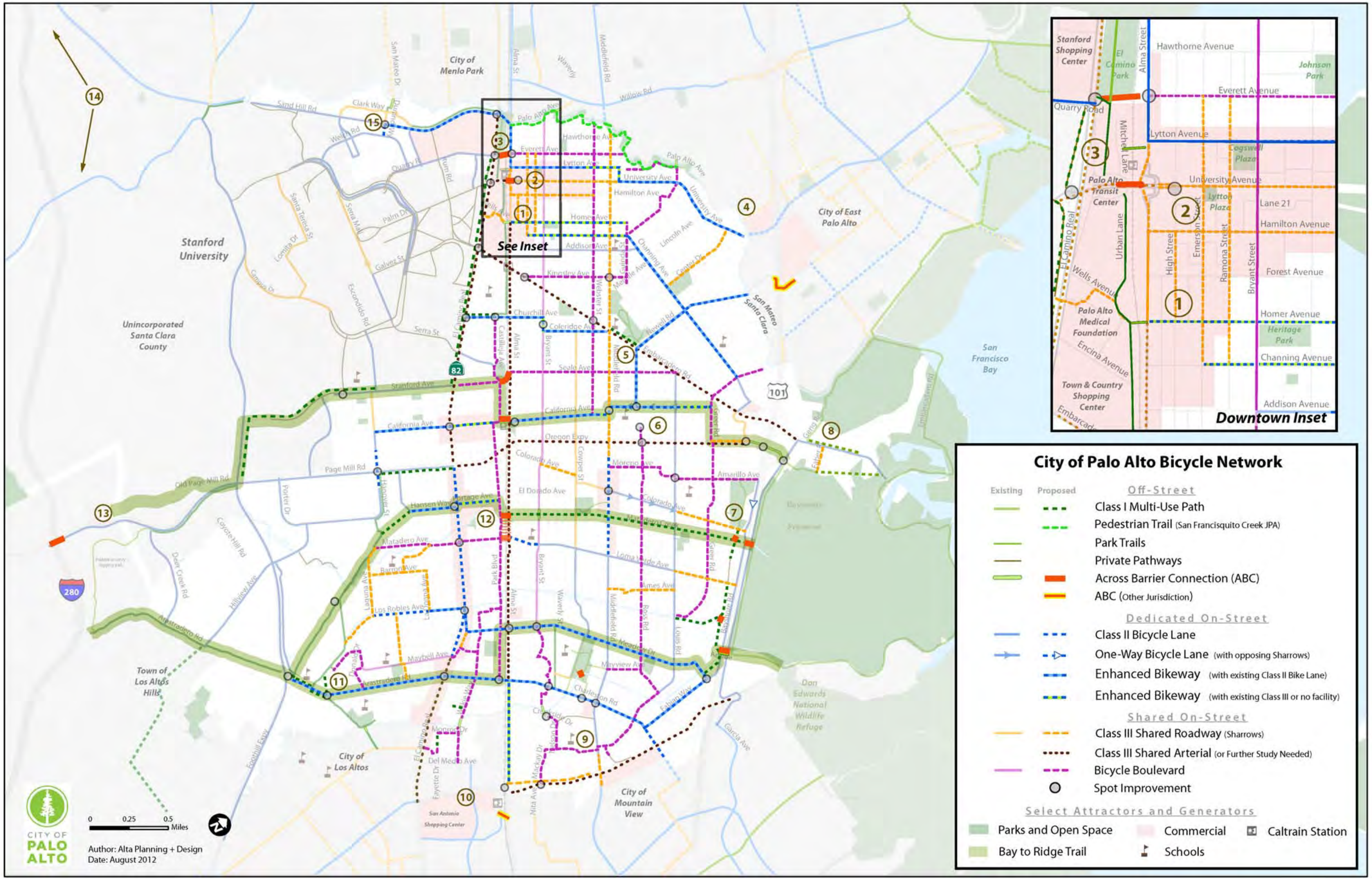


Map 6-1. Proposed Bikeway Network

Palo Alto Bikeway Network Map
Numbered Note Descriptions

1. *In order to provide sufficient access to/from Downtown from the planned contraflow bicycle lane on Homer Avenue from Alma Street to High Street, additional study is needed. Potential scenarios include converting High Street to two-way between Homer and Hamilton Avenue (preferred by PABAC) or extending the contraflow bicycle lane at least one additional block to Emerson Avenue (if potential conflicts at the existing Whole Foods parking lot driveway can be resolved). All scenarios should consider compatibility with the proposed Homer Ave/Channing Avenue Enhanced Bikeway corridor and removal of the (substandard) Addison Avenue bicycle lanes.*

2. *In coordination with future repaving, consider redesigning Emerson and/or Ramona Avenue into a high amenity shared space (e.g. with special pavers and at-grade pedestrian crossings) or "festival street" (i.e., a street that can be closed to traffic for special events) to create a bicycle and pedestrian-friendly connection between the SOFA neighborhood and Downtown.*

3. *Improve access to <u>and through</u> the Palo Alto Transit Center by: (a) upgrading trails within El Camino Park and improving connectivity to the existing Caltrain path; (b) providing an enhanced bikeway and new sidewalk (or Class I trail) along Alma Street from Lytton Avenue to El Camino Real; and (c) widening University Avenue sidewalks under Caltrain and improving pedestrian/ bicycle access across the El Camino Real off/on ramps.*

4. *Proposed trail concept by San Francisquito Creek Joint Powers Authority includes a new underpass at Middlefield Road, and crosses into East Palo Alto (following Woodland Avenue) at the Chaucer Street bridge. In a separate project, East Palo Alto is designing a new Highway 101 pedestrian/bicycle overcrossing at either the Newell Road/Clarke Avenue area south of University Avenue or just north of University Avenue at Manhattan Avenue/West Bayshore Road.*

5. *Connect the Churchill/Coleridge and Newell Road Enhanced Bikeways to Rinconada Park and Walter Hayes School by widening and converting the north sidewalk along Embarcadero Road into a new Class I "sidepath" trail. Further improve bicycle/pedestrian access to the Community Center area by installing a new signal or hybrid beacon crossing of Embarcadero Road to help establish Webster Avenue as a Bicycle Boulevard (and alternative school route to Middlefield Road).*

6. *Work with PAUSD and area neighbors to establish a new Class I trail through the Jordan School campus to connect the proposed Newell Road Enhanced Bikeway and Ross Road Bicycle Boulevard. Such a connection will likely require property acquisition along Garland Avenue, but would provide a continuous, high demand, and low stress bicycle route at a key location in the city.*

7. *Add southbound sharrows along West Bayshore Road between Amarillo Avenue and Matadero Creek. Longer term, work with area landowners and the Santa Clara Valley Water District to build a trail connection from Greer Park south to Adobe Creek/Meadow Drive via the Sterling Canal.*

8. *Include upgrades (widening, repaving) and new trail connections along Embarcadero and Geng Roads with plans to improve the Baylands Athletic Center and Palo Alto Public Golf Course. Improve access across Embarcadero Road and connectivity of the Bay Trail at Faber Place.*

9. *Provide a dedicated bicycle/pedestrian pathway or bicycle boulevard-type connection through the Cubberly Campus as part of future redevelopment or expansion plans. Integrate this connection into the "South Bryant Street Bicycle Boulevard" (at Nelson Drive) and Ross Road Bicycle Boulevard (via Montrose Avenue and Louis Road) via signage and wayfinding.*

10. *Coordinate with Mountain View and private developers on improving bicycle network connectivity and pedestrian access along and across San Antonio Road, particularly at Nita Drive and from Miller Avenue / Del Medio Avenue / Fayette Drive, and across the Central Expressway at the San Antonio Caltrain Station.*

11. *Further explore the feasibility of linking the Bol Park, Gunn High School, and Hetch Hetchy/Los Altos via either shared use "sidepath" connections (crossing Arastradero Road at the existing at Gunn High School entrance traffic signal) or by establishing a new trail connection along the Hetch Hetchy corridor and new signal or hybrid beacon crossing of Arastradero Road near the Alta Mesa Cemetary entrance.*

12. *Advance the conceptual design of a "South Palo Alto ABC" in the vicinity of either Matadero Creek/Park Boulevard or Margarita Avenue/ Loma Verde Avenue. Plan for a new on-street (Enhanced Bikeway) or Class I trail connection from Park Blvd to El Camino Real at Hansen Way with future potential redevelopment of the Fry's Electronics site. Consider designating the Arastradero Rd/Bol Park Path/Hansen Way/Portage Avenue/Matadero Creek Trail as a second "Bay to Ridge" trail concept, and/or clarify as the preferred urban alignment for the S-1 trail identified in the Santa Clara County Countywide Trails Master Plan.*

13. *Work with Caltrans and Santa Clara County to improve the safety and connectivity of bicycle lanes and pedestrian facilities across the Interstate 280 on/off ramps along Page Mill Road. Consider a grade-separated crossing if no on-street solution can be reasonably achieved. Along Old Page Mill Road, maintain high pavement quality and drainage functionality, and provide other enhancements (e.g. wayfinding signage, bicycle rest stops) that are consistent with its importance as a recreational and regional route.*

14. *Participate with Stanford University and San Mateo County on a revised planning effort to improve safety of the Alpine Road corridor for bicyclists and pedestrians, particularly at the I-280 interchange. Advocate for the use of any unspent Stanford University mitigation funds (formerly earmarked for Alpine Road trail improvements) on projects that improve recreational opportunities and open space access for Palo Alto residents, including enhancements to the Sand Hill Road/I-280 interchange.*

15. *The extension of Durand Way across Sand Hill Road is tentatively scheduled for construction in 2018 as part of the Stanford Medical Center expansion activities. This new connection will greatly improve the directness of bicycle facilities into Palo Alto and Stanford University from Menlo Park. In the short term, work to expand and improve bicycle parking within the Stanford Shopping Center and improve wayfinding and bicycle lane quality along Welch and Quarry Roads.*

6.1.1 Class I Trails / Shared Use Paths

The BPTP 2012 generally maintains Class I trail recommendations from the 2003 Plan and provides three additional project concepts at several locations.

First, multiple "sidepath" segments are recommended by widening existing sidewalks behind the face of the curb. These segments would extend existing trails toward El Camino Real along both Churchill Avenue and Page Mill Roads; along Stanford University property frontages at Stanford Avenue and El Camino Real; and along Embarcadero Road near the Community Center campus and out near the Palo Alto Golf Course. As sidepaths can have visibility challenges at intersections, they are identified for areas with long, unobstructed frontages and must be well-designed.

Second, the BPTP 2012 formally acknowledges and supports recent efforts by the San Francisquito Creek Joint Powers Authority to design and build a trail along the Palo Alto side of the creek from Alma Street to Chaucer Road. Lastly, the BPTP 2012 emphasizes the need to modify or replace unnecessary trailhead and barrier crossing obstacles to improve Class I path convenience for larger bicycles and families. **Table 6-2** shows the proposed Class I Multi Use Trails. **Table 7-1.** Top Recommended Projects by Category provides descriptions of the highest priority trail projects, and includes a recommendation to increase trail maintenance funding because of new and backlog facilities.

Table 6-2: Proposed Multi Use Trails

Name	Extent	Length (miles)
Adobe Reach Trail	Adobe Creek 101 crossing to Meadow Drive	0.17
Barron Creek Connector	Louis Road to Sterling Canal Trail	0.32
Baylands Preserve Path Extension	Faber Place to Embarcadero Road	0.43
Churchill Rd Sidepath	El Camino Real to Castilleja Avenue	0.16
Geng Rd Trail (Bay Trail) Widening/Repaving	Geng Road to Embarcadero Way	0.33
Greer Park Connector	John Lucas Greer Park Path to Fallen Leaf Street Path	0.19
Hansen Way Connector Path	Hansen Way to Gunn High School Path	0.23
Hetch Hetchy - Bol Park Connector path	Gunn High School Path to Terman Park Path	0.26
Jordan Trail Connector (MIddlefield Road)	California Avenue to California Avenue	0.05
Matadero Creek Trail	Alma Street to Bayshore Road	1.52
Newell Road/Ross Road Connector	California Ave to Garland Drive	0.16
Page Mill Road Sidepath	Hanover Street to El Camino Real	0.48
Palo Alto Avenue	Alma Street to Chaucer Street	1.70
Stanford Ave Trail Extension(S)	PMF Intersection to Embarcadero Road	0.40
Sterling Canal Trail	Adobe Creek crossing to Loma Verde Avenue	0.45
Walter Hays School/ Rinconada Park Sidepath	Newell Rd to Middlefield Rd	0.20
Total Multi Use Trails		***7.06***

6.1.2 Class II Bike Lanes and Enhanced Bikeways

Many commuters may prefer bike lanes to bicycle boulevards and shared lanes due to their more direct routing and signalization at arterial crossings. The BPTP 2012 recommends an emphasis on removal of and enhancement to existing substandard bike lanes (particularly those that pose potential "dooring" issues adjacent to parked cars or where gutter pans affect the functionality of curbside bike lanes) and the continuation of bicycle lanes across intersections through innovative green colorization and roadway markings that improve bicyclists' visibility. Most proposed new segments of Class II bike lanes on arterials, namely along Middlefield Road and El Camino Real, will require additional analysis and public outreach to assess their feasibility.

In addition to the proposed Class II Bikeways listed in Table 6-3, the City should consider updating existing bicycle facilities that do not meet state and local standards, including locations where a five-foot bike lane is adjacent to a seven-foot parking lane.

Table 6-3: Proposed New or Enhanced Class II Bikeways

Name	Extent	Length (miles)
Standard Class II Bike Lanes		
Charleston Road	San Antonio Road to Fabian Way	0.13
Charleston Road	San Antonio Road to South of San Antonio Road	0.05
Durand Way	Sand Hill Road to Welch Road	0.07
El Camino Real	Page Mill Road to Maybell Avenue	1.20
Hanover Street	North of Page Mill Road to South of Page Mill Road	0.25
Los Robles Avenue	Laguna Avenue to La Donna Avenue	0.36
Middlefield Road	Marion Avenue to Loma Verde Avenue	0.64
Enhanced Class II (and Class III) Bikeways		
Alma Street	Charleston Road to Mountain View border	0.72
California Avenue	Hanover Street to California Turnaround	0.76
Channing Avenue	Emerson Street to Greer Road	1.77
Charleston Road/Arastradero Road	Foothill Expressway to Fabian Way	2.36
Churchill Avenue/Coleridge Avenue	El Camino Real to Middlefield Road	0.99
El Camino Way/Los Robles Avenue	La Donna Avenue to Meadow Drive	0.37
Fabian Way	Meadow Drive to Charleston Road	0.51
Hansen Way	Proposed Stanford Research Park Trail to El Camino Real	0.29
Homer Avenue	Alma Street to Guinda Street	0.74
Portage Avenue	El Camino Real to Park Boulevard	0.27

Name	Extent	Length (miles)
Lytton Avenue/Fulton Street	Alma Street to University Avenue	0.79
Meadow Drive	El Camino Way to Fabian Way	1.64
Newell Road	Woodland Avenue to Channing Avenue	0.43
Newell Road	Embarcadero Road to California Avenue	0.38
Newell Road	Channing Avenue to Embarcadero Road	0.39
North California Avenue	Alma Street to Louis Road	1.57
Palo Alto Avenue/Alma Street	El Camino Real to Lytton Avenue	0.39
Sand Hill Road Path	Durand Way to El Camino Real	0.75
University Avenue	Fulton Street to Crescent Drive	0.95
Total Class II Bikeways		**18.77**

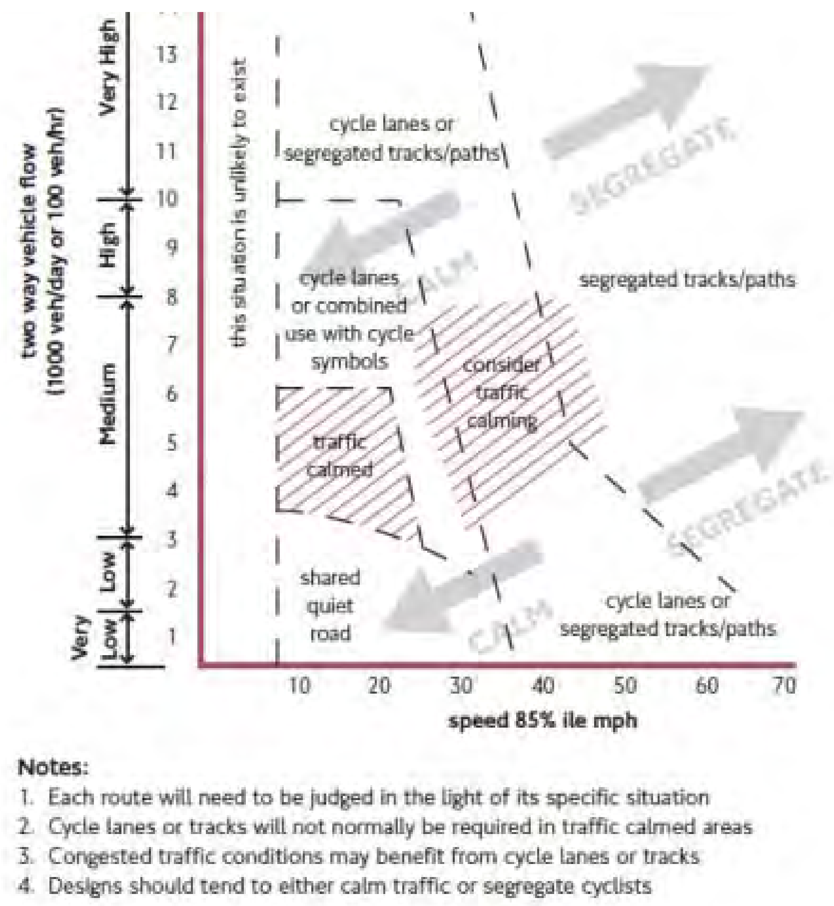


Figure 6-1: Guide to Bicycle Facility Selection

(Source: Transport for London, "London Cycling Design Standards", Chapter 4)

Where conditions indicate potential suitability and demand, the Plan prioritizes additional analysis of green coloration, buffered bike lanes, or two-way cycletracks to attract "interested but concerned" riders who may otherwise avoid arterial bikeway riding of any kind. Although this latter facility type is largely dependent on public support and a detailed engineering assessment of local conditions, **Figure 6-1**: Guide to Bicycle Facility Selection offers general guidance for when (and when not to) introduce greater separation from traffic for bicyclists.

For Palo Alto, the key considerations for cycletrack safety and appropriateness will likely include:

- Feasibility of full-time parking restrictions (as opposed to 7am-7pm only) for one side of the roadway and the potential for further reduced speed limits on segments of Residential Arterials
- Proximity and connectivity to existing or proposed Class I trails and pathways
- Importance of separated facilities for attracting additional student and family bicycle trips
- Perceived and/or actual impact to design safety of limited (but regular) residential driveways
- Need for revised bicycle safety curriculum and training

6.1.3 Class III Shared Roadways

Any street that is legal for bicycles is inherently a shared roadway in which bicyclists and drivers share a lane of traffic, and a car cannot necessarily pass a bicyclist in the same lane. To improve motorists' awareness of the presence of bicyclists and to indicate good routes for bicyclists, cities often post signs indicating that the road is a "Class III Bike Route," as well as painting shared roadway markings in the travel lane.

In 2003 (at the time of the previous bicycle plan), the "shared lane marking" (sharrow) essentially did not exist as a tool for planners and engineers. As such, virtually all shared roadways in Palo Alto are indistinguishable from other roads with the exception of bicycle route confirmation signage. All existing and proposed Class III routes are candidates for sharrow striping, as are segments of other Class II and bicycle boulevard routes where intersection gaps need to be filled or lane positioning guidance is desirable. For shared roadways in busy commercial areas, the Plan suggests ways to introduce elements of enhanced visibility – such as bicycle boxes with lead-in bicycle lanes, or designating festival streets that are regularly closed to traffic for special events.

The BPTP 2012 also identifies Class III accommodations for major arterial routes such as Alma Street, El Camino Real, Embarcadero Road, and San Antonio Road. With regard to the latter, full-time Class II bike lanes were/are not feasible due to the existing right-of-way configuration and demand. Nevertheless, the City has plans to improve bicycling comfort along San Antonio Road by providing wider shoulders and parking restrictions as part of an upcoming paving and median replacement project. The feasibility of Class II facilities along Oregon Expressway is also uncertain in light of the fact that improvement plans are moving forward that do not immediately include bike lanes. On these major arterials, "Share the Road" and "Bicyclists Allowed Full Use of Lane" signage is encouraged as a complement to a high standard of pavement maintenance and shared lane markings where appropriate.

Table 6-4: Proposed Shared Roadways

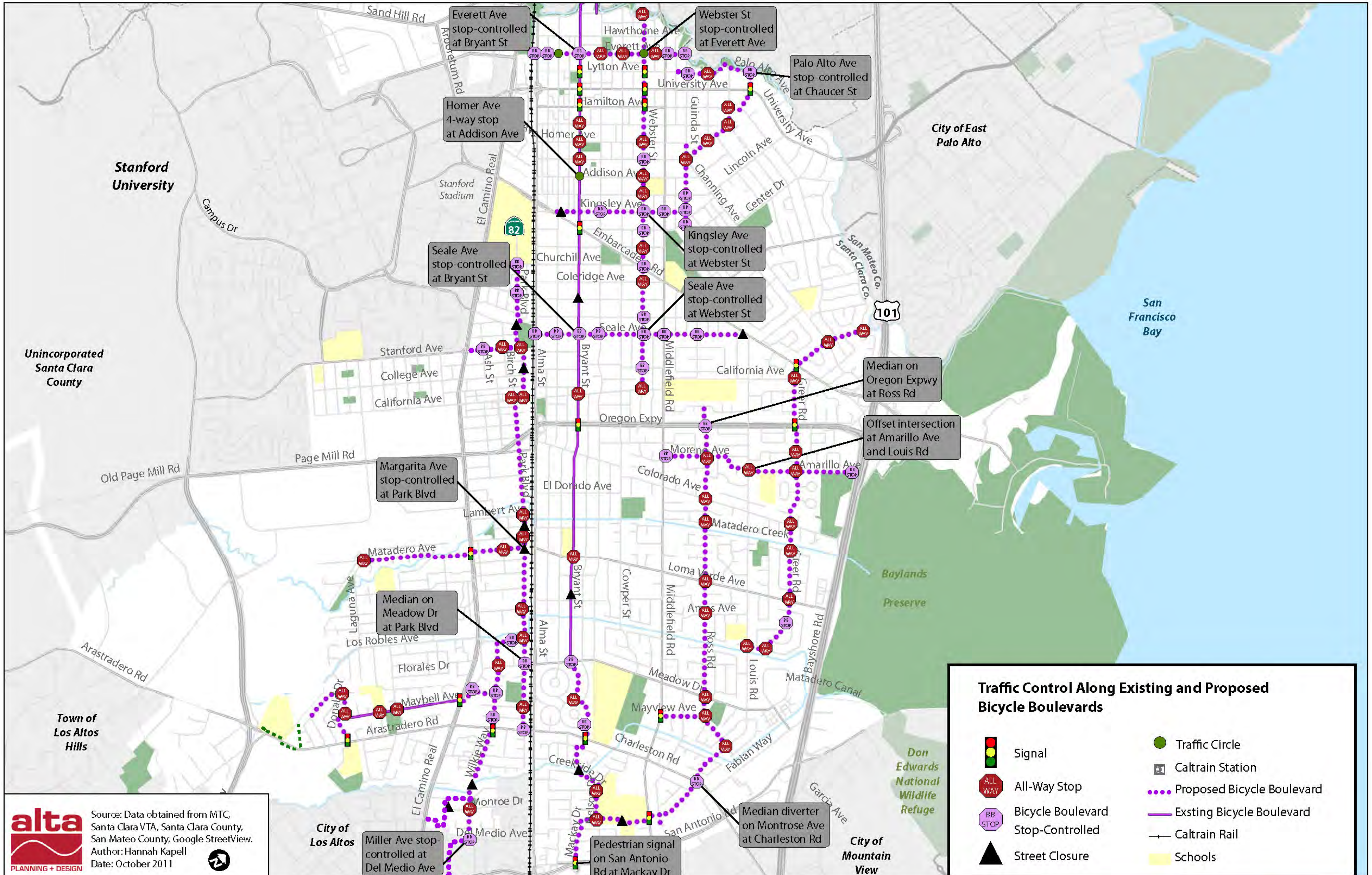
Name	Extent	Length (miles)
Amaranta Way/Clemo Avenue	Los Robles Avenue to Arastradero Road	0.46
Ames Avenue	Middlefield Road to Louis Road	0.45
Barron Avenue	Los Robles Avenue to Barron Park School	0.40
Barron Avenue/Josina Avenue	Laguna Avenue to Matadero Avenue	0.51
California turnaround	California Avenue to California ABC	0.03
Center Drive	University Avenue to Channing Avenue	0.55
Colorado Avenue	Bryant Street to Cowper Street	0.25
Colorado Avenue	Louis Road to W. Bayshore Road	0.47
Emerson Street	Everett Avenue to Channing Avenue	0.52
El Camino Way	West Meadow Drive to James Road	0.12
Faber Place	Embarcadero Rd to Bay Trail	0.15
Hamilton Avenue	Alma Street to Webster Street	0.53
Laguna Avenue	Matadero Avenue to Los Robles Avenue	0.45
Loma Verde Avenue	Louis Road to W. Bayshore Road	0.40
Los Robles Avenue	Laguna Avenue to Gunn High School Path	0.24
Middlefield Road	San Antonio Way to South of San Antonio Way	0.08
Middlefield Road	Keats Circuit to San Antonio Road	0.11
Middlefield Road	Coleridge Avenue/Embarcadero Road to Marion Avenue	0.80
Middlefield Road	Palo Alto Avenue to Embarcadero Road	1.25
Oregon Avenue	Embarcadero Overpass to Greer Road	0.28
Ramona Street	Everett Avenue to Channing Avenue	0.52
University Avenue	Middlefield Road to Alma Street	0.64
Wells Avenue/Urban Lane	PMF Intersection to Caltrain Bike Path	0.19
Total Shared Roadways:		***9.15***

6.1.4 Bicycle Boulevards

The 2012 Bicycle + Pedestrian Transportation Plan takes advantage of analysis conducted in 2003 for identifying and prioritizing bicycle boulevard corridors – although a few changes have been made based on opportunities to improve bikeway spacing and identified priorities for new/enhanced arterial crossings. Although the main priority continues to be removing or reversing unnecessary stop signs on bicycle boulevard corridors and upgrading pavement conditions, the BPTP 2012 includes new guidance on bicycle boulevard signage, custom roadway markings, and alternative traffic calming measures. In order to promote increased ridership and establish bicycle boulevard routes, the Plan recommends focusing implementation on specific bicycle boulevard corridors, In addition, the Plan recommends interim Bike Route signage on future bicycle boulevards citywide, which will be followed by pavement markings, traffic control revisions, and capital improvements on corridors that will then be designated as bicycle boulevards. Palo Alto staff should work closely with the Palo Alto Bicycle Advisory Committee and other stakeholders to identify the appropriate extent of treatments and to prioritize more intensive treatments as specific bicycle boulevards are considered for additional development.

Table 6-5: Proposed Bicycle Boulevards

Name	Extent	Length (miles)
Amarillo Avenue	W Bayshore Road - Louis Road	0.53
Boyce Avenue/Chaucer Street	Woodland Avenue - Guinda Street	0.65
El Camino Way/James Road	El Camino Real - Wilkie Way	0.21
Everett Avenue	Alma Street - Palo Alto Avenue	0.73
Georgia Avenue/Donald Drive	Hubbartt Drive - Arastradero Road	0.50
Greer Road	Edgewood Drive - Louis Road	1.93
Grendell School Path	Nelson Drive - Middlefield Road	0.29
Guinda Street	Homer Avenue - Melville Avenue	0.39
Kingsley Avenue	Embarcadero Road - Guinda Street	0.65
Lytton Avenue/Palo Alto Avenue	Guinda Street - Chaucer Street	0.35
Maclane Street/Wilkie Way	Park Boulevard - Wilkie-Miller Bridge	0.57
Margarita Avenue	El Camino Real - Park Boulevard	0.27
Matadero Avenue	El Camino Real - Laguna Avenue	0.54
Mayview Avenue	Middlefield Road - Ross Road	0.21
Miller Avenue/Del Medio Avenue/California Street	Wilkie-Miller Bridge - San Antonio Road	0.49
Montrose Avenue/Louis Road	Ross Road - Middlefield Road	0.54
Moreno Avenue/ Fielding Drive	Louis Road - Middlefield Road	0.47
Park Boulevard	Churchill Avenue - Maclane Street	1.93
Redwood Circle/Nelson Drive/Mackay Drive	Bryant Street - San Antonio Road	1.04
Ross Road	Garland Drive - Louis Road	1.74
Seale Avenue	Alma Street – Embarcadero Road/Louis Road	1.06
Sutherland Drive	Montrose Avenue - Greenhouse Cut-Though	0.06
Webster Street	Palo Alto Avenue – California Avenue	1.85
Wilkie Way Connector	Charleston Road - Wilkie-Miller Bridge	0.26
Proposed Bicycle Boulevards:		***18.20***



Map 6-2. Proposed Bicycle Boulevard Network with Existing Traffic Control

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6.1.5 Neighboring Community Connections

The BPTP specifically highlights bicycle connections to neighboring jurisdictions in order to provide continuous facilities for entering or leaving Palo Alto for commute, recreation, and other discretionary trip purposes. To improve access to Los Altos Hills and the Arastradero Open Space Preserve, the City is actively working with Santa Clara County and Caltrans to improve the interchange at Page Mill Road and Highway 280, as well as to identify potential enhancements along Old Page Mill Road.

Another recommended interjurisdictional connection is the extension of Durand Way across Sand Hill Road into Stanford campus from the City of Menlo Park. This project is planned for implementation in 2018 in association with the Stanford Medical Center expansion project. Important connections to East Palo Alto include a proposed enhanced bikeway on University Avenue and a barrier connection across Highway 101 south of University Avenue from Newell Road to Clark Avenue. An additional overcrossing of Highway 101 at Adobe Creek is recommended for further design development to provide a critical year-round connection to Mountain View and the Shoreline Amphitheater/Googleplex area via the Bay Trail and E. Bayshore Road.

To the south, key connections into Mountain View include access across San Antonio Road at Charleston and Middlefield Roads, on Mackay Drive connecting to Nita Avenue and California Street, and on Miller Avenue to Del Medio Avenue to California Street to San Antonio Road. Finally, this Plan proposes improved connections to Los Altos and Los Altos Hills at Monroe via a proposed path and Cesano to Los Altos Avenue, as well as Foothill Expressway and along the Bol Park/Hetch Hetchy Path.

6.1.6 Across Barrier Connections

Chapter 3 discusses barriers to bicycling and walking, including major roads, creeks, and the Caltrain/Alma Street corridor. The recommended across barrier connections enhance connectivity and facilitate pedestrian and bicycle access to key destinations. While the recommendation for a Caltrain undercrossing at Quarry Road/Everett Avenue is carried over from the 2003 *Bicycle Transportation Plan* and Stanford Medical Center Expansion EIS, serious implementation issues and potential alternative priorities are identified by this Plan.

Table 6-6: Proposed Across Barrier Connections

Name	Extent
Adobe Creek / Highway 101 Overcrossing	W. Bayshore Road to Bay Trail
California Avenue Caltrain/Alma Undercrossing	California Turnaround to Alma Avenue
Matadero Creek / Highway 101 Seasonal Undercrossing	W. Bayshore Road to the Baylands Preserve Path
Peers Park / Seal Avenue Caltrain/Alma Barrier Connection	Park Boulevard to Seale Avenue
Caltrain/Alma Barrier Connection at Matadero Creek	Park Boulevard to east of Alma Street
University Avenue Caltrain Undercrossings	Palo Alto Caltrain Station to University Avenue
Caltrain/Alma Barrier Connection at El Camino Park	Quarry Road to Everett Avenue

6.1.7 Intersection Improvements

Intersection improvements include a variety of markings, curb extensions, and signalization changes to improve bicyclist and pedestrian visibility in key locations. Intersections recommended for additional consideration include the following:

- Alma Street and Everett Avenue
- El Camino Real and Matadero Avenue
- Arastradero Road and Terman Park Path
- El Camino Real and Quarry Road
- Arastradero Road/Charleston Road and Alma Street
- Embarcadero Road and Kingsley Avenue
- Arastradero Road/Foothill Expressway/ Miranda Rd
- Fabian Way/West Bayshore Drive and Meadow Drive
- Bol Park Path at Matadero Creek
- Hanover Street and Page Mill Road
- Bryant Street and Churchill/Coleridge Avenue
- Kingsley Road and Middlefield Road
- Bryant Street and Meadow Drive
- Meadow Drive and Alma Road
- California Avenue and Middlefield Road
- Middlefield Road at Colorado Avenue
- California Avenue and Newell Road
- Moreno Avenue/Amarillo Avenue and Louis Road
- Charleston Road and Carlson Court
- Oregon Expressway and Ross Road
- Charleston Road and Mitchell Park Path
- Oregon Avenue and St. Francis Drive
- Charleston Road at Middlefield Road
- Oregon Expressway 101 Overpass and East Bayshore Road
- Churchill Avenue and Park Boulevard
- Palm Drive and El Camino Real
- Churchill Avenue at El Camino Real
- Ross Road at Jordan Middle School
- Duncan Place and Duncan-Creekside Path
- San Antonio Avenue/San Antonio Road and Mackay Drive/Nita Avenue
- El Camino Real and Arastradero Road
- Sand Hill Road and Durand Way
- El Camino Real and California Avenue
- Sand Hill/Alma/El Camino Real
- El Camino Real and Galvez Street/Embarcadero Road
- Stanford Avenue and Bowdoin Street
- El Camino Real and Hansen Way
- Webster Street at Embarcadero Road
- El Camino Real and Los Robles Avenue/El Camino Way
- Park Boulevard at Charleston Road
- I-280 and Page Mill Road (non-City facility)

6.2 Relationship of Recommended Bikeway Network to 2003 Plan

This list of key projects reflects many of the projects identified in the 2003 *Bicycle Transportation Plan*, as well as new opportunities that have arisen since 2003. Projects from the 2003 Plan that have been implemented or funded include the Homer Avenue Crossing, Charleston/Arastradero Bike Lanes, California Avenue improvements (California Avenue Streetscape Project), Hanover/Porter Bike Lanes, and the Stanford/El Camino intersection improvements. A few projects recommended in the *2003 Bicycle Transportation Plan* are no longer proposed as part of the BPTP 2012. Other routes have been added or modified based on assessment of existing conditions and opportunities.

In addition, new innovative bicycle facility types provide opportunities to enhance existing well-used or substandard facilities. These modifications from the 2003 recommendations include several new bicycle boulevard recommendations (e.g., at Webster Avenue, Amarillo and Moreno Avenues, Seale and Kingsley Avenues) and new Class III bikeways that utilize sharrows to increase visibility of the bicycle route (e.g. at Emerson Avenue, Ramona Avenue, Hamilton Avenue, Center Road and Ames Road). This list also contains some modified recommendations for Class III bikeways where alternative facilities were previously recommended (e.g., at Lytton Avenue and Middlefield Road north of the Oregon Expressway). Finally, some of the previous recommendations were removed from the network where alternative corridors provide better network spacing and connectivity (e.g., Addison Avenue, Melville Avenue, and a segment of Guinda Street).

Table 6-7: Summary of Changes to Recommended Bikeway Network – 2003 Plan and BPTP provides a summary list of the differences between the BPTP network recommendations and those from the 2003 Plan.

Table 6-7: Summary of Changes to Recommended Bikeway Network – 2003 Plan and BPTP

Corridor/ Bikeway	2003 Plan	BPTP 2012 Recommendation
Alma Street	Potential Long Range Class II between Homer Avenue and E. Meadow Drive	Enhanced Class II north of Lytton Avenue to El Camino Real Class III Shared Arterial (or Further Study Needed) – Lytton Avenue to City limits
Sand Hill Road	Existing Class II	Enhanced Bikeway
Lytton Avenue	Existing Class II Bike Lanes (identified as substandard)	Enhanced Bikeway (Enhanced Class III encouraged)
University Avenue	Existing Class II northeast of Fulton Avenue	Enhanced Bikeway
Homer Avenue	Proposed Bicycle Boulevard	Enhanced Class II couplet with Channing Avenue including a contraflow bicycle lane on Homer Avenue east of Alma Street
Emerson Avenue, Ramona Avenue	None	Class III with sharrows (or redesigned as shared/festival streets)
Hamilton Avenue, Center Drive	None	Class III with sharrows

Corridor/ Bikeway	2003 Plan	BPTP 2012 Recommendation
Middlefield Road	Proposed Class II Bike Lanes	Class II Bike Lanes from Loma Verde Avenue to Oregon Expressway approach (pending feasibility analysis); Class III with sharrows north of Oregon Expressway
Webster Avenue	None	Bicycle Boulevard from Palo Alto Avenue to California Avenue
Guinda Avenue (north of Homer Avenue)	Proposed Bicycle Boulevard	None (No longer recommended)
Addison Avenue	Existing Class II Bike Lanes (identified as substandard)	Remove from the network (pending implementation of the Kingsley Avenue Bike Boulevard and Homer/Channing Avenue Enhanced Bikeway
Melville Avenue	Proposed Bicycle Boulevard	None (No longer recommended)
Kingsley Avenue	None	Bicycle Boulevard
California Avenue	Further Study of business district segment	Enhanced Bikeway (Greer Road to Hanover Street) with future consideration of cycle tracks for segments
Churchill Road – Caltrain Path to El Camino Real	Existing Class II Bike Lanes	(Addition): Sidepath on north side of roadway (Upgrade): Enhanced Bikeway Designation
Seale Avenue	None	Bicycle Boulevard (heavily dependent on Caltrain ABC)
San Antonio Road	Propose Class II Bike Lanes	Class III Shared Arterial (or Further Study Needed)
Oregon Expressway e/o Caltrain to Greer Road	Class II Bike Lanes	Class III Shared Arterial (or Further Study Needed)
Montrose Avenue	Proposed Class III	Bicycle Boulevard (Ross/Louis Road)
Amarillo Avenue	Existing Class III	Bicycle Boulevard (Amarillo-Moreno)
Moreno Avenue	None	Bicycle Boulevard (Amarillo-Moreno)
Ames Road	None	Class III with sharrows
Urban Lane	Part of Proposed Homer Street Bicycle Boulevard	Class III with sharrows and wayfinding
Embarcadero Road	Class II Bikes Lanes	Class III Shared Arterial (or Further Study Needed); Sidepath from Newell Road to Middlefield Road
El Camino Real	Class II Bike Lanes	Class II Bike Lanes Hansen Way to Maybell Avenue; Improved Stanford Trail Serra Road to Quarry Road Class III Shared Arterial all other segments
Page Mill Road	Existing Class II Bike Lanes	(Addition): Sidepath Hanover Street to El Camino Real
Hanover Street at Page Mill Road North Approach	Proposed Class III	Class II Bike Lanes
Hansen Way	Existing Class II	Enhanced Class II Bikeway
Portage Avenue	Proposed Class III	Enhanced Bikeway
Wilkie Way/Miller Avenue	Proposed Bicycle Boulevard	Proposed Bicycle Boulevard extension to San Antonio Road via Fayette Drive (City of Mountain View)

6.3 Priority Pedestrian Areas and Treatments

This section discusses the existing pedestrian environment and proposed improvements by location. Pedestrian priority locations include Palo Alto's Downtown and California Avenue Business Districts, neighborhood commercial centers, employment and shopping centers, school zones and routes, and the Barron Park and Monroe Park neighborhoods.

6.3.1 Downtown and California Avenue Business Districts

Area Description

The Downtown and California Avenue Business Districts are distinct pedestrian activity centers, with compact blocks and numerous alleys, plazas, and ground floor commercial uses that produce a comfortable human scale and vibrant streetscapes. Sidewalks wider than in most other parts of the city allow for the designation of specific zones to maintain a clear path of travel amid a variety of street furniture, landscaping, and spill-out commercial activity. Street trees (Sycamores) planted outside of the curb along University Avenue also help alleviate sidewalk crowding and reduce the actual and visual width of roadway. Both of these districts have existing urban design and/or form-based design guidelines that help ensure a distinct pedestrian character and "sense of place" with new investments. At the time of the writing of this Plan, significant changes and enhancements to the California Avenue street cross-section are being evaluated by the City as part of the California Avenue Streetscape Improvements project.

Where feasible, the City should provide curb extensions that incorporate and expand existing tree pits to improve tree health, reduce long-term sidewalk maintenance, and increase pedestrian queuing capacity or amenities at appropriate intersections.

Treatment Priorities and Locations

- Curb Extensions
  - High collision locations: High Street/University Avenue, Waverly Street/Hamilton Avenue, California Avenue/El Camino Real (including at future BRT stop locations)
  - Midblock crossings: Emerson and Ramona Avenues immediately south of University Avenue, City Hall across Hamilton Avenue (proposed), and multiple locations along California and Cambridge Avenues
  - Transit stop or station approaches: Numerous; must not conflict with transit vehicle turns

- High Visibility Crosswalks with Advance Stop Bars
  - Establish as a standard in the Downtown BID and California Avenue PTOD zones
  - Consider integration with bicycle boxes where appropriate

- **Accessible Pedestrian Signals and Countdown Signals**
  - Establish a timeline for outfitting all signalized intersections citywide with Accessible Pedestrian Signals (where actuation is required) and countdown signals where none currently exist. Prioritize implementation within the two business districts

- **Bicycle Parking Corrals**
  - Integrate bicycle parking corrals as part of new curb extensions to free up existing sidewalks and/or limit impacts of additional bicycle parking
  - Install bicycle corrals on-street by replacing one or two parking stalls or locating within existing red curb zones (including the opposite side of "T" intersections, such as at Florence and Kipling Streets on University Avenue) to free up sidewalk space and/or limit impacts to pedestrians of additional bicycle parking

- **Raised Crosswalks**
  - Most appropriate for mid-block, uncontrolled pedestrian or trail crossings, and at select 'slip ramp' or channelized right turn locations

- **On-street Parking Flex Zones (Parklets)**
  - Offer through existing or modified sidewalk permitting process and fees
  - Enlivens streetscapes and increases room for pedestrians, cafes, and other amenities
  - Consider for similar locations as on-street bicycle corrals and potentially within select public surface parking lots adjacent to retail or food establishments

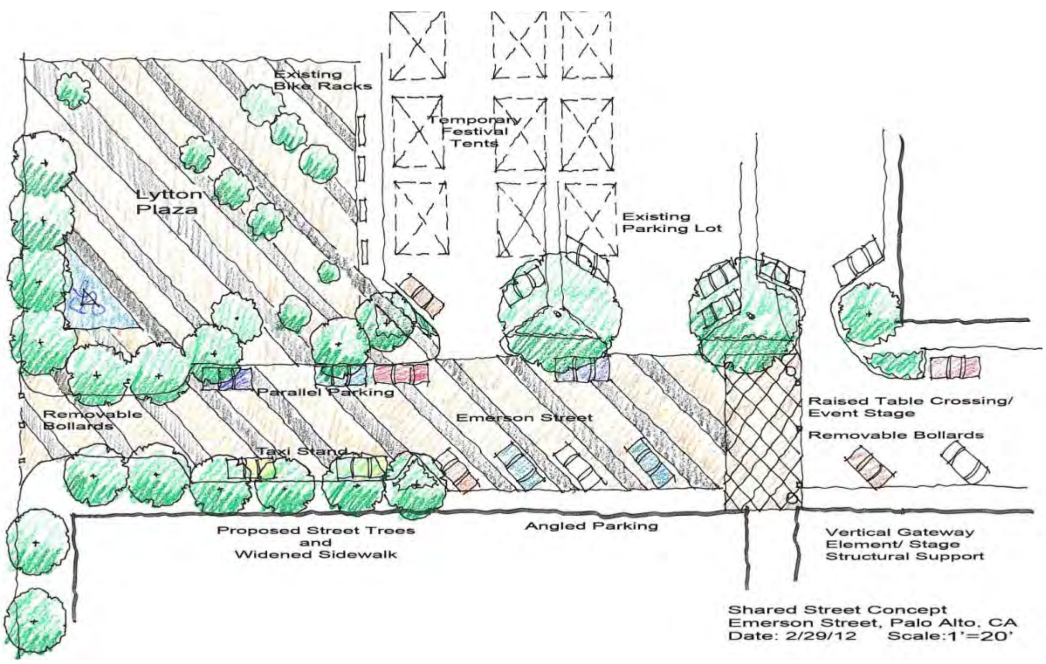
- **Festival Streets and Shared Space Streets**
  - Consider where side streets or alleys, plazas or parks, and public surface lots form contiguous public space improvement opportunities, including Ramona and/or Emerson Street between Lytton and Hamilton Avenues and in the California Ave Business District between New Mayfield Lane and Sherman Lane from El Camino Real to Park Boulevard

- **Pedestrian and/or Catenary Lighting**
  - Pedestrian-scaled lighting provides an attractive element to high-pedestrian activity areas and increases safety. Pedestrian-scaled lighting improvements are highest priority for streets bisecting and adjacent to University Avenue and California Avenue, and within public surface parking lots and connecting lanes/pathways. In addition to decorative street poles with fixtures, overhead catenary (suspended) lighting should also be considered.

Figure 6-2. Photo simulation of a potential Parklet on University Avenue in downtown Palo Alto.

Temporary, permitted use of on-street parking spaces and existing red curb (no parking) zones can help add bicycle parking and café seating while reducing sidewalk "clutter" and barriers for persons with disabilities.

Figure 6-3. ***Photosim (above) and site plan (below) of potential festival street on Emerson Street or Ramona Street, which could be closed to automobile traffic for festivals and other events.***



6.3.2 Neighborhood Commercial Centers

Area Description

Neighborhood-serving commercial and mixed-use centers are very important for encouraging walking and biking for discretionary trips, although most are generally located off arterials and ringed with surface parking near the roadway edge. The Midtown Shopping Center, Charleston Shopping Center, and Cal-Ventura/South El Camino Real corridors are each distinct commercial districts, yet they share similar obstacles to improving sidewalk connectivity, safe pedestrian crossing opportunities, bus/shuttle access, and comfortable gathering spaces.

Treatment Priorities and Specific Locations

El Camino Real and Middlefield Road both have narrow sidewalks, often adjacent to surface parking, that reduce the attractiveness of walking and pose numerous barriers to persons with disabilities and families with strollers.

- Enhanced Pedestrian Crossings
  - El Camino Real: Improve sidewalk approaches to "stacked" crosswalks (i.e. one-sided intersection crossings) at offset intersections; remove channelized right turn lanes ('pork chop islands') and provide high visibility, decorative crosswalks similar to the recent improvements at Stanford Avenue
  - Middlefield Road: Improve Colorado Avenue (a top collision location) and provide additional pedestrian crossing opportunities, especially for the future Matadero Creek Trail
  - Unsignalized Crossing Improvements: Establish criteria for the deployment of Rapid Flashing Beacons and other enhancements to ensure motorists yield to pedestrians in unsignalized crosswalks. These treatments should exclude in-pavement pedestrian flashers, which have proven unsuccessful at various locations in Palo Alto
  - Pedestrian-only actuated signals, e.g. HAWK signals (See **Appendix A** for more details)
  - Requires good data collection efforts to establish priority locations and traffic warrants

- Road Diets
  - Potential road diet opportunities are identified on both the Middlefield Road and El Camino Real corridors, to provide bicycles lanes that help buffer pedestrians and improve crossing opportunities

- Transit Stop Improvements along City Shuttle Routes
  - Wider sidewalks, new shelters, and shelters out of the way of pedestrian through-traffic

- **High Visibility Crosswalks with Advance Stop Bars**
  - High collision locations: Colorado Avenue/Middlefield Road, Charleston Road/Middlefield Road, Los Robles Avenue/El Camino Real
  - Adjacent to community centers, churches, and daycare centers/schools
- **"Green" Connections (e.g., Safe Routes to Parks)**
  - Hoover, Mitchell, and Boulware Park access routes
  - Matadero Creek Trail
  - Los Robles Avenue/El Camino Way Enhanced Bikeway (or Cycletrack)
  - Wilkie Bicycle Boulevard will provide access to Summerhill Park
- **South Palo Alto Caltrain/Alma Undercrossing at Matadero Creek**
  - Knits together two major commercial areas
- **Sunday Streets/Bike Palo Alto! Event Programming**
  - Include routes that connect to or through neighborhood commercial districts, not just the two main business districts

6.3.3 Employment and Shopping Centers

Area Description

Major employment (i.e. office, industrial, medical) districts in Palo Alto include the Stanford Research Park, E. Meadow Drive/Fabian Way sub-area, the greater Stanford Medical Center campus area along Sand Hill Road, and at Embarcadero Road east of Highway 101. These locations generate significant travel demand for weekday commute trips and happen to provide critical connections for recreational trail and open space destinations. The Stanford Research Park is the largest of these areas and poses significant challenges to pedestrians due to its large and un-engaging parcels, narrow and disconnected network of sidewalks, and the overwhelming presence of paved surface parking lots.

Town and Country Shopping Center, as with other "lifestyle malls," may not fall directly under the purview of City transportation planning but are nonetheless important destinations and occasionally, great examples of best practice pedestrian treatments and programming

Treatment Priorities and Locations

- Shared Use Paths
  - Research Park: Extending Bol Park Path to El Camino Real via Research Park/Hansen Way or a Hanover Street/Page Mill Road sidepath
  - Fabian Way/Meadow Drive: Adobe Creek Reach Trail and Highway 101 overcrossing
  - Medical Center: El Camino Park Trail improvements, San Francisquito Creek Trail development

- **Completing Sidewalk Gaps**
  - o Research Park sidewalk completion for transit access: Hillview Street, Hanover Street, Porter Drive (in coordination with Stanford University)
  - o West Bayshore: Complete sidewalk or provide Class I trail between East Palo Alto and Channing Avenue to provide access to Edgewood Plaza
- **Transportation Demand Management (TDM)**
  - o Promote education and encouragement programs and transit service travel planning to increase the appeal of transportation alternatives. Coordinate with the Stanford TDM staff.
  - o Develop a policy that requires private development adjacent to the Caltrain corridor to participate in the Caltrain GO Pass program as a standard TDM element

6.3.4 School Zones/School Commute Corridor Network

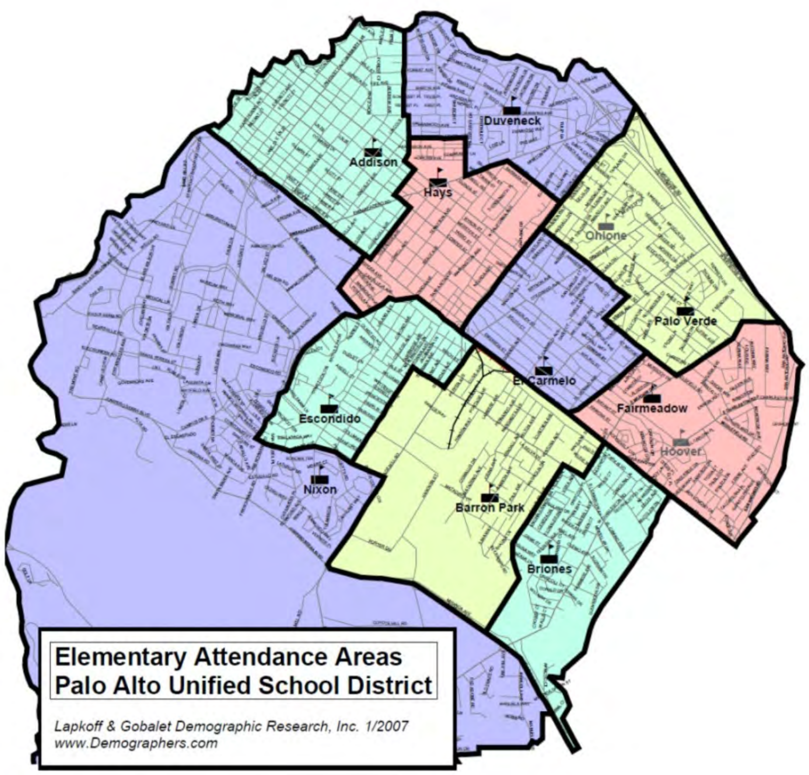


Figure 6-4: Elementary Attendance Areas - PAUSD

Area Description

The Palo Alto Safe Routes to School Program is one of the more successful programs in the nation at encouraging youth and young families to walk, bike, and take transit to school. With well-established national and state Safe Routes to School capital improvement programs, locations in and around schools are great opportunities for leveraging outside investment. With recent funding to conduct school site assessments and develop recommended walking route maps, the Safe Routes to School program is well-positioned to identify and prioritize improvements using consultant assistance, general recommendations from this Plan, and previous planning that defines the official School Commute Corridors Network.

The adopted School Commute Corridors Network depicts key corridors and intersections that are distinct from school zones, identified by a coalition of school and city officials and concerned parents. Map 6-3 depicts the adopted network that has been modified to include the revised bicycle boulevard network proposed by this Plan.

Treatment Priorities and Locations

- **High Visibility Yellow Crosswalks with Advance Stop Bars**
  - School Commute Corridor Network Critical Intersections
  - On suggested routes to school identified by school task forces
  - Crosswalk coloring must be yellow directly adjacent to schools and may include crosswalks within 600 feet of any school

- **All-Pedestrian Signal Interval (potentially restricted to morning commutes)**
  - Existing at Arastradero Road and Donald Drive-Terman Road, Embarcadero Road and Middlefield Road; future potential locations to be determined

- **Pedestrian Actuated Rapid Flashing Beacons**
  - Important school routes across un-signalized arterial intersections

- **'No Right Turn On Red When School Children Are Present' Signs**

- **Crossing Guards**
  - School Commute Corridor Network Critical Intersections
  - On suggested routes to school identified by school task forces

- **Shared Use Pathway Improvements and Extensions**

6.3.5 Barron Park and Monroe Park Neighborhoods

While in a sense all neighborhoods in Palo Alto are priority areas for safe and pedestrian-friendly travel, the lack of dedicated pedestrian facilities in the Barron and Monroe Park neighborhoods requires significantly more attention and creative solutions than elsewhere in the city. Several integrated design strategies to improve bicycle and pedestrian travel are identified in the proposed design guidelines. City staff would work closely with the neighborhood to develop any proposed changes.

A key connectivity issue in the Monroe Park neighborhood is the lack of access to the San Antonio Shopping Center just across San Antonio Road in Mountain View.

Treatment Priorities and Locations

- Pedestrian and Bicycle-Friendly Chicanes and Other Traffic Calming Devices
- Shared Use Trail Access and Lighting Improvements
- Walking Path and Access Improvements to El Camino Real

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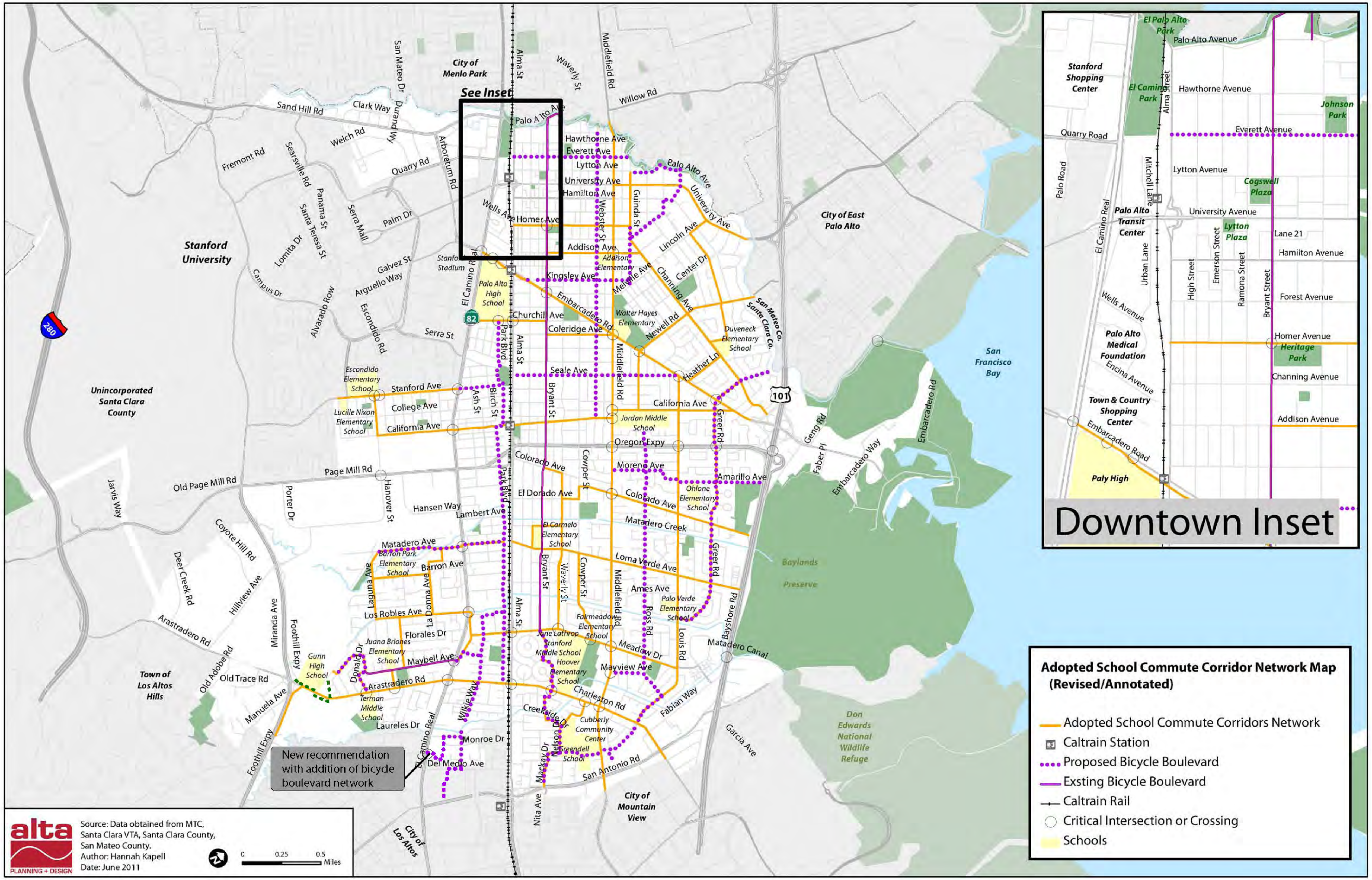

Map 6-3: Adopted School Commute Corridor Network Map (With Revised Proposed Bicycle Boulevards)

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6.4 Recommendations by Sub-Area

This section presents existing and proposed conditions for bicycling and walking by quadrant of the city, starting in the "northeast" and working clockwise to "northwest" Palo Alto. Since several of the bicycling and walking improvements would occur in conjunction and/or benefit both modes, this section is intended to highlight place-based circulation issues shared between modes. **Figure 6-5** shows the quadrants discussed in the following sections.

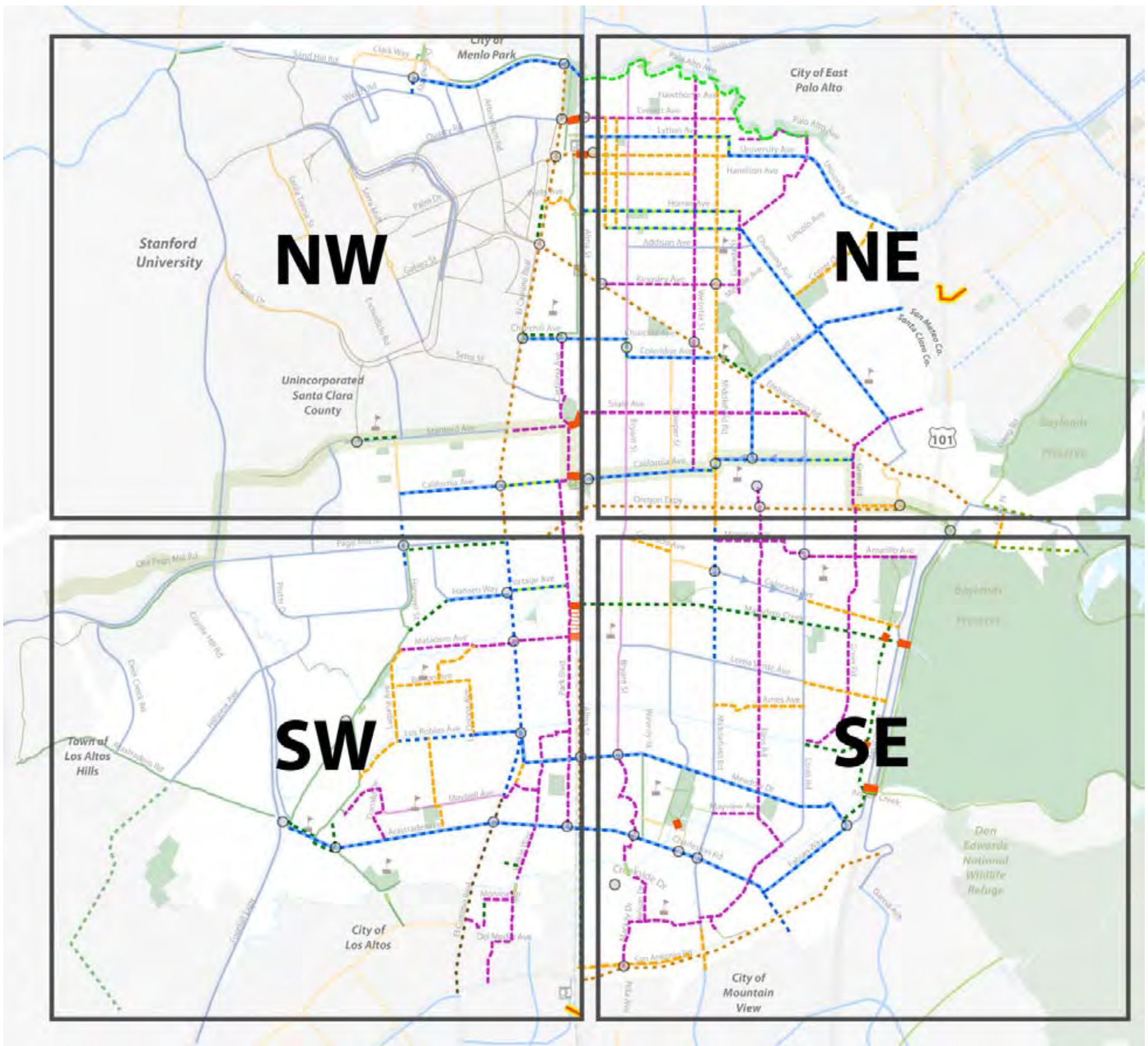
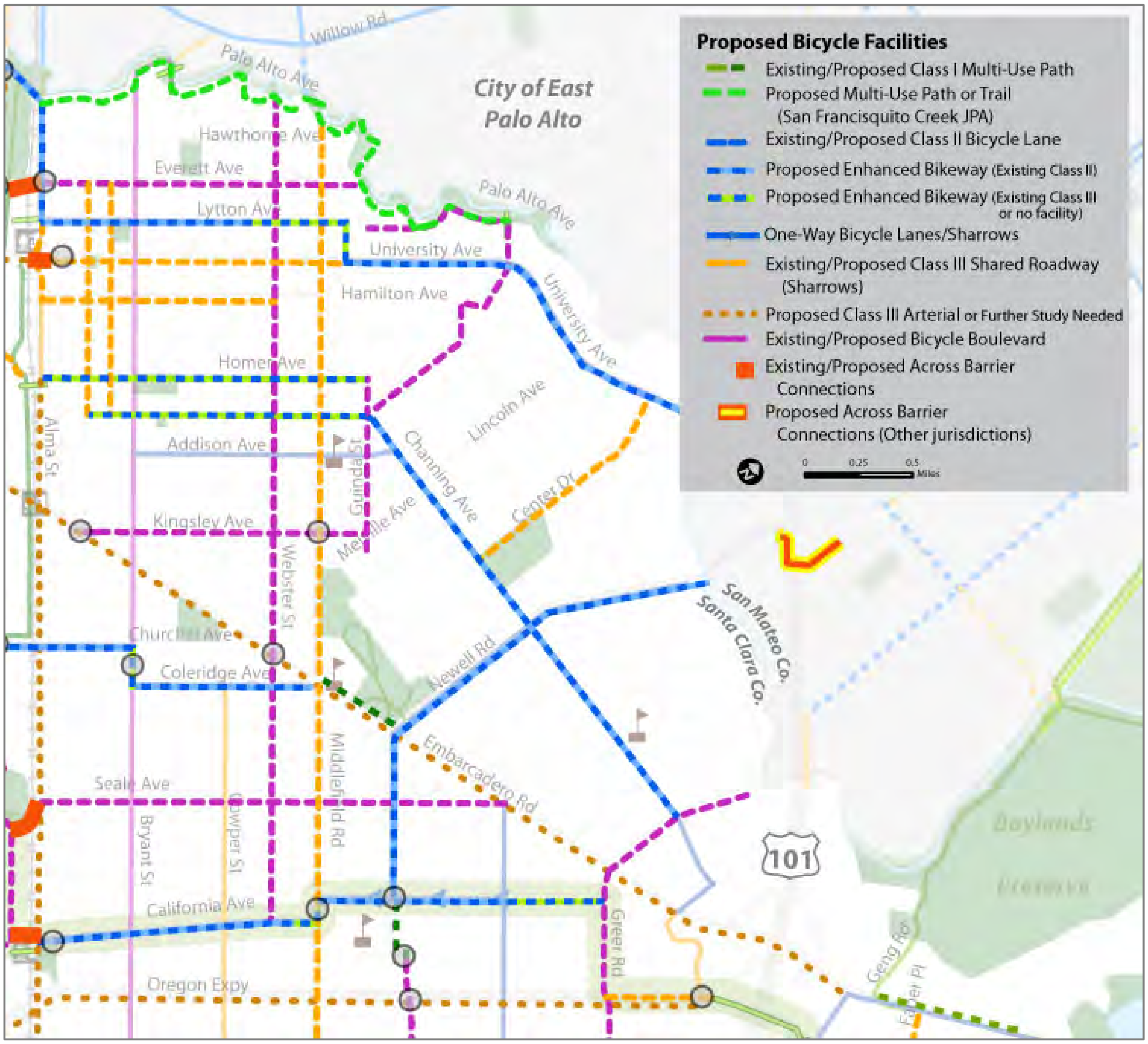


Figure 6-5: City Quadrants for Sub-Area Analysis

6.4.1 Northeast Palo Alto

Proposed Bikeway Map



Area Description

The San Francisquito Creek corridor and primarily residential neighborhood north of University Avenue provides several low-volume, bicycle-friendly connections to downtown Palo Alto. Existing Class II bike lanes on Alma Street connect the Palo Alto Transit Center with Menlo Park via a separated bridge crossing and trail through El Palo Alto Park. A second pedestrian/bicycle bridge connects Willow Road to Palo Alto Avenue and the beginning of the Bryant Street Bicycle Boulevard, providing a comfortable alternative to Middlefield Road for trips extending southward through downtown. However, connections into East Palo Alto are challenging, as the bike lanes on University Avenue in both Palo Alto and East Palo Alto drop on the overcrossing at Highway 101. East Palo Alto has identified this is as a primary transportation priority and is initiating a feasibility study to consider a crossing at Newell Road or elsewhere. The Friendship Bridge on the Bay Trail across the San Francisquito Creek does provide a good access, although it is less convenient for commuting bicyclists. In addition, a sidewalk or Class I path should be provided along West Bayshore between East Palo Alto and Channing Avenue to provide access in the area around Edgewood Plaza.

As would be expected, greater downtown is the area of highest concentrated travel demand for all modes. University Avenue has consistent pedestrian activity and engaging storefronts. Several plazas and well-designed private patios/sidewalk cafes enhance the pedestrian environment, and a handful of pedestrian-friendly lanes maintain a human scale while providing mid-block cut-throughs. Despite high bicycle demand, downtown has few high-quality dedicated bicycle facilities; a single block of bike lanes striped along Bryant Street and sub-standard width bike lanes along Lytton Avenue are the only dedicated bike facilities between Alma Street and Middlefield Road.

South of downtown, the Homer Avenue underpass provides a convenient pedestrian and bicycle connection across Caltrain and Alma Street. Despite good design and proximity to transit, employment, housing and a popular grocery store, the underpass is considered underutilized and lacks good connections from both the western approach from El Camino Real and from the one-way streets to the east.[6] The Bryant Street Bicycle Boulevard has a bicycle-only signalized crossing of Embarcadero Road and is the best connection from downtown to Old Palo Alto and southern neighborhoods. The Coleridge/Churchill Class II bikeway is an important east-west connection, and other bikeway connections are at Palo Alto High School to the Caltrain Bike Path and the Castilleja-Park-Wilkie Bicycle Boulevard. A new trail connects the Caltrain bicycle path to the Town and Country Shopping Center, although access under Embarcadero Road and across El Camino Real to Stanford University is problematic for pedestrians and bicyclists.

Existing Class II bike lanes and the Caltrain undercrossing at N California Avenue provide a second vital east-west connection within and through the Old Palo Alto neighborhood. One of only three bikeways considered by VTA to be of "countywide significance," this corridor directly links the neighborhood to the California Avenue business district and Jordan Middle School. N California Avenue is also part of the larger Bay to Ridge Trail concept linking the Baylands and Foothills Open Space Preserves. The Embarcadero Road overcrossing further east, via St. Francis Drive (or Oregon Avenue), is the only existing year-round pedestrian/bicycle crossing of Highway 101 to the Baylands, although its approaches are obscure and in need of upgrades. Heading south, existing Class II bike lanes on Louis Road extend for several miles toward San Antonio Road.

East of the confluence of Embarcadero and Middlefield Roads, and generally south of Channing Avenue, the Lucie Stern Community Center cluster includes two large parks/public gardens, several schools and churches, and the city's main library, art center, and children's activity center. Land use in this area is primarily single-family residential land, with the exceptions of Jordan Middle School and the small Edgewood Shopping Center near Highway 101. Existing Class II bike lanes on Channing and Newell Roads provide good access to and through the Community Center. Newell Road continues over San Francisquito Creek via the Newell Road Bridge (planned for replacement) and into East Palo Alto's Woodland Avenue.

The VTA and Caltrans are planning a project on the Oregon Expressway, which would make operational, pedestrian and bicycle safety improvements at intersections between West Bayshore and Bryant Street.

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[6] Recent data collection shows that, while use of the Homer underpass is substantial, it is lower than counts at the California Avenue Tunnel.

Improvements will include signal timing modification, construction of pedestrian curb ramps and sidewalk gaps, and studies of operational changes at the unsignalized intersections of Waverly, Ross, and Indian. The project will also include a feasibility study of adding a turn lane at Middlefield Road and improving efficiency and safety.

Recommended Treatments and Locations

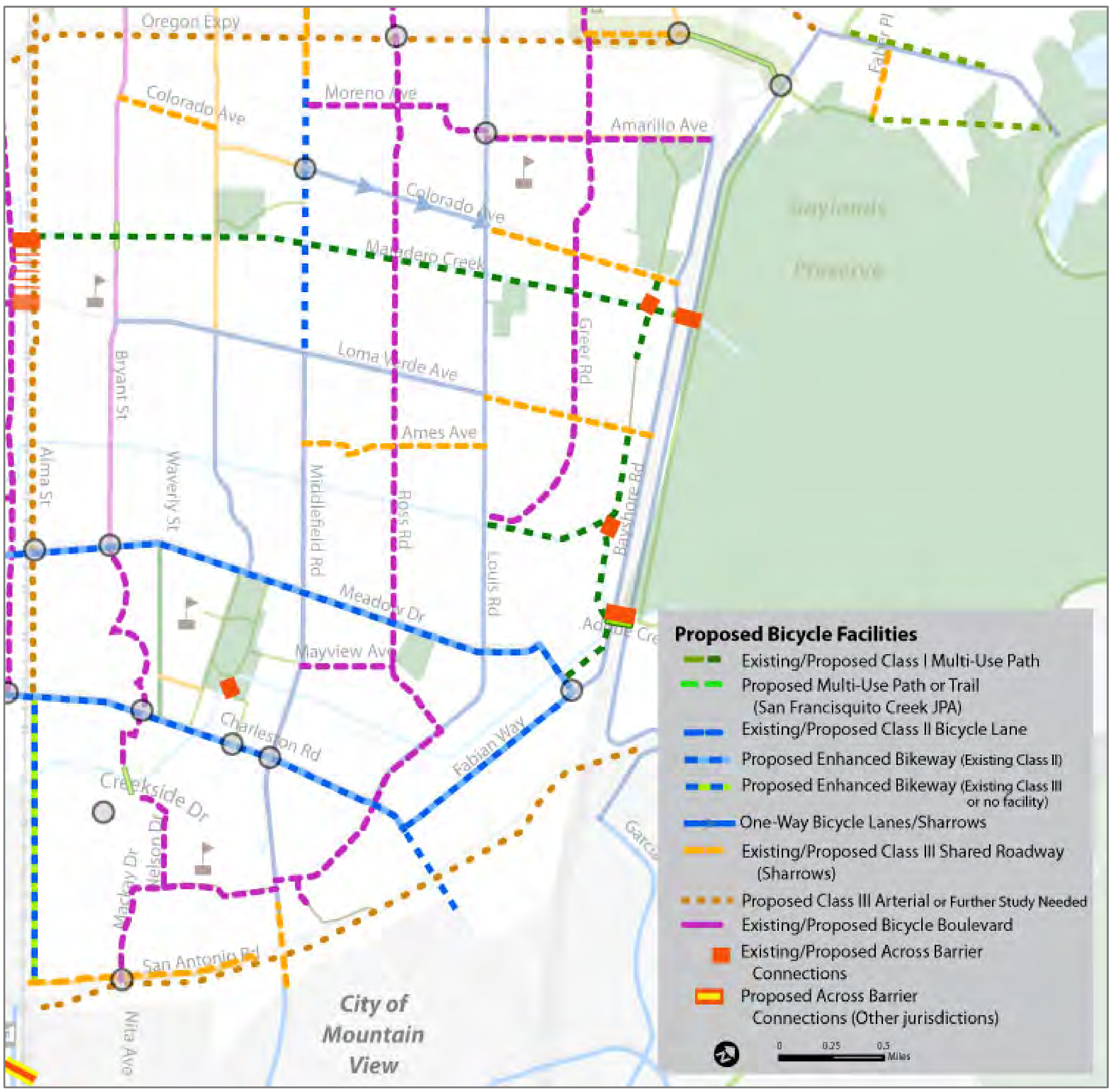
- **Intersection Spot Improvements**
  - Oregon Expressway: Signalize bicycle- and pedestrian-only crossing at Ross Road; improve bicycle and pedestrian crossings at most of the signalized intersections (project in planning).
  - Lytton Avenue/Alma Street Intersection: Install bike box or two-step turn for the southbound approach to facilitate left-turns.
  - Embarcadero Road: Study the feasibility of a signal with forced vehicle right-turns or an actuated bicycle and pedestrian beacon crossing at Webster Street to facilitate school commute access and the proposed bicycle boulevard; reconfigure the design of the Emerson/Kingsley Avenue intersection as part of the larger *Embarcadero Plan Line Study*.
  - N California Avenue at Middlefield Road: Provide a more intuitive, protected crossing of Middlefield Road to establish further the Bay to Ridge Trail and school commute route.
- **Across Barrier Connections**
  - New undercrossing of Caltrain at Peers Park/Park Boulevard: Connects to Serra Road and Stanford University from Seale Avenue, which has the potential to be a future bicycle boulevard once and if the connection is established.
  - Caltrain Stations: Upgrade the existing University Avenue and California Avenue undercrossings of Caltrain for improved access and accessibility. Consider an additional barrier connection across Caltrain between the Palo Alto Transit Center and El Camino Park as a long term option if utility conflict issues can be resolved and other barrier connections prove infeasible.
- **Trails**
  - San Francisquito Creek: Formally support the San Francisquito Creek Joint Powers Authority (JPA)'s efforts to develop a multi-purpose creek trail along the northern City border.
  - Bay to Ridge Trail: Upgrade the California Avenue and Embarcadero Road overcrossing approaches; extend the trail network to Byxbee Park; repave the Bay Trail at Geng Road; and consider paving the spur trail from the Geng Road Sports Center to the International School and Main Post Office.
  - **Embarcadero Road/Rinconada Park** Sidepath: Widen sidewalk to provide a physically separated connection between Newell Road/Coleridge Avenue bikeways and to/from Rinconada Park trails.

- **Bike Lane/Sharrow Roadway Striping**
  - Alma Street: Add Class III signage and markings south of Lytton Avenue, provide enhanced bicycle lanes and/or a Class I trail adjacent to Caltrain north to El Camino Real, and extend sharrows from Homer to Lytton Avenue over the University Avenue overpass.
  - Homer/Channing couplet: Prioritize this corridor with the goal of implementing enhanced bikeway facilities; at minimum, implement two-way bicycle travel on Homer Avenue from Alma Street to High Street, conversion of High Street to two-way north into downtown, and shared lane markings on the couplet with a connection via High Street and Emerson Street.
  - Lytton Avenue: When the street is resurfaced in 2012, replace with enhanced sharrows to position bicyclists away from the "door zone" and facilitate passing of stopped transit vehicles, provide wayfinding signage, curb extensions, and potentially green colorization, bike boxes, and markings through intersections.
  - Addison Avenue: Currently has sub-standard bike lanes. If a dedicated facility is developed on the Homer/Channing couplet, remove from the bikeway network along with the proposed Melville Avenue Bicycle Boulevard further south (providing better network spacing and connectivity to both the Homer Avenue and Embarcadero Road undercrossings). If continuous, dedicated facilities are not possible or are a longer-term solution on Homer/Channing, extend to Emerson Avenue (for two-way access to the Homer Tunnel) and restripe with 9.5-foot travel lanes, a 12-foot shared bicycle/parking lane, and a five-foot time-restricted bike lane; or convert to sharrows.
  - Middlefield Road: Add shared lane markings for wayfinding and visibility; repave deteriorated sections just north of Embarcadero Road.
- **Bicycle Boulevards**
  - Everett Avenue: Repave and install additional traffic circles and signage/wayfinding improvements to "complete" the Everett Avenue Bicycle Boulevard.
  - Kingsley Avenue: Designate as bicycle boulevard and prioritize improvements with future repaving, including an improved connection to the Embarcadero Road Caltrain underpass.
  - Webster Street: Provide an alternative to Middlefield Road for commutes to the Addison and Walter Hayes Elementary Schools; provide an enhanced or signalized crossing of Embarcadero Road, repave numerous deteriorated segments, and remove or replace unwarranted stop signals with traffic circles. Consider additional traffic calming measures near downtown.
  - Guinda/Everett Avenue, Greer Road, Seale Avenue: Convert to bicycle boulevards pending input from the Palo Alto Bicycle Advisory Committee.
  - Ross/Louis Road: Pursue traffic signal installation improvements at Oregon Expressway in partnership with County of Santa Clara and pursue traffic calming projects within residential neighborhoods to allow for phased deployment of bicycle boulevard.
- **Pedestrian Improvements**
  - Lytton Avenue: Provide high visibility crosswalks, advanced stop bars, countdown pedestrian signals, and transit stop upgrades.

- West side of Alma Street: provide sidewalks or a multi-use pathway, depending on the plans for the Alma Street/El Camino Real area as part of the El Camino Park improvements.
- Emerson/Ramona Avenues: Explore the design of these streets as shared spaces or festival streets in conjunction with a roadway maintenance project; improve or provide new midblock pedestrian crossings where feasible.
- Midtown Shopping Center Enhanced Crosswalks: Provide high visibility crosswalks at existing Midtown traffic signals to highlight and provide awareness of pedestrian activity.
- Citywide Traffic Signal Countdown Signals: Complete current countdown signal deployment.

6.4.2 Southeast Palo Alto

Proposed Bikeway Map



Area Description

East of Caltrain between Oregon Expressway and the City of Mountain View lies "southeast" Palo Alto, where a highly modified grid network and variety of bicycle and pedestrian facilities pose numerous challenges and opportunities.

South of Midtown, two at-grade Caltrain crossings at Charleston Road and Meadow Drive provide critical east-west bike lanes across the Mitchell Park and the Greendell/Cubberly community campuses. Meadow Drive is especially popular with school commute bicyclists due to its wide bicycle lanes, numerous bikeway linkages, and lower traffic volumes and speeds as compared to Charleston Road.

Recent upgrades to the Charleston/Arastradero corridor have improved pedestrian crossing opportunities and bicycle connectivity. As this roadway bends south toward San Antonio Road, the bicycle lanes drop amidst higher traffic volumes just shy of the Mountain View border (and major commercial/employment destinations beyond). Pending capital projects on San Antonio Road will enhance the pedestrian comfort and overall character of this corridor while accommodating bicycle detection and connectivity at several locations. An enhanced bikeway on Alma Street from Charleston Road to the Mountain View border will assist bicycle access between jurisdictions.

Existing Class II bike lanes on E Bayshore Road, Louis Road, Middlefield Road, and Cowper Street provide north-south dedicated bikeways, while Bryant Street, Ross Road, Montrose Avenue, Greer Road, Moreno Avenue, and Amarillo Avenue are opportunities for slower-speed bicycle boulevard connections. These routes provide an attractive connection between Midtown retail and Mitchell Park Library, as well as direct access to Ramos Park and recreational opportunities north of Oregon Expressway. Midtown has east-west bike lanes on portions of Loma Verde and Colorado Avenues, both collector arterials important for neighborhood circulation.

Middlefield Road's current four-lane cross-section (including a fifth turn lane at signalized intersections) discourages pedestrian crossing activity and may be a contributing factor to the pedestrian collision hot spot at Colorado Avenue. Between Moreno and Colorado Avenues, Middlefield Court and the adjacent surface parking lot east of Middlefield Road are opportunities for additional bicycle, pedestrian, and "placemaking" improvements as redevelopment and maintenance schedules allow. The City has prioritized a Plan Line Study for Middlefield Road through Midtown as part of the VTA VTP2035 update process.

Recommended Treatments and Locations

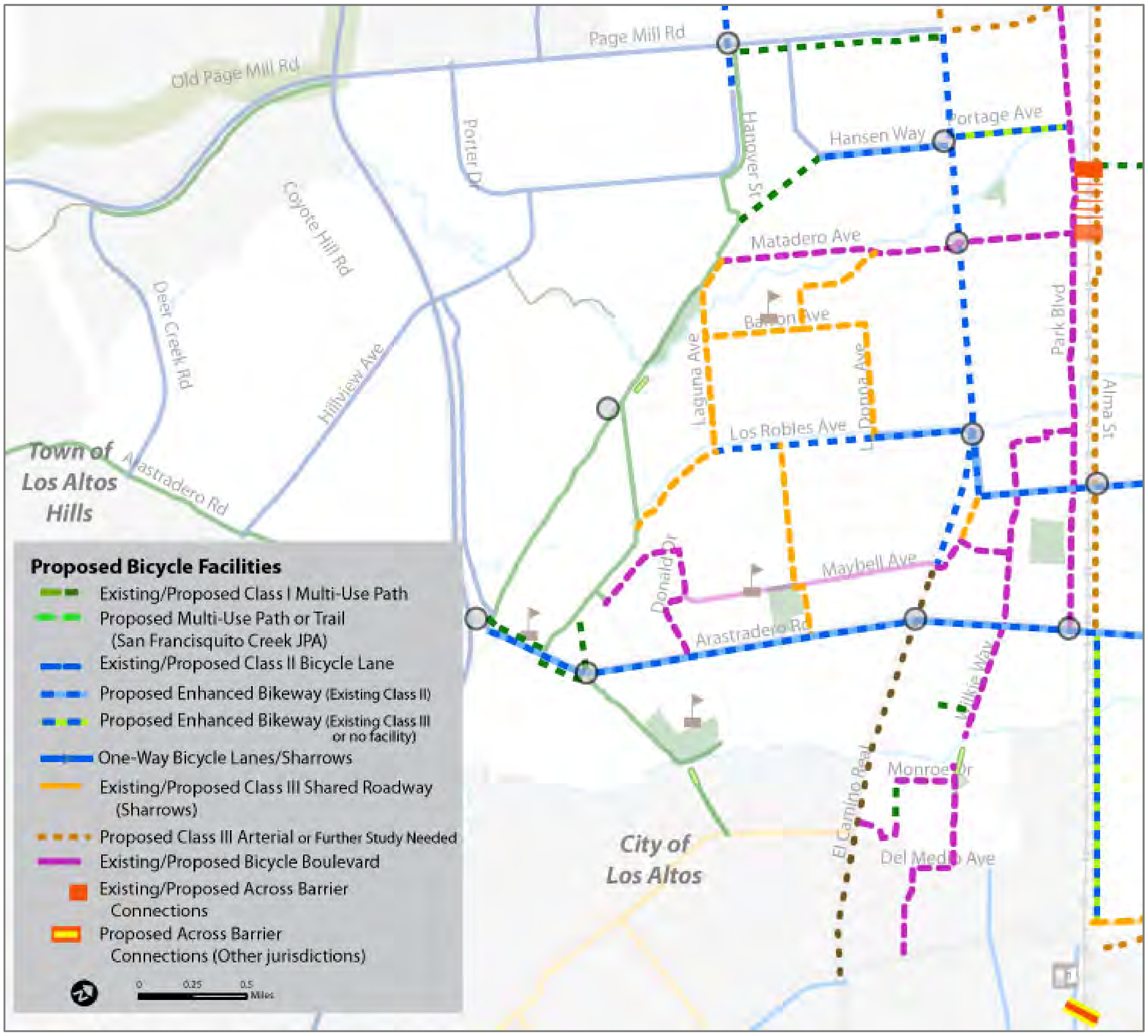
Due to the presence of rolled curbs, the BPTP recommends that future bicycle boulevard projects include some level of physical modification to reduce sidewalk encroachment by vehicles, reduce or maintain low traffic volumes and speeds, and encourage additional landscaping/tree canopy (see **Appendix A** discussion of queuing streets for additional guidance on retrofitting rolled curbed streets).

- **Intersection Spot Improvements**
  - Charleston at Nelson Drive, and Carlson Court: Enhance crossings (e.g. bicycle-friendly medians, curb bulbs, improved signal detection, high visibility crosswalks).
  - Charleston Road at Middlefield Road: Consider redesigning with interior through bike lanes and dedicated right-turn only lanes (except transit) to reduce potential conflicts.

  - San Antonion Road/Avenue at Mackay Drive: Improve bicycle access across San Antonio Road into Mountain View via the Nita Avenue intersection.
- **Trails**
  - Adobe Creek: Connect E Meadow Drive to the existing undercrossing (and potential future overcrossing) of Highway 101 via a spur or "reach" trail with comprehensive wayfinding to guide and link users to/from the various connecting bikeways.
  - Matadero Creek: Study a Class I path with separated crossings of Caltrain/Alma and Highway 101 along the existing maintenance road; consider a phased implementation approach in combination with more aggressive strategies to secure funds for the entire corridor.
  - Benjamin Lefkowitz Undercrossing: Light as short-term improvement for park connectivity due to Highway 101 skylight displacement.
- **Bike Lane/Sharrow Roadway Striping**
  - Charleston/Arastradero Roads: Extend the bike lanes into Mountain View (or via Leghorn Avenue), enhanced wayfinding, and improve Fabian Way as a connection to Adobe Creek and W. Bayshore Road.
  - San Antonio Avenue and San Antonio Road: Stripe sharrow markings along San Antonio Avenue as an alternative to the busy arterial and improve north/south connections across San Antonio Road into Mountain View at Middlefield Road and Charleston Road.
  - Alma Street north of Charleston Road: Study the feasibility of Class II bicycle lanes with future roadway maintenance activities (including potential bridge modifications across Oregon Expressway).
  - Alma Street south of Charleston Road: Construct enhanced bikeway to the Mountain View border.
  - Middlefield Road: Loma Verde to Moreno Avenue, continue existing Class II bike lanes; pursue the Plan Line Study to continue bicycle lanes along Middlefield Road through Midtown and to promote better pedestrian facilities through this high-pedestrian activity area.
  - Ames Avenue: Stripe sharrow markings to provide bicycle access to the back entrance of Palo Verde School.
- **Bicycle Boulevards**
  - Amarillo/Moreno Avenues: Provide a safe, attractive bicycle connection between Midtown and Greer Park (with direct access to Ohlone Elementary School) via Moreno and Amarillo Avenues.
  - Ross/Louis Road: Pursue traffic calming projects within residential neighborhoods to allow for phased deployment of bicycle boulevard.

6.4.3 Southwest Palo Alto

Proposed Bikeway Map



Area Description

From a non-motorized perspective, Southwest Palo Alto is composed of three distinct sections – the greater Barron Park neighborhood(s), the Stanford Research Park, and the neighborhoods between El Camino and Caltrain (including Ventura and Monroe).

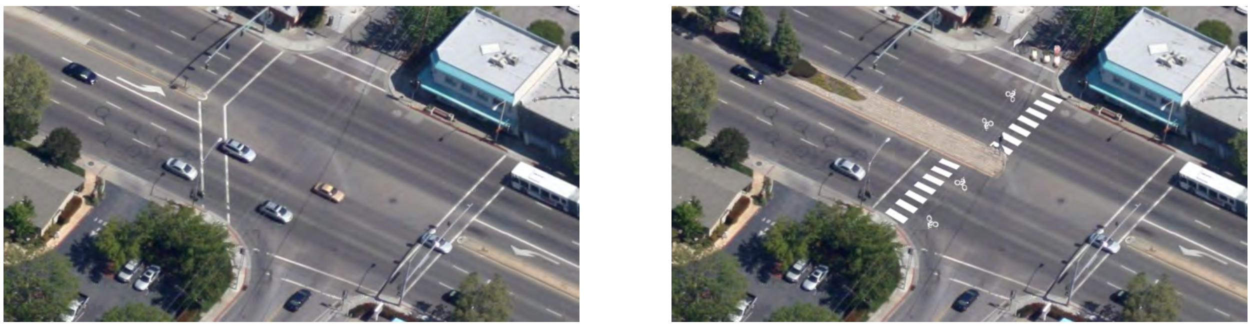
The presence of four schools in Palo Alto (two elementary, one middle, and one high school) and two schools in Los Altos dominates travel demand amid the residential Barron Park, Palo Alto Orchard, Green Acres, and Esther Clark Park (i.e. Greater Barron Park) neighborhoods. Lacking a well-connected grid of streets and sidewalk facilities throughout much of the area, many walkers and bicyclists rely on Class I paths that link the schools, parks, and destinations west and south into Los Altos and Los Altos Hills.

From the east, Charleston Road has bike lanes that jump El Camino Real and pick back up along Arastradero Road, extending to Terman Middle School, Gunn High School, and recreational destinations beyond Foothill

Expressway. At the time of this Plan, the recent re-striping of Arastradero Road to include bike lanes and center left-turn lanes/pedestrian median opportunities remains in a trial phase.

At El Camino Real and Charleston/Arastradero Roads, high traffic volumes, channelized right turns (i.e., "pork chop" islands), and lack of bicycle facilities up to and across the slightly skewed intersection create a major neighborhood and school commute barrier. The presence of channelized right turn lanes also inhibits proper placement of and access to the existing bus stop pair, one of only three locations in Palo Alto planned to serve future El Camino Bus Rapid Transit (BRT) service.

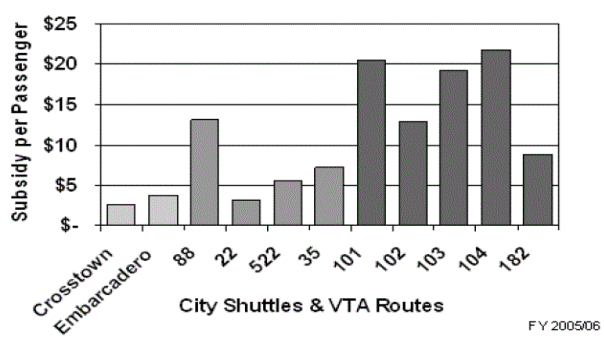
Improving upon and/or mitigating the lack of dedicated on-street facilities for pedestrians and bicycles is also needed for other east-west connections along the School Commute Corridor Network and for access to commercial services along El Camino Real. This need is most acute along Matadero Avenue, a narrow collector arterial and proposed bicycle boulevard that experiences the most neighborhood traffic and has a poor connection across El Camino Real.



Matadero/Margarita Avenue at El Camino Real. *The slightly off-set nature of this intersection creates excessively long and/or out-of-direction crossings. Creative measures to improve the geometry and visibility of this crossing (potential example above right) are needed in order to develop the high priority Matadero-Margarita Bicycle Boulevard.*

Further south, the Meadow Drive Class II bike lanes continue west to El Camino Way, a short frontage-type road that distributes traffic to El Camino Real at Los Robles and Maybell Avenues. Although Class II bike lanes officially connect Meadow Drive to Los Robles, the awkward intersection approach and exposure to turning vehicles may be contributing to the (relatively) high number of pedestrian and bicycle collisions at this location.

The large parcels and auto-orientation of the Stanford Research Park (and VA Medical Center) pose major physical and psychological barriers to increased walking and bicycling. According to Palo Alto's 2008 Transit Study, the area also does not generate much demand for transit despite being served by multiple free shuttles and VTA commuter



The 2008 Palo Alto Transit Study identifies the spread out nature of the Research Park and its highly selective demand market (i.e. a potential customer base that prizes convenience and comfort) as major contributors to its poor transit performance, which is observed in the above graphic that shows a high per-passenger subsidy for routes primarily serving the Research Park. A different strategy, one that re-brands the Research Park by expanding the off-street trail network and promoting bicycle access (and bicycle sharing) from the California Avenue Business District, could be a more effective medium-term solution to encouraging shifts away from vehicular commuting. Such a strategy would also improve connectivity between the Barron Park, Cal-Ventura, and College Terrace neighborhoods.

routes and home to numerous major employers with Transportation Demand Management (TDM) programs. Stanford is currently funding a half-time TDM position focused solely on the Research Park.

For pedestrians, numerous sidewalk gaps, narrow sidewalks, and the absence of destinations within easy walking distance all contribute to an underwhelming experience (and demand), although access to shuttle/transit stops remains essential for those with limited mobility or without access to a vehicle. For bicyclists, several miles of recently installed Class II bike lanes have helped create an extensive on-street network, although this network is attractive generally only to experienced commuter and recreational bicyclists (in part due to traffic, in part due to one of the city's rare hills along Hanover Street near the Hewlett Packard campus).

The Ventura and Charleston Meadows neighborhoods lie east of El Camino Real and south of California Avenue. This area is well-served by the Castelleja-Park-Wilkie corridor, which is slated for bicycle boulevard upgrades in 2012/2013, as well as the proposed Miller/Del Medio extension. The corridor connects the California Avenue business district, Stanford University, and numerous other destinations (including the Town and Country Shopping Center) to the southern city border and San Antonio Shopping Center. While the Ventura neighborhood is mostly residential except for those properties fronting El Camino, the northern section includes several interior commercial parcels (dominated by the large AOL/Fry's Electronics sites) that are included in the greater California Avenue Pedestrian & Transit Oriented Development Combined (PTOD) Overlay District. This zone is designated to absorb additional housing and commercial growth as Palo Alto's only "Priority Development Area" identified in the current draft of MTC's 2040 regional plan. How and when this area is redeveloped will be a major contributing factor to non-motorized demand and accessibility for this area, in particular for the connection between the Hansen Way/El Camino intersection and Park Boulevard.

Without a crossing of Caltrain between California Avenue and Meadow Street, and with a number of streets forming "T" intersections at El Camino Real, the top priority for the Ventura neighborhood is improving east-west connections. This is especially true for school-related trips that require crossing El Camino Real to access the Barron Park neighborhood.

Along El Camino Real between Hansen Way and the southern city limit is a unique commercial strip that, while auto-oriented, provides numerous lunchtime and other community serving destinations that generate substantial pedestrian demand (along with a cluster of pedestrian and bicycle collisions). According to the City's *Comprehensive Plan* Policy L-35, this South El Camino Real area should be established "as a well-designed, compact, vital, Multi-neighborhood Center with diverse uses, a mix of one-, two-, and three-story buildings, and a network of pedestrian-oriented streets and ways." The 2003 *El Camino Real Master Planning Study* established a vision, which, along with the recent design resolution of El Camino BRT, provides opportunities for bicycle and pedestrian enhancements.

Recommended Treatments and Locations

An effective strategy is needed to encourage additional commute mode shift and improved access to El Camino Real and California Avenue for discretionary and commuter trips. To that end, this Plan proposes expanding off-street trail facilities in tandem with a public/private partnership campaign to focus and improve TDM efforts of major employers around the forthcoming Caltrain corridor bicycle share program.

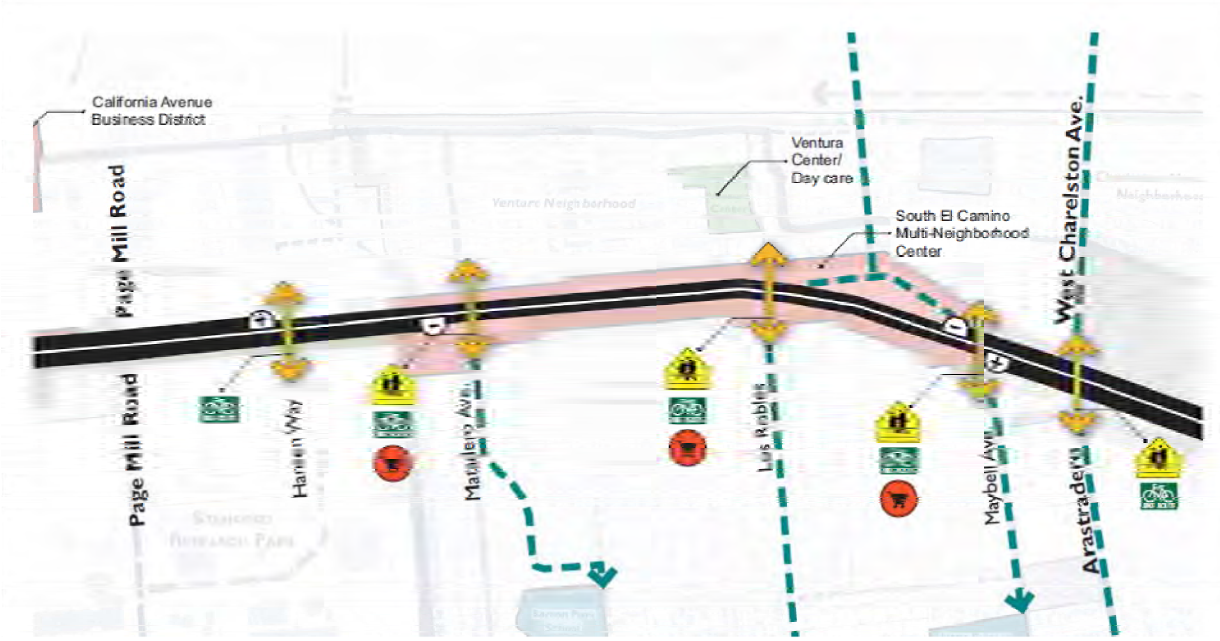


Figure 5-18 from the 2007 revision of the El Camino Real Master Planning Study.

After extensive traffic modeling, the report included several options for creating bicycle and pedestrian improvement opportunities, including the 4/6 lane hybrid option as shown above. Leveraging the analysis to provide bike lanes through this commercial stretch of El Camino is a high priority now that BRT designs are established.

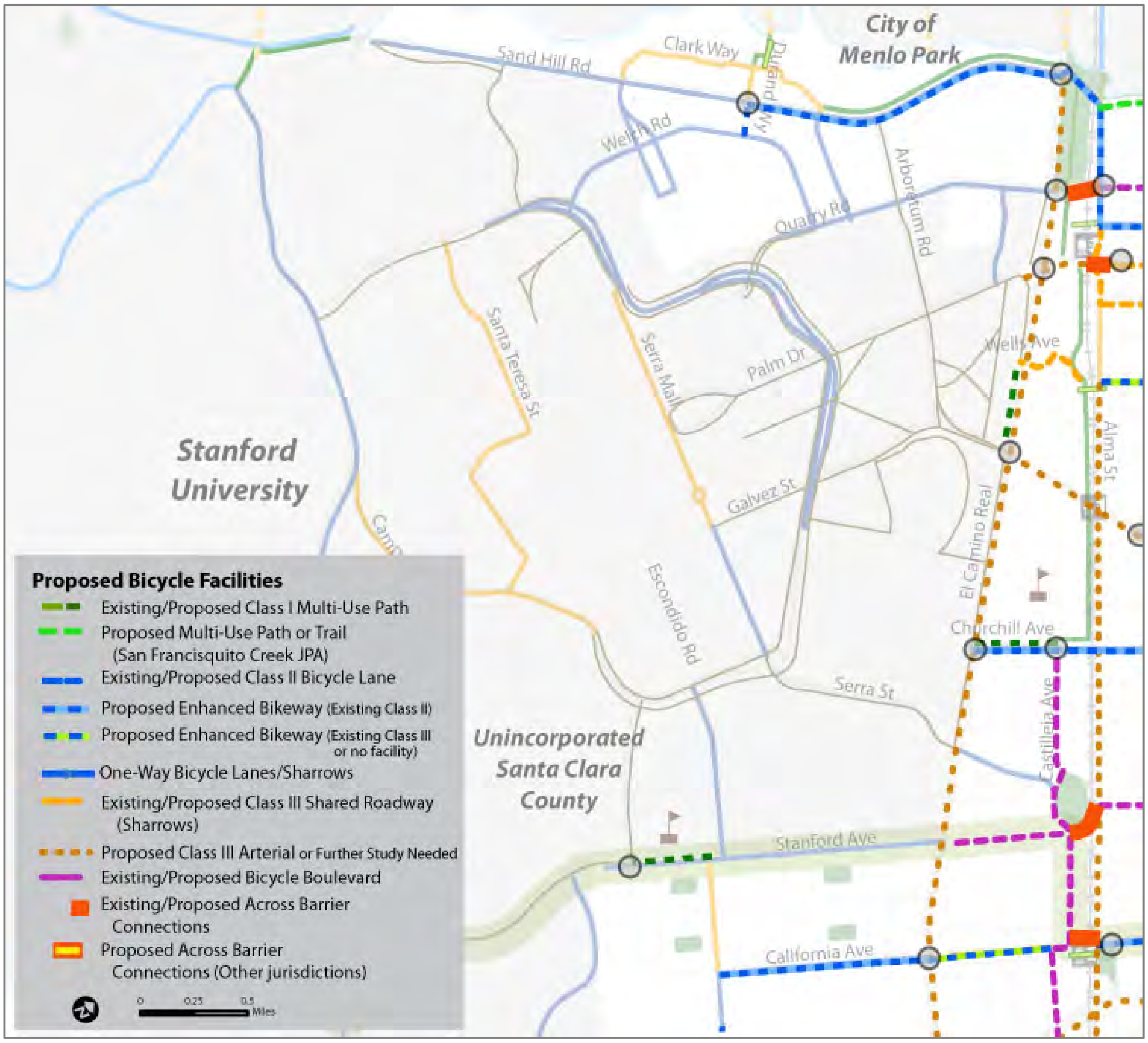
- Intersection Spot Improvements
  - o <u>Arastradero Road at Foothill Expressway:</u> Stripe and enhance signage as part of an upcoming resurfacing project.
  - o <u>Matadero Avenue</u>: Provide enhancements within 200-feet of the El Camino Real approach to separate pedestrians from vehicles; remove the southbound left-turn lane from El Camino Real to Margarita Avenue (at Matadero Avenue) in favor of a median refuge island and realigned (shorter) crosswalk; consider a partial closure of Margarita Avenue (appears viable due to the ability of the Ventura neighborhood street grid to offer alternative access routes for the small number of vehicles that would be displaced).

- **Across Barrier Connections**
  - Matadero Creek Caltrain undercrossing: Connect with Midtown and the proposed Matadero Creek Trail; conduct a feasibility/conceptual design study along with (or soon after) identifying plans for High Speed Rail.
  - In the long-term, consider better trail connections to the VA hospital and across Matadero Creek to an existing private path system.
- **Trails**
  - Greater Barron Park trail network: Extend north into the Stanford Research Park toward the California Avenue Business District; install pedestrian-scaled lighting along existing trails.
  - Bol Park Path: Improve accessibility at Miranda Road and Laguna Avenue (removal of existing trail barriers and curb ramp upgrades). The City should work with Stanford University to reach agreement on extending the current month-to-month lease and developing a connection to the VA hospital.
  - Bol Park/Hanover Street path: Consider extending along Page Mill Road and/or directly through the Research Park campus to Hansen Way along an historic railroad corridor easement. If successful, the latter trail connection would further increase the priority of improving the Hanover/El Camino Real intersection for non-motorized users. Communicate and coordinate with Stanford University and affected Research Park tenants due to the need for improvements on private property.
- **Bike Lane/Sharrow Roadway Striping**
  - Charleston/Arastradero Road corridor: Confirm and enhance the existing bike lanes and traffic calm adjacent corridors as needed to balance safety and access concerns.
  - El Camino Way: Consider sharrows from Meadow to Maybell to enhance this safe routes to school connection.
  - El Camino Way and Los Robles: Enhance bike lanes (potentially consolidate with sidewalks into a shared use path) approaching and across El Camino Real to La Donna Avenue.
  - Hanover Street: Complete and enhance bike lanes at the approaches to Page Mill Road (history of bicycle collisions and connections to the Nixon to Gunn school commute route).
  - El Camino Real: Further evaluate Class II bike lanes from Hanover Street to Maybell Avenue; consider a strategic combination of lane reductions, limited expansion of existing parking restrictions, and striping; coordinate with VTA's El Camino BRT project to assess the potential impact on future bus service.
- **Bicycle Boulevards**
  - Matadero/Margarita Bicycle Boulevard: Improve connection across El Camino Real, traffic calm Matadero Avenue, and provide wayfinding striping and signage.

- o Maybell Bicycle Boulevard: Enhance striping and signage; extend via Donald Drive and Georgia Avenues to Terman Middle School and Gunn High School; spot improvements at Donald Drive and at the spur trail from Georgia Avenue to the Gunn High School shared path.

6.4.4 Northwest Palo Alto

Proposed Bikeway Map



Area Description

Northwest Palo Alto is a backwards "C"-shaped sliver of land between Caltrain, Stanford University properties, and the border with Menlo Park along San Francisquito Creek. Containing the city's other major business district (California Avenue) and its biggest shopping mall (Stanford Shopping Center), travel demand is also driven by numerous medical facilities and three public schools in addition to the University campus. Despite seven crossing opportunities, the Caltrain corridor still represents a physical and psychological barrier to non-motorized connectivity, which is reinforced by its proximity to El Camino Real.

With a grid network of traffic-calmed residential streets and a pedestrian-scaled commercial district, the College Terrace and Evergreen Park neighborhoods provide a dramatic change from the sprawling campuses that lie adjacent. Pedestrian activity centers on and around the California Avenue business district and Caltrain station, and major bicycle connections include the north-south Embarcadero Path/Castilleja/Park Boulevard and Hanover Street/Escondido Road corridors, as well as the east-west Stanford Avenue/California Avenue corridor. The latter is part of the designated Bay to Ridge Trail, including Class II bike lanes west of El Camino (and an almost complete jogging path network past the elementary schools toward the Stanford "Dish"), as well as Class III shared streets to the east of El Camino that terminate at Park Boulevard.

The redesign of the Stanford/El Camino Real intersection (completed 2011) and the streetscape overhaul of California Avenue (in design) are two highly anticipated improvements that will further bolster efforts to encourage compact growth as part of the Pedestrian and Transit Oriented Development (PTOD) zoning overlay district.

On Sundays during much of the year, several blocks of California Avenue are closed to traffic to host a weekly farmer's market. Such events should be expanded and made more regular, where feasible, to encourage and promote active and healthy transportation options for residents and shoppers. The provision of temporary pedestrian and bicycle facilities (and detour routes) will also be important with several large public projects in the works and increased private construction anticipated in the future.

The narrow strip of west Palo Alto north of Park Boulevard includes the Southgate neighborhood, Palo Alto High School campus, the Town and Country Shopping Center, and the Palo Alto Medical Foundation complex. Important bicycle routes to/from Stanford University include the following:

- Park Boulevard spur (Class II bike lanes from the Castilleja-Park Bicycle Boulevard across El Camino Real to Serra Street)
- Homer Avenue underpass and connection through the PAMF campus across El Camino to the Stanford trail network and Lasuen Road
- Churchill/Alma crossing that links into the city's bicycle network east of Caltrain and helps mitigate the long distance between the next available crossing of El Camino over 2,000 feet to the north (at Embarcadero Road)
- Galvez/Embarcadero Road connector at El Camino Real, which is not a bicycle-friendly intersection but offers great access to Stanford Stadium and the Town and Country Shopping Center (recent improvements to which include a connector trail to the Embarcadero/Caltrain path)

The recently completed Medical Center expansion EIS and approved public benefits package provide a rigorously studied, prioritized project list for the majority of Palo Alto that lies west of El Camino and north of University Avenue. These improvements include non-motorized and transit wayfinding improvements along Quarry Road, a dramatically enhanced El Camino Park and Palo Alto Transit Center connection, and Stanford-led pedestrian improvements to connect Welch Road with Vineyard Lane. A future trail connection should be considered to improve connectivity between El Camino Park and Caltrain/Palo Alto High School through the Transit Center.

In addition to (or as part of) the approved Medical Center traffic mitigation and public benefits package, there are several other bicycle and pedestrian improvement opportunities identified by the EIR. Where Durand