Pedestrian and Bicycle Facilities in California

A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers

July, 2005

prepared for California Department of Transportation

by Alta Planning + Design

DISCLAIMER

This reference document does not constitute a standard, specification or regulation. It is not intended to replace existing Caltrans mandatory or advisory standards, nor the exercise of engineering judgment by licensed professionals. The document is simply a reference guide, which compiles information and concepts from various agencies and organizations faced with similar transportation issues. Caltrans acknowledges the existence of other practices and provides this document as a reference guide for those responsible for making professional engineering decisions.

Cover Illustration by Amit Patel for the City of Oakland's Pedestrian Master Plan (2002)

DEPUTY DIRECTIVE (DD-64)

California Department of Transportation

DEPUTY DIRECTIVE

Number:	DD-64
Refer to Director's Policy	05 - Multimodal Alternatives Analysis 06 - Caltrans' Partnerships
Effective Date:	3-26-01
Supersedes:	New

Title: Accommodating Non-Motorized Travel

POLICY

The Department fully considers the needs of non-motorized travelers (including pedestrians, bicyclists and persons with disabilities) in all programming, planning, maintenance, construction, operations and project development activities and products. This includes incorporation of the best available standards in all of the Department's practices. The Department adopts the best practice concepts in the US DOT Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure.

DEFINITION/ BACKGROUND

The planning and project development process seeks to provide the people of California with a degree of mobility that is in balance with other values. They must ensure that economic, social and environmental effects are fully considered along with technical issues, so that the best interest of the public is served. This includes all users of California's facilities and roadways.

Attention must be given to many issues including, but not limited to, the following:

- Safe and efficient transportation for all users of the transportation system
- Provision of alternatives for non-motorized travel
- Support of the Americans with Disabilities Act (ADA)
- Attainment of community goals and objectives
- Transportation needs of low-mobility, disadvantaged groups
- Support of the State's economic development
- Elimination or minimization of adverse effects on the environment, natural resources, public services, aesthetic features and the community
- Realistic financial estimates
- Cost effectiveness

Individual projects are selected for construction on the basis of overall multimodal system benefits as well as community goals, plans and values. Decisions place emphasis on making different transportation modes work together safely and effectively. Implicit in these objectives is the need to accommodate non-motorized travelers as an important consideration in improving the transportation system.

RESPONSIBILITIES

Deputy Director, Planning and Modal Programs:

- Ensures that the needs of non-motorized travelers are incorporated into the program element of Transportation Planning and the modal elements of the statewide strategy for mobility.
- Ensures that liaison exists with non-motorized advocates to incorporate non-motorized needs into all program areas including project and system planning.
- Ensures that the needs of the non-motorized travelers are incorporated in Personal Movement Strategies.

Deputy Director, Project Delivery:

- Ensures that projects incorporate best practices for non-motorized travel in the design and construction of Capital projects.

Deputy Director, Maintenance and Operations:

- Ensures that the transportation system is maintained and operated in a safe and efficient manner with the recognition that non-motorized travel is a vital element of the transportation system.
- Ensures that the needs of non-motorized travelers are met in maintenance work zones.

District Directors:

- Ensure that best practices for non-motorized travel are included in all district projects and project planning.
- Ensure that best practices for non-motorized travel are implemented in maintenance and travel operations practices.

Chief, Division of Design:

- Ensures that project delivery procedures and design guidance include the needs of non-motorized travelers as a regular part of doing business.
- Ensures that all Project Delivery staff is trained and consider the needs of the non-motorized traveler while developing and designing transportation projects.

Chief, Division of Planning:

- Ensures incorporation of non-motorized travel elements in transportation plans, programs and studies prepared by Transportation Planning.
- Ensures planning staff understand and are trained in the principles and design guidelines, non-motorized funding sources and the planning elements of non-motorized transportation.
- Coordinates Caltrans projects with non-motorized interest groups.
- Ensures incorporation of non-motorized travel elements in Corridor Studies prepared by Transportation Planning.

Chief, Division of Environmental Analysis:

- Ensures that non-motorized travel groups potentially affected by Caltrans projects are identified and have the opportunity to be involved in the project development process.
- Advocates effectively for all reasonable project-specific best practices that support or promote non-motorized travel.

Chief, Division of Maintenance:

- Ensures State-owned facilities are maintained consistent with the needs of motorized and non-motorized travelers.
- Provides guidance and training to those maintaining roadways to be aware of and sensitive to the needs of non-motorized travel.

Chief, Division of Traffic Operations:

- Ensures that the transportation system is operated in accordance with the needs of all travelers including non-motorized travel.
- Provides training and guidance on the operation of the transportation facility consistent with providing mobility for all users.

- Recommends safety measures in consideration of non-motorized travel on California's transportation system.

Chief, Division of Local Assistance:

- Ensures that Local Assistance staff, local agencies and interest groups are familiar with funding programs that are available for non-motorized travelers.
- Ensures that program coordinators responsible for non-motorized travel modes are familiar with non-motorized issues and advocate on behalf of non-motorized travelers.

APPLICABILITY

All Caltrans employees who are involved in the planning, design, construction, maintenance and operations of the transportation system.

Tony V. Harris

TONY V. HARRIS
Chief Deputy Director

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…and to the many others who contributed their time and expertise

ACRONYMS

AASHTO	*American Association of State Highway Transportation Officials*
AB	*Assembly Bill*
ACR	*Assembly Concurrent Resolution*
ADA	*Americans with Disabilities Act*
ADAAG	*ADA Accessibility Guidelines for Buildings and Facilities*
ADT	*Average Daily Traffic*
APBP	*Association of Pedestrian and Bicycle Professionals*
ATLC	*Alternative Transportation and Livable Communities Group*
BEES	*Basic Engineers Estimate System*
BISC	*California Blueprint for Bicycling and Walking Implementation Steering Committee*
BPAC	*Non-Motorized Best Practices Advisory Committee*
BTA	*Bicycle Transportation Account*
CalPed	*California Pedestrian Advisory Committee*
Caltrans	*California Department of Transportation*
CBAC	*California Bicycle Advisory Committee*
CBC	*California Bicycle Coalition*
CBTP	*Community Based Transportation Planning*
CDC	*Centers for Disease Control*
CHP	*California Highway Patrol*
CMAQ	*Congestion Mitigation and Air Quality*
COG	*Council of Governments*
CTC	*California Transportation Commission*
CSS	*Context Sensitive Solutions*
CTCDC	*California Traffic Control Devices Committee*
CVC	*California Vehicle Code*
DD-64	*Deputy Directive 64*
DHS	*Department of Health Services*
DOT	*Department of Transportation*
DP-22	*Director's Policy #22*
DSA	*Division of the State Architect*
DSMP	*District System Management Plan*
FHWA	*Federal Highway Administration*
HCM	*Highway Capacity Manual*
HDM	*Highway Design Manual*
HES	*Hazard Elimination Safety Program*
ISTEA	*Intermodal Surface Transportation Efficiency Act*
ITE	*Institute of Transportation Engineers*
LOS	*Level of Service*
LTF	*Local Transportation Fund*
MPO	*Metropolitan Planning Organization*
MTA	*Metropolitan Transportation Authority (Los Angeles County's RTPA)*
MTC	*Metropolitan Transportation Commission (SF Bay Area's MPO & RTPA)*
MUTCD	*Manual on Uniform Traffic Control Devices*
NAAQS	*National Ambient Area Air Quality Standards*

NCHRP	*National Cooperative Highway Research Program*
NCSA	*National Center for Statistics and Analysis*
NHANES	*National Health and Nutrition Examination Survey*
NHTS	*National Household Travel Survey*
NHTSA	*National Highway Traffic Safety Administration*
NPTS	*National Personal Transportation Survey*
OCTA	*Orange County Transportation Authority (Orange County's RTPA)*
OTS	*Office of Traffic Safety*
PACE	*Pedestrian and Cyclist Equity Act of 2003*
PBCAT	*Pedestrian and Bicycle Crash Analysis Tool*
PID	*Project Initiation Document*
PSR	*Project Study Report*
PSSR	*Project Scope Summary Report*
PSTF	*Pedestrian Safety Task Force*
RCR	*Route Concept Report*
RSTP	*Regional Surface Transportation Program*
RTP	*Regional Transportation Plan*
RTPA	*Regional Transportation Planning Agency*
SACOG	*Sacramento Area Council of Governments (MPO & RTPA)*
SAFETEA	*Safe, Accountable, Flexible and Efficient Transportation Equity Act of 2005*
SANDAG	*San Diego County Council of Governments (MPO & RTPA)*
SB	*Senate Bill*
SCAG	*Southern California Association of Governments (6-county MPO)*
SIB	*State Infrastructure Bank*
SR2S	*Safe Routes to School*
STIP	*State Transportation Improvement Program*
STP	*Surface Transportation Program*
STPP	*Surface Transportation Policy Project*
SWITRS	*Statewide Integrated Traffic Records System*
TASAS	*Traffic Accident Surveillance and Analysis System*
TCR	*Transportation Concept Report*
TDA	*Transportation Development Act*
TEA	*Transportation Enhancement Activities*
TEA-21	*Transportation Equity Act for the 21st Century*
TMP	*Transportation Management Plan*
TRB	*Transportation Research Board*
TSDP	*Transportation System Development Program*
USDOT	*United States Department of Transportation*
VMT	*Vehicle Miles Traveled*
VTPI	*Victoria Transportation Policy Institute*

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I. INTRODUCTION

The primary purpose of *Pedestrian and Bicycle Facilities in California—A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers* ("Technical Reference") is to provide Caltrans staff with a synthesis of information on non-motorized transportation. It is intended that this "technology transfer" will assist the Department of Transportation in accommodating pedestrians and bicyclists on the state highway system throughout California, serving as a resource on policies, laws, programs, the Caltrans planning and design process, guidelines, and best practices. Although primarily intended for Caltrans planners and engineers, local agency staff and the general public may also find it useful. Other materials developed as part of this technology transfer project include a non-motorized training curriculum (which may be incorporated into the Division of Design's existing training program), and a computer-based training course in interactive CD and web-based formats.

Innovative bike plates developed by Caltrans on S.R. 395 in Mono County help make cattle guards more bicycle-friendly.

Caltrans and the State of California have a long history of including the pedestrian and bicycle modes of travel into planning and design policies and practices. The original Bikeway Facilities Planning and Design section of the Highway Design Manual (Chapter 1000) was one of the first of its kind in the country in the 1970s, was later used as the basis of the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*, and still has many common elements with that national document.

In 2002, Deputy Directive 64 (DD-64) directed that the California Department of Transportation (Caltrans) "fully considers the needs of non-motorized travelers (including pedestrians, bicyclists and persons with disabilities) in all programming, planning, maintenance, construction, operations and project development activities and products."

California has made a commitment to non-motorized transportation as expressed in all or part of the following documents:

- Deputy Directive on Accommodating Non-motorized Transportation (DD64)
- Director's Policy on Context Sensitive Solutions (DP 22)
- Highway Design Manual
- Main Streets: Flexibility in Design and Operations Assembly Concurrent Resolution 211
- California Supplement to the MUTCD
- California Blueprint for Bicycling and Walking
- California Bicycle Transportation Act
- California Vehicle Code
- California Streets and Highways Code
- California Access Compliance Reference Manual

The non-motorized transportation field consists of a complex and fast-evolving mix of policies, procedures, guidelines, and standards. These elements are currently located in multiple publications. The Technical Reference is a 'snapshot,' providing an overview as of April, 2005, and references to more detailed materials on particular topics. For authoritative and current information on standards and guidance regarding pedestrian and bicycle facilities in California, there is no substitute for Caltrans manuals and policy documents, particularly the Highway Design Manual, the MUTCD 2003, and the MUTCD 2003 California Supplement. Adherence to Chapter 1000 of the Highway Design Manual is required by law for all bikeway design, on or off the State Highway System (*California Streets and Highways Code, Sections 890.8 and 891*).

Relevant federal and state statutes and policies are summarized, as is the Caltrans planning process, regional and local planning efforts, and the project development process including facility design. A valuable tool for implementing these concepts is the "Context Sensitive Solutions" approach of involving stakeholders, in accordance with *Director's Policy on Context Sensitive Solutions (DP 22)*. Potential funding sources are described along with amounts, criteria, and typical applications. The Technical Reference portion concludes with concept sheets on pedestrian facilities, traffic calming, and bicycle facilities. These are followed by appendices on a variety of topics, including pedestrian and bicycle safety conditions in California.

A secondary goal of the Technical Reference is to provide policy and design support for the 'Smart Growth' concepts proposed by the FHWA:

- Managing and operating existing highway, transit, and other transportation modes to maintain or improve performance for each mode without adversely affecting neighborhoods or urban centers,
- Knitting transportation improvement projects and public/private investments so that they merge as seamlessly as possible into the community,
- Supporting the provision of mixed-use development so that transit, pedestrian and bicycle facilities are viable options to driving.

For more information on this topic, see
http://www.mcb.fhwa.dot.gov/Documents/SmartGrowth/Prelimin.htm.

As population and vehicle miles traveled continue to grow, transportation planners, engineers, and policy makers are looking to non-motorized transportation, often in combination with transit, to relieve some of the pressure on the framework of the traditional transportation system. Good walking and bicycle facilities extend the reach of transit systems, provide mobility options, improve accessibility for all persons, and help encourage people to have active lifestyles.

Safe and efficient non-motorized facilities are essential to the development of a balanced, integrated multi-modal transportation system in California.

Gilman Drive at I-5 after being restriped and signed for improved bicycle access (San Diego)

II. STATUTES AND POLICIES

Federal Statutes and Policies

Many of California's laws and policies originate from Federal laws that require planning for non-motorized transportation. The Transportation Equity Act for the 21st Century (TEA-21), like its predecessor the Intermodal Surface Transportation Efficiency Act (ISTEA), has laws and policies that apply to non-motorized transportation. Congress recognized that bicyclists and pedestrians have the same origins and destinations as other transportation system users and that it is important for them to have safe and convenient access to airports, ports, ferry services, transit terminals, and other intermodal facilities as well as to jobs, services, recreation facilities, and neighborhoods. TEA-21 placed a strong emphasis on creating a seamless transportation system that all users can enjoy and use efficiently and safely.

Federal transportation policy is to increase nonmotorized transportation to at least 15% of all trips and to simultaneously reduce the number of nonmotorized travelers killed or injured in traffic collisions by at least 10% (TEA-21, 1998). This policy, which was adopted in 1994 as part of the National Bicycling and Walking Study, remains a high priority for the U.S. Department of Transportation (USDOT). TEA-21 provides the funding opportunities, planning processes, and policy language by which states and metropolitan areas can achieve these ambitious national goals.

TEA-21

The transportation planning process established in 1991 as part of ISTEA continued as part of TEA-21 established in 1998. States and metropolitan areas with populations of more than 50,000 are required to plan for the "development and integrated management and operation of transportation systems and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system..." (§ 1203 and 1204 of TEA-21) Specific implementation criteria and laws include:

- "Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State." (§ 1202(a) of TEA-21)
- "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction and transportation facilities, except where bicycle and pedestrian use are not permitted." (§ 1202(a) of TEA-21)
- "Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians." (§ 1202(a) of TEA-21)
- "In any case where a highway bridge deck is being replaced or rehabilitated with Federal financial participation, and bicyclists are permitted on facilities at or near each end of such bridge, and the safe accommodation of bicyclists can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations." (23 U.S.C. § 217)
- "The Secretary shall not approve any project or take any regulatory action under this title that will result in the severance of an existing major route or have significant adverse impact on the safety for nonmotorized transportation traffic and light motorcycles, unless such project or regulatory action provides for a reasonable alternate route or such a route exists." (23 U.S.C. § 109(n))

- "Even where circumstances are exceptional and bicycle use and walking are either prohibited or made incompatible, States, MPOs, and local governments must still ensure that bicycle and pedestrian access along the corridor served by the new or improved facility is not made more difficult or impossible." (FHWA Guidance, Policy: Mainstreaming Nonmotorized Transportation (February 1999))
- Each State is required to fund a Bicycle and Pedestrian Coordinator position in its State Department of Transportation to promote and facilitate the increased use of nonmotorized transportation, including developing facilities for the use of pedestrians and bicyclists and public educational, promotional, and safety programs for using such facilities. Funds such as the CMAQ or STP may be used for the Federal share of the cost of these positions. In most States, the Coordinator position is a full-time position with sufficient responsibility to deal effectively with other agencies, State offices, and divisions within the State DOT." (FHWA Guidance, State Bicycle and Pedestrian Coordinator Position (February 1999))

A US DOT Policy Statement

The USDOT encourages states, local governments, professional associations, other government agencies and community organizations to adopt its Policy Statement (*A US DOT Policy Statement: Integrating Bicycling and Walking into Transportation Infrastructure,* 2000) as an indication of their commitment to consideration of bicycles and pedestrian facilities as vital components of the transportation system. One of the key principles of the Policy Statement is that "bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist." The USDOT calls on each organization or agency to explicitly adopt one, all, or a combination of the various TEA-21 implementation criteria above **and** to be committed to taking some or all of the actions listed here as appropriate for their situation:

- Define the exceptional circumstances in which facilities for bicyclists and pedestrians will NOT be required in all transportation projects.
- Adopt new manuals, or amend existing manuals, covering the geometric design of streets, the development of roadside safety facilities, and the design of bridges and their approaches so that they comprehensively address the development of bicycle and pedestrian facilities as an integral element of the design of all new and reconstructed roadways.
- Adopt stand-alone bicycle and pedestrian facility design manuals as an interim step towards the adoption of new typical sections or manuals covering the design of streets and highways.
- Initiate an intensive re-tooling and re-education of transportation planners and engineers to make them conversant with the new information required to accommodate bicyclists and pedestrians. Training should be made available for, if not required of, agency traffic engineers and consultants who perform work in this field.

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA), enacted on July 26, 1990, provides comprehensive rights and protections to individuals with disabilities in the areas of employment, public accommodations, state and local government services, and telecommunications. The goal of the ADA is to assure equality of opportunity, full participation, independent living and economic self-sufficiency. The ADA prohibits all state and local governments and most private businesses from discriminating on the basis of disability.

"No qualified individual with a disability shall, by reason of such disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of a public entity, or be subjected to discrimination by any such entity."

Federal Statutes (MPO)

Title 23, CFR §450.322 The Metropolitan Transportation Plan shall include adopted congestion management strategies including, as appropriate, traffic operations, ridesharing, pedestrian and bicycle facilities, alternative work schedules, freight movement options, high occupancy vehicle treatments, telecommuting, and public transportation improvements (including regulatory, pricing, management, and operational options), that demonstrate a systematic approach in addressing current and future transportation demand and identify pedestrian walkway and bicycle transportation facilities in accordance with 23 U.S.C. 217(g).

Title 23, U.S.C. Sec. 134 (a) (3) The plans and programs for each metropolitan area shall provide for the development and integrated management and operation of transportation systems and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system for the metropolitan area and as an integral part of an intermodal transportation system for the State and the United States.

United States Department of Transportation: Design Guidance. Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure. The design guidance is comprised of three items: a policy statement that bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist; an approach to achieving this policy that has already worked in State and local agencies, and a series of action items that a public agency, professional association, or advocacy group can take to achieve the overriding goal of improving conditions for bicycling and walking.

Federal Statutes (State)

Title 23, CFR Sec §450.214 (b) (3) The State shall develop a statewide transportation plan for all areas of the State and contain, as an element, a plan for bicycle transportation, pedestrian walkways and trails which is appropriately interconnected with other modes.

Title 23, CFR Sec §450.214 (b) (4) The State shall develop a statewide transportation plan that is coordinated with the metropolitan transportation plans required under 23 U.S.C. 134.

Title 23, U.S.C. Sec. 135 (a) (3) The plans and programs for each State shall provide for the development and integrated management and operation of transportation systems and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system for the State and an integral part of an intermodal transportation system for the United States.

Title 23 U.S.C. 217(g) Planning and Design. Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and state in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted.

State Statutes and Policies

A key facet to understanding how California compares with other states in terms of laws, policies, standards, and other items, is its size. With about 34.5 million residents, California is the most populous state. The size of California poses a challenge that smaller states do not face. The enormous responsibilities of developing and maintaining thousands of miles of roadway, combined with many disparate local agencies and levels of responsibility, makes coordination and communication the single biggest challenge. For this and other reasons, local and regional agencies and advocacy groups have sometimes played more of a leadership role in the development of innovative bicycle and pedestrian treatments. At the same time, Caltrans is assuming more of a leadership role with policies such as Deputy Directive 64, the Bicycle Transportation Act, and the 2002 California Blueprint for Bicycling and Walking.

State bicycle and pedestrian-related policies and laws can be found in numerous State documents, including:

Assembly Concurrent Resolution 211 (ACR 211) (May 2002) acknowledges the importance of bicycling and walking to the State of California and encourages all cities and counties to "implement the policies of [Deputy Directive 64] and the United States Department of Transportation's design guidance document on integrating bicycling and walking when building their transportation infrastructure."

California Bicycle Transportation Act, Streets and Highways Code 890-894 (1994) is legislation that seeks "to establish a bicycle transportation system...designed and developed to achieve the functional commuting needs of the employee, student, business person, and shopper as the foremost consideration in route selection, to have the physical safety of the bicyclist and bicyclist's property as a major planning component, and to have the capacity to accommodate bicyclists of all ages and skills." A city or county may complete bicycle transportation plan pursuant to Section 891.2 in order for their project to be considered by the Department for funding. Section 890.6 states the Department, in cooperation with county and city governments, shall establish minimum safety design criteria for the planning and construction of bikeways and roadways where bicycle travel is permitted. Section 890.8 states the Department shall establish uniform specifications and symbols for signs, markers, and traffic control devices to designate bikeways, regulate traffic, improve safety and convenience for bicyclists, and alert pedestrians and motorists of the presence of bicyclists on bikeways and on roadways where bicycle travel is permitted. And section 891 states, "All city, county, regional, and other local agencies responsible for the development or operation of bikeways or roadways where bicycle travel is permitted shall utilize all minimum safety design criteria and uniform specifications and symbols for signs, markers, and traffic control devices established pursuant to Sections 890.6 and 890.8."

Bicycle Transportation Account (BTA) (1997) provides State funds for city and county projects that are included in an adopted local Bicycle Transportation Plan that complies with Section 891.2 of the Streets and Highways Code, and are designed and constructed in accordance with the Chapter 1000 of the Highway Design Manual.

California Blueprint for Bicycling and Walking (2002) sets goals to increase bicycling and walking trips 50% by 2010, decrease bicycle and pedestrian fatality rates 50% by 2010, and to increase funding for bicycle- and pedestrian-related programs. Caltrans has established a Steering Committee to guide the Blueprint's implementation.

California Vehicle Code and Streets and Highway Code (CVC Sections 21200-21212 and 39000-39011 and SHC Sections 885-886, 887-888.8, and 890-894.2):

Every person riding a bicycle upon a roadway has all the rights and is subject to all the provisions applicable to the driver of a vehicle by the California Department of Motor Vehicles. As such, bicycles are generally prohibited from riding on sidewalks or in crosswalks. An exception to this is on marked crosswalks of multi-use paths. On multi-use paths, bicyclists function as pedestrians at intersections by activating the pedestrian signal and waiting for the light to change in their favor. A bicycle operated on a roadway, or the shoulder of a highway, shall be operated in the same direction as vehicles are required to be driven upon the roadway. Unless otherwise directed by a bicycle signal, an operator of a bicycle shall obey the provisions applicable to the driver of a vehicle at all traffic signals. As set forth by Section 21202 of the California Vehicle Code, any person operating a bicycle upon a roadway at a speed less than the normal speed of traffic moving in the same direction at that time shall ride as close as practicable to the right-hand curb or edge of the roadway except under any of the following situations:

(1) When overtaking and passing another bicycle or vehicle proceeding in the same direction.

(2) When preparing for a left turn at an intersection or into a private road or driveway.

(3) When reasonably necessary to avoid conditions (including, but not limited to, fixed or moving objects, vehicles, bicycles, pedestrians, animals, surface hazards, or substandard width lanes) that make it unsafe to continue along the right-hand curb or edge. A "substandard width lane" is a lane that is too narrow for a bicycle and a vehicle to travel safely side by side within the lane.

(4) When approaching a place where a right turn is authorized.

Any person operating a bicycle upon a roadway of a highway, which highway carries traffic in one direction only and has two or more marked traffic lanes, may ride as near the left-hand curb or edge of that roadway as practicable.

California Vehicle Code (Sections 2149-21971). The California Vehicle Code describes the responsibilities of pedestrians when crossing the street, or walking along a street on a sidewalk. The Vehicle Code also addresses the roles and responsibilities of motorists in relationship to pedestrians and wheelchair users. California, like most other states, requires both pedestrians and drivers to exercise due care. All street intersections are legally considered crosswalks, whether marked or unmarked. The Vehicle Code states that drivers must yield the right-of-way to a pedestrian crossing the roadway in a marked or unmarked crosswalk. The Vehicle Code does not prohibit pedestrians from crossing roadways at places other than crosswalks, except between adjacent intersections controlled by traffic signals or police officers. Local authorities may adopt ordinances prohibiting pedestrians from crossing streets outside crosswalks. For signalized intersections, the Vehicle Code states that the pedestrian may cross with a green light at any marked or unmarked crosswalk unless expressly prohibited. The pedestrian shall yield the right-of-way to vehicles lawfully within the intersection at the time the signal changed. For closely adjoining intersections, defined in the Vehicle Code as intersections where the outermost boundaries are confined in a distance of 200 or less feet, the Department of Transportation or local jurisdiction may designate a single intersection. When so designated, the single intersection shall be the legal intersection for the purposes of traffic movement and regulation.

The Vehicle Code does not specifically state whether vehicles need to remain stopped until the pedestrian has completely crossed the street. This topic has become an important issue with regard to

pedestrian safety due to the phenomenon known as the "multiple threat." This occurs when one vehicle stops for pedestrians who are in a crosswalk, and the car(s) in the adjacent travel lane(s) fail(s) to yield to the pedestrians. Section 21951 of the California Vehicle Code addresses this issue by stating that "[w]hen a vehicle is stopped at a marked or unmarked crosswalk at an intersection to allow a pedestrian to cross the roadway, vehicles approaching from the rear shall not overtake and pass the stopped vehicle." Because there is no law against driving through the crosswalk after the pedestrian has passed (but not reached the opposite curb), motorists from the rear may not see the pedestrian in the crosswalk due to the other vehicle continuing to move forward.

According to the Vehicle Code, "it is the policy of the State of California that safe and convenient pedestrian travel and access, whether by foot, wheelchair, walker, or stroller, be provided to the residents of the state." The code also states that it is the intent of the Legislature that all government levels, especially Caltrans and other DOTs, will work to provide safe, convenient passage for pedestrians on or across all streets and highways, increase levels of walking, and reduce pedestrian fatalities and injuries.

Government Code 4450 requires that buildings, structures, sidewalks, curbs, curb ramps, and related facilities that are built with State funds, the funds of cities, counties, or of other political subdivisions be accessible to and usable by the physically disabled.

Government Code 65080 (a) Each transportation planning agency designated under Section 29532 or 29532.1 shall prepare and adopt a regional transportation plan directed at achieving a coordinated and balanced regional transportation system, including, but not limited to, mass transportation, highway, railroad, maritime, bicycle, pedestrian, goods movement, and aviation facilities and services. The plan shall be action-oriented and pragmatic, considering both the short-term and long-term future, and shall present clear, concise policy guidance to local and State officials. The regional transportation plan shall consider factors specified in Section 134 of Title 23 of the United States Code. Each transportation planning agency shall consider and incorporate, as appropriate, the transportation plans of cities, counties, districts, private organizations, and State and Federal agencies.

Streets and Highway Code 895-888.8 Non-motorized Transportation: The Department shall, in cooperation with local agencies, publish a statewide map illustrating state highway routes available for the use of bicyclists and where bicyclists are prohibited. The Department shall prepare an annual report to the Legislature summarizing programs it has undertaken for the development of non-motorized transportation facilities.

Caltrans Policies

Deputy Directive 64 (DD-64), "Accommodating Non-Motorized Travel" (March 26, 2001). The policy and definition/background sections are as follows: "POLICY: The Department fully considers the needs of non-motorized travelers (including pedestrians, bicyclists and persons with disabilities) in all programming, planning, maintenance, construction, operations and project development activities and products. This includes incorporation of the best available standards in all of the Department's practices. The Department adopts the best practice concepts in the US DOT Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure. http://www.dot.ca.gov/hq/oppd/non-motor-travel.pdf

Director's Policy 22 (DP-22), "Director's Policy on Context Sensitive Solutions" (November 2001). Supports an approach to managing the transportation system that balances transportation needs with community goals. Solutions involve and integrate community goals in the planning, design,

construction, and maintenance and operations processes, including accommodating the needs of bicyclists and pedestrians. Context Sensitive Solutions is a collaborative approach that considers the needs and concerns of all stakeholders. http://t8web.dot.ca.gov/design/memos/112901.pdf

Main Streets: Flexibility in Design and Operation emphasizes Caltrans' production of transportation projects that make state highways that happen to be local main streets more walkable and livable. This summary identifies design concepts that may be compatible with community values while assuring safe and efficient operations for vehicles, pedestrians, bicyclists and highway workers. http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf

MUTCD 2003 and MUTCD 2003 California Supplement (May 20,2004). The MUTCD provides general standards and guidance for traffic control devices, nationally. The California Supplement clarifies which policies, practices or standards are different in California, by identifying and including them. It also enhances the federal standards by providing additional details. http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/

Project Development Procedures Manual (Chapter 31: Non-motorized Transportation Facilities) outlines pertinent statutory requirements, planning policies, and implementing procedures regarding non-motorized transportation facilities. http://www.dot.ca.gov/hq/oppd/pdpm/pdpm.htm

Highway Design Manual, Chapter 1000, "Bikeway Planning and Design," provides design standards and guidelines for on- and off-street bikeways. State and local transportation agencies are required to comply with Chapter 1000 mandatory standards as a minimum when implementing new bikeways. Chapter 1000 differs from the rest of the Highway Design Manual in that it also applies to facilities off the State Highway System (California Streets and Highways Code, Sections 890.8 and 891). www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

Highway Design Manual, Chapter 100, "Basic Design Policies," provides standards for basic highway design, including design speed, access control, construction, and coordination with other agencies. It devotes a section to pedestrian facilities and access, and also covers special considerations such as scenic values, air pollution, water pollution, and wetlands protection. The design of sidewalks and walkways varies depending on the standards of the local agency. Most local agencies in California have adopted design standards for urban and rural areas, as well as additional requirements for residential areas, downtowns, and special districts.

According to the HDM, the needs assessment for bridges or undercrossings should consider: pedestrian-generating land uses, pedestrian crossing volumes, the type of highway to be crossed, location of adjacent crossings, zoning, and sociological factors. Where a grade-separated crossing is justified, the HDM recommends using an overcrossing because of the potential for vandalism and criminal incidents associated with undercrossings. The HDM also discusses the responsibilities for construction and maintenance of sidewalks and other pedestrian facilities.

With regard to providing for accessibility, the HDM states that it is Caltrans policy to comply with the Americans with Disabilities Act of 1990 (ADA) and California Government Code 4450 by making all State highway facilities accessible to people with disabilities to the "maximum extent possible." The ADA requires that public agencies provide for accessibility following the guidelines set by the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG). DIB 82-01 (see below) is an extension of the HDM (referenced in Chapter 100), and is used statewide for Caltrans projects. The Federal Highway Administration has approved Caltrans HDM and DIB 82-01. The DIB 82-01 procedures are per agreement with the California Department of General Services, Division of the State Architect.

Local agencies are not required to use the HDM, unless their project is on state highway rights of way, in which case they will be working with a Caltrans district office for review and approvals. Local agencies that are Federal-aid recipients are required to design using the Local Assistance Procedures Manual (under the responsibility of the Divison of Local Assistance) and the ADA subject and standards are listed in Chapter 11 "Design Standards." www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

Design Information Bulletin 82-01 (DIB 82-01), Pedestrian Accessibility Guidelines For State Highway Projects provides design guidelines for facilities that accommodate people with disabilities. www.dot.ca.gov/hq/oppd/dib/dib82-01.pdf

Caltrans Maintenance Manual is comprised of two volumes. Volume I describes the maintenance organization and the methods and procedures used in the maintenance program. Volume II of the Manual describes the Maintenance Management system (MMS) used to record, report, and monitor maintenance work planned and performed. The Manual is issued to secure, so far as possible, uniformity of practice and procedures in methods developed by past experience. It is the aim of the Department to practice restorative maintenance, and to maintain existing facilities as nearly as possible in the original condition as constructed or improved. www.dot.ca.gov/hq/maint/manual/maintman.htm

III. PLANNING

Caltrans' System Planning

System planning is the Department's long-range transportation planning process, and is conducted pursuant to Government Code 65086 (a) and the Department's policy. It is part of a continuing, cooperative, and comprehensive statewide transportation planning process that responds to federal law. The Department works with regional and local governments, and the public. The systems planning process is multi-modal and multi-jurisdictional and is used for evaluating and recommending for programming system-wide improvements to the State transportation system. The process considers the entire transportation system including the physical structures, vehicles and operators used for transporting people, goods and services and information. The primary elements of the transportation system include non-motorized (including bicycle and pedestrian transportation facilities and services), highways, streets and roads, transit, railroads, airports, seaports, pipelines, and telecommunications. Below are the planning documents produced in the systems planning process.

Route Concept Reports (RCR) / Transportation Concept Reports (TCR) or their functional equivalents outline the results of corridor studies that are analyses of a transportation corridor service area. The reports establish a twenty-year transportation planning concept and identify modal transportation options, conditions, future deficiencies, route concept and concept level of service, and identify applications needed to achieve the twenty-year concept. Corridor studies are analyses of routes from beginning to end within a Department district and contain a formulated concept level of service and facility type. Corridor analyses are similar to the "Action Element" of a Regional Transportation Plan, but focus on a single route or corridor. The RCR/TCR identifies current operational and conceptual improvements for a route or corridor. Route Fact Sheets contain current information found in an RCR/TCR, including the ultimate route concept, and are used for quick reference within the Department and by local and regional agencies. The non-motorized section of an RCR/TCR should address the following issues:

- Pedestrian programs and facilities.
- Pedestrian design guidelines for transportation facilities.
- Bicycle programs and facilities.
- Bicycle transportation plans including commuter bike trails.
- Transit interfaces with bicyclists and pedestrians.
- Unmet non-motorized needs.
- Non-motorized enhancement activities.
- Bicycle routes to school.
- Where people ride.
- ADA constraints.

The Transportation System Development Program (TSDP) is a bridging document between the RCR/TCR and the District System Management Plan. (Similar to the Regional Transportation Plan "Financial Element") It includes the entire district area, identifies a reasonable, comprehensive, and effective range of transportation improvements on state highways and within modal and new technology categories, strategies, and actions, and demand and systems management options that improve mobility.

The TSDP is the Department's statement of priorities for improvements in negotiation and joint planning with regional agencies. It provides an internal listing of candidate improvements by modal categories that the Department recommends for further analysis through federal, state, regional or local studies and broadens the basis of identifying solutions to transportation problems from identification of infrastructure improvements alone to a larger integrated identification of strategies and transportation system management options including need for revised polices. The TSDP separately identifies and emphasizes the importance of goods movement and intermodal transfer facilities, provides a "sketch level" analysis of multi-modal and intermodal considerations and provides reasonable consistency between districts and headquarters in types and categories of candidate improvement information. The TSDP provides an internal, ready, rough-cut "quick response" reference of potential future state highway, multi-modal and intermodal improvements at a statewide and district level.

The District System Management Plan (DSMP) is a strategic and policy planning document that presents the Department's district vision of how the transportation system will be maintained, managed and developed over a twenty year period and beyond. The DSMP is developed in partnership with regional transportation planning agencies and considers the entire transportation system, including all facilities regardless of jurisdiction, and addresses all modes and services that move people, goods, and services. The DSMP contains a description of overall Departmental goals and polices that relate to district transportation issues and establishes district objectives and strategies in support of the Department's mission to improve mobility across California. The plan contains a multi-modal evaluation of the transportation system and a discussion and analysis of transportation issues. It provides a management tool for informing federal, state, regional and local agencies, and public and private sector interests of the plans the district intends to follow in its partnership role with local and regional agencies. The DSMP summarizes twenty-year planning concepts and proposes transportation improvements on a system-wide level, thereby influencing the development of future transportation concepts and transportation development plans. The DSMP is the Departmental counterpart to the Metropolitan Planning Organization's Regional Transportation Plan.

Regional Planning

Regional Transportation Plans are planning documents developed by Regional Transportation Planning Agencies (RTPAs) and Metropolitan Planning Organizations (MPOs) in cooperation with the California Department of Transportation and other stakeholders. They are required to be developed by statute. (U.S. Code, Title 23, Section 134 and 135 et seq.) Each RTPA shall (Government Code 65080) prepare and adopt an RTP directed at achieving a coordinated and balanced regional transportation system. An RTP must provide a long-term (20^+ year) and a short-term (10 year), clear vision of regional transportation goals, policies, objectives, and strategies. This vision must be realistic and financially constrained. The RTP shall (title 23, CFR Sec 450.322(n)(3)) discuss the way in which the plan will conform to the State Implementation Plan including Transportation Control Measures implementation.

In areas designated non-attainment for Federal or State air quality standards, and areas with adoptive "maintenances" plans, the RTP should include reference to air quality documents. In severe and worse non-attainment areas, land use and growth assumptions shall (Title 40, CFR Sec. 93.122(b)) be documented and compared with historical trends and must show consistency between transportation alternatives for different options. In addition the RTP should acknowledge and reflect consistency with other adopted plans and programs that impact the regional transportation system (California Transportation Plan, the Department of Transportation's Systems Planning Documents, Bike Plans, California Clean Air Act, Federal Legislation). The California Transportation Commission cannot program projects that are not identified in the RTP. The Regional Transportation Plan shall (Government Code 65080) include the three following elements:

- The Policy Element reflects the mobility goals, polices and objectives of the region. Statutes state that each RTP shall (Government Code 650870(b)) include a Policy Element that (1) describes the transportation issues in the region, (2) identifies and quantifies regional needs expressed within both a short and long-range framework: and (3) maintains internal consistency with the Financial Element fund estimate.

  The Policy Element is required to have the following three distinct components: goals, policies, and objectives:

  - Goals are end results toward which effort is directed and they are expressed in general terms and are timeless.
  - Policies are direction statements that guide future decisions with specific actions.
  - Objectives are the results to be achieved by an identified point in time.

- The Action Element identifies programs and actions to implement the RTP and implements the Policy Element. The Action Element identifies the investment strategies, alternatives, and project priorities beyond what is already programmed. It is divided into two sections. The first section includes a discussion of preparatory activities such as identification of existing needs, assumptions, and forecasting, and potential alternatives.

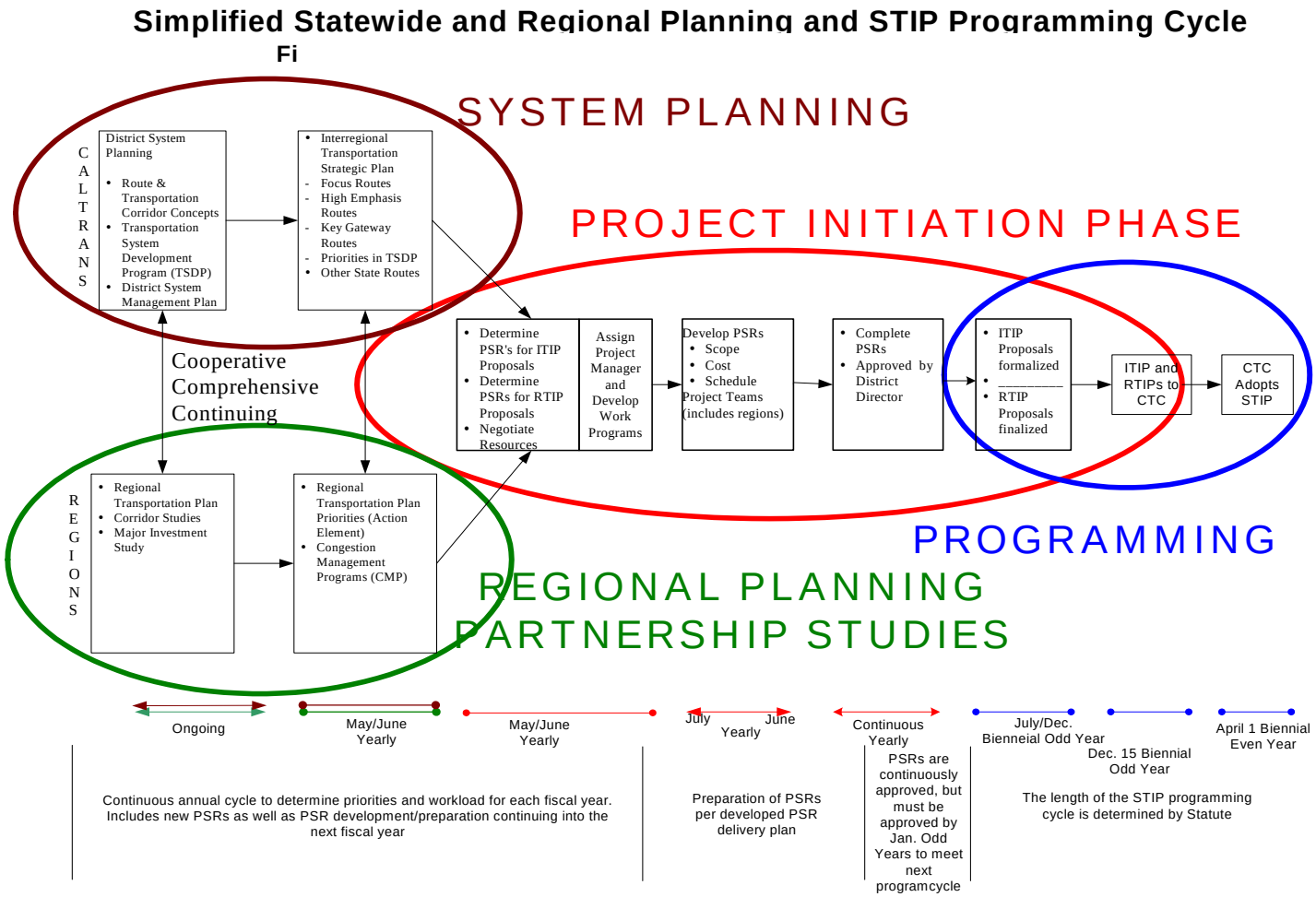


Figure 1. Simplified Statewide and Regional Planning and STIP Programming Cycle

The second section addresses data and conclusions. All transportation modes are addressed. Each Regional Transportation Agency shall (Government Code 56080 (a)) include a discussion of non-motorized transportation (including bicycle, pedestrians, and accessibility or persons with disabilities. Bicycle facilities and pedestrian walkways shall (U.S. Code, Title 23. Sec/135(a) and Title 23 CFR Sec. 540.322 (b)(3)) be identified in conjunction with all new construction and reconstruction of transportation facilities. Transportation plans and projects shall (Title 23, Sec. 135 (c)(3)) consider safety and contiguous routes for bicyclists and pedestrians. The Action element also describes a future transportation system that serves the safety, mobility, air quality, and other environmental objectives.

The non-motorized section should address the following:

- Pedestrian programs and facilities.
- Pedestrian design guidelines for transportation facilities.
- Bicycle programs and facilities.
- Bicycle transportation plans including commuter bike trails.
- Transit interfaces with bicyclists and pedestrians.
- Unmet non-motorized needs.
- Non-motorized enhancement activities.

- The Financial Element summarizes the costs of implementing the projects in the RTP within a financially constrained environment. It identifies the current anticipated revenue sources and financing techniques available to fund the planned transportation investments described in the Action Element. The intent of the Financial Element is to define realistic financing constraints and opportunities. With this information, alternatives are developed and used by State and local decision-makers in funding planned projects.

  The Financial Element contains the following seven major components:

  - Summary of cost to operate and maintain the current transportation system.
  - Estimate of costs and revenues to implement the projects indemnified in the Action Element.
  - Inventory of existing and potential transportation funding sources.
  - List of candidate projects if funding becomes available.
  - Potential funding shortfalls.
  - Identification of alternative policy directions that affect the funding of projects.

City and County Planning

GENERAL PLAN

Every city and county must adopt "a comprehensive, long-term General Plan" (§65300) that must cover a local jurisdiction's entire planning area, and address the broad range of issues associated with a city's or

county's development. The general plan is used to express the community's development goals and embodies public policy relative to the distribution of future land uses: both public and private.

The general plan is presented as a collection of the following seven "elements" or subject categories:

- Land Use
- Circulation
- Housing
- Conservation
- Open-Space
- Noise
- Safety

For the purpose of non-motorized transportation the focus is the circulation element.

The Circulation Element must correlate directly with the land-use element, and be directly related with the housing, open-space, noise and safety elements. A city or county may not ignore its regional setting. The local planning agency should coordinate its circulation element provisions with applicable State and regional transportation plans (see §65103(f) and 65080, et seq.). Likewise, the State must coordinate its plans with local governments (§65080(a)), while the Federal government is under a similar obligation (§134, Title 23 of the U.S. Code).

The circulation element should contain objectives, policies, principles, plan proposals and/or standards for planning the infrastructure that supports the circulation of people, goods and communications. These development policies should be consistent with regional air quality and transportation plans.

With respect to the requirements of the circulation element cities and counties may undertake the following activities by which they can begin the process of incorporating development policies for bicycles and pedestrians into their general plans.

- Assessing the adequacy of existing bicycle routes and facilities and the need for improvement.
- Examining trends in bicycle ownership and usage.
- Assessing the level-of-service of pedestrian facilities (both current and future).
- Assessing historical data and trends with regard to bicycle and pedestrian collisions.
- Developing and improving bicycle routes and pedestrian walkways.
- Insuring the safety of the traveling public; including pedestrians and bicyclists.

TRANSPORTATION/LAND USE CONNECTION

Planners and designers need to consider the importance of land use and transportation connections, and the huge impact that the land use and transportation connection has in promoting (in cases inhibiting or denying) non-motorized pedestrian and bicycle activities. The importance of human scale in building designs (particularly short blocks and distances scaled to the pedestrians) cannot be overestimated, nor can the elimination of obstructions, the distance requirements to promote walking and bicycling to and from activities, and, above all, the importance of traffic calming and street design. All of these enhance pedestrian and bicycling activities and contribute neighborhoods that encourage non-motorized transportation.

The Ahwahnee Principles (Corbett and Velesquez, Ahwahnee Principles for Resource Efficient Communities, 1994) support land use and transportation connections as well through emphasis on street design and intermodal connectivity: "Streets, pedestrian paths, and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic."

Where land use and transportation are connected, people are more likely to understand and support compact development. Urban infill and mixed-use buildings can provide residents a choice of travel to most destinations, particularly if most people live within walking distance (1/2 mile) of 40% of the products and services they need (Burden, Ten Keys to Walkable/Livable Communities 2001).

BICYCLE TRANSPORTATION MASTER PLAN

Although not legally required, a city or county must complete a bicycle transportation master plan if either expects to receive funding from the California Department of Transportation's Bicycle Transportation Account.

The bicycle plan must include an estimate of the following:

- The number of existing bicycle commuters in the plan area, and
- The potential increase in the number of bicycle commuters resulting from the implementation of the plan.

The bicycle plan must include the following maps and descriptions:

- A map and description of existing and proposed land use and settlement patterns, bikeways bicycle transportation and parking facilities, and facilities for changing and storing clothing and equipment.
- A description of bicycle safety and educational programs.
- A description of the extent of citizen and community involvement in the development of the plan.
- A description of how the plan has been coordinated and is consistent with other local or regional plans.
- A description of the proposed projects and their relative priority.
- A description of past expenditures for bicycle facilities.
- A description of future financial needs for bicycle projects.

IV. FUNDING SOURCES

There are a variety of potential funding sources including local, regional, State, and Federal funding programs that can be used to construct bicycle and pedestrian improvements. Most Federal, State, and regional programs are competitive, and involve the completion of extensive applications with clear documentation of the project need, costs, and benefits. Local funding for bicycle projects typically comes from Transportation Development Act (TDA) funding, which is prorated to each community based on return of gasoline taxes. Funding for many of the programs would need to be funded either with TDA, general fund (staff time), or possibly private grants. Table 1 presents a summary of available funding along with timing, criteria, and funding agency.

Federal-Aid Funding

THE TRANSPORTATION EQUITY ACT FOR THE 21ST CENTURY (TEA 21)

Several categories of federal transportation funding may be expended for bicycle and pedestrian projects. This section summarizes the federal funding sources available for non-motorized transportation projects and estimates the fiscal impact of these sources. At the time of preparation of this report, TEA-21 has been extended.

TRANSPORTATION ENHANCEMENT ACTIVITIES (TEA) PROGRAM

Ten percent of each state's annual Surface Transportation Program (STP) must be set aside for Transportation Enhancement Activities. Three of the twelve defined TEA categories are bicycle and pedestrian related:

- Provision of Facilities for Bicyclists and Pedestrians
- Provision of Safety and Educational Activities for Pedestrians and Bicyclists
- Preservation of Abandoned Railway Corridors

TEA funds may be used for the construction of bicycle transportation facilities and pedestrian walkways, or non-construction projects such as training, brochures and route maps related to safe bicycle use.

CONGESTION MITIGATION AND AIR QUALITY (CMAQ) IMPROVEMENT PROGRAM

The CMAQ Program directs funds to transportation projects in Clean Air Act non-attainment areas for ozone and carbon monoxide. These projects should contribute to meeting the attainment of national ambient area air quality standards (NAAQS). CMAQ funds may be used for construction of bicycle transportation facilities and pedestrian walkways, or non-construction projects such as brochures and route maps related to safe bicycle use. Bicycle projects must be primarily for transportation rather than recreation, and be included in a plan developed by each Metropolitan Planning Organization (MPO) and the State. TEA 21 made projects that bring sidewalks into compliance with the Americans with Disabilities Act (ADA) eligible for these funds.

REGIONAL SURFACE TRANSPORTATION PROGRAM (RSTP)

The Regional Surface Transportation Program (RSTP) is a block grant program that annually makes approximately $320 million available statewide for roads, bridges, transit capital and bicycle and

pedestrian projects. MPOs can transfer monies from other federal transportation funding sources to the RSTP program if they want more flexibility in how they allocate their funds. TEA-21 requires states to set aside 10% of their RSTP funds for safety construction activities and another 10% for the Transportation Enhancement activities (TE) program. The State of California distributes sixty-two and one half percent of RSTP funds according to regional population. The remaining thirty-seven and one half percent may be spent anywhere in the state. The California Transportation Commission (CTC) may reprogram the RSTP funds if they are not obligated within three years of federal eligibility.

Applicants eligible for RSTP funds include cities, counties, metropolitan planning organizations (MPOs), transit operators, and the California Department of Transportation. Non-profit organizations and special districts also may apply for funds, but they must have a city, county or transit operator sponsor and, in some cases, administer the project.

SAFE ROUTES TO SCHOOL PROGRAM (SR2S)

The Safe Routes to School program is a state program using federal transportation funds. This program is meant to improve school commute routes by eliminating barriers to bicycle and pedestrian travel through rehabilitation, new projects, and traffic calming. A local match of 10% is required for this competitive program, which allocates $18 million annually. Since it is a capital program, planning grants are not available through this program.

HAZARD ELIMINATION SAFETY (HES) PROGRAM

The Hazard Elimination Safety Program (HES) is a federal safety program that provides funds for safety improvements on all public roads and highways. These funds are intended to eliminate or reduce the number and/or severity of traffic accidents at locations selected for improvement. The amount of funds allocated to the local HES Program each FFY may range from $10 million to $16 million.

Each year, local agencies compete for HES funds by submitting candidate safety projects to Caltrans for review and analysis. Caltrans prioritizes these projects statewide, and releases an annual HES Program Plan that identifies the projects that are approved for funding.

State Funding

PROPOSITION 116 - CLEAN AIR AND TRANSPORTATION IMPROVEMENT ACT

Proposition 116 provided approximately $50 million for bicycle and pedestrian projects. The bicycle and pedestrian elements of the program are essentially completed.

BICYCLE TRANSPORTATION ACCOUNT

The Bicycle Transportation Account (BTA) funds a maximum of 90% of city and county projects to improve safety and convenience for bicycle commuters.

BTA funds are available for the following types of projects:

- New bikeways serving major transportation corridors.

- New bikeways removing travel barriers to potential bicycle commuters.
- Secure bicycle parking at employment centers, park-and-ride lots, rail and transit terminals, and ferry docks and landings.
- Bicycle-carrying facilities on public transit vehicles.
- Installation of traffic control devices to improve the safety and efficiency of bicycle travel.
- Elimination of hazardous conditions on existing bikeways.
- Planning, safety, and education.
- Improvement and maintenance of bikeways.

The Department convenes a committee consisting of representatives from the Department, other State agencies, and advocacy organizations to evaluate applications and recommend projects for funding. The total amount of BTA funds requested by an applicant for a project should not exceed 25% of the total amount transferred to BTA in a single year.

In Section 891.2 of the Streets and Highways Code, eleven criteria are specified to help shape local bicycle transportation plans. The criteria must be met in order to obtain BTA funding for bicycle projects. They include:

- The estimated number of existing bicycle commuters in the plan area and the estimated increase in the number of bicycle commuters resulting from implementation of the plan.
- A map and description of existing and proposed land use and settlement patterns which shall include, but not be limited to, locations of residential neighborhoods, schools, shopping centers, public buildings, and major employment centers.
- A map and description of existing and proposed bikeways.
- A map and description of existing and proposed end-of-trip bicycle parking facilities. These shall include, but not be limited to, parking at schools, shopping centers, public buildings, and major employment centers.
- A map and description of existing and proposed bicycle transport and parking facilities for connections with and use of other transportation modes. These shall include, but not be limited to, parking facilities at transit stops, rail and transit terminals, ferry docks and landings, park and ride lots, and provisions for transporting bicyclists and bicycles on transit or rail vehicles or ferry vessels.
- A map and description of existing and proposed facilities for changing and storing clothes and equipment. These shall include, but not be limited to, locker, restroom, and shower facilities near bicycle parking facilities.
- A description of bicycle safety and education programs conducted in the area included within the plan, efforts by the law enforcement agency having primary traffic law enforcement responsibility in the area to enforce provisions of the Vehicle Code pertaining to bicycle operation, and the resulting effect on collisions involving bicyclists. A description of the extent of citizen and community involvement in development of the plan, including, but not limited to, letters of support.

- A description of how the bicycle transportation plan has been coordinated and is consistent with other local or regional transportation, air quality, or energy conservation plans, including, but not limited to, programs that provide incentives for bicycle commuting.
- A description of the projects proposed in the plan and a listing of their priorities for implementation.
- A description of past expenditures for bicycle facilities and future financial needs for projects that improve safety and convenience for bicycle commuters in the plan area.

OFFICE OF TRAFFIC SAFETY (OTS) PROGRAMS

The Office of Traffic Safety's mission is to obtain and effectively administer traffic safety grant funds to reduce deaths, injuries and economic losses resulting from traffic related collisions. Each October - November, OTS mails Requests for Concept Papers to more than 3,000 eligible agencies outlining the opportunity to participate in the program and the requirements to compete for available funds. OTS grants touch as many state and local agencies as possible. There are eight program priority areas earmarked for grant funding: Alcohol and Other Drugs, Occupant Protection, Pedestrian and Bicycle Safety, Emergency Medical Services, Traffic Records, Roadway Safety, and Police Traffic Services.

ENVIRONMENTAL ENHANCEMENT AND MITIGATION PROGRAM (EEMP)

In 1989, Assembly Bill (AB) 471 allowed the Legislature to allocate $10 million annually for projects to mitigate the environmental impacts of public transportation facilities. Proposed projects must show how they mitigate the impacts of the transportation project. Grants are awarded in three general categories: highway landscape and urban forestry, resource lands, and roadside recreational. The State Resources Agency recommends projects for approval to the California Transportation Commission for funding. In 1999 Senate Bill 117 made the EEM program permanent.

TRANSPORTATION DEVELOPMENT ACT (SB 821)

Transportation Development Act (TDA) Article III funds are state block grants awarded annually to local jurisdictions for bicycle and pedestrian projects in California. These funds originate from the state gasoline tax and are distributed to local jurisdictions through the Regional Transportation Planning Agencies.

Maintaining of such artwork does not create safety concerns on the state highway.

COMMUNITY-BASED TRANSPORTATION PLANNING (CBTP) GRANTS

The CBTP grant program is primarily used to seed planning activities that encourage livable communities. CBTP grants assist local agencies to better integrate land use and transportation planning, to develop alternatives for addressing growth and to assess efficient infrastructure investments that meet community needs. These planning activities are expected to help leverage projects that foster sustainable economies, increase available affordable housing, improve housing/jobs balance, encourage transit oriented and mixed use development, expand transportation choices, reflect community values, and include non-traditional participation in transportation decision making.

CBTP grant funded projects demonstrate the value of these new approaches locally, and provide best practices for statewide application. Funding is provided by 80% Federal/State and 20% local match.

Caltrans Loan Programs

(See http://www.dot.ca.gov/hq/innovfinance/about_us.htm)

CALTRANS SHA LOAN PROGRAM (AB 1012)

This program offers short-term (maximum four-year) construction loans to local entities for State Transportation Improvement Program (STIP)-eligible projects included within an adopted Regional Transportation Plan. Total project costs must be greater than $10 million; however, for counties with populations under 500,000, this requirement may be waived.

Loan Officer (916) 324-7624

CALTRANS GRANT ANTICIPATION REVENUE VEHICLES (GARVEE BONDS)

GARVEE Bond funding offers local entities the means to accelerate construction of critical transportation projects to provide congestion relief benefits significantly sooner than traditional funding mechanisms. Debt service on the bonds is repaid through future county or interregional share allocations. Projects must be STIP-eligible for federal funds apportioned to the State, have environmental clearance, a completed project design, and must meet all applicable federal requirements. Funding is limited to right-of-way and construction costs.

Finance Manager (916) 324-7623

TRANSPORTATION FINANCE BANK (TFB)

The U.S. Department of Transportation (US DOT) designated California to participate in its State Infrastructure Bank (SIB) Pilot Program, authorized under the National Highway System Designation Act of 1995. The SIB Program was established to provide flexible project financing through loans, debt service guarantees, lines of credit, and other capital financing support. California established its SIB, the Transportation Finance Bank, to offer credit assistance to public and private entities for any stage of an eligible highway construction or transit capital project.

Loan Officer (916) 324-7624

Local and Regional Funding

TRANSPORTATION DEVELOPMENT ACT

The 1971 Transportation Development Act created a Local Transportation Fund (LTF) in each county. The LTF is funded from one-quarter cent of the seven-cent sales tax collected statewide. The one-quarter cent is returned to the county in accordance with the amount collected in the county.

Local agencies may expend a portion of the LTF to develop pedestrian and bicycle facilities. Public Utilities Code Sections 99233.3, 99234, and 99400 describe types of projects that are eligible and how funds are to be administered.

SPECIAL TAXING AUTHORITIES

Voters in seventeen counties have approved local ballot measures that permit the collection of additional local sales taxes for transportation purposes.

Table 1. Funding Sources

Acronyms:	Jurisdictions for Contra Costa County, California:
AQMD - Air Quality Management District Caltrans - California Department of Transportation CMA - Congestion Management Agency CTC - California Transportation Commission FHWA - Federal Highway Administration MPO - Metropolitan Planning Organization RTPA - Regional Transportation Planning Agency State DPR - California Department of Parks and Recreation (under the State Resources Agency) TEA-21 - Transportation Equity Act of the 21st Century	AQMD – Bay Area Regional Air Quality Management District (BAAQMD) Caltrans - Caltrans District 4 MTC – Metropolitan Transportation Commission ABAG – Association of Bay Area Governments CCTA – Contra Costa Transportation Authority Resources: Caltrans TEA-21 website - http://www.dot.ca.gov/hq/TransEnhAct/

Grant Source	Due Date	Agency	Annual Total	Matching Requirement	Eligible Applicants	Eligible Bikeway Projects			Comments
						Commute	Recreation	Safety/Ed	
Federal Funding									
TEA-21 Regional Surface Transportation Program (RSTP)	varies by RPTA	RTPAs, Caltrans	$320 m	11.47% non-federal match	cities, counties, transit operators, Caltrans, and MPOs	X	X		RSTP funds may be exchanged for local funds for non-federally certified local agencies; no match may be required if project improves safety. http://www.dot.ca.gov/hq/transprog/reports/Official_RSTP_Web_Page.htm
TEA-21 Congestion Mitigation and Air Quality Program (CMAQ)	Dec. 1 yearly	RTPAs, Caltrans	$400 m	11.47% non-federal match	Federally certified jurisdictions	X			Counties redesignated to attainment status for ozone may lose this source.
TEA-21 Transportation Enhancement Activities (TEA)	varies by RTPA	RPTAs, Caltrans	$60 m	11.47% non-federal match	Federally certified jurisdictions	X	X		Funds are dispersed through the four shares listed below.
Hazard Elimination Safety (HES) program	November	Caltrans	$10-16 m		Local agencies	X	X		Beginning with the FY 2003/2004 HES Program, the maximum federal reimbursement ratio for any HES project will be 90% and the maximum federal reimbursement amount for any project will be $360,000.
Regional Share	varies by RTPA	RTPAs, Caltrans	$45 m	"	Federal, State, or local, depending on category	X	X		Funding share to RTPAs.
Caltrans Share	varies by RTPA	Caltrans	$6.6 m	"	Caltrans	X	X		Funding share to Caltrans. Available only if regional TEA funds are not used
Statewide Transportation Enhancement Share	varies by RTPA	Caltrans, State Resources Agency	$20-30 m	"	Federal, State (except Caltrans), regional and local agencies with a State partner	X	X		Funding share for all 12 TEA categories except conservation lands.

Grant Source	Due Date	Agency	Annual Total	Matching Requirement	Eligible Applicants	Eligible Bikeway Projects			Comments
						Commute	Recreation	Safety/Ed	
Conservation Lands Share	varies by RTPA	Caltrans, State Resources Agency	$11 m	"	RTPAs, counties, cities and non-profits.	X	X		Funding share for conservations lands category - acquisitions of scenic lands with high habitat conservation value.
TEA-21 Recreational Trails Program (RTP)	Oct. 1	State DPR	$3 m	20% match	jurisdictions, special districts, non profits with management responsibilities over the land		X		For recreational trails to benefit bicyclists, pedestrians, and other users.
Transportation and Community and System Preservation Pilot Program	pending	FHWA	$25 m nationwide	--	State, local, MPO's	--	--	--	Projects that improve system efficiency, reduce environmental impacts of transportation, etc.
Land & Water Conservation Fund (LWCF)	May 1st	State DPR	$7.7 m statewide	50%, including in-kind	Federal, State, city, county, eligible districts		X		Federally-funded. Projects that acquire and develop outdoor recreation areas and facilities.
State Funding									
Environmental Enhancement and Mitigation Program (EEMP)	Nov.	State Resources Agency, Caltrans	$10 m statewide	not required but favored	local, State and Federal government non-profit agencies	X	X	X	Projects that enhance or mitigate future transportation projects; can include acquisition or development of roadside recreational facilities.
Safe Routes to School (SB 10)	May 31	Caltrans	$18 m	10% min.	city, county	X	X	X	Primarily construction program to enhance safety of pedestrian and bicycle facilities. Caltrans Headquarters
Habitat Conservation Fund Grant Program	October 1	State DPR	--	50% non-state	city, county, eligible districts	-	-	-	Includes a trails/program/urban access category.
Bicycle Transportation Account	December	Caltrans	$7.2 m	min. 10% local match on construction	city, county	X		X	State-funded. Projects that improve safety and convenience of bicycle commuters.
Regional Transportation Improvement Program (RTIP)	December 15, odd years	RTPA	--	--	city, county, transit operators, Caltrans	X		X	Part of State Transportation Improvement Program (STIP), the main state program for transportation project funding. For "improving transportation within the region." RTPA must program funds.
Petroleum Violation Escrow Account (PVEA)	On-going	State Legislature	$5 m	--	city, county, transit operators, Caltrans	--	--	--	Bicycle and trail facilities have been funded with this program.
Community-Based Transportation Planning (CBTP) Grant Program	Nov.	Caltrans	$1.5 m	20% local match, including up to 10% in-kind	Transit agencies and public entities as applicants or sub-applicants	X			Transportation and land use planning that promotes public involvement and supports livable community concepts.

Grant Source	Due Date	Agency	Annual Total	Matching Requirement	Eligible Applicants	Eligible Bikeway Projects			Comments
						Commute	Recreation	Safety/Ed	
Office of Traffic Safety Grants	Jan. 31	Office of Traffic Safety	--	--	State, city, county			X	Bicycle and pedestrian projects have been funded through this program.
Local Funding									
Transportation Development Act (TDA) Article 3 (2% of total TDA)	Jan.	RPTA	--	--	--	--	--	--	Allocated by MTC
Transportation Fund for Clean Air (TFCA)	June 30	BAAQMD	$10 million	20% for requests >$100,000	City, county, transit agencies	X		X	For construction and design of new Bay Trail segments
Bay Trail Grant Program	On-going	Association of Bay Area Governments	--	encouraged	Local governments, special districts, qualified non-profits	X	X		--
State Gas Tax (local share)	--	Allocated by State Auditor Controller	--	--	--	X		X	--
Developer Fees or Exactions (developer fee for street improvements - DFSI)	--	Cities or County	--	--	--	--	--	--	Mitigation required during land use approval process

V. STANDARD AND INNOVATIVE PRACTICES FOR PEDESTRIAN FACILITIES AND TRAFFIC CALMING

This section presents concept sheets on a variety of topics, many of which are not currently addressed in Caltrans policy documents. They are organized under two related main topic areas: **Pedestrians** and **Traffic Calming**. Topics are organized from the broadest topic element to the most detailed. For example, mid-block crosswalks would be found under Pedestrians: Crossings: Mid-Block Crosswalks. Since there is considerable overlap between the two main topic areas, users may wish to search more than one category to find their topic. The sheets provide a succinct description and discussion of the topic, a drawing or photo, and the sources of the information. These concepts may serve as a starting point, or part of a solution. Full implementation requires design in accord with Caltrans policies.

Caltrans adopts and approves specific standards, which its designers must follow (exceptions are allowed, as discussed in the Introduction). Standards are set forth in Caltrans documents such as the Highway Design Manual and the California Supplement to the MUTCD 2003. For the latest versions of these documents, be sure to consult the appropriate web sites. Caltrans designers may also consider various external advisory and informational resources including (but not limited to):

- Federal standards, policies, and guidelines
- Recommended practice from major agencies and organizations such as FHWA, AASHTO, and ITE
- Published research; experiences and practices of other states and local agencies; international experience

Pedestrian facilities are unique facilities that must accommodate a wide variety of user types, needs, and abilities. Aside from using resources in this and other publications, it is recommended that planners and designers should conduct field reviews of proposed locations, walk the corridor if possible, and that the planning and design be conducted by, or in consultation with, persons with a specialized knowledge of these facilities and are active pedestrians themselves.

EXCEPTIONS FOR PEDESTRIAN FACILITIES

- All efforts should be made to adhere to the best possible designs consistent with standards set forth in the Caltrans Highway Design Manual and guidance provided in the MUTCD 2003 as modified by the MUTCD 2003 California Supplement (May 20, 2004). However, sometimes project conditions may warrant an exception to design standards or MUTCD guidance.
- **Pedestrian Facilities (ADA)** -- Deviations from State pedestrian standards regarding ADA shall be approved by the Division of the State Architect as outlined in Caltrans Design Information Bulletin 82-01, http://www.dot.ca.gov/hq/oppd/dib/dibprg.htm.
- **Pedestrian Facilities (non-ADA)** -- Deviations from standards as defined and indicated in the Caltrans *Highway Design Manual* require approval in accordance with the design exception approval procedures described in Chapter 11 of the Local Assistance Procedures Manual, http://www.dot.ca.gov/hq/LocalPrograms/lam/lapm.htm, Chapter 80 of the HDM, http:www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm, Chapter 21 of the Project Development Procedures Manual, http://www.dot.ca.gov/hq/oppd/pdpm.htm, and memorandum entitled Fact Sheet for Exceptions to Mandatory Design standards, http://www.dot.ca.gov/hq/oppd/design/m092500.htm.
- No deviations are allowed from **standards** set forth in the MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004). MUTCD **guidance** establishes a default recommendation that may be superseded based on an engineering study or engineering

judgment. There is no requirement to follow MUTCD **options**, and MUTCD "**support**" is for informational purposes only.

PEDESTRIANS: ANALYTICAL TOOLS

DESCRIPTION

Planners and designers of non-motorized facilities have a need for the same range of analytical tools that are available for other transportation modes. Many of these tools are still being developed and researched with varying degrees of acceptance.

Demand Projections

A wide variety of methodologies exist to help predict bicycle and pedestrian usage, either area wide or on a specific corridor. Methodologies include gravity models, latent demand models, and aggregate models. The *Guidebook on Methods to Estimate Non-Motorized Travel* (FHWA-RD-98-166) determined that the reliability of all of the models was uncertain due to the lack of empirical data on before and after usage. The Los Angeles Metropolitan Transportation Authority (MTA) developed a region-wide model using a method based on before and after counts on bikeways to help predict future usage levels.

Pedestrian Level of Service

Chapter 18 of the 2000 *Highway Capacity Manual* includes methods of estimating pedestrian levels of service based on qualitative measures of pedestrian flow (delay, flexibility, etc.). This methodology can be used to assess walkway, stairway, cross flow, and queuing area requirements based on expected pedestrian volumes, all using a square feet per pedestrian formula.

SOURCE

Federal Highway Administration (1998) *The Guidebook on Methods to Estimate Non-Motorized Travel* Washington, D.C. (FHWA-RD-98-166)
Federal Highway Administration (2000) Highway Capacity Manual. Washington, D.C.

PEDESTRIANS: AMERICANS WITH DISABILITIES ACT (ADA)

(Source: Pedestrian and Bicycle Information Center, 2003)

THE LAW

The State of California has adopted regulations specifying that all buildings, structures, sidewalks, curbs and related facilities constructed in California by the use of State, county or municipal funds, or the funds of any political subdivision of the State, shall be accessible to and usable by persons with disabilities. The Division of the State Architect (DSA) is given responsibility for developing regulations and standards to ensure full accessibility. These regulations and standards are to prescribe no lesser a standard of accessibility or usability than provided by the Accessibility Guidelines prepared by the Federal Access Board to implement the ADA (ref: Government Code Section 4450).

Based on both the federal and State laws and regulations, **all newly-constructed facilities must allow full accessibility. When existing facilities are being reconstructed or modified, the contract must also include work to make these facilities fully accessible.**

"Title II-6.6000" of the Department of Justice's "Technical Assistance Manual" further clarifies this by stating: "**When streets, roads, or highways are newly built or altered, they must have ramps or sloped areas wherever there are curbs or other barriers to entry from a sidewalk or path. Likewise, when new sidewalks or paths are built or are altered, they must contain curb ramps or sloped areas wherever they intersect with streets, roads, or highways.** Resurfacing beyond normal maintenance is an alteration. Merely filling potholes is considered to be normal maintenance."

State and local governments, regardless of whether they receive federal funds, are required to comply with the Federal ADA Accessibility Guidelines (ADAAG), Title 24, USFAS, or Local Code, whichever provides the greatest access. Private-funded improvements are required to comply with the Federal ADA Accessibility Guidelines (ADAAG) and with Title 24, whichever code offers the greatest access or protections to individuals with disabilities.

SOURCE

Local Assistance Procedures Manual (11-8 – 11-8a).

Design Information Bulletin 82-01 (DIB 82-01): Pedestrian Accessibility Guidelines for Highway Projects.

www.dot.ca.gov/hq/oppd/dib/dib82-01.pdf

PEDESTRIANS: CROSSINGS: CROSSWALKS

GRAPHIC

DESCRIPTION

Pedestrian crossing measures, including signal protection and crosswalks, are addressed in the MUTCD and the California Supplement. Generally, traffic control signals may be installed based on pedestrian needs according to the following criteria:

- Signalized intersections with substantial pedestrian volumes (100 or more for each of any 4 hours or 190 or more during any 1 hour).
- There are less than 60 gaps per hour in the major street traffic stream or adequate length for pedestrians to cross.
- The nearest traffic signal along the major street is greater than 100 meters away.
- A new traffic signal will not seriously disrupt progressive traffic flow on the major street.
- Traffic gaps do not provide sufficient time to cross the street or cross to or from a median when medians are present.
- Where blocks are long and controlled intersections spaced far apart, mid-block marked crosswalks may be appropriate.

The California Vehicle Code states the responsibilities of pedestrians when crossing the street, or walking along a street on a sidewalk. The Vehicle Code also addresses the roles and responsibilities of motorists in relationship to pedestrians and wheelchair users. California, like most other states, requires both pedestrians and drivers to exercise due care. All street intersections are legally considered crosswalks, whether marked or unmarked.

SOURCES

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 6D.01: Pedestrian Considerations
http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/

Institute for Transportation Engineers (2001) Alternative Treatments for At-Grade Pedestrian Crossings
California Department of Motor Vehicles (2004) *2004 Vehicle Code*

PEDESTRIANS: CROSSINGS: OVERCOMING MOVEMENT AND INFORMATION BARRIERS

GRAPHIC

DESCRIPTION

A movement barrier is anything that restricts an individual's ability to physically move along or within the sidewalk and crosswalk environment. The greatest movement barriers for pedestrians at pedestrian crossings are:

- Long crossing distances,
- Short signal timing
- Medians and islands without ramps or cut-throughs
- Curbs without curb ramps
- Curb ramps without level landings
- Pedestrian actuated signal devices that are difficult to activate or in hard to reach locations
- Lack of information during pedestrian signal phase
- Lack of crosswalks or prohibited pedestrian crossings

An information barrier restricts an individual's ability to utilize information contained within the sidewalk environment. The greatest information barriers for pedestrians at crossing locations are:

- Conditions that make it difficult to identify the boundary between the sidewalk and street
- Blocked sight lines
- Signal devices (including actuated) that do not provide accessible information
- Lack of accessible information about the pedestrian crossing, location, direction, or interval
- Crosswalk locations that are only detectable by sight
- Vehicular actuation mechanisms that make the onset and duration of signal phases unpredictable without accessible pedestrian signal information;
- Motorists making right turns during a red light
- Non-signalized slip lanes or roundabouts that permit a continuous flow of vehicular traffic
- Rectilinear or unusual geometrics in the design of the intersection where the crossing location and correct direction of travel is not clear
- Small signage/signals at intersections with long crossing distances

SOURCE

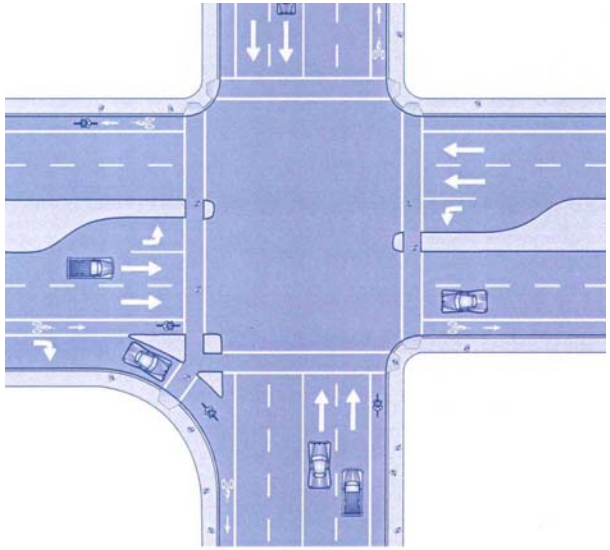
Federal Highway Administration. (2001) Chapter 8: Pedestrian Crossings. *Designing Sidewalks and Trails for Access: Best Practices Design Guide (Part II)*

Design Information Bulletin 82-01 (DIB 82-01): Pedestrian Accessibility Guidelines for Highway Projects.

www.dot.ca.gov/hq/oppd/dib/dib82-01.pdf

PEDESTRIANS: CROSSINGS: MEDIANS AND REFUGES

GRAPHIC



DESCRIPTION

Refuge islands allow pedestrians to cross fewer traffic lanes at a time and to judge conflicts separately. They also provide a refuge so slower pedestrians can wait for a gap in traffic.

Raised medians or islands in street crossing paths shall be either cut through level with the street or have curb ramps and a level area at least 1.2 m long between curb ramps (Federal AADG). Widths of cut through paths should be consistent with "Width" above. Since a cut through path is adjacent to traffic without a barrier, it must have a detectable warning surface such as “truncated domes”.

The use of free right turns may create higher speeds and conflicts between vehicles and pedestrians and bicyclists. This problem is not entirely offset by the use of “pork chop” chanelizing islands.

SOURCES

Design Information Bulletin 82-01 (DIB 82-01): Pedestrian Accessibility Guidelines for Highway Projects.
www.dot.ca.gov/hq/oppd/dib/dib82-01.pdf

Oregon Department of Transportation (1995) Section II. 5: Street Crossings. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

PEDESTRIANS: CROSSINGS: MID-BLOCK CROSSWALKS

GRAPHIC

DESCRIPTION

Crosswalk markings may be established between intersections (mid-block) in accordance with CVC 21106(a).

Mid-block pedestrian crossings are generally unexpected by the motorist and should be discouraged unless, in the opinion of the engineer, there is strong justification in favor of such installation. Particular attention should be given to roadways with two or more traffic lanes in one direction as a pedestrian may be hidden from view by a vehicle yielding the right-of-way to a pedestrian.

According to *Alternative Treatments for At-Grade Pedestrian Crossings* (ITE, 2001), mid-block locations may be warranted if:

- Protected intersections crossings are more than 180 meters apart, 100 meters in high pedestrian volume locations.
- Adequate sight distance is available.
- The combination of traffic and pedestrian volumes justifies the installation.

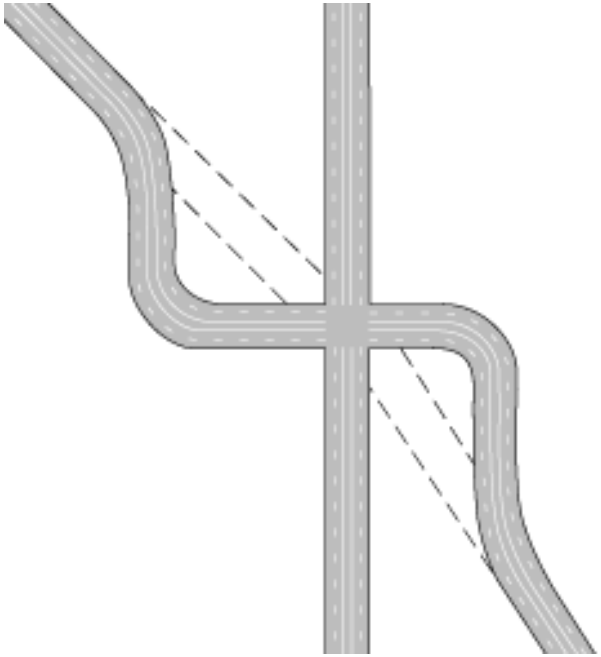
Although simply installing marked crosswalks by themselves cannot solve pedestrian crossing problems, the safety needs of pedestrians must not be ignored. More substantial engineering and roadway treatments need to be considered, as well as enforcement and education programs and possibly new legislation to provide safer and easier crossings for pedestrians at problem locations.

SOURCES

Institute for Transportation Engineers (2001) Alternative Treatments for At-Grade Pedestrian Crossings
Main Streets: Flexibility in Design and Operation (January 2005).

PEDESTRIANS: CROSSINGS: SKEWED INTERSECTIONS

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

Skewed intersections are generally undesirable for all roadway users and pose these complications for bicyclists and pedestrians:

- Bicyclists and pedestrians approaching from an acute angle on the right are not very visible to motorists;
- The crossing distance for pedestrians is increased, which lengthens the pedestrian phase at a signalized intersection; and
- The path a bicyclist must follow may not be evident.

To alleviate these concerns, several options should be considered:

Every reasonable effort should be made to design the intersection closer to a right angle;

- Sight distance should be improved by removal of obstacles;
- Pedestrian refuges should be provided if the crossing distance is excessive; and·
- Bike lanes may be striped with dashes if needed to guide bicyclists through a long undefined area.

SOURCE

Highway Design Manual, Index 403.3: Angle of Intersection
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm
Oregon Department of Transportation (1995) *Oregon Bicycle and Pedestrian Plan.* Salem, OR.
National Center for Bicycling and Walking (2003) *Pedestrian Facilities Reference Guide: Intersections.* Retrieved October 3, 2003, from http://www.bikewalk.org/walking/design_guide/pedestrian_design_guide_index.htm

PEDESTRIANS: CROSSINGS: UNCONTROLLED CROSSWALK SITING GUIDELINES

DESCRIPTION

Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled intersections*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

SOURCES

C.V. Zegeer, J. R. Stewart, H. H. Huang, and P. A. Lagerwey. (2002) Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines. *Washington D.C.: Federal Highway Administration (FHWA-RD-01-075)*

Federal Highway Administration. (2001). *Pedestrian Facilities Users Guide: Providing Safety and Mobility.* : FHWA-RD-01-102. Washington, D.C.

PEDESTRIANS: PERSONAL MOBILITY DEVICES: SEGWAY HT

GRAPHIC

DESCRIPTION

The Segway HT personal mobility device is a relatively new mode of transportation and personal mobility device. The Segway HT is an upright device that is powered electrically and can go as fast as 8 to 12 miles per hour.

There are no statewide laws regulating the use of the Segway as of the time of this publication, but some municipalities such as San Francisco have prohibited use of the Segway HT on sidewalks. Senate Bill 1918 took effect in March 2003. The bill simply allows for the use of the Segway HT, while also allowing for local governments (i.e. cities) to regulate the time, place and manner of their use or prohibit the use of the devices in public altogether. SB 1918 will sunset, or expire, January 1, 2008.

Some of the characteristics of the Segway HT include:

- 12.5 mph maximum speed is about three times as fast as walking
- Total weight of the HT is about 80 lbs
- The footprint is 48 cm by 66 cm (19 in by 26 in), and the platform is 20 cm (8 in) off the ground

The Segway HT is a relatively new and untested device. They are not yet widely used and thus are no established standards in terms of safety and their use on the street or sidewalk. Unless specifically regulated, Segway user behavior and right-of-way privileges should be relative to the type of facility being used. For example, if they are being used in the street, it should be used in the same manner as automobiles and bicycles. If it is being used on the sidewalk, it should follow the rules governing pedestrians. However, Segways, like bicycles, should always yield to pedestrians, especially if being used on a public sidewalk or trail.

Design considerations for Segways should include:

- Wide sidewalks to accommodate Segways and pedestrians
- Curb cuts to allow for street to sidewalk transitions at crossings

SOURCE

Segway LLC. *Segway HT: Personal Stories.* Retrieved on October 22, 2003 from http://www.segway.com/segway/profiles/personal_jeff.html

Tom Harris. *How Segways Work*. December 2001. Chapel Hill, NC. Retrieved on October 22, 2003 from http://travel.howstuffworks.com/ginger.htm

PEDESTRIANS: SIGNALS: IN-ROADWAY WARNING LIGHTS

GRAPHIC

DESCRIPTION

Background

In-Roadway Warning Lights at crosswalks is a new concept used as a supplement to the standard signings and markings to alert motorists about the presence of pedestrians in the roadway at uncontrolled crosswalks. The California Traffic Control Devices Committee (CTCDC) determined that the devices had the potential to be an effective traffic control device, since it fulfills a need, commands attention, and gives adequate time for an appropriate response by the driver.

In-Roadway Warning Lights are special flashing lights installed on the roadway surface to enhance driver awareness at uncontrolled pedestrian crossings. This includes, but is not limited to, school crosswalks, mid-block crosswalks, and crosswalks at uncontrolled intersection approaches.

Implementation

In-Roadway Warning Lights shall not be placed on or within the crosswalk markings. When activated, In-Roadway Warning Lights shall display a flashing yellow light indication.

The following shall be considered when evaluating need:

- Whether the crossing is controlled or uncontrolled
- An engineering study to determine if In-Roadway Warning Lights are compatible with the safety and operation of nearby intersections
- Standard traffic signs for crossings and crosswalk pavement markings are provided
- At least 40 pedestrians regularly use the crosswalk during each of any two hours (not necessarily consecutive) during any 24-hour period.
- The vehicular volume through the crossing exceeds 200 vehicles per hour in urban areas or 140 vehicles per hour in rural areas during peak-hour pedestrian usage
- The critical approach speed (85th percentile) is 45 mph or less
- In-Roadway Warning Lights are visible to drivers at the minimum stopping sight distance for the posted speed limit
- Public education on In-Roadway Warning Lights is conducted for new installations

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20,2004), Chapter 4L: In-Roadway Lights
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: COUNTDOWN SIGNALS

GRAPHIC

DESCRIPTION

A pedestrian interval countdown display may be added to a pedestrian signal head in order to inform pedestrians of the number of seconds remaining to cross the street.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 4E.07: Countdown Pedestrian Signals
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: ACCESSIBLE SIGNALS: VERBAL/VIBROTACTILE TONE

GRAPHIC

DESCRIPTION

When verbal messages are used to communicate the pedestrian interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies.

The verbal message that is provided at regular intervals throughout the timing of the walk interval shall be the term "walk sign," which may be followed by the name of the street to be crossed.

A verbal message is not required at times when the walk interval is not timing, but, if provided:

1. **It shall be the term "wait."**
2. **It need not be repeated for the entire time that the walk interval is not timing.**

Accessible pedestrian signals that provide verbal messages may provide similar messages in languages other than English, if needed, except for the terms "walk sign" and "wait."

A vibrotactile pedestrian device communicates information about pedestrian timing through a vibrating surface by touch.

Vibrotactile pedestrian devices, where used, shall indicate that the walk interval is in effect, and for which direction it applies, through the use of a vibrating directional arrow or some other means.

When provided, vibrotactile pedestrian devices should be located next to, and on the same pole as, the pedestrian pushbutton, if any, and adjacent to the intended crosswalk.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 4E.06: Accessible Pedestrian Signals
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: SIGNAL ACTUATION

GRAPHIC

DESCRIPTION

There are several simple design considerations that greatly enhance the safety and comfort of pedestrians at signalized intersections:

- In areas with high pedestrian use (over 100 persons per hour), incorporate a pedestrian phase into the signal sequence instead of an on-demand signal phase,
- Alternatively, install countdown pedestrian signals instead of the traditional “flashing hand” signal. This communicates to the pedestrian exactly how much time they have to cross the road safely.
- Place pedestrian push-buttons in locations that are easy to reach and ADA compliant, facing the sidewalk and clearly in-line with the direction of travel (this will improve operations, as many pedestrians push all buttons to ensure that they hit the right one);
- Place additional actuators prior to the intersection so that pedestrians may activate the signal before they reach the corner of the intersection, to decrease pedestrian waiting time;
- Adjust the signal timing to accommodate the average walking speeds of anticipated intersection users (longer crossing times for intersections near schools and community centers, etc.), or to limit the time a pedestrian has to wait.
- Motion detectors (both infrared and video) are being experimented with; these automatically change the signal phase when a pedestrian approaches.

SOURCE

Oregon Department of Transportation (1995) *Oregon Bicycle and Pedestrian Plan.* Salem, OR.

National Center for Bicycling and Walking (2003) *Pedestrian Facilities Reference Guide: Intersections.* Retrieved October 3, 2003, from http://www.bikewalk.org/walking/design_guide/pedestrian_design_guide_index.htm

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 4E.08: Pedestrian Detectors

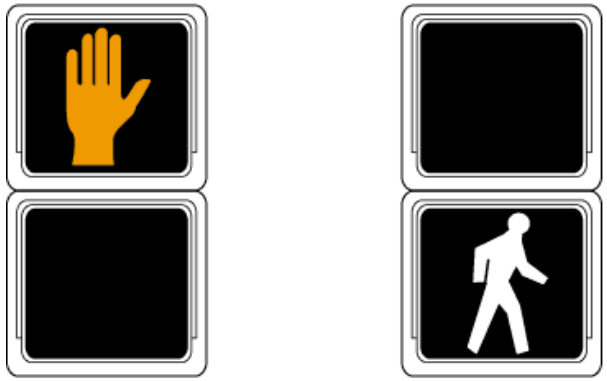
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: SIGNAL FACES

GRAPHIC

One Section (Outlined Symbol)

One Section (Solid Symbol)



Two Section

DESCRIPTION

Signal design must provide for or prohibit pedestrian movements. Pedestrians are better controlled by pedestrian signal faces rather than vehicular signal faces. This is because pedestrian signal faces used with appropriate pedestrian timing intervals provide adequate crossing and clearance times and in addition reduce the possibility of pedestrians unnecessarily blocking the intersection by entering a crosswalk near the end of a vehicle green interval.

The design and operation of traffic control signals shall take into consideration the needs of pedestrian as well as vehicular traffic.

If engineering judgment indicates the need for provisions for a given pedestrian movement, signal faces conveniently visible to pedestrians shall be provided by pedestrian signal heads or a signal face for an adjacent vehicular movement.

Safety considerations should include the installation, where appropriate, of accessible pedestrian signals that provide information in non-visual format (such as audible tones, verbal messages, and/or vibrating surfaces).

Where pedestrian movements regularly occur, pedestrians should be provided with sufficient time to cross the roadway by adjusting the traffic control signal operation and timing to provide sufficient crossing time every cycle or by providing pedestrian detectors.

Pedestrian signal faces at new signal installations on State highways shall be the international symbol type as shown in the MUTCD, i.e., the WALKING PERSON and the upraised HAND.

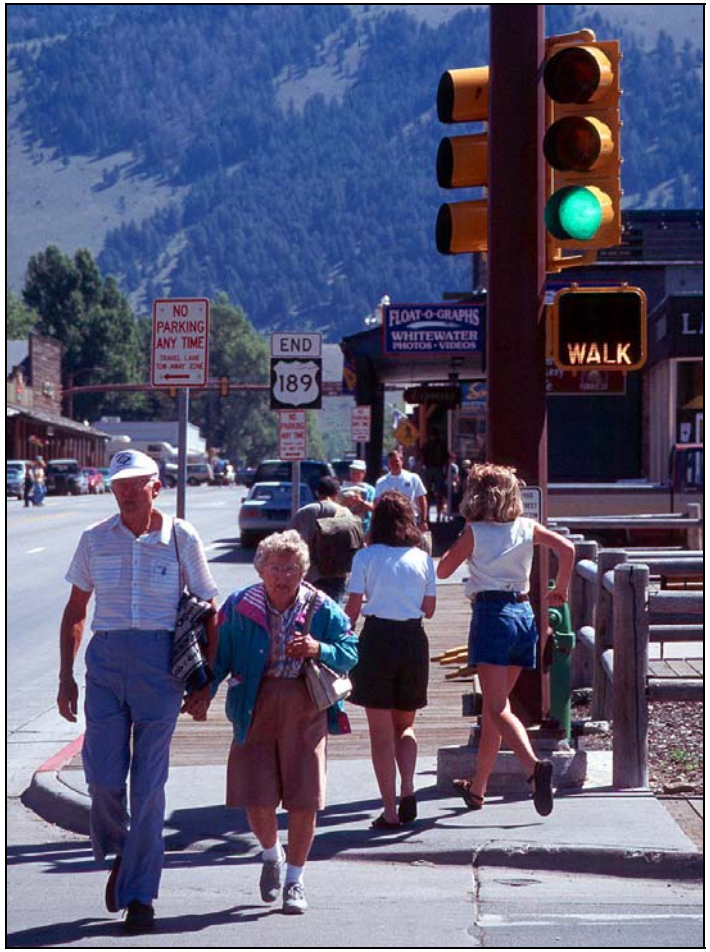
Existing "WALK - WAIT" signal faces may continue to be kept in operation. However, they should be replaced as a part of a major modernization project.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 4D.03 Provisions for Pedestrians
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: SIGNAL TIMING

GRAPHIC



(source: Pedestrian and Bicycling Information Clearinghouse)

DESCRIPTION

MUTCD standard identifies a “normal” walking speed as 1.22 m/s (4 ft/s). However, researchers have found that older pedestrians cross more slowly than younger pedestrians, approximately 2.8 ft/s, and within both age groups, women walk more slowly than men. The same relationships are found in start-up times.

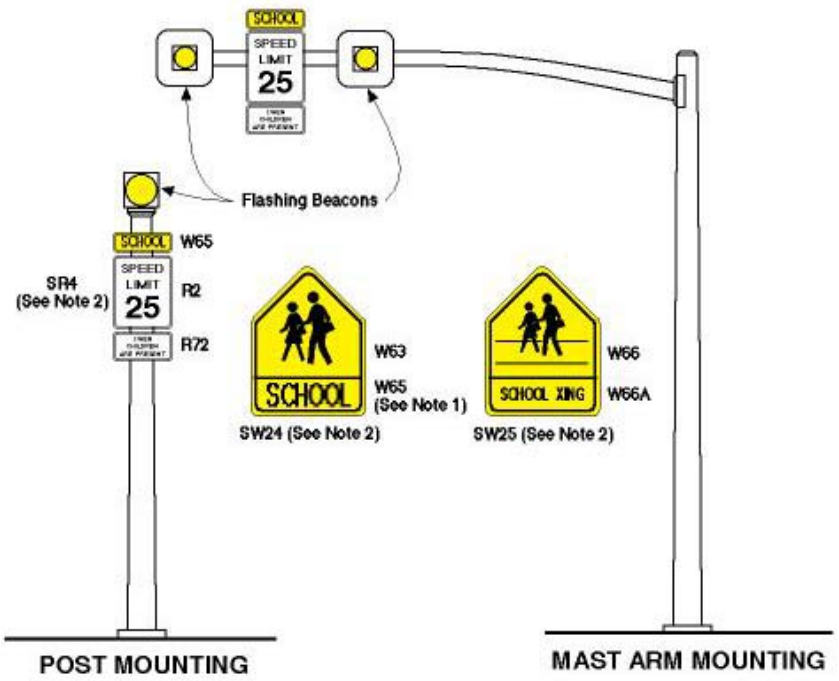
The City of San Francisco calculates pedestrian crossing times based on a walking speed of 855 mm/s (2.8 ft/s), and tries to use 2.5 ft/s where feasible.

Federal Highway Administration (2001) Chapter 4: Sidewalk Corridors. *Designing Sidewalks and Trails for Access: Best Practices Design Guide (Part II)*

Knoblauch, Pietrucha, and Nitzburg (1996) *Field Studies of Pedestrian Walking Speed and Start Up Time*. Transportation Research Board. Retrieved on October 20, 2003 from http://www.enhancements.org/trb%5C1538-004.pdf

PEDESTRIANS: SIGNALS: FLASHING YELLOW BEACONS

GRAPHIC



DESCRIPTION

Flashing yellow beacons may be installed to supplement standard school signing and markings for the purpose of providing advance warning during specified times of operation when justified.

If school authorities are to operate the flashing yellow beacon, an inter-agency agreement shall be executed to assure designation of a responsible adult to operate the beacon controls and to provide accessibility for necessary equipment maintenance.

A flashing yellow beacon may be justified when ALL of the following conditions are fulfilled:

1. The uncontrolled school crossing is on the Suggested Route to School"; and

2. At least 40 school pedestrians use the crossing during each of any two hours (not necessarily consecutive) of a normal school day; and

3. The crossing is at least 180 m from the nearest alternate crossing controlled by traffic signals, stop signs or crossing guards; and

4. The vehicular volume through the crossing exceeds 200 vehicles per hour in urban areas or 140 vehicles per hour in rural areas during the same hours the students are going to and from school during normal school hours; and

5. The critical approach speed (85 percentile) exceeds 35 mph (56 km/h) or the approach visibility is less than the stopping sight distance.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Chapter 4K: Flashing Beacons
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIGNALS: SIGNAL WARRANTS

GRAPHIC

DESCRIPTION

A traffic signal may be warranted where the pedestrian volume crossing the major street at an intersection or mid-block location during an average day is:

- 100 or more for each of any four hours; or
- 190 or more during any one hour.

The pedestrian volume crossing the major street may be reduced as much as 50% of the values given above when the predominant pedestrian crossing speed is below **1.2 m/s** (4 ft/s).

In addition to a minimum pedestrian volume of that stated above, there shall be fewer than 60 gaps per hour in the traffic stream of adequate length for pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for the pedestrian(s) to wait, the requirement applies separately to each direction of vehicular traffic.

Where coordinated traffic signals on each side of the study location provide for platooned traffic which result in fewer than 60 gaps per hour of adequate length for the pedestrians to cross the street, a traffic signal may not be warranted.

This warrant applies only to those locations where the distance to the nearest traffic signal along the major street is greater than **90 m** (295 ft) and where a new traffic signal at the study location would not unduly restrict platooned flow of traffic. Curbside parking at non-intersection locations should be prohibited for **30 m** (98 ft) in advance of and **6 m** (20 ft) beyond the crosswalk.

A signal installed under this warrant should be of the traffic-actuated type with push buttons for pedestrians crossing the main street. If such a signal is installed within a signal system, it should be coordinated if the signal system is coordinated.

Signals installed according to this warrant shall be equipped with pedestrian indications conforming to requirements set forth in Chapter 4E of the MUTCD.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20,2004), Section 4C.05. Warrant 4, Pedestrian Volumes.
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

PEDESTRIANS: SIDEWALKS: ASSESSMENT TECHNIQUES

GRAPHIC

DESCRIPTION

A system to collect and provide to the public information about grade, cross slope, surface type, obstacles, and trail width was developed into the Universal Assessment Process to help make trail systems and walkways more accessible to users. This process can be used to assess local walkway conditions using the following criteria:

Grade The average grade between two designated stations along the walkway is measured. These measurements are then used to compute the average grade for the entire walkway. Short, steep sections are measured and recorded as maximum grade sections.

Cross Slope Cross slope is measured at designated stations along the trail. These measurements are then used to compute the average cross slope for the entire trail. Cross slope information is most useful to wheelchair users. Wheelchairs are very difficult to drive or maneuver on steep cross slopes.

Width
The minimum tread width, or "beaten path," is measured at each station and is used to calculate the average tread width. The minimum amount of usable passage space between stations, or minimum clearance width, is also measured. This information is critical for people who use mobility devices such as strollers, walkers, and wheelchairs. The average manual wheelchair has a wheelbase width of less than 71 cm (28 in).

Surface
The type of surface found in between stations is recorded, as well as a description of its characteristics. Walkway surface type is a major influence on the degree of access for all user groups.

SOURCE

The Universal Trail Assessment Process (2003) Retrieved on October 23, 2003 from http://www.beneficialdesigns.com/trails/utap.html

PEDESTRIANS: SIDEWALKS: MAINTENANCE

GRAPHIC

(Source: Oregon Department of Transportation)

DESCRIPTION

Sidewalk surfaces that have settled or heaved over time can be a significant barrier for pedestrians. Surfaces that are smooth and rollable when newly installed may not stay that way, particularly where masonry units are installed without an adequate subbase. Knowledgeable design, wise material selection, good construction practices, and regular maintenance procedures can help ensure that differences in level between adjacent units do not exceed the limits of usability. Surface provisions for an accessible route limit allowable vertical differences in level between abutting surfaces to no more than 6 mm (1/4 in); if beveled at 1:2, a 13 mm (1/2 in) difference in elevation is permitted.

Caltrans is responsible for maintaining and replacing damaged sidewalks within the state highway right of way except:

(a) Where the sidewalk was placed by a private party under encroachment permit that requires the permittee to maintain the sidewalk, but only if the original permittee still owns the abutting property.

(b) Where the city or county has placed nonstandard sidewalks with colored or textured surfaces, or meandering alignment. See Maintenance Manual for additional discussion on State's maintenance responsibilities regarding sidewalks.

SOURCE

Architectural and Transportation Barriers Compliance Board. (1999) Chapter 3: Pedestrian Accessibility. *Accessible Public Rights-of-Way Design Guide*. Retrieved October 6, 2003, from http://www.access-board.gov/publications/PROW%20Guide/PROWGuide.htm#3_2_1

Highway Design Manual, Index 105.1: Sidewalks

www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

PEDESTRIANS: SIDEWALKS: MAINTENANCE: ROOT PROTECTION

GRAPHIC

(Source: Texas A&M)

(Source: City of Ventura, CA)

DESCRIPTION

Trees often ruin sidewalks, and sidewalk repair often kills trees. This conflict comes from the fact that sidewalks and trees have competing needs. Trees need a soil that is moist and loose, and that they can push aside as they grow. Sidewalks should be constructed on a dense soil that will not shift with a load. Most of the damage to sidewalks is caused as roots become thicker, lifting up the concrete slabs.

In 2001, Dr. Greg McPherson of the Western Center for Urban Forest Research and Education reported that of the $70 million spent annually on sidewalk repair (due to tree roots) in California, 61% goes for hardscape repair, 13% for liability and legal fees, 10% for tree removal and replacement, 8% for prevention and mitigation, and 8% for administration and inspection.

To prevent extensive sidewalk damage, the appropriate rootstocks should be chosen for the trees planted at each location. Trees and rootstocks that have extensive, shallow root systems should not be planted adjacent to sidewalks. Also, tree selection should be made based on the available soil, water and light conditions, and most importantly, the width of the planting strip.

Where mature trees are in place, root barriers, root pruning techniques, and *interlocking sidewalk pavers* could be used to retain as many mature trees as possible. The paving blocks can also be set in sand, and not mortared together.

SOURCE

Dodge, Linda and Jim Geiger (2001). Tree Roots and Sidewalk Damage. *City Trees, The Journal of The Society of Municipal Arborists*, Vol 37, Number 4

PEDESTRIANS: SIDEWALKS: SURFACES

GRAPHIC

DESCRIPTION

People who have difficulty walking or maintaining balance or who use crutches, canes, or walkers, and those with restricted gaits are particularly sensitive to slipping and tripping hazards. For such people, a stable and regular surface is necessary for safe walking, particularly on stairs. Wheelchairs can be propelled most easily on surfaces that are hard, stable, and regular. Soft loose surfaces such as loose sand or gravel, wet clay, and irregular surfaces such as cobblestones can significantly impede wheelchair movement. There are a variety of materials and stamping techniques that are both aesthetically pleasing and accessible (see photos).

The use of paving units, stamped concrete, or stamped asphalt concrete, although within the surface uniformity requirements of an accessible route, could lead to a vibration effect causing repeated jarring to a wheelchair user. No roughness index exists for walkways, as it does for roadway surfaces. Until such guidance becomes available, districts will have to exercise designer discretion. As a general rule, cobblestone or similar treatments should not be used.

If paving units are used, they must meet the specification requirements of the American Society for Testing and Materials (ASTM) C936.

All walkway surfaces shall have a broom finish texture or an equivalent. A broom finish surface is described in Section 73 of the current Standard Specifications (State). Regardless of surface type, if the walkway encroaches onto a roadway, as in the case of a crosswalk, the surface must have a coefficient of friction not less than 0.35 as determined by using California Test Method 342.

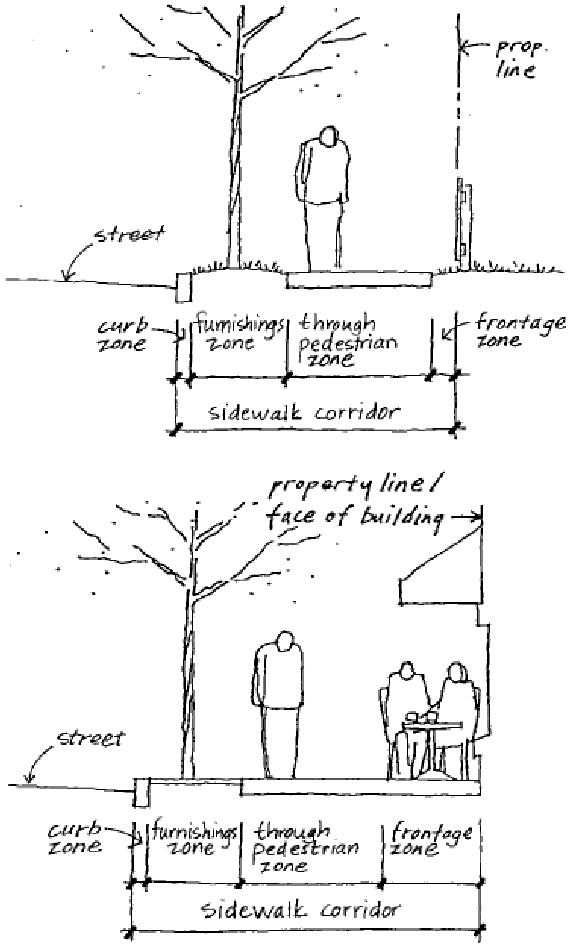
SOURCE

Design Information Bulletin 82-01 (DIB 82-01): Pedestrian Accessibility Guidelines for Highway Projects.
www.dot.ca.gov/hq/oppd/dib/dib82-01.pdf

Architectural and Transportation Barriers Compliance Board. (1999) Chapter 3: Pedestrian Accessibility. *Accessible Public Rights-of-Way Design Guide*. Retrieved October 6, 2003, from http://www.access-board.gov/publications/PROW%20Guide/PROWGuide.htm#3_2_1

PEDESTRIANS: SIDEWALKS: ZONE SYSTEM

GRAPHIC



(Source: Portland Pedestrian Plan)

DESCRIPTION

Where paved sidewalks exist, a *sidewalk corridor* lies in a public right-of-way between the street and a property line adjacent to the street. The *curb zone* is designed for drainage, and to isolate pedestrians from the street; it is typically about 15 cm (6 in) wide, and 15 cm (6 in) high. The *furnishings zone* buffers pedestrians from the street, and is the proper place for utility poles, signs, litter baskets, etc. (these are called *street furniture*). The furnishings zone is also the place to plant trees or shrubs, and for this reason it is sometimes called the *planter strip*. Other things being equal, the wider the furnishings zone, the better, since a wide buffer makes walking safer and more pleasant.

The furnishings zone provides width for any slopes that must exist for access through the sidewalk corridor; for example, a *driveway apron*, the part of the driveway that slopes to the street level, or a *curb ramp* for disabled pedestrian access.

The space adjacent to the property line that is not part of the normal walking surface is called the *frontage zone*. Its width will vary, depending on its use. The lower diagram shows a sidewalk café in the frontage zone. If there is a barrier on the property line, such as a fence or the side of a building, the frontage zone should be at least wide enough so that a pedestrian on the edge of the sidewalk will not touch the barrier. This extra room is called *shy distance*.

The *through pedestrian zone* is the clear space to walk commonly referred to as a sidewalk.. The *through pedestrian zone* should ideally be at least 1.8 m (6 ft) wide and free of both permanent and temporary obstructions. Walking surfaces in the through pedestrian zone should be firm and stable, resistant to slipping when wet, and allow for use by people using canes, wheelchairs, etc. Except where absolutely required by the topography, there should be no significant *slope* (in line with the direction of travel) or *cross-slope* (at right angles to the direction of travel) in the through pedestrian zone.

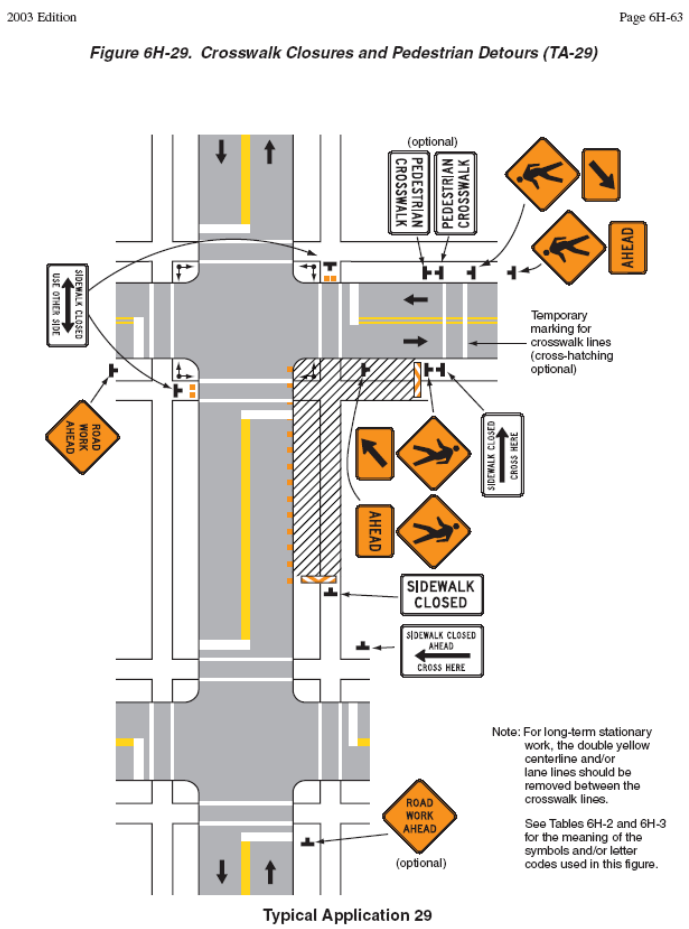
SOURCE

Portland Office of Transportation (1998) *Pedestrian Plan.* Portland, OR

Architectural and Transportation Barriers Compliance Board. (1999) Chapter 3: Pedestrian Accessibility. *Accessible Public Rights-of-Way Design Guide*. Retrieved October 6, 2003, from http://www.access-board.gov/publications/PROW%20Guide/PROWGuide.htm#3_2_1

PEDESTRIANS: WORK ZONES: SIGNING AND STRIPING

GRAPHIC



DESCRIPTION

The needs of pedestrians are often overlooked when sidewalks and crosswalks are closed for construction and maintenance activities. Wherever pedestrians are allowed, it is a mandatory standard that the temporary traffic control zone provide for the continuity of pedestrian trips through or around a closure. This requirement is set forth in the MUTCD 2003, along with substantial supplementary material.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 6D.01: Pedestrian Considerations

http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/

TRAFFIC CALMING

DESCRIPTION

In the publication *Traffic Calming: State of the Practice* (ITE/FHWA, August 1999), traffic calming is described as "the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users. Traffic calming (is differentiated) from route modification, traffic control devices, and streetscaping. Traffic control devices, notably STOP signs and speed limit signs, are regulatory measures that require enforcement. By contrast, traffic calming measures are intended to be self-enforcing.

Most traffic calming programs, which are also termed 'neighborhood traffic management programs, "traffic mitigations', among other names, are instituted by local agencies rather than regions or states. Traffic calming measures are also included in many general circulation plans, pedestrian and bicycle plans, streetscape plans, and safe routes to school plans.

Various traffic calming measures are covered in Caltrans documents including *Main Street: Flexibility in Design and Operations*. http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf Caltrans' interest and role in traffic calming is primarily related to safe operation and management of its state highways, especially where these roads also serve as local roadways. Caltrans also has an interest in providing guidance and encouragement in establishing traffic calming improvements where they help improve vehicle, bicycle, and pedestrian safety. Not all traffic calming devices are approved for use on Caltrans facilities, however, including speed humps.

Traffic Calming Publications

Traffic Calming: State of the Practice. 1999. Institute of Transportation Engineers, 525 School Street, SW, Suite 410; Washington, DC 20024.

Florida Department of Transportation's Roundabout Guide. Florida Department of Transportation, 605 Suwannee St., MS-82, Tallahassee, FL 23299-0450.

National Bicycling and Walking Study. Case Study # 19, Traffic Calming and Auto-Restricted Zones and other Traffic Management Techniques-Their Effects on Bicycling and Pedestrians, Federal Highway Administration (FHWA).

Traffic Calming (1995), American Planning Association, 122 South Michigan Avenue, Chicago, IL 60603

Traditional Neighborhood Development Street Design Guidelines, 1997. Proposed Recommended Practice, Institute of Transportation Engineers, 525 School Street, SW, Suite 410; Washington, DC 20024.

Making Streets that Work, City of Seattle, 600 Fourth Ave., 12th Floor, Seattle, WA 98104-1873, Phone: (206) 684-4000, Fax: (206) 684-5360.

Traffic Control Manual for In-Street Work, 1994. Seattle Engineering Department, City of Seattle, 600 4th Avenue, Seattle, WA 98104-6967, Phone: (206) 684-5108.

TRAFFIC CALMING: CHICANES AND CHOKERS

GRAPHIC

DESCRIPTION

Chicanes are curb extensions that alternate from one side of the street to the other, forming S-shaped curves. Chicanes can also be created by alternating on-street parking, either diagonal or parallel, between one side of the street and the other. Each parking bay can be created either by restriping the roadway or by installing raised, landscaped islands at the ends of each parking bay.

When properly designed, chicanes slow traffic speeds through horizontal deflection and are still relatively easy for large vehicles, like fire trucks, to maneuver when traffic volumes are low to moderate. Chicanes should be designed carefully to ensure that drivers not deviate out of the appropriate lane.

Chokers are curb extensions that extend from both sides of the street directly across from each other, narrowing the curb-to-curb width of the roadway at that point. As with chicanes, chokers should not be designed to force bicyclists to merge with vehicular traffic.

Additional design recommendations include:

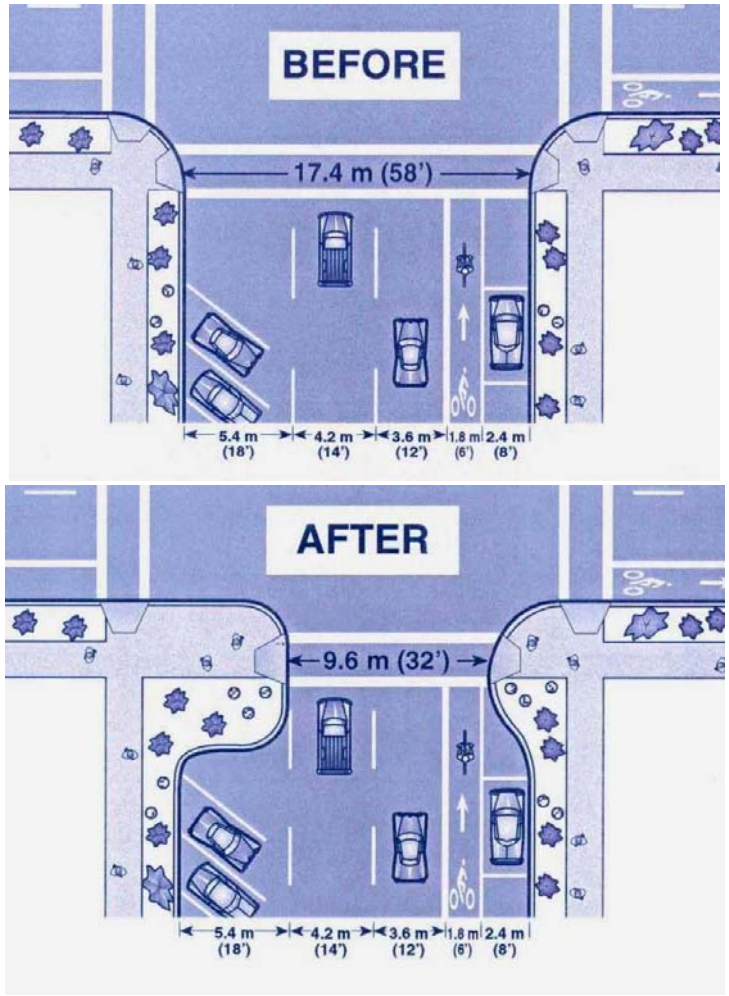
- *Install sidewalks that continue in a straight path rather than following the path of the chicane or choker*
- *Design chokers to include curb extensions with landscaping when designed at mid-block crossings*

SOURCE

Federal Highway Administration (September 2001). *Designing Sidewalks and Trails for Access Part II: Best practices Design Guide*. Washington, D.C.

TRAFFIC CALMING: CURB EXTENSIONS

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

Curb extensions, also known as bulb-outs or neck downs, are achieved at an intersection or mid-block by extending the curb corners to the center of the roadway. Curb extensions reduce the crossing distance for pedestrians and may slow motorists, though minimally, at the intersection.

Careful consideration for bicyclists is required. Shoulder striping should be installed to warn motorists and bicyclists of the narrowing at the intersection of a roadway and assist them in maintaining proper spacing. The following recommendations were made for the City of Los Altos in the report *Neighborhood Traffic Management Devices*.

- Average daily traffic (ADT) on the affected street should be between 800 and 3,500 vehicles
- Street must be at least 228.6 m (750 ft) long must have existing curbs, and an asphalt width of 6.7 m (22 ft)
- The speed limit may not be greater than 25 miles per hour
- The 85th percentile speed must be at least 32 miles per hour
- The street must be a local street; it may not be a two-lane (each direction) roadway or a collector
- Excessive cut through or nonresident traffic (above 25 percent) as calculated from the expected generation based on the Institute of Transportation Engineers (ITE) *Trip Generation Handbook* or by an origin and destination study (license plate survey)
- Adequate provisions for emergency vehicles must be provided

The City of Berkeley reports success with curb extensions in locations that are inconsistent with some of the Los Altos recommendations. As always, engineering judgement is key.

SOURCE

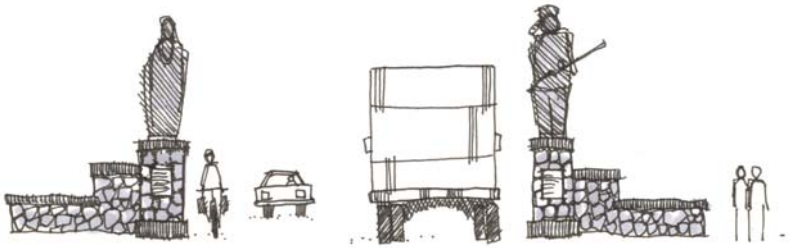
City of Los Altos Neighborhood Traffic Management Program (1999) Neighborhood Traffic Management Plan. Retrieved on October 16, 2003 from http://www.ci.los-altos.ca.us/publicworks/trafficplan/29-36.pdf

Oregon Department of Transportation (1995) Oregon Bicycle and Pedestrian Plan. Salem, OR.

Federal Highway Administration (September 2001). *Designing Sidewalks and Trails for Access Part II: Best practices Design Guide*. Washington, D.C.

TRAFFIC CALMING: GATEWAY MONUMENTS (ENTRY TREATMENTS)

GRAPHIC



((Source:http://www.pedbikeimages.org/searchResult.cfm?searchtype=simple&categoryId=161)

DESCRIPTION

Entry treatments may be used to designate a transition into a residential neighborhood or other specific areas such as business and retail districts. They may provide for traffic calming as well as a symbolic gateway.

Entry treatments may include:

- Signage
- Landscaped medians
- Textured pavement surfaces such as brick
- Archways or other large, decorative gateways with narrow driveways to slow motorists upon entry

Fixed objects in the islands such as trees, boulders, bollards, sign posts, and light poles must be set back from the islands' curb faces (see *Encroachment Permits Manual*, Section 505.7.) or made breakaway. Landscaping within the raised island should not restrict sight distance. **The District Traffic Liaison must approve pedestrian crossings and end treatments that use high barriers or vertical curbs as a planter.** Access for maintenance workers and their equipment should be considered in the design of islands and in the selection of paved surface treatments, plant materials and irrigation systems.

Caltrans District Permit Offices review requests and authorize permits for the erection of banners, decorations and temporary signing for events by local agencies and nonprofit organizations over and within state right-of-way. Authorized banners and decorations over the roadway must have a minimum vertical clearance and be suspended securely from permanent structures or poles. Banners displaying private advertisements are not allowed except when used as part of an event's official title (e.g. Kellogg's Napa Valley Marathon).

For more information, including specific minimum horizontal and vertical clearance requirements, refer to the *Encroachments Permit Manual* and *Main Streets: Flexibility in Design and Operations.*

An updated Caltrans policy on Gateway Monuments is scheduled for release late in 2004.

SOURCE

Main Streets: Flexibility in Design and Operations (January, 2005).
http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf
Solano County Transportation Authority (2003). *Transportation and Land Use Toolkit.* Retrieved on October 20, 2003 from http://www.sta.dst.ca.us/publications/Toolkit.pdf

TRAFFIC CALMING: FULL CLOSURES

GRAPHIC

(Source: http://www.trafficcalming.org)

DESCRIPTION

Full street closures are barriers placed across a local street to completely close the street to vehicular traffic, usually leaving only sidewalks open.

Full street closures are generally used for locations with extreme traffic volume problems and other measures have been unsuccessful. They are also often used together throughout the internal street network of a neighborhood to make external streets more attractive, thus reducing unwanted traffic.

The primary advantage of full closures is that they cut off traffic volumes while maintaining pedestrian and bicycle access.

The primary disadvantages are that they may:

- Create circuitous routes for that disrupt emergency services and local residents, and limit access to businesses
- They may divert significant traffic volumes onto other streets, potentially disrupting the street network on the whole

The three primary installation and design issues are:

- Legal issues that may be associated with public street closures
- They can be installed mid-block or at an intersection
- They may feature barriers, landscaped vegetation, bollards, or concrete walls, or any other obstruction that leaves an opening smaller than the width of a small passenger car

Design recommendations include:

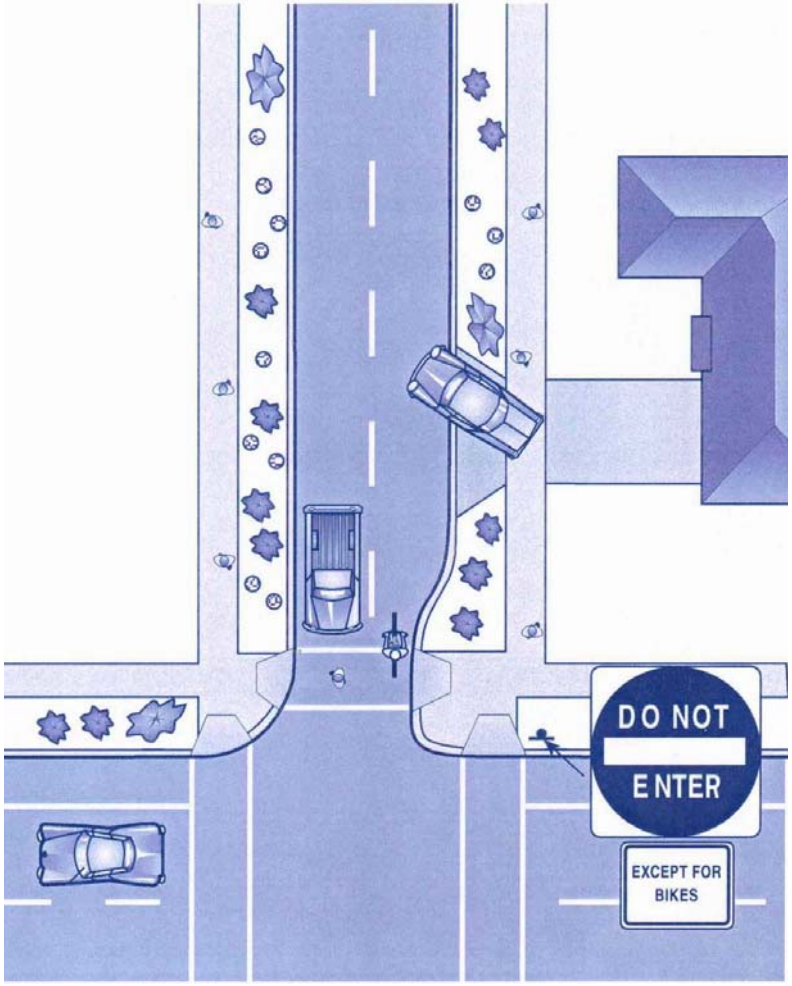
- *Provide pedestrian and bicycle pathways between the street closures to maintain an efficient network of walkways*
- *Design the constructed obstruction to permit pedestrian and bicycle access. For example, if landscaping is used, access routes through that landscaping should have a minimum clear width of 915 mm (36 in).*
- *Bollards should be provided in odd numbers to make the travel direction of openings unambiguous*

SOURCE

Federal Highway Administration (September 2001). *Designing Sidewalks and Trails for Access Part II: Best practices Design Guide*. Washington, D.C.
Institute of Transportation Engineers (1999) *Traffic Calming Measures.* Retrieved on October 15, 2003 from http://www.ite.org/traffic/closure.htm
Fehr and Peers Associates. *Traffic Calming Toolbox*. Retrieved on October 15, 2003 from http://www.trafficcalming.org

TRAFFIC CALMING: HALF CLOSURES

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

Half closures, also known as partial closures, entrance barriers or one-way closures, are barriers that block travel in one direction for a short distance on otherwise two-way local streets.

Half closures are generally used for locations with extreme traffic volume problems where more non-restrictive measures have been unsuccessful.

The advantages of half closures include:

- They are able to maintain two-way bicycle and pedestrian access
- They are effective in reducing traffic volumes

Disadvantages of half closures include:

- They causes circuitous routes for local residents and emergency services
- They may limit access to businesses
- Depending on the design, drivers may be able to circumvent the barrier

When two half-closures are placed across from one another at an intersection, the result is a semi-diverter.

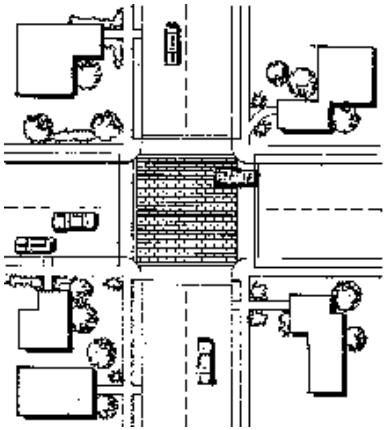
Note: The signage in this graphic may not be appropriate for use in California.

SOURCE

Institute of Transportation Engineers. (1999) *Traffic Calming: State of The Practice* . Washington D.C. Retrieved on October 16, 2003 from http://www.ite.org/traffic/tcsop/Chapter3c.pdf
Oregon Department of Transportation (1995) Oregon Bicycle and Pedestrian Plan. Salem, OR

TRAFFIC CALMING: RAISED INTERSECTIONS

GRAPHIC



(Source: Institute of Transportation Engineers

(Source: Institute of Transportation Engineers

DESCRIPTION

Raised intersections are flat raised areas that cover an entire intersection, often with textured materials on the flat section. Ramps are installed on all approaches. The intersections are usually raised to the level of the sidewalk, or slightly below to provide a "lip" that is detectable by the visually impaired.

The appropriate locations for a raised intersection treatment would include intersections with substantial pedestrian activity, and areas where other traffic calming measures would be unacceptable because they take away scarce parking spaces, such as in an active commercial retail neighborhood. With the whole intersection raised with a different surface, the intersection is recognized by motorists as being different than other roadway segments, or as "pedestrian territory".

Design recommendations include:

- Installation of detectable warnings, such as truncated domes, to identify the transition between street and sidewalk, especially for the visually impaired.
- Use a smooth surface such as colored asphalt instead of brick, to enhance access for people with mobility impairments

The advantages of raised intersections as a calming tool are:

- They can improve safety for both pedestrians and vehicles
- If designed well, they can have positive aesthetic value
- By calming the intersection, they can calm two streets at once.

The disadvantages of raised intersections are:

- They tend to be expensive, varying by materials used, and impact to drainage
- They are less effective in reducing speeds than other measures such as speed humps, speed tables and raised crosswalks
- People with back and neck problems can experience additional pain or discomfort by the jarring effect when traveling over the raised intersection

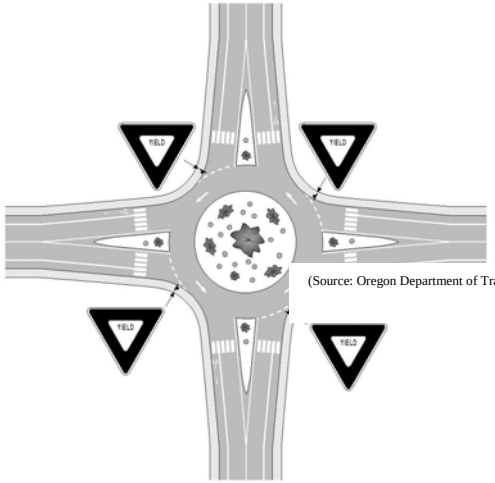
SOURCE

Federal Highway Administration (September 2001). *Designing Sidewalks and Trails for Access Part II: Best practices Design Guide*. Washington, D.C.

Institute of Transportation Engineers (1999) *Traffic Calming: State of The Practice* Washington D.C. Retrieved on October 16, 2003 from http://www.ite.org/traffic/tcsop/Chapter3c.pdf

TRAFFIC CALMING: MODERN ROUNDABOUTS

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

Modern roundabouts can serve to reduce traffic speeds and simplify pedestrian crossings. Even so, they are not always considered to be traffic calming intersection treatments. Caltrans endorses the use of modern roundabouts at freeway-to-street interchanges and at other sites with limited space available for queueing. In some cases, roundabouts can also be used to increase the capacity of an intersection and/or roadway.

All proposals for roundabouts on the State highway system shall be approved by the Design Coordinator and Traffic Liason prior to the approval of the Project Study Report or other project initiation document. The approval will be based on whether the proposal conforms with the general concepts contained in DIB 80-01.

According to DIB 80-01, the modern roundabout is defined by two basic principles that distinguish it from a traffic circle:

1. Roundabouts follow the "yield-at-entry" rule in which approaching vehicles wait for a gap in the circulating flow before entering the circle,
2. Roundabouts involve low speeds for entering and circulating traffic, as governed by small diameters and deflected entrances.

Roundabouts also reduce the number of potential conflicts between motorized vehicles and pedestrians. While a pedestrian crossing a leg of a typical signalized intersection may encounter six potential conflicts (from thru/turning vehicles), the pedestrian will only encounter two potential conflicts from vehicles at a modern roundabout. While roundabouts provide advantages, they must be designed to safely accommodate pedestrians, especially sight-impaired pedestrians. Furthermore, safety issues increase for pedestrians as roundabouts become more complex and increase the number of travel lanes. High-volume, multi-lane roundabouts can be more dangerous than a traditional signalized intersection for pedestrians and bicyclists without proper engineering, education and enforcement.

SOURCE

Design Information Bulletin 80-01: Roundabouts – Appendix, http://www.dot.ca.gov/hq/oppd/dib/dibprg.htm
Federal Highway Administration (2000) *Roundabouts: An Informational Guide*. Washington, D.C. FHWA-RD-00-67
Main Streets: Flexibility in Design and Operations (January, 2000)
http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf

TRAFFIC CALMING: TEXTURED/COLORED PAVEMENT

GRAPHIC

(Source: http://www.sta.dst.ca.us/publications/Toolkit.pdf)

DESCRIPTION

Textured and colored pavement includes the use of stamped pavement or alternate paving materials to emphasize either an entire street, intersection or a pedestrian crossing. Textured pavement may be used for "Main Street" areas where there is substantial pedestrian activity and noise is not a major concern.

The advantages of textured pavement include aesthetic value, potential to slow traffic over an extended length, and can potentially calm two streets when placed at an intersection.

The primary disadvantages of textured pavement is that it can be more expensive to install and maintain, relative to materials chosen, and that textures may impede wheelchair, walker or other mobility assistive devices for disabled citizens.

In general, stamped concrete and asphalt concrete are preferred over brick or unit pavers when a textured/aesthetic surface treatment is desired. **Either texture type must meet the criteria specified in the MUTCD and California Supplement for crosswalks**. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles maintenance, and ADA requirements for a continuous, smooth, vibration-free surface.

Any textured or aesthetic crosswalk surface treatment must also have painted crosswalk markings. The use of textured surface treatments for crosswalks may be considered for approval from Headquarters Traffic on a case-by-case basis. Traffic Operations should be consulted early in project scoping. It is important that the design engineer ensure that the project is in compliance with accessibility requirements and that the proposed textured/aesthetic surface treatment meets structural section requirements as specified by the Caltrans District Materials Engineer.

SOURCE

Main Streets: Flexibility in Design and Operations (January 2005).
http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf
Federal Highway Administration (September 2001). *Designing Sidewalks and Trails for Access Part II: Best Practices Design Guide.* Washington D.C.
Fehr and Peer Associates. *Traffic Calming Toolbox.* Retrieved on October 15, 2003 from http://www.trafficcalming.org

VI. STANDARD AND INNOVATIVE PRACTICES FOR BICYCLE FACILITIES

This section presents concept sheets on a variety of topics, many of which are not currently addressed in Caltrans policy documents. Topics are organized from the broadest topic element to the most detailed. For example, the use of wide curb lanes in lieu of (or as part of) Class III Bike Routes would be found under Class III Bike Routes: Wide Curb Lanes. The sheets provide a succinct description and discussion of the topic, a drawing or photo, and the sources of the information. These concepts may serve as a starting point, or part of a solution. Full implementation requires design in accord with Caltrans policies.

Caltrans adopts and approves specific standards, which its designers must follow (exceptions are allowed, as discussed in the Introduction). Standards are set forth in Caltrans documents such as the Highway Design Manual and the California Supplement to the MUTCD 2003. For the latest versions of these documents, be sure to consult the appropriate web sites. Caltrans designers may also consider various external advisory and informational resources including (but not limited to):

- Federal standards, policies, and guidelines
- Recommended practice from major agencies and organizations such as FHWA, AASHTO, and ITE
- Published research; experiences and practices of other states and local agencies; international experience.

Bicycle facilities are unique facilities that must accommodate a wide variety of user types, needs, and abilities. Aside from using resources in this and other publications, it is recommended that planners and designers should conduct field reviews of proposed locations, ride a bicycle along the corridor if possible, and that the planning and design be conducted by or in consultation with persons who have a specialized knowledge of these facilities and are active bicyclists themselves.

EXCEPTIONS FOR BICYCLE FACILITIES

- All efforts should be made to adhere to the best possible designs consistent with standards set forth in the Caltrans Highway Design Manual and guidance provided in the MUTCD 2003 as modified by the MUTCD 2003 California Supplement (May 20, 2004). However, sometimes project conditions may warrant an exception to design standards or MUTCD guidance.
- All deviations from mandatory, advisory and permissive design standards must be justified and documented in accordance to the specific document's requirements. Deviations from standards as defined and indicated in the Caltrans *Highway Design Manual* require approval in accordance with the design exception approval procedures described in Chapter 11 of the Local Assistance Procedures Manual, http://www.dot.ca.gov/hq/LocalPrograms/lam/lapm.htm, Chapter 80 of the HDM, http:www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm, Chapter 21 of the Project Development Procedures Manual, http://www.dot.ca.gov/hq/oppd/pdpm.htm, and memorandum entitled Fact Sheet for Exceptions to Mandatory Design standards, http://www.dot.ca.gov/hq/oppd/design/m092500.htm.
- No deviations are allowed from **standards** set forth in the MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004). MUTCD **guidance** establishes a default recommendation that may be superseded based on an engineering study or engineering judgment. There is no requirement to follow MUTCD **options**, and MUTCD "**support**" is for informational purposes only.

BICYCLE PARKING: LOCATION CRITERIA AND GUIDELINES

DESCRIPTION

Every bicycle trip has two basic components: the route selected by the cyclist, and the "end-of-trip" facilities available at the destination. These end-of-trip facilities include parking for the bicycle and showers and changing space for commuters. If the end-of-trip facilities do not meet the users' needs, other means of transportation will be substituted. Cyclists' needs for bicycle parking range from simply a convenient piece of street furniture, to storage in a bicycle locker that affords weather, theft and vandalism protection, gear storage space, and 24-hour personal access. Where a cyclist's need falls on this spectrum is determined by several factors:

- **Type of trip being made:** whether or not the bicycle will be left unattended all day or just for a few minutes.
- **Weather conditions:** covered bicycle parking is apt to be of greater importance during the wetter months.
- **Value of the bicycle:** the more a cyclist has invested in a bicycle, the more concern she or he will show for theft protection. Most new bicycles cost $400-500, and often considerably more.
- **Security of area:** determined by the cyclist's perception of how prone a given area is to bicycle theft. This is fairly subjective, and probably predicated to a degree on an individual's experiences with bicycle theft.

SHORT-TERM PARKING Bicycle parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours. Requires approved standard rack, appropriate location and placement, and weather protection.

LONG-TERM PARKING Bicycle parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location. Long-term parking type will be either a bicycle locker, a locked room with standard racks and access limited to bicyclists only, or standard racks in a monitored location.

STANDARD RACK A non-enclosed rack that is designed to reasonably protect the wheels from accidental damage and allows use of a high security U-shaped lock to lock the frame and one wheel.

SECURE AND COVERED As invulnerable as possible to theft and the elements, depending on an appropriate combination of parking type, location, and access.

PLENTIFUL Enough short- and long-term bicycle parking spaces to exceed peak season demand.

EASILY-ACCESSIBLE Bicycle parking should not be impeded by nearby stationary objects, parked bicycles or parked cars. Indoor bicycle parking must be on a floor that has an outdoor entrance open for use and a floor location that does not require stairs to access the space; exceptions may be made for parking on upper stories with elevator access within multi-story buildings. Directional signs should be used to locate bicycle parking areas when it is not visible from the street.

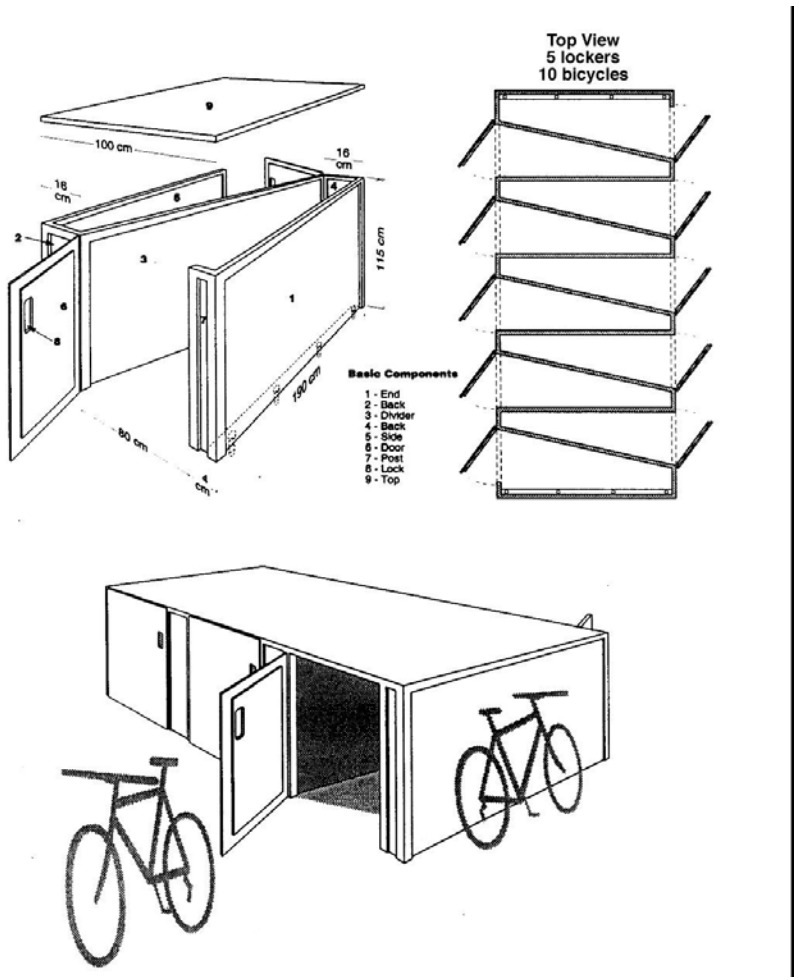
ADJACENT TO DESTINATIONS Short-term bicycle parking should be located no farther from the main entrance than the closest auto parking, and within 15.2 m (50 ft) of a main entrance to the building. Close proximity to a main entrance is desirable for long-term parking but is not required.

SOURCE

Portland Office of Transportation (1996) End-of-Trip Facilities. *Portland Bicycle Plan*. Portland, OR.

BICYCLE PARKING: LOCKERS

GRAPHIC



DESCRIPTION

Long-term bicycle parking provides employees, students, residents, commuters and others who generally stay at a site for several hours a secure and weather-protected place to park bicycles. The measure of security for long-term bicycle parking must be greater than that provided by short-term parking.

What's required:
Locate on site or within 750 feet of the site - daily bicycle commuters are generally willing to walk a short distance, about three blocks, if they are confident the parking is secure.
Cover - at least 50% of long-term bicycle parking must be covered.

Security can be achieved in at least one of the following ways:
1) in a locked room or area enclosed by a fence with a locked gate;
2) within view or within 100 feet of an attendant or security guard;
3) in an area that is monitored by a security camera; or
4) in a location that is visible from employee work areas.

What works:
Secure locations - cyclists will be more likely to park where they are confident their bicycle will be there upon return.
Locate in well lit areas - lighting increases security of property and personal safety.
Install lockers - in areas where security is in question or where there is limited opportunity to provide weather protection, enclosed bike lockers are the best solution

(Source: Bicycle Institute of South Australia)

SOURCE

Portland Office of Transportation (1996) Portland, OR.

BICYCLE PARKING: BIKE STATIONS

GRAPHIC

DESCRIPTION

Bike stations are attended facilities typically at major transit locations that offer secure bicycle parking, bicycle rentals, and other services. The first bike station in California was developed in Long Beach in 1996 by the Bikestation Coalition. Additional bike stations have been developed in Palo Alto, Berkeley, and San Francisco. Each bike station location provides unique services and amenities; but they all provide:

- A secure parking spot;
- Shared-use bicycle rentals;
- Access to public transportation;
- Convenient operating hours;
- Friendly and helpful staff;
- Information to plan your commute trips.

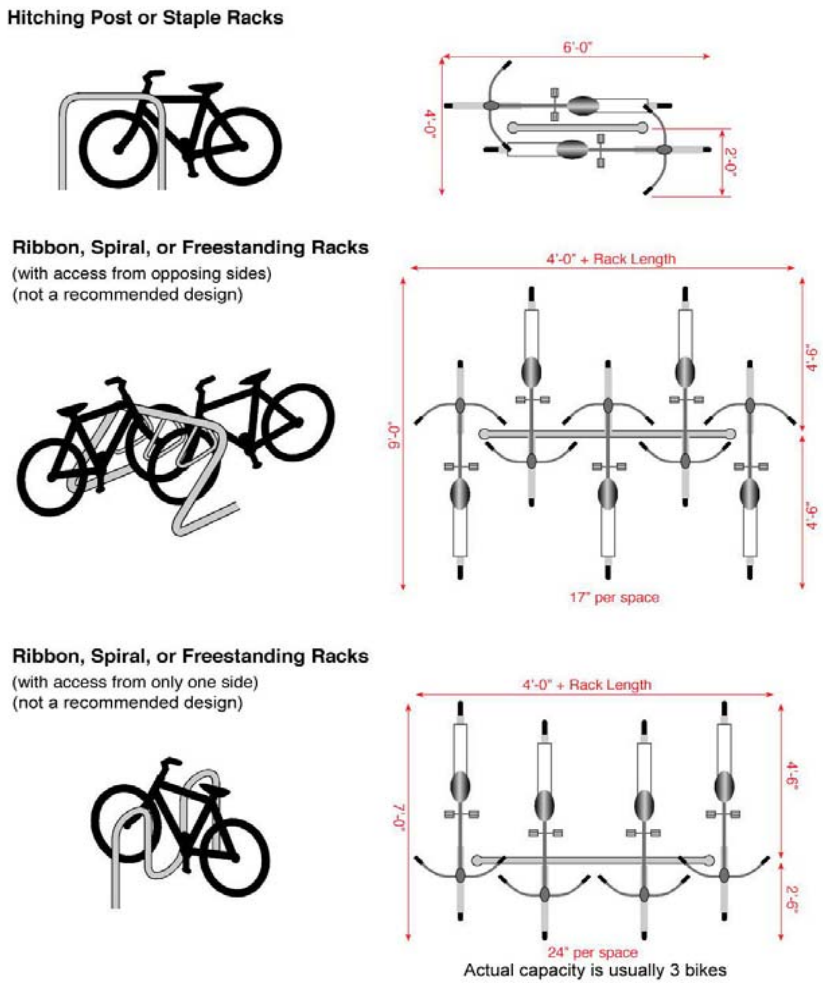
Some bike station locations offer bicycle repairs, bicycle and commute sales & accessories, restroom/changing rooms and access to environmentally-clean vehicle-sharing. Bike stations are typically subsidized by local agencies as part of an effort to expand the range of their transit services and encourage bicycling.

SOURCE

Bikestation (2004) http://www.bikestation.org/ Last accessed on March 5, 2004

BICYCLE PARKING: RACKS

GRAPHIC



GRAPHIC

Hitching post (staple) racks are highly recommended. Ribbon racks are not recommended, as bicyclists commonly use these racks as if they were hitching post racks, limiting the capacity of the rack to two bicycles, regardless of the potential or stated capacity. Some proprietary rack designs have desirable features such as multiple points of support, encouraging more uniform bike placement and higher capacity.

Code regarding Bicycle Parking No person shall leave a bicycle lying on its side on any sidewalk, or shall park a bicycle on a sidewalk in any other position, so that there is not an adequate path for pedestrian traffic. Local authorities may, by ordinance or resolution, prohibit bicycle parking in designated areas of the public highway, provided that appropriate signs are erected (*CVC 21210*).

SOURCE

Pedestrian and Bicycling Information Clearinghouse (2003) *Bicycle Parking Guidelines*. Retrieved on October 22, 2003 from http://www.bicyclinginfo.org/de/parkguide.htm
Oregon Department of Transportation (1995) II.3. Bicycle Parking. *Oregon Bicycle and Pedestrian Plan* Salem, OR.
California Department of Motor Vehicles (2003) California Vehicle Code: Section 21210

CLASS I BIKE PATH: RAILS-WITH-TRAILS (RWT)

GRAPHIC

No national standards or guidelines dictate rail-with-trail facility design. Guidance must be pieced together from standards related to shared use paths, pedestrian facilities, railroad facilities, and/or roadway crossings of railroad rights-of-way. Trail designers should work closely with railroad operations and maintenance staff to achieve a suitable RWT design. Whenever possible, trail development should reflect standards set by adjacent railroads for crossings and other design elements. Ultimately, RWTs must be designed to meet both the operational needs of railroads and the safety of trail users. The challenge is to find ways of accommodating both types of uses without compromising safety or function.

For a comprehensive understanding of Rail-with-Trail issues, design guidelines, and recommendations, refer to FHWA's "Rails-with-Trails: Lessons Learned."

DESCRIPTION

Rail with trail (RWT) describes any shared use path or trail located on or directly adjacent to an active railroad corridor.

General Design Guidelines:

1. RWT designers should maximize the setback between any RWT and active railroad track. The setback distance between a track centerline and the closest edge of the RWT should correlate to the type, speed, and frequency of train operations, as well as the topographic conditions and separation techniques.

2. Subject to railroad and State and Federal guidelines and the advice of engineering and safety experts, exceptions to the recommended setbacks may include:

   a. Constrained areas (bridges, cut and fill areas)
   b. Low speed and low frequency train operations

In these cases and in areas with a history of extensive trespassing, fencing or other separation technique is recommended.

3. When on railroad property, RWT planners should adhere to the request or requirements for fencing by the railroad company. Fencing and/or other separation techniques should be a part of all RWT projects.

4. Trail planners should minimize the number of at-grade crossings, examine all reasonable alternatives to new at-grade track crossings, and seek to close existing at grade crossings as part of the project.

5. RWT proposals should include a full review and incorporation of relevant utility requirements for existing and potential utilities in the railroad corridor.

6. The feasibility process should clearly document the cost and environmental impact of new bridges and trestles.

7. Trails should divert around railroad tunnels; if they need to go through a single-track railroad tunnel, they likely are not feasible due to extremely high cost.

8. Where a RWT is proposed to bypass a railroad yard (such as in Seattle, WA), adequate security fencing must be provided along with regular patrols by the RWT manager. High priority security areas may need additional protection.

9. An environmental assessment should be conducted concurrent with, and usually independent from, the feasibility analysis, and should include project alternatives located off the railroad corridor if at all possible.

SOURCE

Federal Highway Administration (2004) Chapter 5: Design: *Rails-with-Trails: Lessons Learned*. Washington, DC

CLASS I BIKE PATH: RAILS-TO-TRAILS

GRAPHIC

Chuck Perkins-Tailwinds photos

Melanie Mintz

DESCRIPTION

Rail with trail (RWT) describes any shared use path or trail located on or directly adjacent to an active railroad corridor. Rails to trails refers to any potential trail which would replace an abandoned railroad line with a trail

Rail-trails can be a crucial element to a seamless urban or regional multi-modal transportation system. Many areas of the country incorporate rail-trails and similar facilities into their transit plans, relying upon trail facilities to "feed" people in to and out of transit stations in a safe and efficient manner. Rail-trails tend to be flat and direct, and often connect residential and business districts, so many people find rail-trails convenient as a primary means of getting safely to and from work, school, shopping areas and other destinations. In addition to transportation, rail-trails also offer pleasant, safe and traffic-free environments for recreational walkers, bicyclists, and kids.

Rail-to-Trail conversions should follow Caltrans Class I Bike Path standards, outlined in Chapter 1000 of the Highway Design Manual. Amenities like benches, water fountains, interpretive areas, pullouts, signs, and landscaping should also be provided.

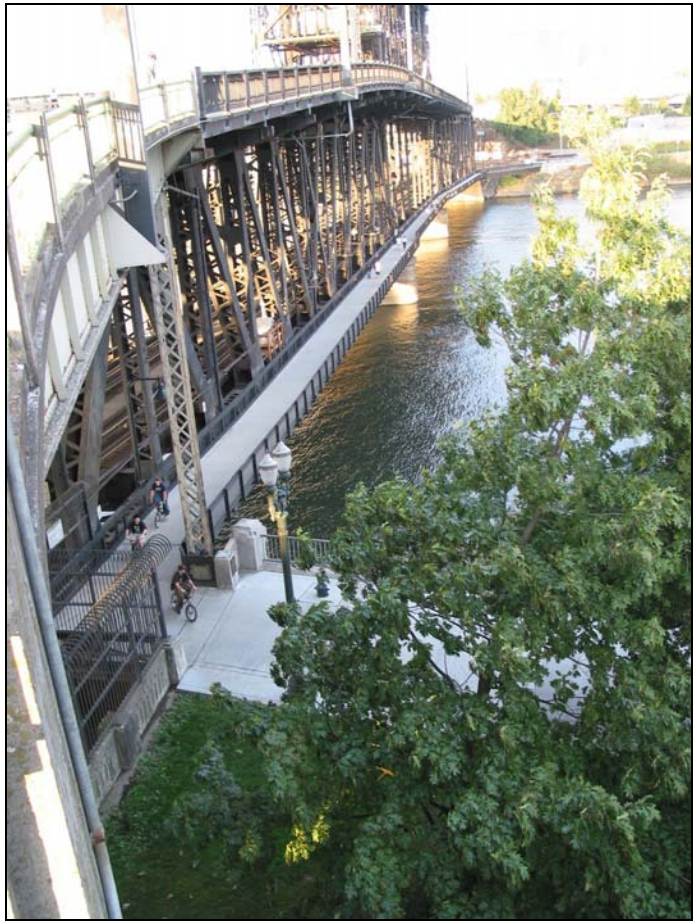
SOURCE

Rails-To-Trails Conservancy. http://www.railtrails.org/ Last accessed on March 5, 2004.

California Department of Transportation (2001) Chapter 1000: Section 1002.4: Selection of the Type of Facility. *Highway Design Manual*. Sacramento, CA www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

CLASS I BIKE PATH: RIVERS WITH TRAILS

GRAPHIC



Steel Bridge RiverWalk, Eastbank Esplanade Portland, OR

DESCRIPTION

The Rivers, Trails, and Conservation Assistance Program, also known as the Rivers & Trails Program or RTCA, is a community resource of the National Park Service. Rivers & Trails staff work with community groups and local and State governments to conserve rivers, preserve open space, and develop trails and greenways. Rivers & Trails works in urban, rural, and suburban communities with the goal of helping communities achieve on-the-ground conservation successes for their projects.

The focus of Rivers & Trails is to help communities help themselves by providing expertise and experience from around the nation. From urban promenades to trails along abandoned railroad rights-of-way to wildlife corridors, the organization's assistance in greenway efforts is wide ranging. Similarly, their assistance in river conservation spans downtown riverfronts to regional water trails to stream restoration.

SOURCE

National Park Service. http://www.nps.gov/rtca/ Last accessed on March 5, 2004

CLASS I BIKE PATH: UNDER-CROSSINGS

GRAPHIC

(Source: City of Davis)

DESCRIPTION

For high-volume roads and/or roads with fast-moving traffic, a grade-separated crossing should be used to allow bicyclists and pedestrians to safely cross the street.

The width of multi-use path structures is the same as the approach paved path, plus shy distances on both sides.

Although over-crossings are generally preferred for personal security reasons, under-crossings may be allowable with good horizontal and vertical clearance, so users approaching the structure can see through to the other end. Illumination is needed in areas of poor visibility.

For under-crossings, the advantages are:

- They provide an opportunity to reduce approach grades, as the clearance is less than the clearance required for crossing over a roadway. If the roadway is elevated, an under-crossing can be constructed with little or no grade.
- They are often less expensive to build.

For under-crossings, the disadvantages are:

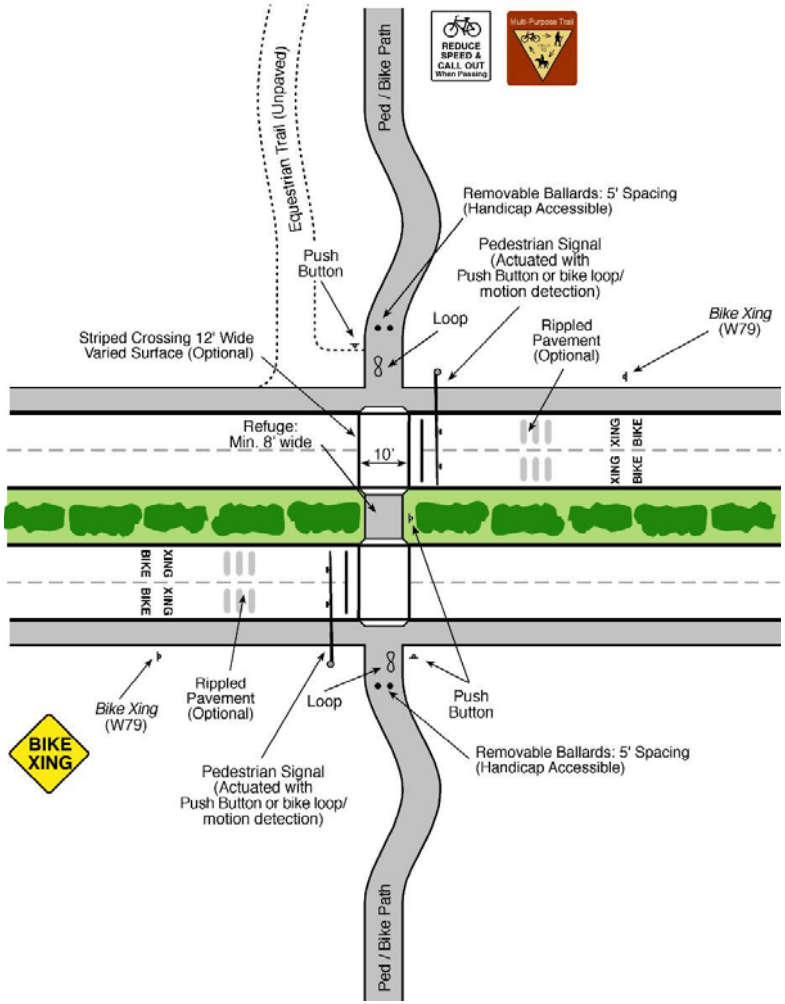
- They may present security problems, due to reduced visibility.
- An open, well-lighted structure may end up costing as much as an over-crossing.
- They may require drainage if the sag point is lower than the surrounding terrain.

SOURCE

Highway Design Manual Chapter 1000
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm
Oregon Department of Transportation (1995) Section II. 6: Multi-use Paths. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

CLASS I BIKE PATH: MID-BLOCK CROSSINGS

GRAPHIC



DESCRIPTION

The number of at-grade crossings with streets or driveways should be limited. Poorly designed crossings put pedestrians and cyclists in a position where motor vehicle drivers do not expect them at street crossings. At the same time, the presence of grade separated crossings may actually endanger pedestrians, because drivers will not be expecting them if they attempt to cross at-grade. Because of the lack of marked at-grade crossing or signal, the speed of cars will generally be higher than that of a roadway with a signalized or marked crossing.

The design of at-grade crossings should feature traffic calming and crossing improvements (detailed in this manual) such as: curb extensions, marked crosswalks, pedestrian refuge medians, and traffic control devices.

Note: The specific signing and striping package in this graphic may not be appropriate for use in California.

SOURCE

American Association of State Highway and Transportation Officials (1999). Guide for the Development of Bicycle Facilities. Washington D.C.
Highway Design Manual Chapter 1000
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm
Oregon Department of Transportation (1995) Section II. 6: Multi-use Paths. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

CLASS I BIKE PATH: OPERATIONS

GRAPHIC

Springwater Corridor – Willamette River Extension, Portland, OR

DESCRIPTION

Class I Bike Paths carrying heavier volumes of users and a variety of user types will require a combination of greater width and higher levels of management as design manuals now acknowledge that paths are "shared use" facilities and that they must be designed to accommodate bi-directional mixed use.

Bike Paths carrying peak period volumes in excess of 300 people per hour should provide 10 feet of width and centerline striping, over 500 people per hour should provide 12 feet of width and centerline striping, as recommended by the AASHTO guide.

In all cases, unpaved 2-4 feet wide shoulders should be provided wherever possible for pedestrians.

All bike paths should provide clear signage indicating:

- Hours of operation (if limited)
- Maximum speed
- Protocols for passing
- Direction of flow of traffic

Generally, people and bicycles on a Class I bike path should operate in a similar manner as motor vehicles on a roadway. All people should stay to the right of the center line, with slower moving traffic staying as far right as possible and any stopped traffic moving off the pathway entirely. If an unpaved adjacent walkway at lest four feet wide is available, pedestrians may be encouraged to use this surface rather than the bike path.

SOURCE

American Association of State and Highway Transportation Officials (1999) Guide for the Development of Bicycle Facilities. Washington D.C.

CLASS II BIKE LANES: ON-STREET PARKING

GRAPHIC

DESCRIPTION

Parked vehicles can pose a serious hazard to bicyclists as moving vehicles, both by being hit by an opening door, and by the parking maneuver itself. On streets with parked vehicles, experienced bicyclists will ride 0.9 m -1.2 m (3 or 4 ft) away from parked vehicles even if it means riding in a travel lane. Several techniques are available to help maximize separation between bicyclist and parked vehicle:

- Minimize the parking lane width. This technique may be used in conjunction with widening the bike lane. Some research suggests that the narrower the parking lane, the closer vehicles park to the curb. The traditional 2.4 m (8 ft) wide parking lane can be reduced to 2.1 m (7 ft), and in some cases, to 1.9 m (6.5 ft), to achieve this result.
- Space markings. Marked parking spaces with cross hatches indicating the parking lane limits may help guide drivers closer to the curb.
- Stencils. Bike route stencils help educate drivers on narrow roadways with on-street parking to expect bicyclists in the travel lane.
- Angled parking should be avoided in areas of high bike traffic. If angled parking is used on a street, one approach that is being tried in some locations is to require vehicles to use reverse angle parking so that drivers back into spaces. This allows for greater visibility of bicyclists both entering and leaving the space.

The City of San Francisco recommends the following parking lane and bike lane widths:

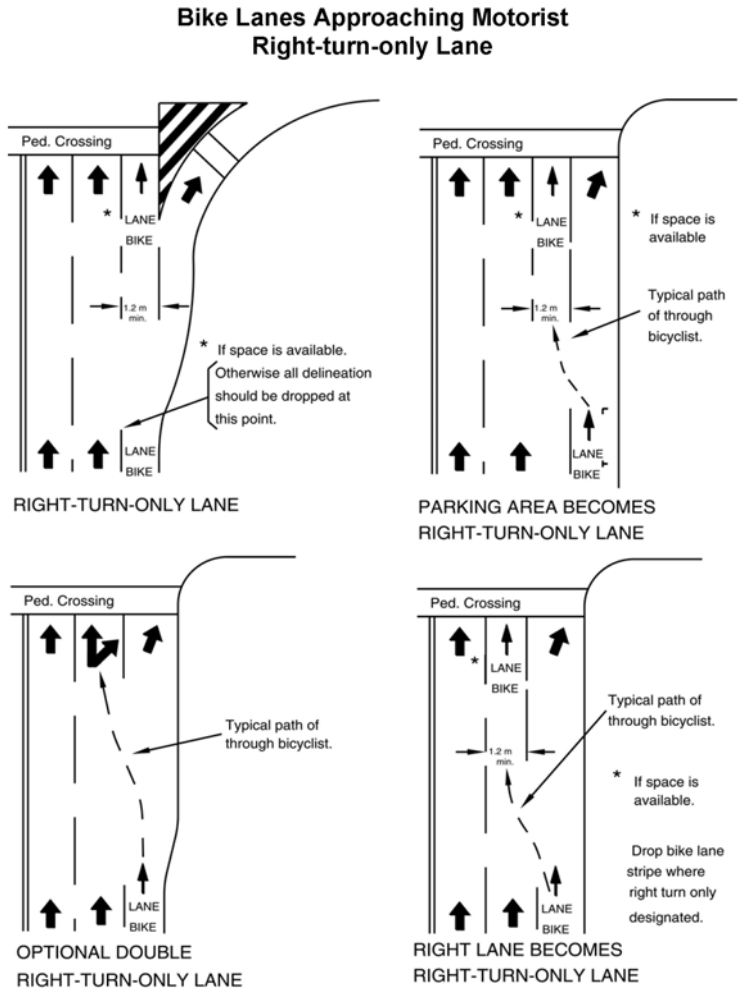
Total Avaliable	Parking Lane	Bike Lane
3.7 m (12 ft)	2.1 m (7 ft)	1.5 m(5 ft)
4.0 m (13 ft)	2.4 m (8 ft)	1.5 m (5 ft)
4.3 m (14 ft)	2.7 m (9 ft)	1.5 m (5 ft)

SOURCE

Institute of Transportation Engineers (2002) *Innovative Bicycle Treatments: An Informational Report*. Washington, D.C.

CLASS II BIKE LANES: RIGHT TURN LANES

GRAPHIC



DESCRIPTION

The figure at left illustrates recommended striping patterns for bike lanes crossing a right-turn-only lane. When confronted with such intersections, bicyclists will have to merge with right-turning motorists. Since bicyclists are typically traveling at speeds less than motorists, they should signal and merge where there is a sufficient gap in right-turning traffic, rather than at any predetermined location. For this reason, it is recommended that all delineation be dropped at the approach of the right-turn lane. A pair of parallel lines (delineating a bike lane crossing) to channel the bike merge is not recommended, as bicyclists will be encouraged to cross at a predetermined location, rather than when there is a safe gap in right-turning traffic.

A dashed line across the right-turn-only lane is not recommended on extremely long lanes, or where there are double right-turn-only lanes. For these types of intersections, all striping should be dropped to permit judgment by the bicyclists to prevail. A Bike Xing sign may be used to warn motorists of the potential for bicyclists crossing their path.

At intersections where there is a bike lane and traffic-actuated signal, installation of bicycle-sensitive detectors within the bike lane is desirable. Push button detectors are not as satisfactory as those located in the pavement because the cyclist may have to go out of direction, lean over excessively, or traverse an undesirable portion of the bike lane in order to actuate the push button. It is also desirable that detectors in left-turn lanes and through lanes be able to detect bicycles (see MUTCD 2003 California Supplement, Figure 4D-111).

Where space is available, it would be desirable to maintain a 4 ft shoulder or wide lane to the intersection for those who wish to use the pedestrian crossing.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20,2004), Figure 4D-111
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/
Highway Design Manual, Index 1003.2(3),
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm

CLASS III BIKE ROUTE: BICYCLE BOULEVARDS

GRAPHIC

DESCRIPTION

Class III Bikeway (Bike Route). Bike routes are shared facilities which serve either to: (a) Provide continuity to other bicycle facilities (usually Class II bikeways); or (b) Designate preferred routes through high demand corridors. As with bike lanes, designation of bike routes should indicate to bicyclists that there are particular advantages to using these routes as compared with alternative routes. This means that responsible agencies have taken actions to assure that these routes are suitable as shared routes and will be maintained in a manner consistent with the needs of bicyclists. Normally, bike routes are shared with motor vehicles. The use of sidewalks as Class III bikeways is strongly discouraged.

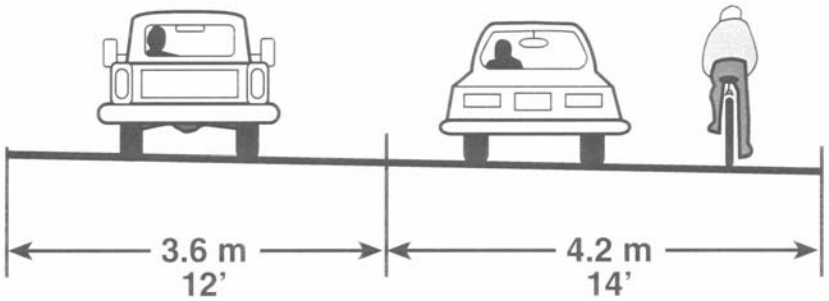
A Bicycle Boulevard, sometimes called a bicycle priority street, is a street where all types of vehicles are allowed, but the roadway is modified as needed to enhance bicycle safety and convenience. Bicycle boulevards are not approved for use on the State Highway System. Typically these modifications will also calm traffic and improve pedestrian safety. Modifications include signage, unique pavement (colored, textured, etc.), pavement legends, landscaping/street trees, traffic circles, bulb outs, traffic signals, and highly visible crosswalks. In some cases, bicycles may be granted through access to the roadway while vehicles may not, as shown in the photo below.

SOURCE

Highway Design Manual, Index 1002.4
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm
City of Berkeley (2000) Chapter 4: Toolbox and Sample Bike Boulevard Layout. *Bicycle Boulevard Design Tools and Guidelines.* Berkeley, CA

CLASS III BIKE ROUTE: WIDE CURB LANE

GRAPHIC



(Source: Oregon Department of Transportation)

(Source: Pedestrian and Bicycling Information Clearinghouse)

DESCRIPTION

On all streets, but especially where shoulder bikeways or bike lanes are warranted but cannot be provided due to severe physical constraints, a wide outside lane may be provided to accommodate bicycle travel. A wide lane usually allows an average size motor vehicle to pass a bicyclist without crossing over into the adjacent lane. Wide curb lanes are generally appropriate to accommodate bicyclists, whether or not the street is considered a bikeway.

Bike lanes should resume where the restriction ends. It is important that every effort be made to ensure bike lane continuity. Practices such as directing bicyclists onto sidewalks or other streets for short distances should be avoided, as they may introduce unsafe conditions. For curb lanes 16 ft or wider, the edge line should be striped.

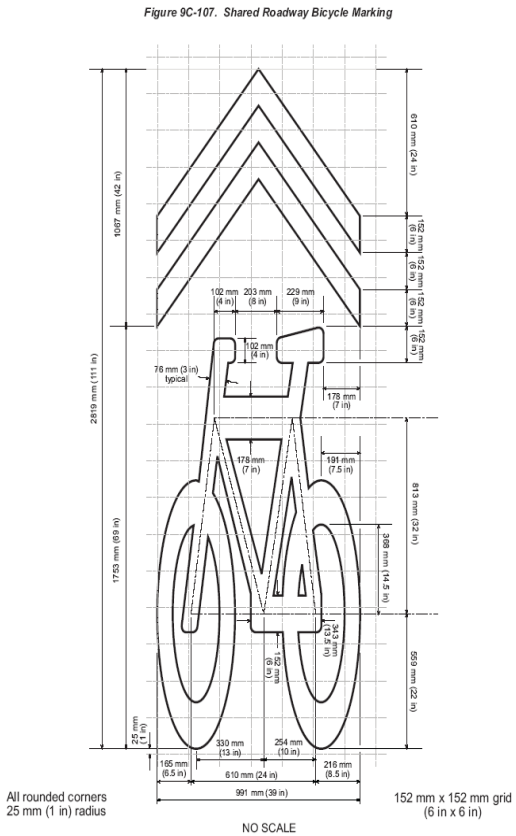
12' is the miniumum width on State Highways without obtaining a Design Exception.

SOURCE

Oregon Department of Transportation (1995) Section II. 1: On-Road Bikeways. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

CLASS III BIKE ROUTE: BICYCLE PAVEMENT MARKINGS: “SHARROWS”

GRAPHIC



Shared-Use Arrow (Sharrow) Bicycle Pavement Marking

DESCRIPTION

The rightmost lane on signed/shared Class III bikeways is often too narrow to be safely shared side-by-side by cyclists and passing motorists. On these routes, cyclists wishing to stay out of the way of drivers often ride too close to parked cars and risk being struck by a suddenly opened car door (being “doored”).

To avoid this, experienced cyclists ride further to the left and position themselves closer to the center of narrow lanes. This is permitted by the California Vehicle Code (C.V.C. 21202), but it often irritates motorists who are not aware that this is permitted.

Many cities have experimented with a "shared lane marking" as a potential solution. The marking does not connote a separated bicycle lane, but instead directs the bicyclist to travel outside the car door zone and encourage safe co-existence.

In a study conducted for the San Francisco Department of Parking and Traffic (SF DPT), the stencil markings significantly improved both motorists’ and cyclists’ positions in the roadway. The markings also reduced sidewalk and wrong-way riding.

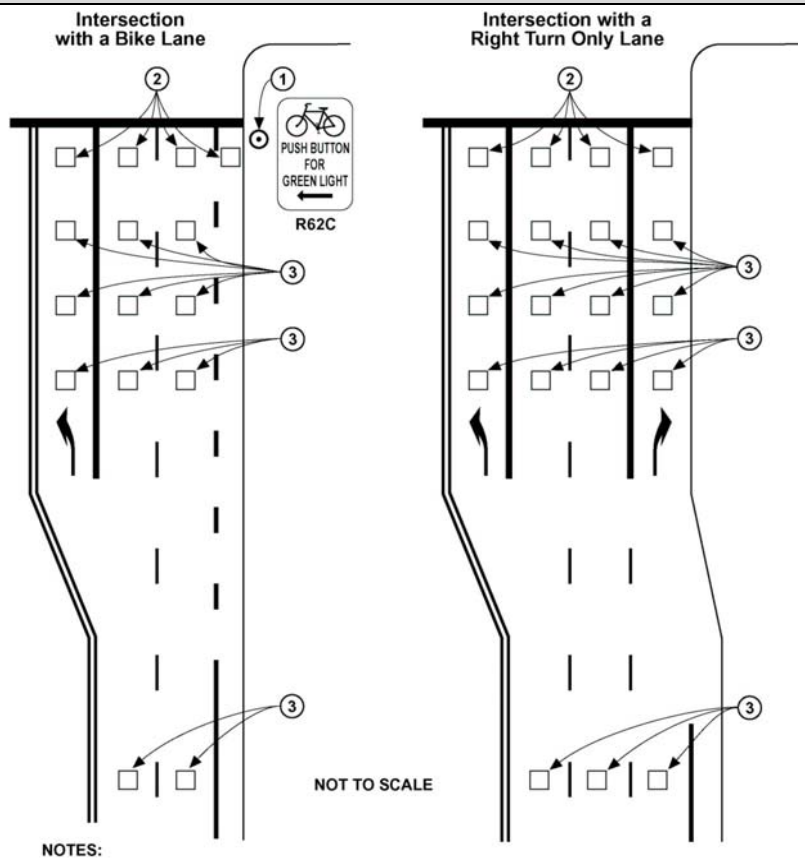
This study for SF DPT was accepted by the California Traffic Control Devices Committee (CTCDC), which has approved the shared lane marking as an optional marking for roadways in California.

SOURCE

Policy and Figure currently (June 2005) being drafted for *MUTCD 2003 California Supplement* (2004), Section 9C.103 & Figure 9C-107. Sacramento, CA.

SIGNALS: LOOP DETECTORS

GRAPHIC



NOTES:

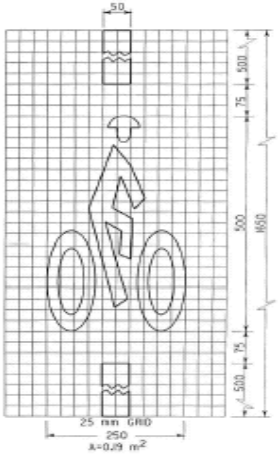
1. Bicycle Push Button and Sign (R62C) or a Type D Loop Detector may be used to activate a traffic signal. A push button should be located so it is convenient to use by bicyclists.
2. Typical Type D Loop Detector locations.
3. Typical Loop Detector locations. See Section 9-03.24.
4. See Standard Plan A24C for Bicycle Loop Detector pavement marking details.

DESCRIPTION

Loop detectors are devices placed at signalized intersections that detect bicycles and trigger actuated signals. The MUTCD 2003 California Supplement addresses bicycle detectors in Section 4D.105, calling for a Type D loop configuration shown on Standard Plan ES-5B. This is effective at detecting bicycles, but should not be located within sidewalks or crosswalks. A loop detector logo as shown on Standard Plan A24C (see below), located in the center of the Type D loop may be used to show bicyclists where to place their bicycles to trigger the signal. Figure 4D-111 in the California Supplement illustrates suggested bicycle detector locations and the Standard Plans for typical bike lane pavement markings. Loop detectors should be located on all new or rebuilt actuated traffic signals, and existing signals on designated bike routes should be a priority for retrofitting with loop detectors.

Loop detector logos, if used, would be appropriate for:

- left turn lane
- right-most through lane
- bike lane
- right turn only lane



BICYCLE LOOP DETECTOR SYMBOL

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Section 4D.105, Figures 4d-111 and 9C-105.
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

SIGNALS: BICYCLE SIGNALS

GRAPHIC

DESCRIPTION

A bicycle signal is an electrically powered traffic control device that may only be used in combination with an existing traffic signal. Bicycle signals shall direct bicyclists to take specific actions and may be used to address an identified safety or operational problem involving bicycles.

When bicycle traffic is controlled, only green, yellow and red lighted bicycle symbols, shall be used to implement bicycle movement at a signalized intersection. The application of bicycle signals shall be implemented only at locations that meet Department of Transportation Bicycle Signal Warrants. A separate signal phase for bicycle movement will be used. Alternative means of handling conflicts between bicycles and motor vehicles shall be considered first.

Bicycle Signal Warrant

A bicycle signal may be considered for use only when the volume and collision or volume and geometric warrants have been met:

1. *Volume*. When W = B x V and W > 50,000 and B > 50.

Where:

W is the volume warrant.
B is the number of bicycles at the peak hour entering the intersection.
V is the number of vehicles at the peak hour entering the intersection.
B and V shall use the same peak hour.

2. *Collision*. When 2 or more bicycle/vehicle collisions of types susceptible to correction by a bicycle signal have occurred over a 12-month period and the responsible public works official determines that a bicycle signal will reduce the number of collisions.

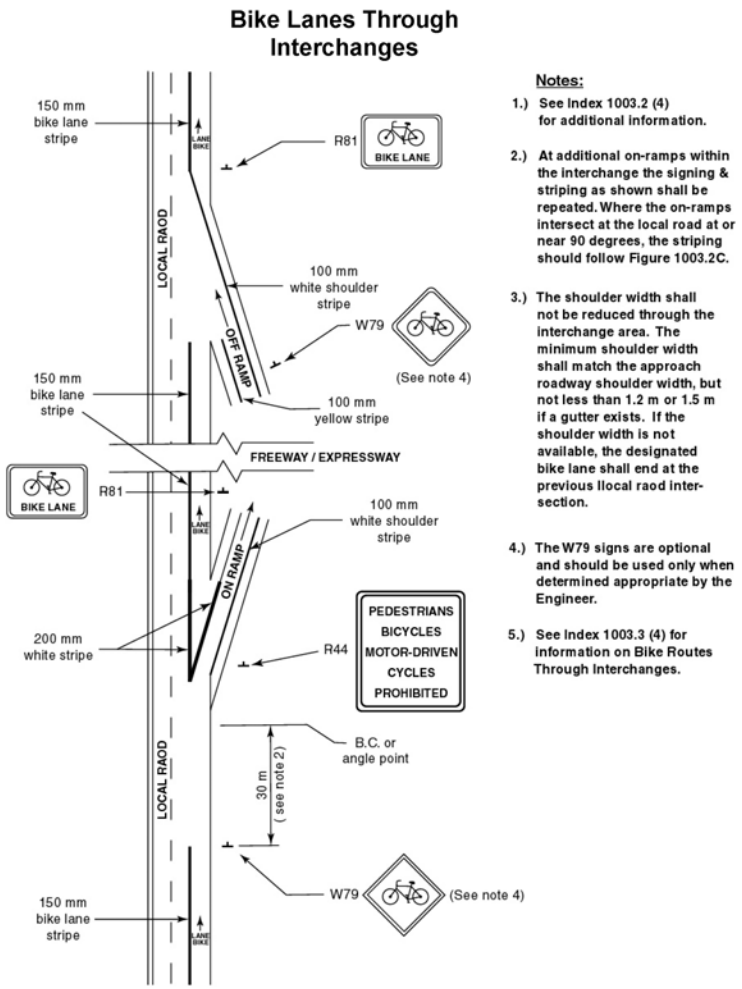
3. *Geometric*. (a) Where a separate bicycle/multi use path intersects a roadway. (b) At other locations to facilitate a bicycle movement that is not permitted for a motor vehicle.

SOURCE

MUTCD 2003 and MUTCD 2003 California Supplement (May 20, 2004), Sections 4C.103 & 4D.104
http://www/dot.ca.gov/hq/traffopps/signtech/mutcdsupp/

ROADWAY DESIGN: FREEWAY RAMPS

GRAPHIC



Notes:

1.) See Index 1003.2 (4) for additional information.

2.) At additional on-ramps within the interchange the signing & striping as shown shall be repeated. Where the on-ramps intersect at the local road at or near 90 degrees, the striping should follow Figure 1003.2C.

3.) The shoulder width shall not be reduced through the interchange area. The minimum shoulder width shall match the approach roadway shoulder width, but not less than 1.2 m or 1.5 m if a gutter exists. If the shoulder width is not available, the designated bike lane shall end at the previous llocal raod inter-section.

4.) The W79 signs are optional and should be used only when determined appropriate by the Engineer.

5.) See Index 1003.3 (4) for information on Bike Routes Through Interchanges.

DESCRIPTION

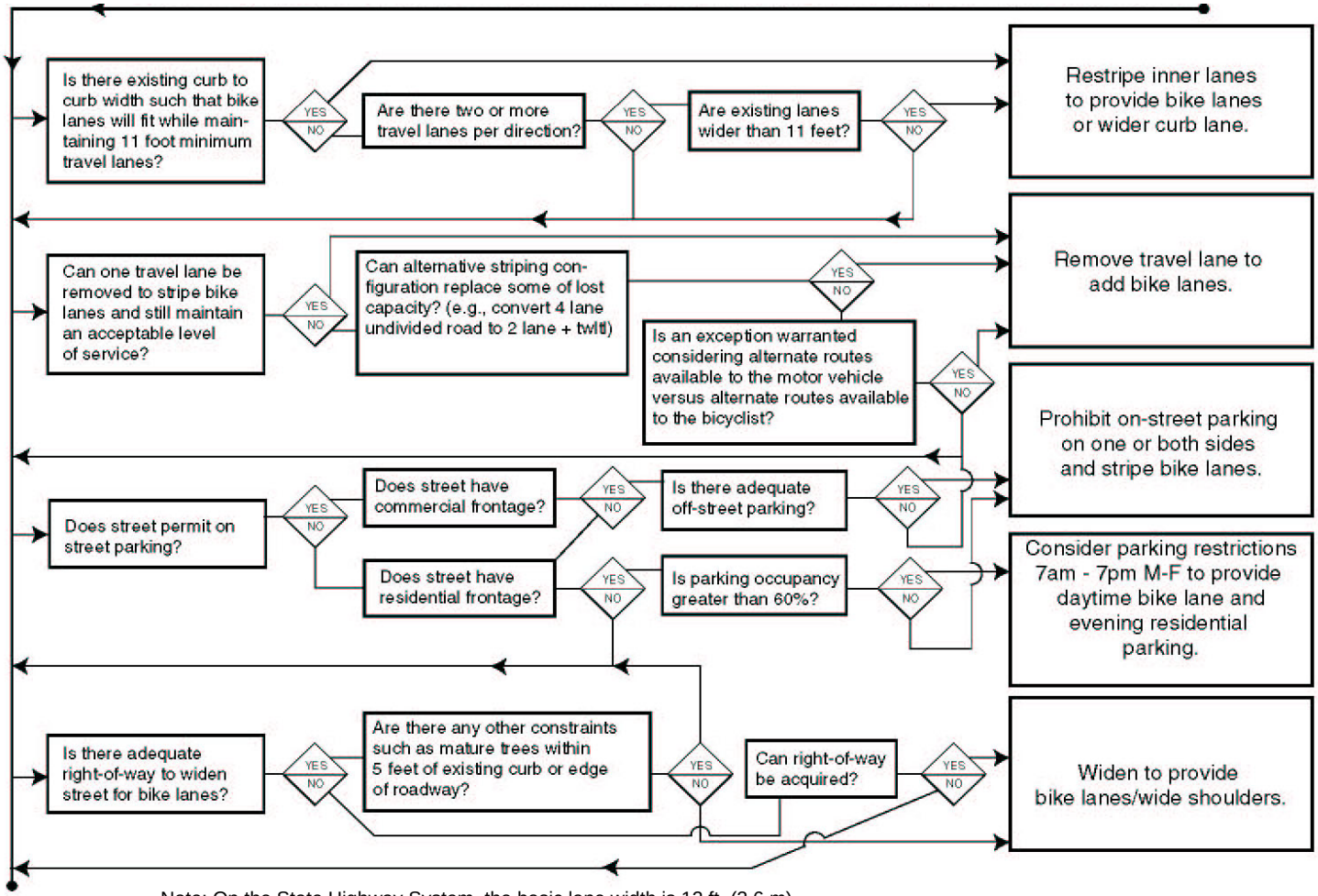
As with bikeway design through at-grade intersections, bikeway design through interchanges should be accomplished in a manner that will minimize confusion by motorists and bicyclists. Designers should work closely with the local agency in designing bicycle facilities through interchanges. Local Agencies should carefully select interchange locations which are most suitable for bikeway designations and where the crossing meets applicable design standards. The local agency may have special needs and desires for continuity through interchanges which should be considered in the design process.

SOURCE

California Department of Transportation (2002) Chapter 1000: Bikeway Planning and Design, Section 1003.2, *Highway Design Manual*, Sacramento, CA
www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm
Oregon Department of Transportation (1995) Section II. 1: On-Street Bikeways. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

ROADWAY DESIGN: RETROFITTING STREETS FOR BICYCLES

GRAPHIC



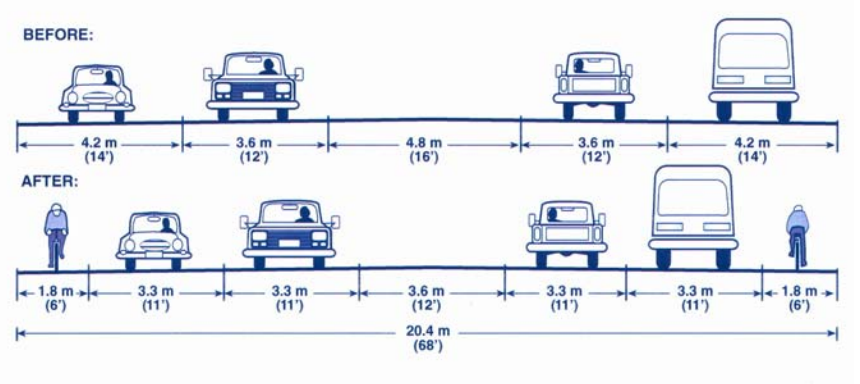
Note: On the State Highway System, the basic lane width is 12 ft. (3.6 m).

SOURCE

DeRobertis, Michelle (2004). San Francisco, CA.

ROADWAY DESIGN: REDUCE TRAVEL LANE WIDTHS

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

To accommodate bicyclists on busy roadways in urban areas, bike lanes generally serve bicyclists and motorists best. Many roadways in urban areas were originally built without bike lanes. These roadways often act as deterrents to bicycle travel and may cause conflicts between bicyclists and motorists.

The following motor vehicle travel lane and bicycle lane widths may be used when street width is limited. All reduced lane widths are within AASHTO minimums. It is important to remember that travel lanes on Caltrans facilities can be considered to be reduced to 3.3 m (11.0 ft) wide. Any travel width reduction below 3.6 m (12.0 ft) on a State Highway must receive approval by the Deisgn Coordinator.

The need for full-width travel lanes decreases with speed. There are some rules of thumb for lane reductions:

- 50 to 65 km/h (30 to 40 MPH): 3.3 m (11 ft) travel lanes and 3.6 m (12 ft) center turn lanes.
- 70 km/h (45 MPH) or greater: a 3.6 m (12 ft) outside travel lane and a 4.2 m (14 ft) center turn lane if there are high truck volumes.

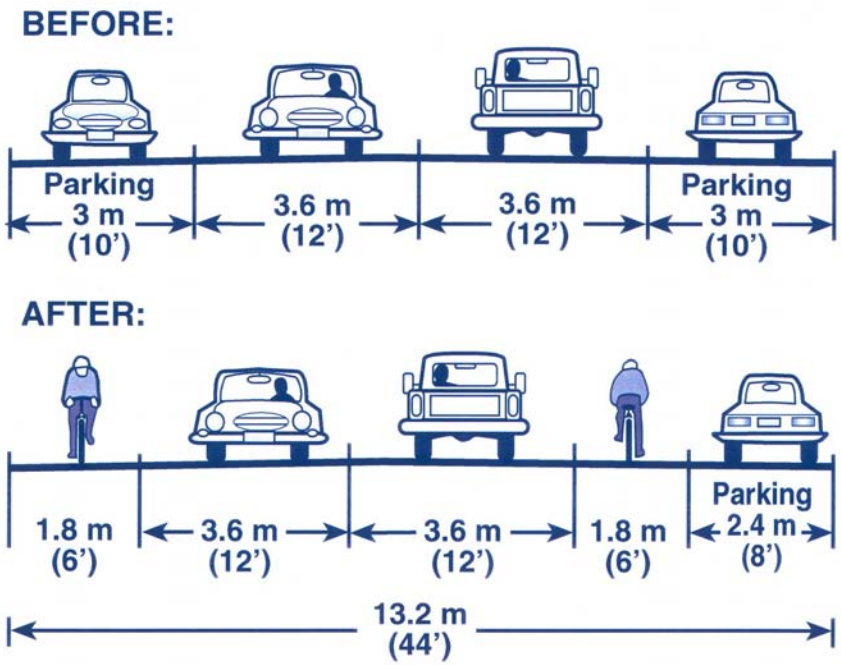
Note: Not all existing roadway conditions will be as simple to retrofit. In many instances unique and creative solutions will have to be found.

SOURCE

Oregon Department of Transportation (1995) Section II. 1: On-Road Bikeways. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.
Highway Design Manual, Index 1003.2
www.dot.ca.gov/hq/hdm/hdmtoc.htm

ROADWAY DESIGN: REMOVING PARKING

GRAPHIC



(Source: Oregon Department of Transportation)

DESCRIPTION

In some cases, parking may be needed on only one side to accommodate residences and/or businesses. *Note: It is not always necessary to retain parking on the same side of the road through an entire corridor.*

By removing one parking lane and narrowing the other to 2.4 m (8 ft), two 1.8 m (6 ft) bicycle lanes can be established.

Note: Not all existing roadway conditions will be as simple to retrofit. In many instances unique and creative solutions will have to be found.

SOURCE

Oregon Department of Transportation (1995) Section II. 2: Restriping Existing Roads with Bike Lanes. *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

ROADWAY DESIGN: REMOVING TRAVEL LANES

GRAPHIC

NE Glisan, Portland, OR before

NE Glisan, Portland, OR after

DESCRIPTION

Nationwide, transportation planners and engineers are looking at removing travel lanes. Removing travel lanes broadens transportation choices and encourages mobility and access for transit users, pedestrians, and bicyclists. Removing travel lanes also improves the livability and quality of life for residents and shoppers.

Removing travel lanes and creating a shared center turn lane can also help improve the roadway efficiency by shifting left turn movements from main through movements, which may also reduce crashes.

The best candidates for removing travel lanes should fit some of the following criteria:

- Moderate traffic volumes (8-15,000 ADT)
- Transit corridors
- Popular or essential bicycle routes / links
- Commercial reinvestment areas
- Economic enterprise zones
- Historic streets
- Scenic roads
- Entertainment districts
- Main streets

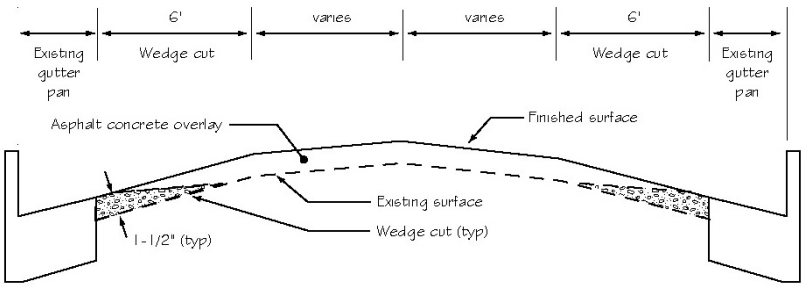
These criteria are just a general guide, as streets with much higher ADT's have been successfully converted. In Santa Monica, officials feel most comfortable working with streets less than 20,000 ADT, although they have converted streets with ADT's up to 25,000 vehicles. In California alone, more than twenty cities have made successful street conversions. This includes Santa Barbara, Palo Alto, Sacramento, and Sunnyvale, among others.

SOURCE

Walkable Communities (1999), "Road Diets: Fixing the Big Roads." .

ROADWAY RESURFACING

GRAPHIC



(Source: Santa Clara Valley Transportation Authority)

DESCRIPTION

To provide a safe riding surface for bicyclists after resurfacing a roadway, smooth longitudinal gutter joints should be ensured by grinding and/or milling prior to applying the overlay. This will maintain a smooth transition between the asphalt surface of the roadway and the gutter pan.

The depth of the milled wedge should be equal to the depth of the asphalt concrete overlay, typically 2" on arterial streets and 1-1/2" on local streets. The finished surface should match the level of the gutter to within ¼".

This is Caltrans standard practice, and is also standard practice in several California cities.

SOURCE

Santa Clara Valley Transportation Authority (1999) Bicycle Technical Guidelines *Section II: Maintenance Guidelines*. Santa Clara County, CA.

VII. APPENDICES

Benefits of Walking and Bicycling

Many California residents are interested in walking and bicycling as a means of transportation. As modes of travel, walking and bicycling are healthy, efficient, low cost, and available to nearly everyone. They help communities achieve the larger goals of developing and maintaining "livable communities;" making neighborhoods safer and friendlier; reducing transportation-related environmental impacts, mobile emissions, and noise; and preserving land for open space, agriculture, and wildlife habitat. Perhaps most importantly, they provide transportation system flexibility by giving people alternatives in congested conditions and by providing improved multimodal access, particularly in combination with transit systems. There is also growing interest in encouraging walking and bicycling as a means for improving public health. Increasingly, public health organizations are looking to urban and state transportation planners to create more walkable and bikeable communities to encourage healthier lifestyles in the United States.

Transportation System Flexibility

There are many benefits of realizing the full potential of integrating bicycle, pedestrian, and transit methods of travel. Transit enables the pedestrian or bicyclist to take longer trips. Adequate non-motorized facilities enlarge transit's catchment area. Transit enables the pedestrian or bicyclist to pass over or through topographical barriers. Good bicycling and walking facilities that complement a comprehensive transit system create a transportation synergy that can provide millions of people easy, quick, and inexpensive access to work, school, shopping, and other desirable destinations. After bike racks were installed on Caltrain, a 4% ridership increase was attributed to bicyclists (Ciccarelli, 1998). In 1999, Denver's Regional Transportation District (RTD) conducted a survey of bicyclists who utilized the bike racks on buses. Survey results showed that approximately 50% of the bike on bus trips were transit passengers that would not make the trip on transit if it were not for bike racks (Epperson, Kent. RTD Bike-n-Ride Survey. December 1999).

Health

Bicycling and walking are excellent ways to improve cardiovascular health and help prevent chronic diseases associated with excessive body weight. A 2001 National Health and Nutrition Examination Survey (NHANES) reported that 64% of Americans are either overweight (34%) or obese (30%), conditions associated with heart disease, certain types of cancer, type II diabetes, increased risk of stroke, arthritis, breathing problems, and psychological disorders such as depression. This trend has increased

dramatically over the past decade (Figure 2): in 1991, only four of 45 states participating in the survey had obesity rates of 15% to 19%. No states had rates in excess of 20%. In 2000, 49 states (all but Colorado) had obesity rates in excess of 15% and 22 of the 49 states had obesity rates of 20% or greater. California's rate of adult obesity increased from 10% in 1991 to 21% in 2001 (National Health and Nutrition Examination Survey, 2001). There is good news in the most recent data available (2002), as California's rate of adult obesity dropped from 21% to 19%.

The National Center for Disease Control (CDC) recommends *at least* 30 minutes of brisk activity five days per week to maintain cardiovascular fitness and control weight. Other organizations recommend *at least* one hour of physical activity per day. Currently, fewer than one third of adults meet the recommended amount of physical activity. In fact, 40% of American adults lead sedentary lifestyles, participating in no leisure time physical activity at all (Office of the Surgeon General, 2001).

Bicycling or walking to work, the store, or to visit friends are excellent ways to integrate exercise into one's daily activities. National studies show that many trips made by American households are within comfortable bicycling or walking distance. Almost half (49%) of all trips are shorter than three miles, 40% are shorter than two miles, and 28% are shorter than one mile.

Environment

Walking and bicycling are important to the health of all Californians, not just to those doing the walking or cycling. The California Air Resources Board estimates that statewide, bicycle travel spares the air from about seven tons of smog-forming gases and almost a ton of inhalable particles per day. People choosing to ride or walk rather than drive are typically replacing short automobile trips, which contribute disproportionately high amounts of pollutant emissions. Since bicycling and walking contribute no pollution, require no external energy source, and use land efficiently, they effectively move people from one place to another without adverse environmental impacts.

Bicycling and walking can also help alleviate congestion and stressed transportation systems. Nationally, the number of vehicle miles traveled (VMT), rates of car ownership, and trips have continued to grow, which has increasingly stressed transportation systems (primarily roadways) and contributed to congestion (NPTS, 2003). Bicycling and walking are more space efficient, requiring less space and infrastructure when compared to automobile facilities. For example, 10 to 12 bicycles can fit into a single automobile parking space.

Community

As noted urban theorist and author Jane Jacobs stated, "People love activity, not emptiness." Walking and bicycling allow people to get outside and interact with one another. There are more opportunities to speak to neighbors and more "eyes on the street" to discourage crime and violence. It is no accident that communities with low crime rates and high levels of walking and bicycling are generally attractive and friendly places to live.

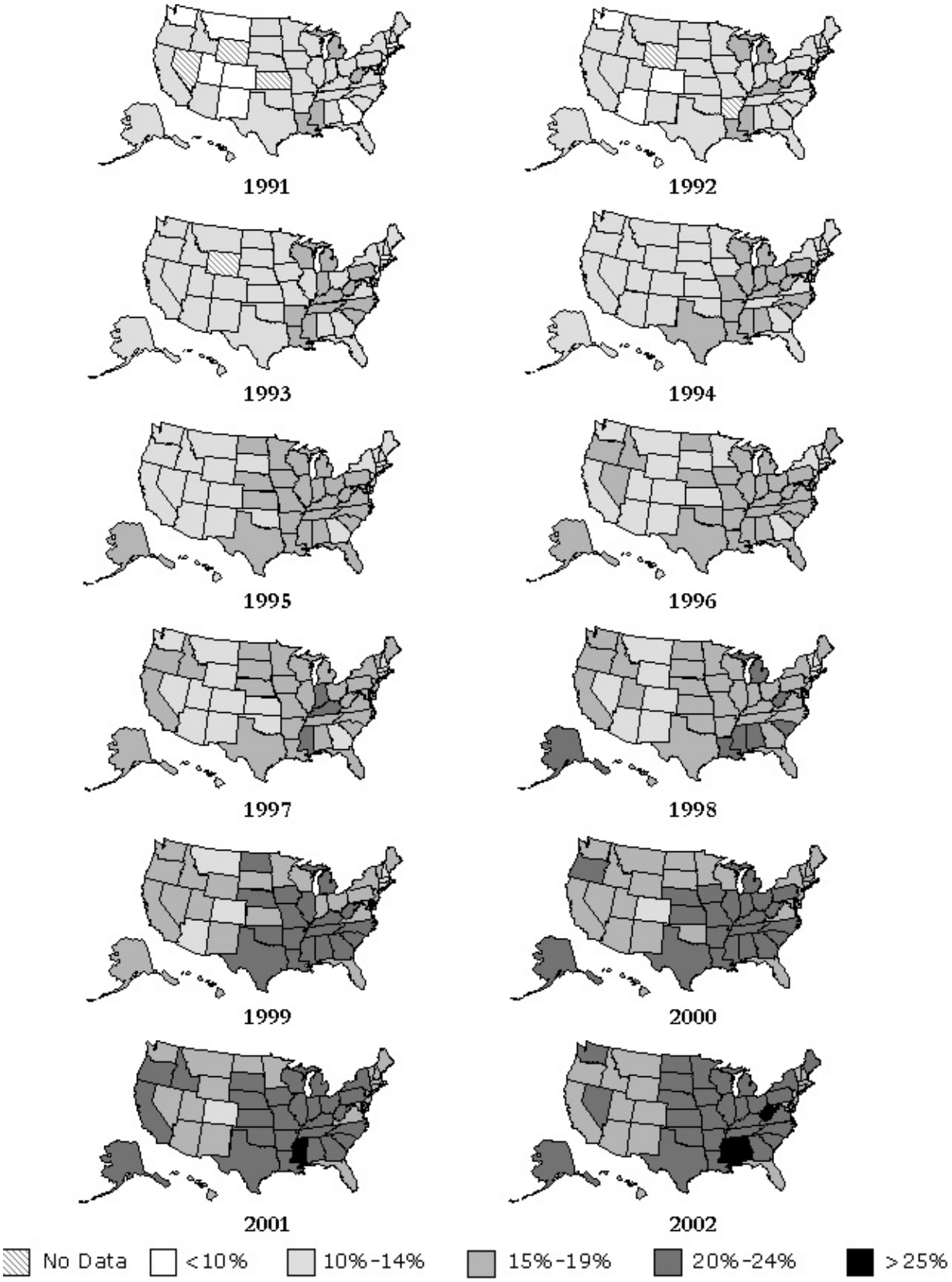


Figure 2. Percentage of U.S. adults considered obese by state 1990 – 2001

Source: Center for Disease Control (Mokdad A H, et al. J Am Med Assoc 1999; 282:16, 2001; 286:10)

Walking and bicycling are also choices good for families. A bicycle enables a young person to explore her neighborhood, visit places without being driven by her parents, and experience the freedom of personal decision-making. More trips by bicycle and on foot mean fewer trips by car. In turn, this means less traffic congestion around schools and in the community, and less time spent by parents driving kids around.

Approximately 3.5 million households - representing 7 million youngsters - spend an hour or less a week in some type of physical activity. A study conducted for the Boys & Girls Clubs of America and the Pennsylvania-based nonprofit group KidsPeace found 54% of respondents said they had little or no time, or wished they had more time, to spend in physical activities with their kids. Riding a bicycle or walking a child to school or around the neighborhood after dinner can give parents and kids one-on-one time to talk about the day and spend time with one another.

Economy

One study (McCann, 2000) found that households in automobile-dependent communities devote more than 20% of household expenditures to surface transportation (more than $8,500 annually), while those in communities with more accessible land use and more multi-modal transportation systems spend less than 17% (less than $5,500 annually), representing a savings of thousands of dollars a year.

Bicycling and walking are inexpensive means of travel, costing as little as $0.07 and $0.04 per mile respectively (in 1996 dollars) (Litman, 2003). For pedestrians, this would simply be the cost of an average pair of shoes (with an average lifespan of 2,500 miles). For bicycle users, this includes the costs of acquiring a bicycle and basic safety equipment, as well as the maintenance and repair costs. For automobiles, costs include fuel, repairs, routine maintenance, parking fees, tolls, insurance, and registration fees. For public transit, the cost is the fare for travel. While telework requires no travel, there are typical expenses involved with setting up an average home office. These costs have been divided by the average teleworker's actual commute distance (11 miles each way) to determine a per-mile cost of the office, furniture, equipment. The average cost of these expenses are annualized at about $500-$1500 per year. These costs are shown in Figure 3.

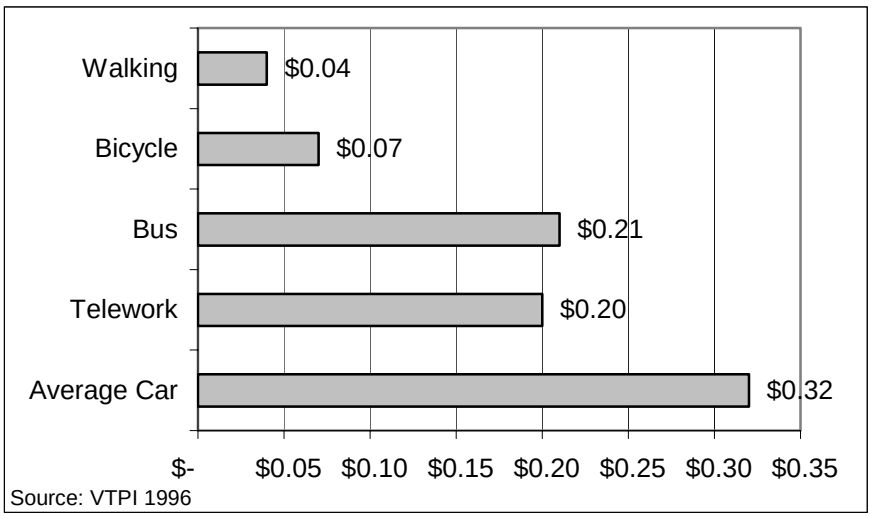
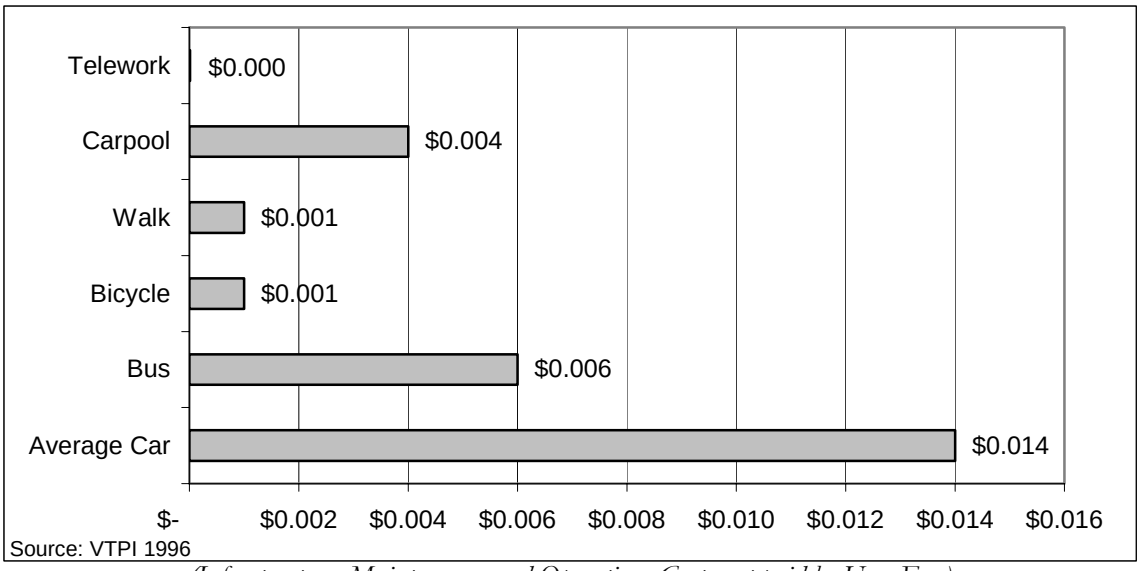


Figure 3. Private Costs per Passenger Mile

External public costs were determined by examining public expenditures on roadway facilities, including construction, maintenance and operating costs, as well as costs related to land acquisition and traffic services. Roadway costs include public expenditures to build and maintain roadway facilities, including land, road construction, maintenance, and operations. Roadway user fees such as gasoline taxes, registration fees, and tolls help pay for a portion of these public expenditures, but do not cover the full cost of roadway construction and maintenance. Based on a study of transportation agencies by the Victoria Transportation Policy Institute (VTPI), the following chart (Figure 4) summarizes the "unrecovered" costs incurred by various transportation modes.

In addition to bicycling and walking providing direct savings to the user, there are also numerous economic benefits for the community at large. A comprehensive trail system or a continuous sidewalk network may increase community livability and thus, property values, improve accessibility, support equity objectives, benefit the local economy (increasing employment, tax revenue and property values) (Litman, 2002).



(Infrastructure, Maintenance, and Operations Costs not paid by User Fees)

Figure 4. External Public Costs per Passenger per Mile

When working with economic data it is important to remember:

- They include non-market costs such as users' travel time, crash risk, and environmental impacts. This is why they are higher than cost estimates that consider only monetary costs.
- Estimates reflect average vehicles and conditions. Costs may vary significantly depending on circumstances (vehicle type, location and time).
- Some costs are estimated per *vehicle* mile, while others are estimated per *passenger* mile, assuming average vehicle occupancy.

Pedestrian and Bicycle Mobility and Safety Data

It is challenging to present an accurate picture of bicycling and walking trends at the state level. This is primarily due to the cost of collecting data and the lack of good data sources. To help close this gap, Caltrans is currently partnering with UC Berkeley's Institute for Transportation Studies on a research project entitled Estimating Pedestrian Accident Exposure. This project seeks to examine new technology and establish a methodology for counting and estimating pedestrian volumes.

A secondary data problem is the lack of uniformity in reporting pedestrian and bicyclist injury accidents. Because of the large number of unreported injury accidents, fatalities are usually used as the main non-motorized safety indicator. It would be useful to develop a methodology for counting or estimating non-motorized injuries to develop safety indices more directly comparable to those used for vehicular safety.

A third data insufficiency is in the area of resources expended. In the California Blueprint for Bicycling and Walking, the Legislature calls for "increased funding for bicycle and pedestrian programs." Although California has some excellent programs such as the groundbreaking 'Safe Routes to School' program (a $20 million effort funded through federal Hazard Elimination Safety Program funds), the Bicycle Transportation Account, and a portion of the TEA program, it has been suggested that the funding of bicycle and pedestrian facilities in California may be low compared to some other states. According to the Surface Transportation Policy Project's Mean Streets report (2003), California spent nearly $12.5 billion on federal surface transportation projects from 1998 to 2001, about 0.6% of which was spent on pedestrian and bicycle projects, averaging $0.52 per person on pedestrian and bicycle facilities. This percent is slightly below the national average state percentage (0.7%), perhaps due in part to inconsistent accounting practices among states. Unfortunately, much of California's spending on non-motorized facilities is often rolled into larger projects. Until these costs can be broken out separately, California's status and progress in this area will remain unclear.

Lack of good data is one of the largest problems confronting the field of pedestrian mobility and safety [see USDOT's Bicycle and Pedestrian Data: Sources, Needs & Gaps (2000)]. Without data, it is difficult to establish meaningful program performance measures or conduct trend analysis. Even such ostensibly simple issues as establishing which streets are the important corridors, or which intersections are more "dangerous" than others, or how much money was spent on bicycle and pedestrian facilities in a larger project, become difficult to resolve.

Mobility

The Legislature's California Blueprint calls for a major increase in pedestrian and bicyclist mobility, as measured by the number of modal trips. Currently, the most reliable data source for non-motorized mobility trend analysis is the U.S. Decennial Census. The U.S. Census has collected "Journey to Work" data that have included bicycling and walking since 1980. But the U.S. Census is very limited and does not account for the 73% of all trips that are not commute trips (National Household Travel Survey, 2001). Additionally, the U.S. Census only surveys people over the age of 16, eliminating most school-based trips, which are often done on foot or by bicycle.

It is a common misperception that California, known for its reliance on the automobile, has few pedestrians and bicyclists. In fact, California has the highest number of bicycle commuters in the

country, and the largest bicycle commute mode percentage of any large state. California has the second highest number of pedestrian commuters, after New York.

Unfortunately, bicycle use in California decreased from 130,700 bike commuters in 1990 (0.94% of the total commuter population), to 120,500 (0.83%) in 2000. Likewise, walking commute trips decreased from about 470,000 in 1990 (3.3% of all commuters), to 414,500 in 2000 (2.8%). The drop in percent is partly due to increases in the overall population of commuters. It is consistent with a national trend toward fewer non-motorized commute trips.

Trying to increase non-motorized traffic volumes is not just a matter of meeting Caltrans' goals for mobility and flexibility. There is also research supporting the surprising notion that, as the number of bicycling and walking trips increases, accident rates go down due to a "safety in numbers" effect (http://www.ecf.com/publications/Download/walking_and_cycling_2003.pdf).

Safety

A major goal of the State of California is to improve safety for pedestrians and bicyclists. The California Blueprint calls for a large reduction in the non-motorized crash rates. At this point, about 19% of California's traffic fatalities are pedestrians, and another 3% are bicyclists. This compares with national averages of 11% ped fatalities and 2% bike fatalities. In part, California's high non-motorized fatality percentages are due to California's excellent vehicular safety record, since our vehicular fatality rate is low compared to other states. But regardless of how the accident rates are calculated, California's performance in pedestrian and bicycle safety is not yet up to the excellent standards we have established: seeking to achieve the best safety record in the nation.

The National Highway Traffic Safety Administration (NHTSA) provides national accident data, the CHP provides statewide data, and Caltrans provides geo-coded data for the State Highway System. These are excellent sources, but without comparable bicycle and pedestrian exposure data, injury or fatality trends may be misleading because the level of bicycling and walking activity is not fully known. For instance, pedestrian fatalities could be decreasing as a result of fewer people walking. One method that is currently used to gauge injury and fatality rates is to compare the number of injuries and deaths to the population (as shown in Table 2). This approach may provide insight into the level of safety with the understanding that population is only a very rough index of pedestrian incident exposure.

Table 2 shows both the bicyclist and pedestrian casualty rates of California and a few other states in 2001. Figure 5 shows the injury rates of bicyclists in the past five years.

Table 2. Comparison of Statewide Bicycle and Pedestrian Deaths, 2001

State	Total Traffic Deaths	Resident Population (thousands)	Bicyclist Deaths	Bicyclist Deaths per Million Population	Ped. Deaths	Ped. Deaths per Million Population
California	3,956	34,501	105	3.04	711	20.7
Oregon	488	3,473	15	4.32	58	16.6
Minnesota	568	4,972	7	1.41	43	8.7
Florida	3,011	16,397	127	7.75	489	29.8
Texas	3,724	21,325	46	2.16	449	21.1
US Total	42,116	284,797	728	2.56	4882	17.1

Sources of Data: National Highway Traffic Safety Administration; US Census 2001
Note: Deaths per population rates may not reflect overall bicycle ridership. Therefore, some states with higher fatality rates per population may actually have lower rates of fatalities based on the number of cyclists or bicycle-miles ridden.

BICYCLE COLLISION TRENDS

In 2001, 728 bicyclists were killed and about 45,000 bicyclists were injured on U.S. roadways. This represents 2% of all traffic-related deaths, and 1% of all traffic-related injuries in the United States (NCSA, 2002). The number of fatalities in 2001 was actually 14% lower than the number of fatalities in 1991. Over the past 10 years, bicyclists' injury and fatality rates have been decreasing, while vehicle miles traveled have been increasing.

Collision Types

Contrary to popular belief, most bicycling crashes do not involve collisions with motor vehicles. They usually involve falls or collisions with stationary objects, other cyclists and pedestrians. Also, most crashes are due to bicyclists or motorists disobeying the rules of the road. In a review of bicycle-motorist crash causes, the fault lies equally with motorists and bicyclists. Most collisions occur where two roadways or a roadway and a driveway intersect, and one user fails to yield the right of way to the other. Child errors account for more than 90% of all child bicycle crashes. In contrast, 60% of adult bicycle collisions are the result of motorist, not bicyclist, error. The most common is a left turn across the path of an oncoming bicycle. A frequent and unexpected error among both adult and child bicyclists is riding the wrong way in traffic. Wrong-way bicycle riding is involved in 1/3 of all bicycle-motor vehicle collisions.

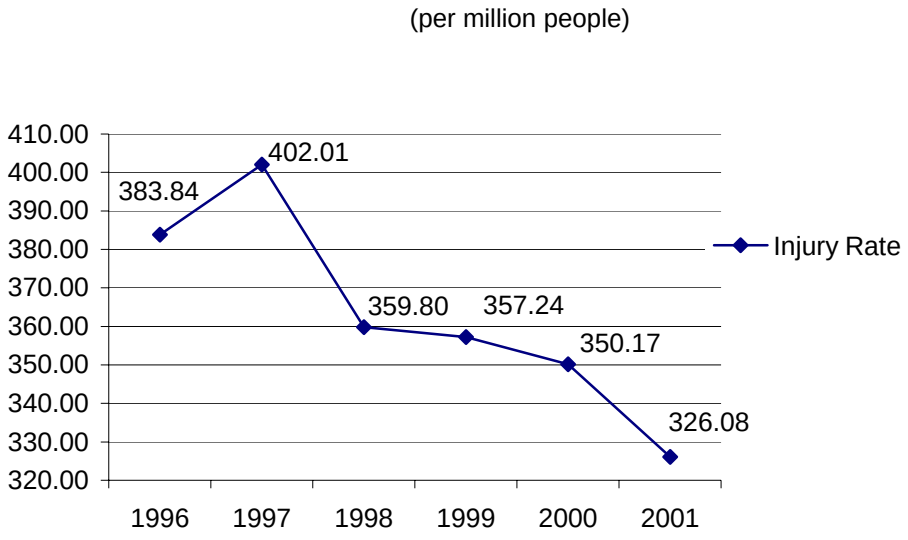


Figure 5. Bicycle Crash Rate in California, 1996-2000

Nationwide, 64% of bicycle fatalities occur in urban areas and 20% of those killed on bicycles are between the ages of 5 to 15. Nationwide, males are 3-4 times more likely to be killed in bicycle collisions than females.

In their 1994 study, Wachtel and Lewiston analyzed the causes of 371 reported bicycle collisions in Palo Alto, California from 1985 to 1989. They determined that collisions at intersections accounted for 64% of the reported crashes. Overtaking collisions, where the bicyclist is struck from behind, accounted for about 1% of the collisions. The authors determined that the greatest factor that contributed to collisions were position on the road and direction of travel. On average, bicyclists traveling against the flow of traffic are at 3.6 times the risk as those biking with traffic. This is probably due to the fact that motorists who are entering a roadway are not expecting cyclists traveling the "wrong way." Likewise, the authors found that cyclists riding on the sidewalk incur a risk about 1.8 times greater than bicyclists riding on the street. Wrong-way sidewalk riding is even more dangerous, with 4.5 times the risk of right-way sidewalk riders. Sidewalk riders are typically at a greater risk, because drivers often do not expect them, or even see them, as they enter roadways or intersections.

PEDESTRIAN COLLISION TRENDS

Nationwide, the numbers of pedestrian fatalities and injuries rates have been decreasing. While this would represent a decrease in the rate based on the total population, it does not accurately reflect the state of pedestrian safety, as the actual amount of pedestrian activity is not known. A more accurate pedestrian injury or fatality rate would be based on the level of "exposure" of pedestrians (i.e., number of miles walked). Since the number of pedestrian commuters has been decreasing, we may presume that the numbers of pedestrian injuries and fatalities are decreasing only because fewer people are walking. Figure 6 shows the injury rate of pedestrians (based on population) from 1996-2000.

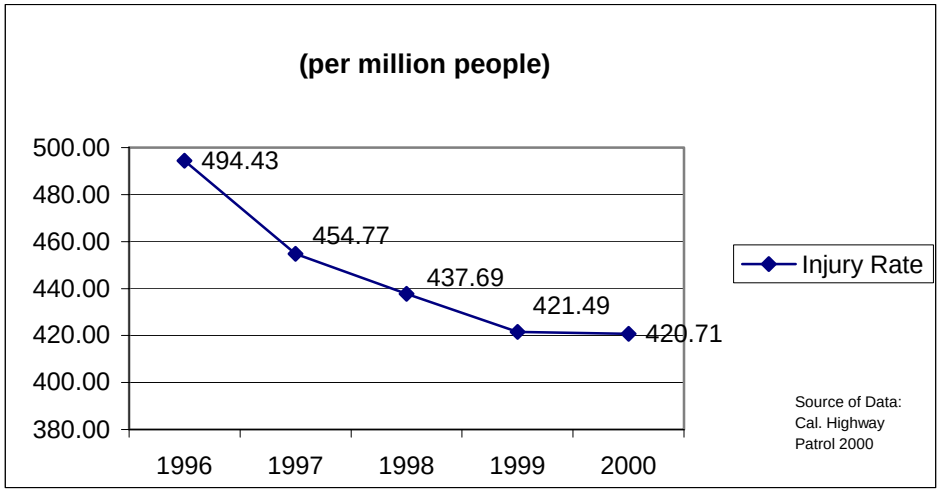


Figure 6. Pedestrian Crash Rate in California, 1996-2000

In 2002, the Surface Transportation Policy Project and the advocacy group California Walks attempted to rank California cities and counties (over 100,000 residents) in terms of pedestrian safety based on the pedestrian injuries, fatalities and a pedestrian "exposure" index. According to the report, the most "dangerous" counties were Solano, Sacramento, and Los Angeles, while the least dangerous were San Diego, Shasta, and Fresno.

A number of factors are likely contributing to pedestrian danger. Development patterns that favor automobile travel may put pedestrians at greater risk. Demographic changes may also be a factor. California's populations of children and seniors have increased in recent years, and both groups rely disproportionately on walking as a means of transportation. Another important factor may be the arrival of immigrants who are not accustomed to walking on and across American streets

Collision Types

In the 1990s, the National Highway Traffic Safety Administration (NHTSA) analyzed 5000 pedestrian collisions from five states (including California). They determined the leading causes and characteristics of vehicle-pedestrian collisions. Based on their study, 32% of all collisions occurred within 15.2 m (50 ft) of an intersection. 30% of these collisions involved a driver turning into the pedestrian, and 22% involved a pedestrian "darting" out in front of a vehicle. About 26% of pedestrian collisions occurred at mid-block locations. Finally, about 7% of pedestrian collisions involved a pedestrian walking along a roadway (not on the sidewalk) and being struck by cars traveling on the same roadway. Seventy-two percent of these collisions involved pedestrians being struck from behind.

Also, according to NHTSA and the California Highway Patrol:

- More than two-thirds of all pedestrian collisions occur in urban areas, and in many urban areas, pedestrian collisions account for 30% or more of all traffic fatalities. As shown in Figure 9, Sacramento, Los Angeles, Orange, and San Diego counties all had lower pedestrian fatality rates in 2000 (CHP, 2000) than the "average" of 30% or greater. In San Francisco county, however, more than 67% of all fatalities are pedestrians.

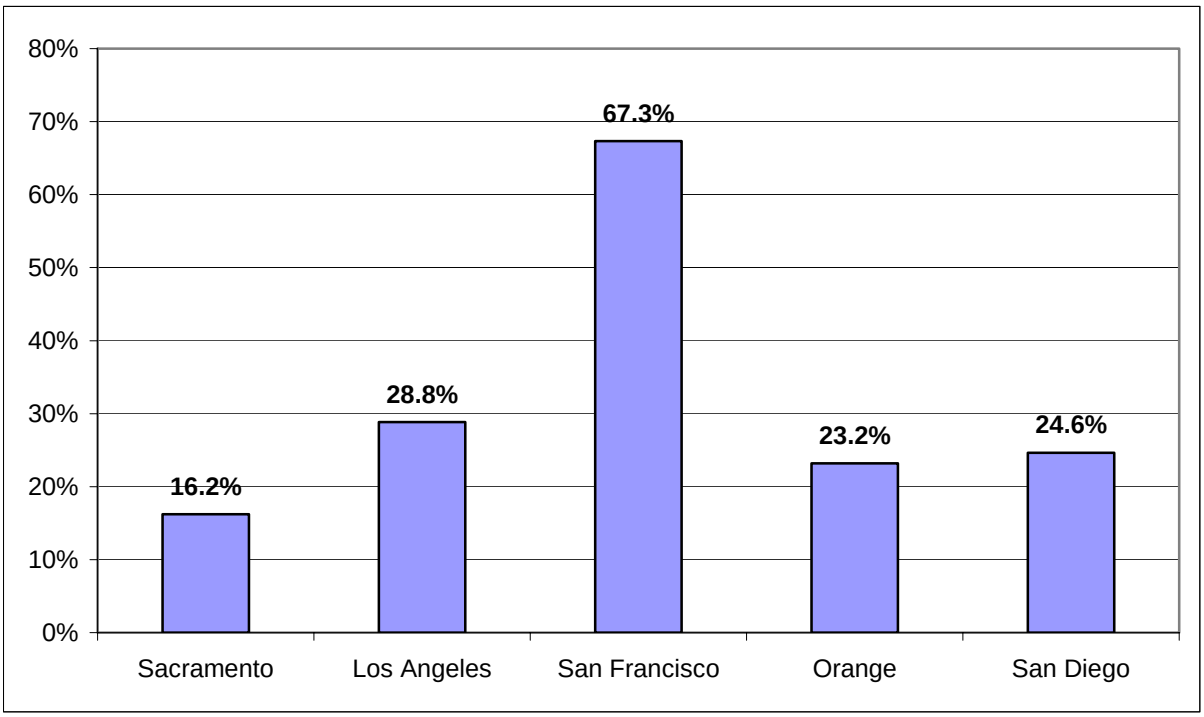


Figure 7. Pedestrian Percentage of Traffic Fatalities by Select County, 2000

- Almost half of fatal collisions involving pedestrians occur between the hours of 6pm and midnight.
- Approximately 40% of pedestrian fatalities occur in just four states: California, Florida, New York and Texas. While these are among the most populous states, the figure is still high - the same states account for 28 % of all traffic fatalities.

Based on NHTSA's research, the FHWA partnered with NHTSA to produce Pedestrian and Bicycle Crash Analysis Tool (PBCAT), a no-cost computer program designed to help local and state bicycle and pedestrian coordinators analyze trends and identify problem areas.

State	Average Annual Pedestrian Deaths (2000-2001)	Average Annual Pedestrian Deaths per 100,000 Capita (2000-2001)	Portion of All Traffic Deaths that were Pedestrians (2000-2001)	Percent of All Federal Transportation Funds Spent on Bicycle/ Pedestrian Projects (FY1998-FY2001)
Alabama	66	1.47	7%	0.9%
Alaska	9	1.35	9%	2.7%
Arizona	150	2.86	15%	0.7%
Arkansas	40	1.47	6%	1.6%
California	711	2.08	19%	0.6%
Colorado	71	1.62	10%	1.0%
Connecticut	42	1.21	13%	0.8%
Delaware	20	2.47	15%	2.0%
Florida	497	3.06	17%	1.2%
Georgia	144	1.73	9%	1.2%
Hawaii	31	2.50	23%	1.2%
Idaho	9	0.69	3%	0.9%
Illinois	189	1.51	13%	1.0%
Indiana	57	0.93	6%	1.2%
Iowa	23	0.77	5%	0.9%
Kansas	22	0.80	5%	0.7%
Kentucky	54	1.33	7%	1.1%
Louisiana	100	2.24	11%	1.0%
Maine	15	1.13	8%	0.7%
Maryland	97	1.81	16%	0.5%
Massachusetts	81	1.27	18%	1.8%
Michigan	169	1.69	13%	1.0%
Minnesota	44	0.88	7%	1.7%
Mississippi	62	2.16	7%	0.6%
Missouri	86	1.52	8%	1.1%
Montana	11	1.16	5%	1.2%
Nebraska	17	0.96	6%	1.9%
Nevada	46	2.23	15%	0.7%
New Hampshire	9	0.68	6%	1.6%
New Jersey	140	1.66	19%	0.3%
New Mexico	60	3.29	14%	0.9%
New York	344	1.81	23%	0.5%
North Carolina	155	1.90	10%	0.7%
North Dakota	4	0.63	4%	0.8%
Ohio	99	0.87	7%	0.9%
Oklahoma	47	1.36	7%	1.1%
Oregon	56	1.61	12%	1.1%
Pennsylvania	182	1.48	12%	0.3%
Rhode Island	8	0.76	10%	0.8%
South Carolina	95	2.35	9%	0.2%
South Dakota	15	1.92	9%	0.3%
Tennessee	90	1.57	7%	0.7%
Texas	437	2.07	12%	0.3%
Utah	33	1.46	10%	0.8%
Vermont	6	0.98	7%	2.2%
Virginia	97	1.36	11%	0.4%
Washington	72	1.20	11%	1.0%
West Virginia	28	1.52	7%	0.0%
Wisconsin	49	0.90	6%	1.1%
Wyoming	9	1.72	5%	0.8%
Nationwide	**4885**	**1.73**	**12%**	**0.7%**

Figure 8. Pedestrian Fatalities and Spending on Walking and Bicycling by State

Source: Surface Transportation Policy Project, Mean Streets, 2003.
** See Table 2 on page VII-9 for a comparison of bicycle fatalities.*

Pedestrian Characteristics in California survey (DHS)

Although pedestrian travel includes several types of activities, walking is by far the most common. A recent study by the Department of Health Services (Pedestrian Characteristics in California, 2003) found that 73% of people walked for exercise and about 61% of people walked to run errands. The most popular place for pedestrians to walk was on a neighborhood sidewalk (88.3%).

More than half of the respondents (56%) cited that they did not engage in more pedestrian activities due to lack of time. Having a safe place to walk is also a concern for California residents. Sixty percent or more of the respondents considered the following issues when deciding where to walk: sidewalks (76.2%), signs or signals (72.9%), speed of traffic (68.9%), amount of traffic (66.4%), buttons at crosswalks (64.2%), slow signs (63.1%), and painted crosswalks (60.5%). About a quarter of the respondents did not participate in more pedestrian activities due to fast traffic, too many cars, and the lack of safe roadway crossings.

Figure 5 below shows on average how many minutes per week Californians walk by Caltrans district. The statewide average, about 2.5 hours per week of walking, translates to about 30 minutes of activity for 5 days of the week. District 9 (Mono/Inyo) reported the highest average, about 3.2 hours of walking each week. District 8 (San Bernardino/Riverside) reported the lowest average, about 1.8 hours of walking each week.

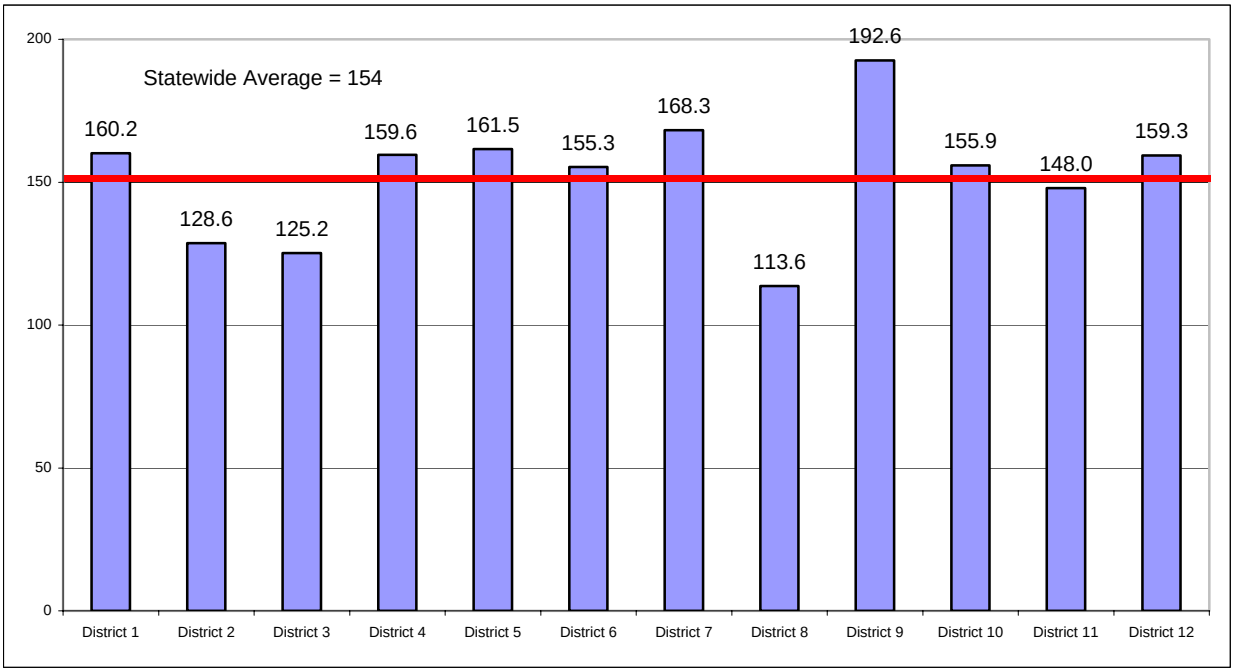
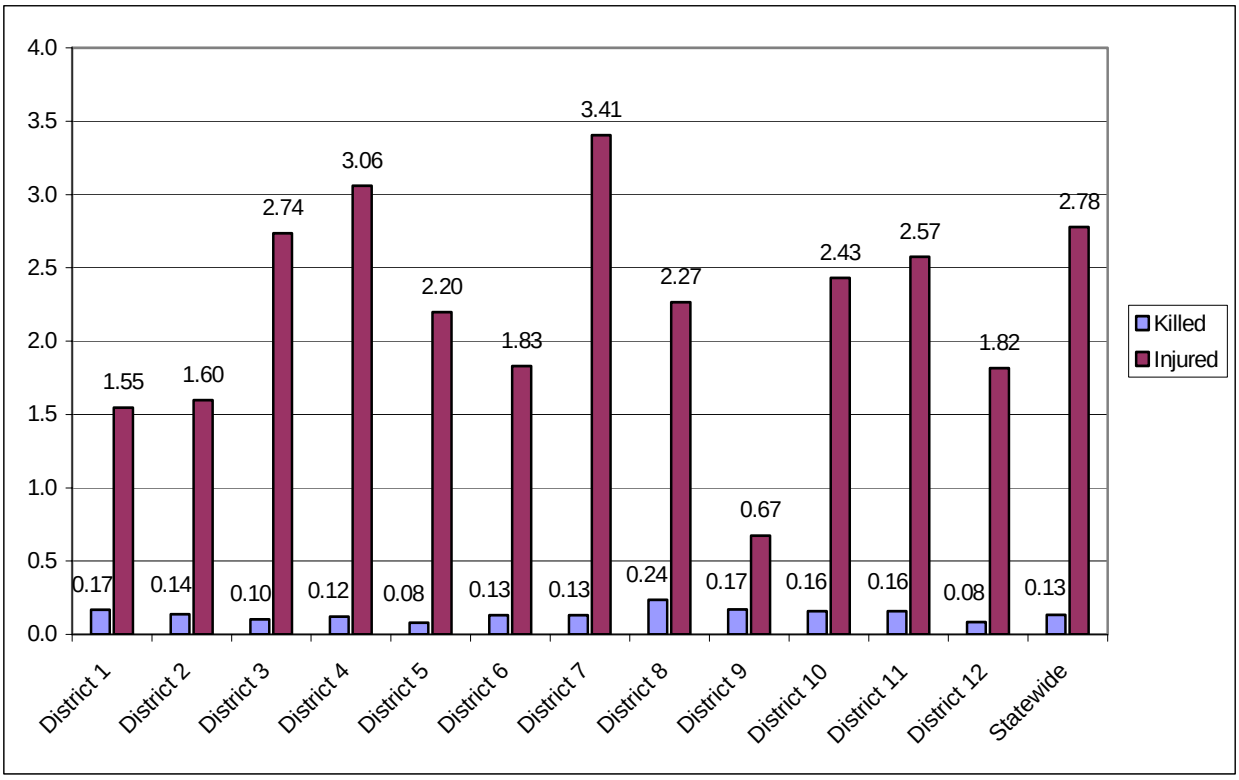


Figure 9. Average Minutes Walking Each Week by Caltrans District

It is possible to combine the DHS mobility data, used as an index of pedestrian accident exposure, with accident statistics to arrive at an accident rate analogous to vehicular crashes normalized by vehicle miles traveled. This method shows that for every million person-minutes of walking in the State per week,

approximately 3 pedestrians are injured and 0.1 pedestrians are killed. The data vary in each District, as shown in Figure 6. Areas with the highest injury rates are District 7 (Los Angeles area) with 3.4 pedestrian injuries per million person minutes per week and District 4 (Bay Area) with 3 pedestrian injuries per million person minutes per week. These districts also have the highest populations and two of the highest average time of walking per week.

Interestingly, District 8 (San Bernardino/Riverside), which has the lowest average time walking also has the highest fatality rate (.235). Fatality rates are often given preference as a measure of pedestrian safety because pedestrian injuries often do not result in police reports, and therefore are not accurately reflected in available statistics.



Rate Calculations: Pedestrians Killed and Injured per Million Person-Minutes Walking Each Week

Pedestrian Fatality and Injury Collision rate = Number of Pedestrians Fatality and Injury Collisions x 1,000,000/(Average weekly minutes walking * Population)
Pedestrians Killed and Injured rate = Number of Pedestrians killed and Injured x 1,000,000/(Average weekly minutes walking * Population)
Pedestrians Killed rate = Number of Pedestrians killed x 1,000,000/(Average weekly minutes walking * Population)
Pedestrians Injured rate = Number of Pedestrians Injured x 1,000,000/(Average weekly minutes walking * Population)

Figure 10. Pedestrian Crash Rates by Caltrans District

Safe Access to Transit

The benefits of pedestrian-transit or bicyclist-transit travel in comparison with automobile travel are readily recognized: lower air pollutant emissions, reduced highway congestion, lower capital costs for park & ride facilities, reduction in the reliance on foreign oil, improved neighborhoods, and increased mobility.

The California Department of Transportation's mission is to improve mobility across California, as mobility is critical to the well-being of all Californians. To live full and active lives, and avoid isolation, people must be able to access friends, relatives, jobs, health care, shopping, and social and recreational opportunities. Many in our society do not drive, or prefer not to drive for environmental, convenience, health or financial reasons. Seniors, disabled individuals, youth, and low-income groups are particularly limited in their mobility choices. Some are dependent on walking, transit or bicycles to get around. In addition to the other benefits discussed in this Guide of making neighborhoods more walkable and friendly to cyclists, another critical need for better sidewalks, bike lanes and paths, and other pedestrian and bicyclist oriented facilities is for safe access to transit services.

One of the ways the Department improves mobility is by making transit a more practical travel option, to promote an alternative choice to automobile use. A key component to the success of this effort is making transit facilities more accessible. Transit trips tend to have a greater pedestrian component than automobile trips. But often there are design problems preventing people from being able to safely and conveniently access the transit facilities.

Design Issues

Bicycle and pedestrian facilities should be designed with transit access and use in mind. Some sidewalks end a half-block or more from a bus or train station, requiring individuals to have to walk in the street. Some crosswalks are a half-block or more away from the transit station or stop – resulting in pedestrians crossing busy streets at unmarked unsafe places. Or there are no safe bike routes to use to get to transit, and some transit stations do not have adequate bike racks, lockers, or other secure storage facilities. Such design problems result in accidents and injuries involving conflicts with automobile traffic, and potential transit riders choosing to not use transit.

Pedestrian Facilities

Safe, comfortable and convenient sidewalks leading to transit, with a minimum number of street and intersection crossings, are key to reinforcing a pedestrian environment that supports efficient transit systems. Desirable pedestrian-friendly design features to improve pedestrian access to transit include:

- Continuous sidewalk systems should be placed within the transit station areas.
- Sidewalks with curb cuts at intersections to allow for wheelchair access.
- Pedestrian routes to stations located along or visible from all streets providing clear, comfortable, safe, and direct connections between core commercial areas and transit stations and stops.
- Short pedestrian paths that provide walking connections to stations when street connections are not feasible.

- Weather protection and benches at all transit stations, and at most transit stops. Shelters a minimum of 6 feet wide.
- Signalized, well-designed pedestrian crossings at all road intersections in the station areas.
- Bulb-outs and median strips used to shorten or break up crossing distances near stations, and mid-block crossings established where intersections are far apart.
- Safe and direct access routes to transit from park & ride lots and bicycle parking facilities.
- Bus stops connected with adjacent pedestrian destinations, including building entrances, street crossings, other walkways, and with the nearest intersection.
- Landscaping, berms or fences that do not impede pedestrian access or visibility.
- Buffers between pedestrians and moving traffic which do not obstruct transit boardings and deboardings. Sidewalk widths and buffer widths based on traffic volumes.
- Bus stops placed at the far side of intersections when possible to encourage pedestrians to cross the street behind the bus. Placing the stop on the near side results in the bus blocking the pedestrian's view of oncoming traffic, and the approaching driver's view of pedestrians.
- Bus stops that are fully accessible to wheelchair users. Sidewalks connected to the bus stop pad, with adequate room allowed for the operation of the buses' wheelchair lifts or ramps.

Bicycle Facilities

There are many benefits of realizing the full potential of integrating bicycle and transit methods of travel. Transit enables the bicyclist to take longer trips, bicycle access enlarges transit's catchment area, transit enables the bicyclist to pass over or through topographical barriers, and bicyclists can increase transit ridership during surplus capacity periods such as weekends, midday, and holidays.

Many bicyclists would choose to use transit to complete their longer trips if they had better access to stations and there was a secure place for their bike. Key concerns are lack of safe paths of travel to the stations, the potential for the theft or vandalism of their bicycle and accessories at the stations, and other design issues. Desirable bike-friendly design features to improve bicycle access to transit include:

- Clearly visible signage using the bicycle symbol for bicycle routes, parking facilities, and bus stops serving bicyclists
- Bicycle-compatible roadways or bicycle lanes on station access roads
- Bicycle routes through park & ride lots
- Priority siting of bike parking equipment near the bus/train loading zone
- Bicycle paths from neighboring communities that are shorter in length than roadways
- Station design and siting accommodations to bicycles, such as curb cuts at parking locations, locating parking equipment so that the cyclists not be required to carry bicycles up or down stairs or through large crowds of travelers, and parking equipment in the clear view of the general public, or station attendants
- Adequate lighting

- Overhead protection from weather conditions at bike parking sites
- Establishment of bikestations and other advanced secure bicycle storage facilities at more transit stations and park & ride lots
- Bicycle paths alongside active rail lines

Bike lockers and racks can provide the necessary security, if it is the right type of equipment for the location, installed properly and monitored. Attended bike stations at transit stations and park & ride lots are even better facilities for ensuring bike security. Bike stations are short-term storage facilities with an attendant checking in the bikes and issuing a claim check, similar to a dry cleaners taking in cleaning. There are already a half-dozen such facilities in the State that have proven to be effective in ensuring bike security.

Estimating Auto Trip Reduction by Non-Motorized Facilites

Caltrans/Air Resources Board December 1995

The average daily bike traffic for a project can be used to represent the number of vehicle trips replaced. If no local estimates are available, use the following optional methodology given to estimate the daily bike traffic.

If you do not know the average daily bicycle traffic and your city has a relatively high ratio of bike lanes to roads, you may choose to use this method to get a rough estimate for the percentage of total citywide person trips taken by bicycle. The share of bicycle trips increases as the ratio of bike lane miles to arterial and freeway lane miles gets larger.

Step 1: Determine the future city miles of bike lanes (or trails) anticipated in a completed bike system as defined in the transportation improvement plan or local bike plan.

Step 2: Determine the city miles of arterials and freeways that will exist when the bicycle system is completed.

Step 3: Calculate the ratio of bicycle lane miles to arterial/freeway miles. This ratio corresponds to the percentage of total person trips taken by bicycle. If the ratio is less than 0.35, use 0.6% as the bicycle mode share of total trips. If the ratio is greater than 0.35, use 2% for non-university towns and 6.8% for university towns. (Source: This approach is based on Implementing Effective Travel Demand Management Measures, September 1993, prepared by COMSIS Corp. for FHWA and the FTA. There is a dramatic increase in ridership for cities with ratios greater than 0.35.)

Step 4: Divide the bicycle trips percentage (from Step 3) by length of bicycle system (Step 1) to get the percentage per bike lane mile.

Step 5: Determine the number of total citywide daily person trips and length (miles) of the project.

Step 6: Multiply the percentage of regional bicycle trips per bike lane mile (from Step 4) by the length of the particular bicycle project. Then multiply this result by total citywide person trips (from Step 5) to get average daily bicycle trips for the project.

Assessing State DOT Performance

The National Center for Bicycling and Walking conducted a survey in February 2003 of all state DOT bicycle and pedestrian coordinators/representatives to gauge the progress of bicycle and pedestrian planning and facility development since the establishment of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Four benchmarks were established with indicator criteria for each.

Benchmark 1: Does the state DOT have a long-range bicycle and pedestrian plan element? If so, does the plan element conform to the guidance issued by the FHWA?

> 1(a): Does the DOT have a plan as a document entitled bicycle plan, bicycle and pedestrian plan, or similar; or, a chapter or section on bicycle and walking in the statewide long-range transportation plan, if the chapter or section has the same format and scope as the chapters on other modes?
>
> 1(b): Did the plan contain measurable objectives by which to evaluate whether the goals of the plan are being met or not?

Benchmark 2: Does the state DOT routinely include accommodations for bicycles in all state highway projects?

Benchmark 3: Does the state DOT include sidewalks in all state highway projects in urban areas?

> 3(a): Are sidewalks included in all new state highway projects in urban areas (except where pedestrians are prohibited)?
>
> 3(b): Are sidewalks included in most state highway <u>reconstruction</u> projects in urban areas?
>
> 3(c): Are sidewalks <u>generally</u> included in state highway projects in urban areas?

Benchmark 4: Does the state have any special programs (i.e., Safe Routes to School, training programs, building trails, improving connections to transit, creating statewide bike routes, creating maps, etc.)?

Table 3 highlights the level of compliance for the 50 states and Washington D.C. California meets Benchmark 2 (routine accommodation of bicycles), has a statewide Safe Routes to School program, and provides other statewide programs. However, the state DOT does not have a bicycle and pedestrian plan and fails to meet all the criteria for the Pedestrian Benchmark 3 (sidewalks).

Table 3. State DOT Benchmark Assessment (February 2003)

BENCHMARK / STATE	1(a) BIKE/ PED PLAN?	1(b) PLAN MEETS FHWA GUIDANCE?	2 BIKE ACCOMMODATIONS IN NEW PROJECTS?	3(a) SIDEWALKS IN NEW PROJECTS?	3(b) SIDEWALKS IN RECONSTRUCTION?	3(c) SIDEWALKS GENERALLY INCLUDED?	3 MEET PED BENCHMARK?	4 STATEWIDE SAFE ROUTES PROGRAM?	OTHER STATEWIDE PROGRAM*?
ALABAMA	no	n/a	no	no	no	no	no	pending	no
ALASKA	yes	yes	yes	yes	yes	Yes	yes	no	no
ARIZONA	yes	yes	no	no	no	no	no	no	no
ARKANSAS	yes	no	no	no	no	no	no	no	no
CALIFORNIA	no	n/a	yes	no	no	no	no	yes	yes**
COLORADO	no	n/a	no	no	no	No	no	no	no
CONNECTICUT	yes	no	yes	no	no	No	no	no	yes
DELAWARE	no	n/a	yes	yes	no	n/a	no	yes	yes
DC	yes	yes	yes	yes	no	yes	no	no	yes
FLORIDA	no	n/a	yes	yes	yes	yes	yes	no	no
GEORGIA	yes	no	yes	yes	yes	yes	yes	no	yes
HAWAII	yes	no	yes	no	yes	no	no	no	no
IDAHO	yes	yes	yes	yes	yes	yes	yes	no	no
ILLINOIS	no	n/a	no	yes	no	yes	no	no	no
INDIANA	yes	no	no	no	no	no	no	no	yes
IOWA	no	n/a	yes	yes	yes	yes	yes	no	yes
KANSAS	yes	no	no	no	no	no	no	no	yes
KENTUCKY	yes	no	yes	yes	yes	yes	yes	no	yes
LOUISIANA	yes	no		no	?	?		no	yes
MAINE	yes	yes	yes	no	no	no	no	pending	yes
MARYLAND	yes	no	yes	yes	yes	yes	yes	yes	yes
MASSACHUSETTS	yes	yes	yes	yes	yes	yes	yes	yes	yes
MICHIGAN	no	n/a	?	?	?	?		no	yes
MINNESOTA	yes	yes	yes	yes	yes	yes	yes	yes	yes
MISSISSIPPI	yes	no	no	no	no	no	no	no	no
MISSOURI	no	no	no	no	no	no	no	yes	yes
MONTANA	yes	no	yes	no	yes	yes	no	no	yes
NEBRASKA	no	no	no	no	no	yes	no	no	no
NEVADA	no	no	no	yes	yes	yes	yes	no	yes
NEW HAMPSHIRE	yes	no	no	no	no	no	no	no	yes
NEW JERSEY	no	no	yes	yes	yes	yes	yes	pending	no
NEW MEXICO	yes	no	yes	yes	yes	yes	yes	yes	yes
NEW YORK	yes	yes	no	no	no	no	no	no	yes
NORTH CAROLINA	yes	no	yes	yes	yes	yes	yes	no	yes
NORTH DAKOTA	no	n/a	yes	yes	yes	yes	yes	no	no
OHIO	no	n/a	no	no	no	no	no	no	yes

BENCHMARK / STATE	1(a) BIKE/ PED PLAN?	1(b) PLAN MEETS FHWA GUIDANCE?	2 BIKE ACCOMMODATIONS IN NEW PROJECTS?	3(a) SIDEWALKS IN NEW PROJECTS?	3(b) SIDEWALKS IN RECONSTRUCTION?	3(c) SIDEWALKS GENERALLY INCLUDED?	3 MEET PED BENCHMARK?	4 STATEWIDE SAFE ROUTES PROGRAM?	OTHER STATEWIDE PROGRAM*?
OKLAHOMA	no	no	no	yes	no	yes	no	no	no
OREGON	yes	yes	yes	yes	yes	yes	yes	no	yes
PENNSYLVANIA	yes	no	no	no	no	no	no	no	yes
RHODE ISLAND	no	n/a	yes	yes	yes	yes	yes	no	yes
SOUTH CAROLINA	no	no	no	no	yes	yes	no	no	yes
SOUTH DAKOTA	yes	no	no	no	no	yes	no	no	no
TENNESSEE	no	n/a	yes	no	no	yes	no	yes	yes
TEXAS	no	n/a	no	no	no	no	no	yes	yes
UTAH	yes	no	no	no	no	no	no	yes	yes
VERMONT	yes	no	yes	no	yes	yes	no	no	yes
VIRGINIA	no	n/a	no	no	no	yes	no	no	no
WASHINGTON	yes	no	yes	yes	yes	yes	yes	yes	yes
WEST VIRGINIA***									
WISCONSIN	yes	yes	no	no	no	yes	yes	no	yes
WYOMING	yes	no	yes	yes	yes	yes	yes	no	yes

* Includes related programs such as context sensitive design, grant programs, training, etc..

** Bicycle Transportation Account, Pedestrian Safety Task Force, Pedestrian/Bicycle Facilities training, and Context Sensitive Solutions training

*** West Virginia did not respond.

N/A = not applicable

? = information not available at time of publication

Source: Wilkinson, B. & Chauney, B. (2003). *Are We There Yet? Assessing the Performance of State Departments of Transportation on Accommodating Bicycles and Pedestrians*. Washington, D.C.: National Center for Bicycling and Walking.

This survey indicates that Caltrans, although generally above average in accommodating non-motorized travel, may still have room for improvement, particularly in the area of planning and developing pedestrian facilities.

COMPARISON OF HIGHWAY DESIGN MANUAL WITH OTHER STATES' MANUALS

Chapter 1000 of the Highway Design Manual provides information about bikeway design and implementation standards. The Manual clearly outlines minimum standards for Class I, II, and III bikeways, and briefly discusses intersection treatments, railroad and highway ramp crossings, surface treatments, and signing and striping treatments.

Chapter 1000 covers only the most basic elements of bikeway design and implementation. As can be seen in Table 1, Chapter 1000 is strong in general design guidelines and standards, but provides little guidance on safety or amenities. Chapter 1000 also provides little guidance on the various options available for roads that cannot be re-striped for bike lanes.

Some more recent manuals use a more comprehensive approach. The Vermont Bicycle and Pedestrian Facility Planning and Design Manual, for example, provides a chapter each on bikeway planning, design, and implementation. In addition, it provides detailed chapters on rail-trails and rails-with-trails, traffic calming, pavement markings, surface treatments, landscaping and amenities, and maintenance guidelines. Each chapter provides thorough information with accompanying photos and graphics on each topic. This type of design manual is useful for engineers, as well as others involved in statewide transportation planning processes, like planners, policy makers, government officials, and citizens. There are advantages to both types of manuals but, in general, the more comprehensive the approach, the less need there is for supplementary materials.

Table 4. Comparison of California HDM With Other States' Manuals

Topic	Highway Design Manual Chapter 1000	Oregon Bicycle and Pedestrian Plan	Wisconsin Bicycle Transportation Plan 2020	Florida Bicycle Facilities Planning and Design Handbook	Vermont Pedestrian and Bicycle Facility Planning and Design Manual	AASHTO Guide for the Development of Bicycle Facilities	Dutch "Sign Up for the Bike" Bicycle Design Guide
General							
Benefits of bicycling		✓	✓	✓	✓		
Federal laws related to bicycling		✓	✓	✓	✓		✓
Planning criteria	✓	✓		✓	✓	✓	✓
Design criteria	✓	✓		✓	✓	✓	✓
Description of bikeways	✓	✓	✓	✓	✓	✓	✓
Design and Standards							
Restriping roads with bike lanes	✓	✓	✓	✓	✓	✓	✓
Shoulder path design	✓	✓	✓	✓	✓	✓	
Shared-use path designs	✓	✓	✓	✓	✓	✓	✓

Topic	Highway Design Manual Chapter 1000	Oregon Bicycle and Pedestrian Plan	Wisconsin Bicycle Transportation Plan 2020	Florida Bicycle Facilities Planning and Design Handbook	Vermont Pedestrian and Bicycle Facility Planning and Design Manual	AASHTO Guide for the Development of Bicycle Facilities	Dutch "Sign Up for the Bike" Bicycle Design Guide
Wide curb lane designs		✓	✓	✓	✓	✓	✓
Intersection designs	✓	✓		✓	✓	✓	✓
Signing and marking	✓	✓		✓	✓	✓	✓
Safety							
Bicycle safety		✓	✓	✓		✓	✓
Bikeway and walkway maintenance		✓		✓	✓		
Operating bikeway and walkways during construction	✓	✓			✓		✓
Traffic calming		✓		✓	✓		✓
Amenities							
Bicycle maps		✓		✓	✓	✓	
Bicycle parking		✓		✓	✓	✓	✓

Case Study: Davis – A Bicycling and Walking Laboratory for California

Davis, California, is known across the county as being a model community for planning and implementation of non-motorized transportation facilities, and especially bicycle facilities. Davis has been designated by the League of American Cyclists as a "Bicycle Friendly Community" (May 2000), and has also received national recognition as being the preeminent community for bicycle facility development and promotion of non-motorized mobility modes. With a current estimated population of just over 64,000 (U.S. Census, 2003), it is estimated that there is a much higher number of bicycles, considering that many residents own more than one. The presence of good bicycling facilities has led to an excellent walking environment as well, allowing pedestrians to comfortably walk throughout the community. But how has Davis become such a haven for cycling and walking as a means of transportation? What has Davis done that other communities have not been able to achieve?

Background

Davis is a true college town, with approximately half of the city's population enrolled at the University of California, Davis. Naturally, many college students rely on the bicycle as their main mode of transportation due to economic and logistical reasons, especially when enrolled in schools located in smaller university cities or towns. Additionally, Davis benefits from relatively flat topography and moderate climates. Located about 12 miles west of Sacramento on Interstate 80, Davis sits in California's Central Valley surrounded by vast reaches of agricultural lands. Though temperatures in the summer average in the 90s, with highs well into the 100s, Davis benefits from mild temperatures much of the year, and receives only a moderate amount of rainfall (approximately 48 cm, or 19 in., annually). Davis' orientation as a college town, its relatively flat topography, and its temperate climate all contribute to the promotion of bicycle use, but these factors alone do not account for the widespread use of the bicycle. Only through a dedicated effort on the part of elected officials, its public works staff, and its residents has Davis grown to be the bicycle mecca that it is.

In the 1950's, before his tenure as Davis' Director of Public Works, Dave Pelz took a trip to Europe, where he toured several countries by way of bicycle. At the time (and today as well) much of Europe was much more accessible via bicycle travel than the United States, and it was this trip that proved to Dave that bicycle transportation was, in fact, a viable and important factor for a sustainable and thriving community. Mr. Pelz served as the Director of Public Works for 27 years (35 years total as a staff member with the Public Works Department), and through his foresight and vision, created a legacy of cooperation among the individual facets of community development with the central goal of creating a bicycle-friendly city. According to Tim Bustos, Davis' Bicycle and Pedestrian Facilities Coordinator, in order for bike or pedestrian projects to move efficiently through the planning and implementation process, a community needs to have a combination of a dedicated public works staff, elected officials, and citizens. Davis has all three, and this "golden triangle" has worked to establish Davis as a model growing community.

The Comprehensive Bicycle Plan

Much of Davis's success can be attributed to its atypical Comprehensive Bicycle Plan (updated May 2001). According to Tim Bustos, this "advanced evolution plan" predates most communities' bicycle plans by 10 to 20 years. He also notes,

> *"[The Davis Bicycle Plan] put bicycle transportation on par with all other modes – not as a special case or 'alternative transportation'. Because bicycle transportation is treated more as 'mainstream,' most of the language in the bike plan and general plan is more definitive than in many other communities. There is no on-going debate as to whether or not the city 'should' provide bicycle facilities on any given project. This simply advances any project to the point of deciding on 'how' to best accommodate bicycle transportation on any given project."*

Bicycle Signal Head: Sycamore Lane and Russell Boulevard Intersection

As such, Davis does not rely on its Bicycle Plan alone to drive the development of the City's bike facilities. According to Tim, the Bicycle Plan is not a stand-alone document; equally as important is institutionalizing the development of bike facilities in the general plan.

Innovative Solutions

Davis' population growth has required the City to develop innovative engineering solutions to problems created by increased bicycle trips that were not anticipated when facilities were originally designed. One example of this is the bicycle signal head installed at an intersection that sees over one thousand bicycle crossings per hour at peak times. The signal provides separate phasing, during which only cyclists may cross the busy arterial. The signal, considered a success for dramatically reducing the number of bicycle collisions at the intersection, has recently gained approval by the California Traffic Control Devices Committee (CTCDC) (Takemoto-Weerts, 1998 and Bustos, Flecker and Pelz, 1996).

Davis has spent approximately $10 million on its bicycle facilities since 1993, a large number considering Davis' size. Much of the success in funding these projects has come from its innovative approach to seeking funding sources. Davis relies on three main sources of funding: general revenue set aside by the City Council, aggressively-pursued State and Federal funding, and funding gained from development impact fees. Davis has adopted policies that require developers to provide for and/or upgrade bicycle and pedestrian facilities as well as roads in conjunction with appropriate development projects. It is a foregone conclusion that anyone wishing to engage in improvement or development projects will factor bicycle and pedestrian facilities into the project scope.

The Future of Davis

As Davis continues to grow, one of the greatest challenges facing the "bike-ability" of the community as a whole was the development of the southern portion of the city. Being separated by the Interstate 80 corridor, South Davis had a perception of being disconnected from the rest of Davis. Until recently, the only way to travel from South Davis to the center of town and/or the university was to travel over a four-lane freeway overpass that crosses the interstate. Because of the inherent problems of such facilities for cyclists, even when designed with the cyclist in mind, a solution was needed to bridge the non-motorized gap between South Davis and the rest of town.

As such, Davis spent $4.7 million on the Putah Creek Bicycle Undercrossing that leads underneath Interstate 80, Chiles Road (a county road), and the Union Pacific Railroad right-of-way. This complex and expensive project, along with Davis' 26 other grade-separated bike crossings, 50 miles of dedicated bike lanes, 51 miles of bike paths, and a city staff and citizenry focused on the continued promotion of bicycle transportation, illustrates Davis' dedication in maintaining a thriving bicycle friendly community.

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Putah Creek Bicycle Undercrossing

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Pedestrian-related collision data for California state highways from 1989 to 1999 showed that about 81% of such collisions involved injuries and 14% resulted in fatalities. When compared to non-pedestrian collisions, 30% resulting in injuries and 0.6% in fatalities, pedestrians are 2.7 times more likely to be injured and approximately 23 times more likely to be killed. Furthermore, demographic collision data from 1997 in California suggests that children and the elderly – populations that are more likely to walk to school, shopping, and employment destinations – are more likely to have mobility, cognitive and sensory impairments. Not surprisingly, they also are more likely to be involved in such collisions. While younger children (ages 0 – 14) comprise 24% of the state's population, 31% of all pedestrian-related collisions resulted in them being injured. The elderly, who make up 18% of the total state population, accounted for 37% of all pedestrian fatalities. (Blue, Gibby, and Ferrara, 2001).

Several factors that affect pedestrian safety include:

- Motorists and pedestrians participating in risky behaviors are more likely to be involved in collisions. In 1998, 46% of traffic collisions occurring nationally involved alcohol consumption by either the motorist or pedestrian; "More than one-third of all pedestrians 16 years of age or older killed in traffic collisions in 1998 were intoxicated;"
- Group walking, whereby the entire group usually slows to accommodate slower members, restricts the quickness of the group as a whole;
- Lower income Californians are more likely to be pedestrians;
- Children, the elderly, and people with disabilities are more likely to be pedestrians;
- The quality and character of pedestrian facilities influence pedestrian behavior;
- Pedestrians will be more likely to submit to traffic control if it is closely enforced;
- Pedestrians that are better educated about potential hazards are safer.

Department of Justice (1994) Title III regulations, 28 CFR Part 36, Appendix A. *ADA Standards for Accessible Design*. Washington D.C.

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General Information and Design Resources

"Liability Issues, Social Needs Dictate Design." (1996). *American City & County*, Vol. 111 Issue 1, p38.

Focuses on the factors that public transportation planners need to consider in designing streets and access points. Designing process; Requirements for residential analysis; Challenges in residential traffic planning; Need for considering community links; Pedestrian flow considerations; Liability issues and overall social needs.

"National Highway Institute Update." (2003). *Public Roads*, Vol. 66 Issue 4, p59.

Focuses on Bicycle Facility Design and Pedestrian Facility Design, new courses that the National Highway Institute developed and added to its course catalog during 2002. Things needed in designing bicycle facilities; Reasons behind the National Highway Institute's decision to develop the Pedestrian Facility Design course; Significance of completing the course.

American Association of State Highway and Transportation Officials. *(2001). Policy on Geometric Design of Highways and Streets [The Green Book]* Washington D.C.

The Green Book provides guidance for the design of roadways including the provision of pedestrian-related elements.

American Association of State Highway and Transportation Officials. *(2004). A Guide for Achieving Flexibility in Highway Design* Washington D.C.

Provides guidance in how agencies can accomplish the objects of Context Sensitive Solutions within accepted design processes and criteria.

American Association of State Highway and Transportation Officials. (2002). *Roadside Design Guide* Washington, D.C.

This publication contains information on roadside safety and economics, topography and drainage features, sign and luminary supports, roadside barriers, median barriers, bridge railings, and crash cushions.

Appleyard, B. (2002). "Livable Streets Revisited." *Planning*, Vol. 68 Issue 10, p18.

Focuses on the effects of the automobile in streets on the quality of life in a neighborhood. Relation between the level of traffic and the level of social contact; Activities happening in streets; Efforts in designing the street for pedestrians and transit riders.

Better Environmentally Sound Transportation (BEST). (Updated December 2002). *Street Reclaiming Guide Book*. Retrieved October 7, 2003 from the BEST website: http://www.best.bc.ca/streets/guidebook.html

This guide is meant to inspire and assist neighborhood groups in reclaiming their streets through creative neighborhood organizing, celebration, art, and strategies to reduce car use.

Centre for Research and Contract Standardization in Civil and Traffic Engineering. (1998). *Recommendations for Traffic Provisions in Built-up Areas, ASVV*. The Netherlands.

This publication discusses knowledge relating to the design, implementation and management of traffic provisions in built-up areas.

Ewing, R. (2002). "Impediments to Context-Sensitive Main Street Design." *Transportation Quarterly*, Vol. 56 Issue 4, p51.

This paper explores impediments to context-sensitive design of main streets, and suggests ways of overcoming them. It is based on a guidebook for the New Jersey Department of Transportation titled Flexible Design of New Jersey's Main Streets. Contrary to conventional wisdom, minimum design values in the American Association of State Highway and Transportation Officials' A Policy on Geometric Design of Highways and Streets (AASHTO's 2001 Green Book) do not appear to constrain main street design. Nor do tort liability considerations in most states, primarily because of broad design immunity under state statutes and case law. From case studies conducted for this project, the real impediments to context-sensitive design appear to be: state design standards in excess of AASHTO minimums, and in excess of what is required for driver safety in low-speed environments; minimum level-of-service standards adopted for driver convenience, which may be less important on main streets than pedestrian safety and comfort; over-reliance on typical sections from state roadway design manuals, when multiple cross sections tailored to abutting land uses would be more appropriate; and reluctance to seek design exceptions for purposes of "context savings," only for purposes of cost savings.

Additional impediments include application of new construction standards to 3R and reconstruction projects, even when a street's history suggests no safety problem; misclassification of streets as rural and application of rural design standards to them, when they in fact run through small urban places; misclassification of streets as arterials, when bypasses and other parallel improvements have caused main streets to function as local streets; and reluctance of state DOTs to assume maintenance responsibilities for street trees, landscaped medians and bulbouts, textured crosswalks, and similar common main street improvements. Case studies from Albuquerque, NM; Anchorage, AK; Brooklyn, CT; Saratoga.

Federal Highway Administration. (1997). Flexibility in Highway Design. Washington D.C.: U.S. DOT.

This guide provides guidance about designing highways that incorporate community needs. It is written for highway engineers and project managers who want to learn more about the flexibility available to them when designing roads and illustrates successful approaches used in other highway projects. It can also be used by citizens who want to gain a better understanding of the highway design process. Also online at http://www.fhwa.dot.gov/environment/flex/.

Federal Highway Administration. (1998). *Improving Conditions for Bicycling and Walking: A Best Practices Report*. Washington D.C.: U.S. DOT.

This document provides one-page anecdotal articles on successful bicycle and pedestrian programs and case studies around the United States, plus broad topics such as streetscape design and bicycle boulevards.

Federal Highway Administration. (2002). *Design Guidelines: Accommodating Bicycle and Pedestrian Travel - A Recommended Approach, A US DOT Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure*. Washington D.C.: U.S. DOT.

This document is a policy statement adopted by the United States Department of Transportation that incorporates three key principles: a policy statement that bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist; an approach to achieving this policy that has already worked in State and local agencies; and a series of action items that a public agency, professional association, or advocacy group can take to achieve the overriding goal of improving conditions for bicycling and walking.

Key selected policies of the Policy Statement include:

- Bicycle and pedestrian ways shall be established in new construction and reconstruction projects in all urbanized areas unless one or more of three conditions are met:

  Bicyclists and pedestrians are prohibited by law from using the roadway. In this instance, a greater effort may be necessary to accommodate bicyclists and pedestrians elsewhere within the right of way or within the same transportation corridor.

  The cost of establishing bikeways or walkways would be excessively disproportionate to the need or probable use. Excessively disproportionate is defined as exceeding twenty percent of the cost of the larger transportation project.

  Where sparsity of population or other factors indicate an absence of need. For example, the Portland Pedestrian Guide requires "all construction of new public streets" to include sidewalk improvements on both sides, unless the street is a cul-de-sac with four or fewer dwellings or the street has severe topographic or natural resource constraints.

- In rural areas, paved shoulders should be included in all new construction and reconstruction projects on roadways used by more than 1,000 vehicles per day, as in states such as Wisconsin. Paved shoulders have safety and operational advantages for all road users in addition to providing a place for bicyclists and pedestrians to operate.

  Rumble strips are not recommended where shoulders are used by bicyclists unless there is a minimum clear path of four feet in which a bicycle may safely operate

- Sidewalks, shared use paths, street crossings (including over- and undercrossings), pedestrian signals, signs, street furniture, transit stops and facilities, and all connecting pathways shall be designed, constructed, operated and maintained so that all pedestrians, including people with disabilities, can travel safely and independently.

Florida Department of Transportation Quality. (2002). *Level of Service Handbook*. Tallahassee, FL

This comprehensive report addresses multi-modal quality and level of service measurement techniques, including a Bicycle Level of Service and a Pedestrian Level of Service methodology. Also available online at http://www.dot.state.fl.us/planning/systems/sm/los/los_sw2.htm#handbook.

Institute of Transportation Engineers. (1995, 5th edition). *Traffic Engineering Handbook*. James L. Pline, editor. Washington D.C.

This publication is a technical handbook that provides professionals with a day-to-day reference on principles and proven techniques of transportation and traffic engineering. The Handbook may be useful for non-technical readers, such as policy and neighborhood activists, who want to learn about transportation engineering basics.

National Health and Nutrition Examination Survey. (2001). *Prevalence of Overweight and Obesity Among Adults: United States, 1999-2000*. Washington, D.C.: National Center for Health Statistics, Centers for Disease Control and Prevention.

The 1999-2000 National Health and Nutrition Examination Survey (NHANES) found that an estimated 64 % of U.S. adults are either overweight or obese, approximately 8 % more than in the last NHANEE study, 1988-94.The rates of measurement may have changed in the 10-year period. Overweight is currently defined as having a Body Mass Index (BMI) of 25.0 – 29.0. Obesity is defined as having a BMI greater than or equal to 30.0. Healthy weight is currently defined as having a BMI of 18.5 – 24.9. BMI is calculated by (weight in pounds/height in inches^2) x 703.Results of this survey are also available online at http://www.cdc.gov/nchs/releases/02news/obesityonrise.htm.

Ourston, L., Bared, J. (1995). "Roundabouts: A Direct Way to Safer Highways" *Public Roads*, Vol. 59 Issue 2, p41.

Features the safety record of modern roundabouts in Western Europe. Proposal to adopt them in the United States; Design and function of roundabouts; Statistics on safety features of roundabouts; Pedestrians and cyclists; Crash-involvement rates.

Pedestrian and Bicycle Information Center (PBIC). (2002). *Exemplary Bicycle and Pedestrian Plans*. Retrieved July 29, 2003 from PBIC website: http://www.bicyclinginfo.org/pp/exemplary_print.htm.

This list of exemplary bicycle and pedestrian plans was compiled to provide easy access to a number of good examples of comprehensive bicycle and pedestrian planning.

Pucher, J., Dijkstra, L. (2000). "Making Walking and Cycling Safer: Lessons from Europe." *Transportation Quarterly*, Vol. 54 Issue 3, p25.

Offers tips in improving pedestrian and bicycling safety in the United States. Advantage and comfort of separate right of ways; Importance of calming traffic in residential neighborhoods; Need of a traffic education for drivers; Proposed modifications in traffic regulations and enforcements.

Ruth, K. (2002). "The Battle Over Dead Ends." *Planning*, Vol. 68 Issue 5, p10.

Discusses street design standards implemented to solve suburban traffic problems in several states in the U.S. Significance of street connectivity in solving suburban traffic problems; Results of a study on connectivity ordinances in the country; Challenges faced in implementing the standards.

Saelens, Brian E.; Sallis, James F.; Frank, Lawrence D. (2003). "Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures." *Annals of Behavioral Medicine*. Vol. 25 Issue 2, p80.

Research in transportation, urban design, and planning has examined associations between physical environment variables and individuals' walking and cycling for transport. Constructs, methods, and findings from these fields can be applied by physical activity and health researchers to improve understanding of environmental influences on physical activity. In this review, neighborhood environment characteristics proposed to be relevant to walking/cycling for transport are defined, including population density, connectivity, and land use mix. Neighborhood comparison and correlational studies with non-motorized transport outcomes are considered, with evidence suggesting that residents from communities with higher density, greater connectivity, and more land use mix report higher rates of walking/cycling for utilitarian purposes than low-density poorly connected, and single land use neighborhoods. Environmental variables appear to add to variance accounted for beyond sociodemographic predictors of walking/cycling for transport. Implications of the transportation literature for physical activity and related research are outlined. Future research directions are detailed for physical activity research to further examine the impact of neighborhood and other physical environment factors on physical activity and the potential interactive effects of psychosocial and environmental variables. The transportation, urban design, and planning literatures provide a valuable starting point for multidisciplinary research on environmental contributions to physical activity levels in the population.

Wade, B. (2001). "Lose a Road, Gain a Neighborhood." *American City & County*, Vol. 116 Issue 14, p36.

Reveals the plans of Milwaukee, Wisconsin to demolish its Park East Freeway and replace it with a surface street system. Scope of the city's revitalization plan; What prompted city officials to pursue residential and destination development.

US Census (2000) *Journey to Work*
www.census.gov

The Census website provides access to Census information from 1980 to present. The information can be downloaded into Excel spreadsheets or manipulated on the site. Journey to Work data provides information on how workers aged 16 and over commuted to work on a specific day in the spring. This information is typically used for most trend analysis at the state level.

Bicycle and Pedestrian Facility Resources

"Bridging Rochester's Downtown." (1995). *Progressive Architecture*, Vol. 76 Issue 7, p33.

> Reports on Rochester, N.Y. officials' acceptance of a plan device by William Rawn Associates and LaBella Associates, aimed at making the Aqueduct Bridge an effective pedestrian link between the downtown areas east and west of the Genesse River. Planned insertion of a glass enclosed winter garden; Provision of a sitting body of water for ice skating in winter.

American Association of State Highway and Transportation Officials (2004). *AASHTO Guide for the Development of Bicycle Facilities. Washington, D.C.*

> This guide compiles information related to the planning, design, and operation of bicycle facilities.

American Association of State Highway and Transportation Officials (2004). *AASHTO Guide for the Planning, Design, and Operations of Pedestrian Facilities. Washington, D.C.*

> This guide compiles information related to the planning, design, and operation of pedestrian facilities, including the accommodation of pedestrians with disabilities.

Aveni, M. (2001). "Competition Generates Innovative Design for Pedestrian Crossing." *Civil Engineering*, Vol. 71 Issue 3, p32.

> Focuses on a pedestrian footbridge designed for an international competition in Stockholm, Sweden. Designers of the bridge; Solution created to provide access for the handicapped; Description of the bridge's design.

Brambilla, R., Longo, G. (1977). *Handbook for Pedestrian Action*. Washington, D.C.: Columbia University/Housing and Urban Development.

California Department of Transportation (Caltrans). (2001). *Chapter 100: Topic 105 – Pedestrian Facilities, Highway Design Manual.* Sacramento, CA.

> Topic 105 discusses design guidelines and standards for California State roadway projects involving pedestrians. The segment discusses sidewalks, grade separated crossings, and ADA-compliance.

California Department of Transportation (Caltrans). (2002). *Main Streets: Flexibility in Design and Operation*. Sacramento, CA.

This pamphlet has been developed by the California Department of Transportation (Caltrans) to give designers some basic guidelines for recreating a main street in communities with state highways in their town center. It encourages a mix of solutions to serve vehicles, pedestrians, bicyclists, and highway workers.

Community involvement is highlighted as an extremely important factor in designing a traffic solution, as well as with finding funding for projects. It encourages adopting performance measures so that members of the community have a way of understanding how a project is being implemented.

There are descriptions of a series of design elements that can be utilized to help ease conflicts between pedestrians and vehicles in high-speed areas. Safety is emphasized through things like synchronized signals, lowering the speed limit, adding on-street parking and widening or adding sidewalks. Some ideas for different crossing treatments are suggested as well as changes in lighting, street furniture and landscaping.

Community support for a project is necessary when implementing design concepts such as those discussed in these guidelines. While the department considers it vital to solicit community involvement as part of the early project planning, it is incumbent on the Department to become fully engaged with a community that initiates contact with Caltrans in possible implementation of the community's vision. The level of community support for a project will usually be noted during the public participation phase of the planning and project development process, but can also be expressed through willingness of the community to fund elements of project construction and maintenance, and by its commitment to the implementation of associated mitigation measures such as improvements to parallel city streets and/or the implementation of access management techniques along the main street.

Federal Highway Administration. (1994). *National Bicycling and Walking Study: Transportation Choices for a Changing America*, FHWA-PD-94-023. Washington, D.C.

This report synthesizes 24 case-study research reports carried out for the National Bicycling and Walking Study. Current bicycling and walking levels, ways to increase them, and benefits of walking and bicycling are described. Actions to be carried out by various agencies of the U.S. Department of Transportation are listed. Action plans and programs at the State and local level similarly appear; additionally, specific city examples provide concrete data. Appendices include a list of the 24 case studies and a brief look at other nations' policies.

Federal Highway Administration. (1999). *Implementing Pedestrian Improvements at the Local Level,* HSR 20. Washington, D.C.

This publication reviews pedestrian-friendly policy and design recommendations that strive to improve the pedestrian environment in U.S. communities. It discusses the opportunities and challenges of implementing pedestrian improvements, and the necessary engineering, education, encouragement, and enforcement needed to make communities more pedestrian-friendly. Also online at http://safety.fhwa.dot.gov/fourthlevel/pdf/LocalPedGuide.pdf.

Federal Highway Administration. (2001). *Pedestrian Facilities Users Guide: Providing Safety and Mobility.* : FHWA-RD-01-102. Washington, D.C.

The purpose of the Pedestrian Facilities Users Guide is to provide useful information on how to identify the safety and mobility needs of pedestrians within roadway rights-of-way. This guide is intended primarily for engineers, planners, safety professionals, and decision-makers, but citizens also may find the guide useful in identifying ways to improve the safety and mobility of pedestrians.

The guide provides an overview of the creation of a pedestrian-friendly environment, describing basic pedestrian crash trends and examining and classifying crash types to determine appropriate countermeasures. It also features definitions of 13 pedestrian crash-type groupings and factors important in selecting the best countermeasures. These crash groupings then are presented in terms of how to select pedestrian safety improvements to address specific crash problems. Engineers will find useful details regarding 47 different engineering improvements for pedestrians. These improvements relate to the walking environment, roadway design, intersection treatments, traffic calming, traffic management, and signals and signs. At the end of the guide, users will find a simplified list of improvements to address certain broad objectives (e.g., reducing speeds on a street and reducing pedestrian exposure) without the need for pedestrian crash data.

Griffin, K., Holmes, B. (1997). "Making Mean Streets a Little Nicer." *Health*, Vol. 11 Issue 5, p22.

Reports that few simple design changes to sidewalks and roads could lower both the number of people who were injured and killed by walking in the streets. How pedestrian crashes dropped in Seattle; Groups supporting the project.

Institute of Transportation Engineers. (1998). *Design and Safety of Pedestrian Facilities: A Recommended Practice*. Washington, D.C.

This recommended practice discusses guidelines for the design and safety of pedestrian facilities to provide safe and efficient opportunities for people to walk near streets and highways.

Koepsell, T. et al. (2002). "Crosswalk Markings and the Risk of Pedestrian–Motor Vehicle Collisions in Older Pedestrians." *Journal of the American Medical Association*, Vol. 288 Issue 17, p. 2136.

> Motor vehicles struck and killed 4739 pedestrians in the United States in the year 2000. Older pedestrians are at especially high risk. Objective: To determine whether crosswalk markings at urban intersections influence the risk of injury to older pedestrians. Design: Case-control study in which the units of study were crossing locations. Setting: Six cities in Washington and California, with case accrual from February 1995 through January 1999. Participants: A total of 282 case sites were street-crossing locations at an intersection where a pedestrian aged 65 years or older had been struck by a motor vehicle while crossing the street; 564 control sites were other nearby crossings that were matched to case sites based on street classification. Trained observers recorded environmental characteristics, vehicular traffic flow and speed, and pedestrian use at each site on the same day of the week and time of day as when the case event had occurred. Main Outcome Measure: Risk of pedestrian–motor vehicle collision involving an older pedestrian. Results: After adjusting for pedestrian flow, vehicle flow, crossing length, and signalization, risk of a pedestrian–motor vehicle collision was 2.1-fold greater (95% confidence interval, 1.1-4.0) at sites with a marked crosswalk. Almost all of the excess risk was due to 3.6-fold (95% confidence interval, 1.7-7.9) higher risk associated with marked crosswalks at sites with no traffic signal or stop sign. Conclusions: Crosswalk markings appear associated with increased risk of pedestrian–motor vehicle collision to older pedestrians at sites where no signal or stop sign is present to halt traffic.

Lalani, N. (2001).*Alternative Treatments for At-Grade Pedestrian Crossings: An ITE Informational Report.* Washington D.C.: Institute of Transportation Engineers Pedestrian and Bicycle Task Force.

> This informational report documents studies on crosswalks and warrants used by various entities. The report summarizes studies on pedestrian crossings and assembles in a single document the various treatments currently in use by local agencies in the U.S., Canada, Europe, New Zealand and Australia to improve crossing safety for pedestrians at locations where marked crosswalks are provided. The report also summarizes the results of various studies conducted by public agencies on pedestrian-related collisions, including those documenting the results of removing crosswalk markings at uncontrolled locations.

Lockwood, C. (1997). "Onward and Upward in Downtown Santa Monica." *Planning*, Vol. 63 Issue 9, p14.

> Focuses on the Santa Monica city council's approval of a streetscape plan prepared by the ROMA Design Group of San Francisco. Plans to improve traffic and transit patterns; Flaws of the pedestrian mall Third Street Promenade; Success of the Santa Monica Place; Details of the revitalization plan for the pedestrian mall; Phases of construction.

McMahon, P. et al. (2002). *An Analysis of Factors Contributing to "Walking Along Roadway" Crashes: Research Study and Guidelines for Sidewalks and Walkways*. Washington, D.C.: Federal Highway Administration. (FHWA-RD-98-107)

This study uses a case-control methodology and applies conditional and binary logistic models to determine the effects of cross-sectional roadway design attributes and socioeconomic and other census block group data on the likelihood that a site is a crash site. A total of 47 crash sites and 94 comparison sites are analyzed. Physical design factors found to be associated with a significantly higher likelihood of being a crash site are higher traffic volume, higher speed limit, the lack of wide grassy walkable areas, and the absence of sidewalks. When these roadway factors are controlled for, non-geometric factors associated with a significantly higher likelihood of being a crash site are high levels of unemployment, older housing stock, lower proportions of families within households, and more single-parent households. This information suggests that some neighborhoods, due to increased exposure or specific types of exposure, may be especially appropriate sites for pedestrian safety measures such as sidewalks, lower speed roadway designs, and the addition of wide grassy shoulders. Also online at http://www.walkinginfo.org/pdf/r&d/SidewalkReport.pdf

Mullan, E. (2003). "*Do You Think that Your Local Area is a Good Place for Young People to Grow Up? The Effects of Traffic and Car Parking on Young People's Views." Health & Place*, Vol. 9 Issue 4, p351.

The damaging effects on well-being of the increasing number of motor vehicles on the roads, crashes and emissions aside, are often overlooked. Among 11–16 year olds in Wales, those who reported living with busy traffic and car parking were found to be less likely to have positive perceptions of the safety, friendliness, appearance, play facilities and helpfulness of the people in their local area. This was independent of the effect of socio-economic circumstance. Results are discussed in terms of the potential negative effect on sense of community identity, health and well-being, and the need for good environmental design and development of more pedestrian-friendly living areas.

National Center for Bicycling and Walking (NCBW). (2003). *Pedestrian Facilities Reference Guide*. Retrieved September 2003 from the NCBW website: http://www.bikewalk.org/walking/design_guide/pedestrian_design_guide_index.htm

This web-based reference guide provides links (.html and .pdf) to a variety of pedestrian facility related topics, including (but not limited to) walkways, intersections, crosswalks, curb ramps, signal timing, signing and marking, amenities, traffic calming, bridges, and the economic benefits of bicycle and pedestrian-based tourism. The documents discuss typical concerns, possible solutions, implementation strategies, and evaluation processes for each topic.

National Center for Bicycling and Walking. (2002). *Vermont Pedestrian and Bicycle Facility Planning and Design Manual.* Montpellier, VT: Agency of Transportation.

This manual is a compilation of national and state guidance and information, which has been adapted to the context of Vermont. This manual shows how to accommodate pedestrians and bicyclists in most environments but cannot cover all possible situations. It does not propose specific projects but offers the general principles and policies that VTrans will follow. It presents sound guidelines that will be valuable in attaining good design sensitive to the needs of pedestrians, bicyclists and other users specific to Vermont conditions. The manual covers planning, pedestrian facilities, on-road bicycle facilities, shared use paths, rails-trails and rails-with-trails, traffic calming, signs and pavement markings, landscaping and amenities, and maintenance. Also online at http://www.aot.state.vt.us/progdev/Documents/LTF/FinalPedestrianAndBicycleFacility/PedestrianandBicycleFacilityDesignManual.pdf

National Cooperative Highway Research Program. (1988). Pedestrians and Traffic Control Measures, Synthesis of Highway Practice 139. Washington, D.C.: Transportation Research Board.

New Jersey Department of Transportation. (1995). *Pedestrian Compatible Roadways: Planning and Design Guidelines, Bicycle / Pedestrian Transportation Master Plan*. Trenton, NJ.

This publication outlines pedestrian planning and design guidelines for the state of New Jersey. The document covers an introduction to pedestrian facilities, guidelines for accommodating pedestrians on roadways, guidelines for encouraging pedestrian travel and operations and maintenance. Also online at http://www.state.nj.us/transportation/publicat/pedest_guide.htm.

Nikkel, C. (1999). "Countdown at the Crosswalk." *Motor Trend,* Vol. 51 Issue 8, p30.

Reports on pedestrian signs in the United States. How the pedestrian traffic signs works; States that have installed pedestrian timers; Cost of the signs.

Oregon Department of Transportation. (1995). *Oregon Bicycle and Pedestrian Plan*. Salem, OR.

This comprehensive plan discusses bicycle and pedestrian planning and policy in the context of Oregon. It also provides design guidelines and best practices for nearly everything related to bicycling and walking and is considered a model plan for the United States. Part One contains the policies and actions that drive ODOT; Part Two, Sections I and II contain planning and design guidelines; Part Two, Section III has maintenance and construction guidelines; Part Two, Section IV contains information for bicycle and pedestrian safety. The appendices contain other information, such as the Oregon statutes that pertain to bicycling and walking. Also online at http://www.odot.state.or.us/techserv/bikewalk/obpplanold.htm.

Portland Office of Transportation. (1998). *Portland Pedestrian Design Guide*. Portland, OR

The purpose of this comprehensive design document is to integrate the wide range of design criteria and practices of pedestrian planning and design into a coherent set of new standards and guidelines that, over time, will promote an environment conducive to walking in Portland, Oregon. Also online at http://www.trans.ci.portland.or.us/designreferences/Pedestrian/DesignGuide.PDF.

Rails to Trails Conservancy and Association of Pedestrian and Bicycle Professionals. (1998). *Improving Conditions for Bicycling and Walking: A Best Practices Report*. Washington, D.C.

This "best practices" report, prepared for the Federal Highway Administration, provides information on some outstanding pedestrian and bicycle projects that have been recognized for increasing walking and bicycling and improving user safety in communities across the Unites States. Also online at http://safety.fhwa.dot.gov/fourthlevel/pdf/intro.pdf.

Retting, R. (1999). "Traffic Engineering Approaches to Improving Pedestrian Safety." *Transportation Quarterly*, Vol. 53 Issue 2, p87.

Focuses on urban traffic planning, transportation facility design, and traffic operations as the primary means to ensure pedestrian safety. Motor vehicle injury as one of the leading causes of death and disability; Previous approaches to pedestrian safety; Improvements on traffic control measures.

Rouphail, N. et al. (1998). *Capacity Analysis of Pedestrian and Bicycle Facilities: Recommended Procedures for the "Pedestrians" Chapter of the Highway Capacity Manual* (FHWA-RD-98-107). Washington, D.C.: Federal Highway Administration.

This report's objective was to develop revised operational analysis procedures for transportation facilities with pedestrian and bicyclist users. This document contains both new and revised procedures for analyzing various types of exclusive and mixed-use pedestrian facilities. These procedures are recommended to determine the level of service for pedestrian facilities on the basis of a summary of available U.S. and international literature. Also online at http://www.tfhrc.gov/safety/pedbike/pubs/98-107/contents.htm

San Diego Association of Governments. (2000) *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region*. San Diego, CA.

Siuru, B. (1999). "A Super-Safe Smart Crosswalk." *Electronics Now*, Vol. 70 Issue 7, p48.

Features a warning system that makes it much easier for drivers to know when pedestrians are in a crosswalk. Features of the LightGuard System Smart Crosswalk unit from LightGuard Systems Inc.; Brainchild of former commercial pilot, Michael Harrison; Similarity to flashing lights embedded in landing strips and taxi ways at airports; Design considerations.

WalkBoston. (1998). Improving Pedestrian Access to Transit: An Advocacy Handbook. Washington D.C.: US Federal Transit Administration.

This report was written as a teaching tool for citizens, and for transportation and urban planners working with citizen groups who advocate for public transit and walkable neighborhoods. It illustrates key steps that activists can take to ensure that public transit supports community needs and creates livable communities through improved pedestrian access. The authors present their personal experience in case studies that detail advocacy techniques and strategies, as well as identify some failures and setbacks. The report also discusses several public transit modes (e.g. bus, light rail, and subway) used in different kinds of communities (low income urban neighborhoods, upper and middle income inner suburb).Also online at http://safety.fhwa.dot.gov/fourthlevel/pdf/fta.pdf.

Washington Department of Transportation, Bicycle and Pedestrian Program. (1997). *Pedestrian Facilities Guidebook: Incorporating Pedestrians Into Washington's Transportation System.* Olympia, WA:

This guidebook provides the basic principles behind planning for pedestrians and encourages good design practices for traffic and transportation engineers, planners and designers, cities, counties, private developers, design professionals, and others in designing, constructing, and maintaining pedestrian facilities in a variety of settings throughout Washington. The guidebook is also useful for school districts, neighborhood councils, metropolitan planning organizations and citizen advocates. Also online at http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals

Xudong J. (2003). *Design of Bicycle and Pedestrian Facilities*. California State Polytechnic University, Pomona.

This publication is currently used as a pedestrian and bicycle resource guide and curriculum for training courses offered to Caltrans staff. The publication includes materials from Chapter 1000 of the Highway Design Manual along with other topics including construction zones and pedestrian facilities.

Trail Resources

Contra Costa County Public Works Department. (2002). *Contra Costa County Trail Design Guidelines*. Martinez, CA.

This manual provides planning and design guidelines for multi-use trail crossings, focusing on Contra Costa County but applicable to a wide variety of other areas.

The Conservation Fund. (1993). *Greenways: A Guide to Planning, Design, and Development*. Arlington, VA.

This guide provides professionals and citizen activists with the tools for dealing with all aspects of developing a greenway plan. The volume offers guidance in approaching the overall process of greenway creation while providing as much detail as possible about each step along the way. Topics covered include: the physical development of a greenway, organizing community resources, forging partnerships among public agencies, private groups, citizens, and businesses, principles of ecological design, including wetland restoration, water quality, and wildlife issues.

Florida Department of Transportation. (1996). *Trail Intersection Design Guidelines*. Tallahassee, FL.

This handbook discusses design processes and principles of designing trail/roadway intersections. It includes information on various crossing types, regulating traffic and site design. This handbook also reviews some European trail crossing guidelines. Guidelines from the Netherlands and development of a bicycle crossing time equation are included in the appendices. Also online at http://www11.myflorida.com/Safety/ped_bike/handbooks_and_research/TRAILINT.PDF

Rails to Trails Conservancy. *(1993). Trails for the 21st Century: Planning, Design, and Management Manual for Multi-Use Trails*. Washington, D.C.

This book gives step-by-step guidance in all aspects of the planning, design, and management of multi-use trails. Topics discussed include: how to make physical and cultural assessments of the site and surrounding communities, planning the trail, public involvement, meeting the needs of adjacent landowners, compliance with legislation, designing the trail, meeting the needs of different users, working with special features, managing the trail, and maximizing the trail's potential.

Helbing, D. et al. (2001). "Self-Organizing Pedestrian Movement." *Environment & Planning B: Planning & Design*, Vol. 28 Issue 3, p361.

Investigates the self-organizing phenomena, the collective patterns of motion arising from the nonlinear interactions among pedestrians. Explanation of self-organizing phenomena; Computer simulation of pedestrian walking; Optimization of trail system.

ADA-related Resources

Federal Highway Administration. (1999). *Designing Sidewalks and Trails for Access, Part I of II*, FHWA-EP-01-027. Washington, D.C.

The report is a compilation of data and designs gathered during a comprehensive literature search and site visits conducted throughout the United States. It presents a number of factors that affect the accessibility of sidewalks and trails in the United States. The history of accessibility legislation and an overview of current accessibility laws are provided. The travel characteristics of people with disabilities, children, and older adults are analyzed in relation to their use of sidewalks and trails. Current design practices used in the design of sidewalks and trails are described and analyzed in terms of accessibility, engineering, and construction. Also online at http://www.fhwa.dot.gov/environment/bikeped/access-1.htm.

Federal Highway Administration. (2001). *Designing Sidewalks and Trails for Access: Part II of II, Best Practices Design Guide*, FHWA-HEP-99-006. Washington, D.C.

This guidebook is a companion piece to Designing Sidewalks and Trails for Access, Part I of II and is focused on the best practices for designing sidewalks and trails for access. This document provides planners, designers, and transportation engineers with a better understanding of how sidewalks and trails should be developed to promote pedestrian access for all users, including people with disabilities.

Plae, Inc. (1993). *Universal Access to Outdoor Recreation: A Design Guide*. Berkeley, CA: MIG Communications.

This book provides the latest in universal design concepts and guidelines for outdoor environments, establishing a framework for determining the appropriate level of access in outdoor sites. It presents detailed design guidelines for the systems and elements necessary for ensuring accessibility to recreational trails, campsites, picnic areas, group meeting areas, and more. Examples demonstrate how the guidelines can be applied in typical outdoor settings to achieve a range of recreational opportunities for individuals of varying abilities.

U.S. Access Board. (1984). *Uniform Federal Accessibility Standards*. Washington, D.C.

This document presents uniform standards for the design, construction and alteration of buildings so that physically handicapped persons will have ready access to and use of them in accordance with the Architectural Barriers Act, 42 U.S.C. 4151-4157. This document strived to minimize the differences in standards and develop standards for facility accessibility by physically handicapped persons for Federal and federally-funded facilities. Also online at http://www.access-board.gov/ufas/ufas-html/ufas.htm.

U.S. Access Board. (1998). *Accessible Pedestrian Signals*. Washington, D.C.

This document discusses audible pedestrian signals and the accommodation of blind pedestrians at signalized intersections. The document provides design guidelines and implementation strategies for determining appropriate intersections, performing installations, and using advanced detection technology. http://www.access-board.gov/research&training/pedsignals/pedestrian.htm.

U.S. Access Board. (1998). *ADA Accessibility Guidelines for Buildings and Facilities*. Washington, D.C.

This document contains scoping and technical requirements for accessibility to buildings and facilities by individuals with disabilities under the Americans with Disabilities Act (ADA) of 1990. These scoping and technical requirements are intended to be applied during the design, construction, and alteration of buildings and facilities covered by titles II and III of the ADA. Also online at http://www.access-board.gov/adaag/html/adaag.htm.

U.S. Access Board. (1999). *Accessible Rights of Way: A Design Manual*. Washington, D.C.

This design manual is divided into two sections. The first section provides background information on the regulatory requirements for accessible public rights-of-way, including an overview of the Americans with Disabilities Act (ADA) and title II requirements. The second section discusses the Best Practices in accessible rights-of-way design and construction and provides detailed information about accessible pedestrian facilities. Also online at http://www.access-board.gov/publications/PROW%20Guide/PROWGuide.htm.

U.S. Access Board. (2002). *Draft Regulations for Public Rights of Way*. Washington, D.C.

This document provides the latest draft changes to ADA that is a good source on the latest potential changes likely to occur in this area. Also online at http://www.access-board.gov/rowdraft.htm.

Traffic Calming Resources

American Planning Association. (1995). *Traffic Calming*. Washington, D.C.

Davidson, M. (2002). "Taming the Beast." *Planning,* Vol. 68 Issue 10, p16.

> Focuses on the traffic calming initiative in Chicago, Illinois. Problems related to traffic; Overview of the planning process; Implementation of traffic calming projects.

Ewing, R. (2001). "Impacts of Traffic Calming." *Transportation Quarterly*, Vol. 55 Issue 1, p33.

> Focuses on the impact of traffic calming measures on the transportation system of the United States. Speed impacts of traffic calming measures; Determinants of traffic volumes; Comparison of the impact of traffic calming measures on collisions outside and within the United States.

Federal Highway Administration. (1992). *National Bicycling and Walking Study: Case Study # 19, Traffic Calming and Auto-Restricted Zones and other Traffic Management Techniques - Their Effects on Bicycling and Pedestrians,* FHWA-PD-93-028. Washington, D.C.

> This report discusses traffic calming and other traffic management methods. The report is divided into three parts. The first two major sections examine the history and traffic-calming techniques installed in Europe, Japan, and the United States. The final section of the report examines the practical and policy implication of traffic calming. Also online at http://www.fhwa.dot.gov/safety/fourthlevel/pdf/Case19.pdf.

Federal Highway Administration. (1995). *Bicycle Safety-Related Research Synthesis*. Washington, D.C.

> This synthesis reviews research into current and potential levels of bicycle use, identifies the scale and nature of crashes related to bicycle use; discusses engineering countermeasures to prevent crashes; and describes current practices related to bicycle facility selection and design. The report also introduces readers to traffic-calming techniques; discusses helmet use; and reviews education and enforcement programs. Conclusions on the current state of knowledge in this field are offered, and where possible, reference to current practices are included.

Federal Highway Administration. (1997). *Bicycle Crash Types: A 1990's Informational Guide*, (FHWA-RD-96-104). Washington, D.C.

This pedestrian crash type informational guide is a supplement to a research report entitled, "Pedestrian and Bicycle Crash Types of the Early 1990's" (FHWA-RD-95-163). The purpose of the research was to apply the basic National Highway Traffic Safety Administration (NHTSA) pedestrian and bicyclist typologies to a sample of recent crashes and to refine and update the crash type distributions with particular attention to roadway and locational factors. This particular informational guide provides detail on specific pedestrian-motor vehicle crash types (e.g., intersection dash) through two-page layouts that contain a sketch, description, and summary of the crash type, various graphs, and "bullet" information boxes. Also online at http://www.tfhrc.gov/safety/pedbike/ctanbike/ctanbike.htm.

Federal Highway Administration. (1999). *Injuries to Pedestrians and Bicyclists: An Analysis Based on Hospital Emergency Department Data,* FHWA-RD-99-078. Washington, D.C.

The purpose of this study was to broaden understanding about the safety of pedestrians and bicyclists. Traditionally, the U.S. Department of Transportation has relied on State motor vehicle crash data, based on reports completed by police and other law enforcement officers, as their primary source of information on events causing injury to pedestrians and bicyclists. This study was conducted to provide a more accurate description of the entire spectrum of events causing injury to pedestrians and bicyclists, as an aid to more effective countermeasure and program development. Also online at http://www.tfhrc.gov//safety/pedbike/research/99078/contents.htm.

Federal Highway Administration. (2001). *The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior*, FHWA-RD-00-104. Washington, D.C.

The objective of this study is to evaluate the effects of selected traffic calming treatments, at both intersection and mid-block locations, on pedestrian and motorist behavior. "Before" and "after" data were collected in Cambridge, MA (bulbouts and raised intersection), Corvallis, OR (pedestrian refuge island), and Seattle, WA (bulbouts). Data were also collected at "treatment" and "control" sites in Durham, NC (raised crosswalks), Greensboro, NC (bulbouts), Montgomery County, MD (raised crosswalks), Richmond, VA (bulbouts), and Sacramento, CA (bulbouts). The key findings include: (1) Overall vehicle speeds were often lower at treatment sites than at control sites. (2) The combination of a raised crosswalk with an overhead flasher increased the percentage of pedestrians for whom motorists yielded. It is not known what part of the improvement was attributable to the raised crosswalk and what part was attributable to the flasher. None of the other treatments had a significant effect on the percentage of pedestrians for whom motorists yielded. (3) The treatments usually did not have a significant effect on average pedestrian waiting time. (4) Refuge islands often served to channelize pedestrians into marked crosswalks. The raised inter- section in Cambridge also increased the percentage of pedestrians who crossed in the crosswalk. In conclusion, these devices have the potential for improving the pedestrian environment. However, these devices by themselves do not guarantee that motorists will slow down or yield to pedestrians. Also online at http://www.tfhrc.gov/safety/pedbike/pubs/0104.pdf

Florida Department of Transportation. (1999). *Florida Department of Transportation's Roundabout Guide.* Tallahassee, FL.

This guide developed guidelines to assist operating agencies with decisions regarding roundabout design and implementation. The purpose of the guide is to provide guidance for the planning, design and operation of roundabouts in Florida. It deals with the identification of appropriate sites for roundabouts, the geometric design of roundabouts to meet FDOT requirements and operational considerations such as signing, marking, lighting and landscaping.

Institute of Transportation Engineers. (1997). *Traditional Neighborhood Development Street Design Guidelines: Proposed Recommended Practice.* Washington, D.C.

This report includes a discussion of the concepts of traditional neighborhood development (TND), which are also referred to as "the new urbanism," as they relate to the role of streets in TND communities; a discussion of the community design parameters under which the guidelines would apply; presentation of the design principles underlying the guidelines; specific guidance on geometric street design; and an appendix that summarizes some recent findings on the relationship between urban design and travel demand. Also online at http://safety.fhwa.dot.gov/fourthlevel/pdf/TND_Manual.pdf

Institute of Transportation Engineers. (1999). *Traffic Calming: State of the Practice*. Washington, D.C.

This report contains a synthesis of traffic calming experiences to date in the United States and Canada. It includes information on traffic calming in residential areas and in areas where high speed rural highways transition into rural communities. The report draws from detailed information collected on traffic calming programs in twenty featured communities, another 30 communities surveyed less extensively, and a parallel Canadian effort by the Canadian ITE (CITE) and the Transportation Association of Canada (TAC). The intended audience is transportation professionals. Also online at:http://safety.fhwa.dot.gov/fourthlevel/pdf/ite/intro.pdf (document in full)http://www.ite.org/traffic/tcstate.htm#tcsop (by chapter)

Langdon, P. (2003). "Calming Rural Roads." *Planning*, Vol. 69 Issue 5, p30.

Describes how traffic calming and context-sensitive design can improve small towns bisected by state routes. Objective of the road design to reduce speed along selected segments; Entrance points containing devices intended to lower average speed; Importance of research to demonstrate that traffic-calming techniques do not endanger motorists.

National Highway Traffic Safety Administration. (2000). *Bicycle Safety Resource Guide*. Washington, D.C.

This guide, available on CD, provides an excellent summary of current bicycle safety research along with specific recommendations..

Opiela, K. et al. (2003). "Driving After Dark." *Public Roads*, Vol. 66 Issue 4, p22.

Focuses on the efforts of the U.S. Federal Highway Administration (FHWA) to improve the night visibility of traffic control devices to make the roads safer for motorists and pedestrians. Actions taken by the FHWA to provide state and local agencies with information on verifiable improvements that can save lives and reduce traffic crashes; Analysis of the Fatality Analysis Reporting System data for 2000 regarding fatal crashes.

Seattle Department of Transportation. (1996). *Making Streets that Work – A Neighborhood Planning Tool*. Seattle, WA.

This document is a two-part educational tool for the creation of strong, sustainable communities based on street design. The guidebook is divided into four chapters preceded by a brief introduction discussing general project information and followed by an extensive section on additional resources. The guidebook is intended to help communities better understand neighborhood issues, identify opportunities, and recommend changes to streets as part of their neighborhood's planning process.

Seattle Engineering Department. (1994). *Traffic Control Manual for In-Street Work*. Seattle, WA.

This report provides information about establishing safe construction and work zones that consistently and clearly convey to motorists that work is being performed in the roadway.
http://www.cityofseattle.net/transportation/trafficcontrolmanual.htm

Safety Resources

Bustos, T. et al. (1996). "Use and Review of Bicycle Signal Head Installations in Davis, California", paper presented at Pro Bike/Pro Walk, September 1996, Portland, Maine.

Do, A. (2002). "Walking the Safety Walk." *Public Roads*, Vol. 66 Issue 2, p2.

> Focuses on the launch of the guidebook 'Pedestrian Facilities User Guide--Providing Safety and Mobility' by the U.S. Federal Highway Administration. Benefits of the guidebook for pedestrian safety; Key factors that affect pedestrian crash problems in the country; Information on locations for safety treatments where pedestrian crashes have occurred and are likely to occur again.

Federal Highway Administration. (1996). *Pedestrian and Bicycle Crash Types of the Early 1990's*, FHWA-RD-95-163 (Out of print). Washington, D.C.

> The purpose of this research was to apply the basic National Highway Traffic Safety Administration (NHTSA) pedestrian and bicyclist typologies to a sample of recent crashes, and to refine and update the crash-type distributions, paying particular attention to roadway and locational factors.

Federal Highway Administration. (1997). *Pedestrian Crash Types: A 1990's Informational Guide*, FHWA-RD-96-163. Washington, D.C.

> The purpose of the research was to apply the basic National Highway Traffic Safety Administration (NHTSA) pedestrian and bicyclist typologies to a sample of recent crashes and to refine and update the crash type distributions with particular attention to roadway and locational factors. This particular informational guide provides detail on specific pedestrian-motor vehicle crash types (e.g., intersection dash) through two-page layouts that contain a sketch, description, and summary of the crash type, various graphs, and "bullet" information boxes.

Federal Highway Administration. (1999). *Pedestrian and Bicycle Crash Analysis Tool (PBCAT), Software and User's Manual*, FHWA-RD-99-192. Washington, D.C.

> PBCAT is a software product intended to assist state and local pedestrian and bicycle coordinators, planners, and engineers with the problem of bicycle and pedestrian crashes and fatalities. PBCAT uses a data base to analyze details associated with crashes between motor vehicles and pedestrians or bicyclists. Once the data base is developed, the software can then be used to produce reports and select countermeasures to address the problems identified. Also online at http://www.fhwa.dot.gov/safety/fourthlevel/pdf/pbcat.pdf

Federal Highway Administration. *(2002). Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines,* FHWA-RD-01-075. Washington, D.C.

The study results revealed that on two-lane roads, the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate, compared to an unmarked crosswalk. Further, on multi-lane roads with traffic volumes above about 12,000 vehicles per day, having a marked crosswalk alone (without other substantial improvements) was associated with a higher pedestrian crash rate (after controlling for other site factors) compared to an unmarked crosswalk. Raised medians provided significantly lower pedestrian crash rates on multi-lane roads, compared to roads with no raised median. Older pedestrians had crashes that were high relative to their crossing exposure. More substantial improvements were recommended to provide for safer pedestrian crossings on certain roads, such as adding traffic signals with pedestrian signals when warranted, providing raised medians, speed-reducing measures, and others.

Federal Highway Administration. *Pedestrian and Bicycle Safety Research Guide*. Retrieved October 7, 2003 from FHWA website: http://www.tfhrc.gov/safety/pedbike/research/research.htm

This web-based referenced guide is sponsored by the Federal Highway Administration The website provides information on issues and research related to improving pedestrian and bicyclist safety. Emphasis is on fostering public awareness of pedestrian and bicycle safety matters, and providing safety tools for use at the national, state and local levels. The site provides links (html and pdf) containing quantitative data which evaluate the success of both local and international cases.

National SAFE KIDS Campaign. (2003). *Stop Sign Violations Put Child Pedestrians at Risk: A National Survey of Motorist Behavior at Stop Signs in School Zones and Residential Areas*. Washington D.C.

This study examines the frequency of driver compliance with stop signs at unsignalized, marked and unmarked pedestrian crosswalks near schools and in residential areas. And finds that despite the fact that decreased rates of walking have contributed to a significant decline in child pedestrian deaths and injuries, pedestrian injury remains a leading cause of unintentional injury-related death among children. Concludes with policy recommendations through education, enforcement and engineering. Also online at http://www.safekids.org/content_content_documents/Stop_Sign_Violation_Put_Child_Pedestrians_At_Risk_-full_report.pdf

Redmond, T.; Boodlal, L. (2003). "Life in the Crosswalk." *Public Roads*, Vol. 66 Issue 4, p32.

Focuses on the importance of pedestrian safety. Purpose of the pedestrian safety outreach campaign; Efforts made by the U.S. Federal Highway Administration (FHWA) to educate drivers on pedestrian safety; Unique features of the Pedestrian Safety Engineering and Intelligent Transportation System-Based Countermeasures Program launched by FHWA; University course on pedestrian and bicyclist facility design. INSETS: Pedestrian and Bicycle Crash Analysis Tool; Safer Journey.

Retting, R. (1999). "Traffic Engineering Approaches to Improving Pedestrian Safety." *Transportation Quarterly*, Vol. 53 Issue 2, p87.

Details case studies that illustrate methods for designing pedestrian bridges. Collaboration between architect and engineer; Use of hybrid of design and safety standards from many sources; Innovative structural combinations; Cable-stay and suspension bridges; Factors being considered when choosing materials for pedestrian bridges; Importance of lighting; Vibration and loads.