Eugene Pedestrian and Bicycle Facility Design Toolkit

2008

Acknowledgments

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Introduction

Pedestrian and bicycle facilities are the physical components of the transportation infrastructure used by those who walk, ride or otherwise propel themselves by human power. They may also be facilities that are not used by pedestrians and bicyclists directly, but serve to enhance the walking or biking experience. Transportation infrastructure planning and design involves balancing the needs and desires of a range of users while considering the myriad trade-offs presented by different alternatives. Transportation planners and engineers strive to serve their communities by following best planning and design practices while adhering to recommendations and guidelines set by various professional and technical organizations. A selection of current best practices in pedestrian and bicycle infrastructure is included in this design toolkit. It is meant to be used as a resource to aid in decision making that supports a balanced transportation system.

This design toolkit draws on national, state and local design and planning documents to integrate these resources into one convenient, easy to use facility design guide. Specifically, it seeks to: (1) collect and summarize the existing standards into one document; (2) offer guidelines for determining what type of design is appropriate for a given situation; and (3) present information about innovative designs that may be in use in some cities, but lack standardization in current design guides.

Creating a safe, practical and enjoyable transportation network involves the coordination of many different stakeholders. This design toolkit is intended to serve not only transportation engineers and planners, but also advocates, community leaders and interested citizens. The toolkit is organized into three sections:

- Pedestrian Facilities
- Bicycle Facilities
- Traffic Calming Features

Regulations and Policy Framework

Transportation planning and engineering is part science, part art and part sociology. Given its dynamic and often political nature, it is impossible and impractical to create a guide prescribing cookie-cutter solutions for complex issues.

One approach to balancing the need for consistency with flexibility is to provide a range of standards from the preferred to the minimum. For example, The *Oregon Bicycle and Pedestrian Plan*, a non-regulatory guide for Oregon communities, recommends a standard sidewalk width of 6 feet and a minimum of 5 feet[1]. Eugene's *Arterial and Collector Street Plan* (ACSP) calls for a minimum sidewalk width of 5 feet, but up to 10 feet for pedestrian oriented commercial areas.[2]

This design toolkit references these local and state documents as well as national guidelines where appropriate to ensure that designs meet regulatory requirements. In

1 Oregon Department of Transportation, *Oregon Pedestrian and Bicycle Plan*, 1995, 91.
2 City of Eugene, Arterial Collector Street Plan, 1999, 52.

some cases these resources are national in scope such as the *Manual on Uniform Traffic Control Devices* (MUTCD). Others like the *Oregon Bicycle and Pedestrian Plan* are regulatory for the State of Oregon. Local planning documents often reference these guides while establishing policies and regulations for specific locations within the community.

National Standards and Guidelines

The following documents from the Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers (ITE) serve as references for the guidelines and standards in this design toolkit.

Several organizations operate at a national level to regulate facilities design and application. FHWA is an agency in the U.S. Department of Transportation that provides technical assistance and financial support for roads and highways throughout the nation. AASHTO is a national non-profit organization that provides technical support and policy guidance for states to "*foster the development, operation and maintenance of an integrated national transportation system*".[3] ITE is an association of transportation professionals that is international in scope. ITE's primary mission is education and research to promote the effective application of science and policy to transportation planning and technology.[4]

Manual on Uniform Traffic Control Devices (MUTCD)

The Federal Highway Administration produced the *Manual on Uniform Traffic Control Devices* to provide guidelines and standards to ensure nationwide uniformity in traffic control devices such as signs and pavement markings. Non-compliance with MUTCD can ultimately lead to a loss of federal funding for transportation infrastructure as well as expose the agency or jurisdiction to liability.[5] In Oregon all traffic control devices must conform to MUTCD.[6]

The American Association of State Highway and Transportation Officials (AASHTO)

A Policy on the Geometric Design of Highways and Streets provides recommended standards for roadway dimensions. Pedestrian and bicycle facility designs are treated separately in *The Guide for Planning, Design, and Operation of Pedestrian Facilities* and *Guide for the Development of Bicycle Facilities (1999).* Each of these documents provides recommendations rather than regulations, but state Departments of Transportation often adopt AASHTO guidelines as their standards. The *Oregon Pedestrian and Bicycle Plan* includes standards for pedestrian and bicycle facilities that meet or exceed AASHTO guidelines.[7]

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3 American Association of State Highway and Transportation Officials website, http://www.transportation.org/?siteid=37&pageid=310, (May 14, 2007).

4 Institute for Transportation Engineers website, http://www.ite.org/aboutite/index.asp, (May 14, 2007).

5 Federal Highway Administration website, http://mutcd.fhwa.dot.gov/kno-overview.htm, (May 14, 2007).

6 Oregon Department of Transportation, *Oregon Pedestrian and Bicycle Plan*, 1995, 37.

7 Oregon Department of Transportation, *Oregon Pedestrian and Bicycle Plan*, 1995, 37.

Americans with Disabilities ACT of 1990 (ADA)

ADA is a landmark civil rights bill that prohibits discrimination towards individuals with disabilities. In regards to transportation systems, this act establishes the legal rights of people with disabilities to have access to both public and private facilities. The ADA Accessibility Guidelines (ADAAG) serve as a regulatory guide for designing facilities that are compliant with this legislation.

ITE Design and Safety of Pedestrian Facilities

The ITE guide to pedestrian facilities incorporates MUTCD, ADA and AASHTO standards and cites primary research to support guidelines for design application. This document published in 1998 still contains relevant information, but more current documents may include more information on innovative approaches to facilities design that were not well researched at the time of the last edition of *Design and Safety of Pedestrian Facilities*.

More recent references from ITE include, *Improving the Pedestrian Environment Through Innovative Transportation Design* (2005) and *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities* (2006). Both documents include information on bicycle facility designs in addition to pedestrian facility designs. *Improving the Pedestrian Environment Through Innovative Transportation Design* includes case studies of safety awareness programs and examples of design implementation. *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities* promotes Context Sensitive Solutions (CSS), a holistic approach to infrastructure design that emphasizes flexibility and collaboration between engineers, planners and citizens.

State Guidelines

The Oregon Department of Transportation (ODOT) published the *Oregon Bicycle and Pedestrian Plan* in 1995 and is in the process of developing a revised edition. The policies and standards described in the ODOT manual meet or exceed the AASHTO standards and comply with the ADAAG. Similarly, all signing and striping designs in this plan are compliant with the MUTCD.

While these standards are applied to all State Highway projects within ODOT jurisdiction, they are recommended but not required for local jurisdictions. In some cases the local design standards may exceed ODOT standards. When ODOT is working with a local jurisdiction on a project, the more appropriate design standard should be used. What is deemed appropriate is dictated by local planning goals, physical constraints, environmental concerns and other context variables.

> "Traffic control devices installed on highways within the State of Oregon are required to conform to the Manual on Uniform Traffic Control Devices (MUTCD), published by the Federal Highway Administration (FHWA). Deviations to the MUTCD are published in the Oregon Supplement to the MUTCD and made for justifiable reasons such as instances where Oregon law deviates from the MUTCD. These deviations are adopted through the OAR process and by permission of the FHWA."[8]

8 Oregon Department of Transportation. Oregon Supplement to the MUTCD, 1995, 2.

Local Framework

Policies in the Eugene-Springfield Metropolitan Area Transportation Plan (*TransPlan*) direct growth and development of the transportation infrastructure in the Eugene-Springfield Metropolitan Area. More specific details can be found in the plans that serve as functional and refinement plans to *TransPlan*. Figure 1 shows the relationship between these plans.

The Eugene-Springfield Metropolitan Area Transportation Plan (TransPlan)

TransPlan is the transportation component of the Eugene-Springfield Metropolitan Area General Plan (Metro Plan). Adopted in 2001, the policies in TransPlan are designed to support Metro Plan goals and land use patterns by addressing the principle modes of transportation in the metropolitan area including automobiles, buses, bicycles and walking.

Arterial and Collector Street Plan (ACSP) and Local Street Plan (LSP)

Adopted in 1999, ACSP describes specific policies that apply to Eugene's major streets. The street classification that is defined in ACSP and LSP provide common terms and concepts that guide future street development. The terms 'Arterial', 'Collector' and 'Local' streets apply to functional categories. ACSP is a policy and design standards guide; it does not propose specific projects. Unlike *TransPlan*, ACSP applies only to the City of Eugene.[9] Where roadways fall under the jurisdiction of the County or the state, ACSP standards will be advisory and not replace existing intergovernmental agreements.[10]

The Design Standards for Eugene Streets, Sidewalks, Bikeways, and Accessways

This document was adopted in 1999 in conjunction with ACSP. It contains standards for facilities that are usually included in the transportation right-of-way such as sidewalks, cross-walks, on-street bicycle lanes and vehicle travel space. Traffic calming measures and pedestrian facility enhancements are also included. Prior to the development of this Pedestrian and Bicycle Design Toolkit, ACSP was the primary source for pedestrian and bicycle facility design standards in Eugene.

The Central Area Transportation Study (CATS)

Unlike ACSP, CATS applies to a limited area of the City and includes specific projects and implementation strategies. The original CATS was completed in 1987. Its purpose was to improve transportation infrastructure and parking and preserve air quality in the downtown area. In the early 1990's the City Council directed City staff to update CATS to address alternative modes of transportation with the goal of increasing bus ridership and bicycle use. The CATS update, adopted in 1993, included policies and strategies that have since been largely implemented. The implemented accomplishments include a new central transit station adjacent to the library, increased on-street parking, new parking structures, increased bike lanes, re-opening of the downtown pedestrian mall to vehicle traffic, conversion of some one-way streets to two-way and the adoption of land use and development codes that facilitate pedestrian oriented mixed-use development.

The CATS area includes the downtown area, the University of Oregon, Riverfront Research Park, the Federal Courthouse, Eugene Water and Electric Board (EWEB) property and portions of the Jefferson-Westside and Fairmount Neighborhoods. The

9 City of Eugene, Arterial Collector Street Plan, 1999, 12.
10 City of Eugene, Arterial Collector Street Plan, 1999, 15.

2003 CATS update focuses on the downtown area. It includes 11 adopted policies aimed at improving the system for walking, biking, transit use and ensuring adequate and convenient automobile parking. For each of the adopted policies, CATS also describes proposed implementation strategies, although these strategies are not adopted City policies.

City of Eugene Municipal Code

Adopted City codes also establish regulations for some transportation facilities. In particular, Chapter 7 of the City Code addresses sidewalks, curbs and driveway requirements. In some instances the facilities must meet the approval of the City engineer or established City specifications. In other instances the code is written to include detailed specifications.

Summary of Acronyms

ACSP – City of Eugene Arterial Collector Street Plan

ADA – Americans with Disabilities Act

ADAAG - Americans with Disabilities Act Accessibility Guidelines

AASHTO - American Association of State Highway and Transportation Officials

CATS - Central Area Transportation Study

FHWA - Federal Highway Administration

ITE - Institute of Transportation Engineers

LSP – City of Eugene Local Street Plan

MUTCD - Manual on Uniform Traffic Control Devices

ODOT – Oregon Department of Transportation

Pedestrian Facilities

Pedestrian Refuges

Definition: Pedestrian refuges are asphalt rises (sometimes they have landscaping) in the street that physically separates the directional flow of traffic. Refuges are wide enough for pedestrians to stand on while waiting to continue crossing the street.

Purpose: Pedestrian refuges are recommended when the roadway used for pedestrian crossing is greater than 60 feet wide or has more than four travel lanes. Refuges are used at both signalized and unsignalized crosswalks and where it's preferable to have additional safe space. Refuges are especially effective in locations with concentrations of elderly individuals or individuals with disabilities.

Guidelines: (1) The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings. (2) On streets with speeds above 25 mpg (40 km/h) there should also be double centerline marking, reflectors, and "KEEP RIGHT" signage. (3) If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Tree species should be selected for small diameter trunks and tree branches should be no lower than 14 feet. Shrubs and ground plantings should be no higher than 1 foot 6 inches. (4) Refuge islands at intersections should have a median "nose" that gives protection to the crossing pedestrian (Portland Pedestrian Design Guide, page C-15). (5) Islands must be large enough to provide refuge for several pedestrians waiting at once. (6) For wheelchair accessibility, it is preferable to provide at-grade cuts rather than ramps. (7) "Poles must be mounted away from curb cuts and out of the pedestrian path" (ODOT Bicycle and Pedestrian Plan 2007, Chapter 6, page 5).

Advantages: Reduces the distance a pedestrian must cross in the allotted crossing time.

Disadvantages:

Policy/Regulations: (1) Pedestrian facilities must be designed to meet or exceed the requirements of the Americans with Disabilities Act (ADA). (2) The Manual on Uniform Traffic Control Devices (MUTCD) requires that clearance intervals be based on a walking speed of 4 feet per second for typical pedestrians and 3 feet per second for elderly pedestrians (FHWA: A Review of Pedestrian Safety Research in the United States and Abroad, January 2004, page 86). (3) Installation of crossing islands should be considered where the crossing distance exceeds 60 feet (AASHTO, July 2004, page 75).

Dimensions: An island must be a minimum of 6 ft wide, preferably 8 ft or more. (ODOT Bicycle and Pedestrian Plan 2007, Chapter 6, page 5)

Cost: Range from $4,000 to $30,000. The cost for an asphalt island without landscaping is less than the cost of installing a raised concrete pedestrian island with landscaping. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 72)

Curb Extensions (pedestrian and traffic calming)

Definition: Curb extensions are sidewalk segments that extend into the roadway at an intersection or mid-block crossing.

Purpose: Extensions reduce the crossing width for pedestrians and can help reduce motorist traffic speeds. Curb extensions are appropriate for crosswalks where shortening the crossing distance is desirable.

Guidelines: (1) A parking lane must be adjacent to the curb wherever curb extensions are installed. (2) For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 feet and the two radii should be balanced to nearly equal. (Portland Pedestrian Design Guide, page C-14)

Advantages: (1) Increases access for fire engines and other large emergency vehicles. (2) Creates additional space for curb ramps, landscaping, and street furniture. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, pages 69-70)

Disadvantages: Turning needs of larger vehicles, such as school buses, should be considered in curb extension design. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, pages 69-70)

Policy/Regulations: A new standards plan is currently under development. (Portland Pedestrian Design Guide, page C-14)

Dimensions: Curb extensions should extend the width of the parking lane, approximately 6 feet from the curb. (AASHTO, July 2004, page 74)

Cost: Curb extensions cost $2,000 to $20,000 per corner. Drainage is usually the most significant determinant of cost. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, pages 69-70)

Raised Crosswalks (pedestrian and traffic calming)

Definition: Raised crosswalks are found in the roadway extending across intersections. Raised crosswalks differ from conventional crosswalks by having a 6 in. surface level increase above the roadway.

Purpose: To increase the visibility and prominence of pedestrians crossing the roadway.

Guidelines: Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway. The design of the vehicular approach to a raised crosswalk will vary depending on the context (i.e. whether the road is an emergency response route or if a traffic calming effect is desired).

Advantages: (1) Reduces traffic speeds at crosswalks. (2) Allows pedestrians easier crossing. (3) The highlighted crossing allows motorists to focus on pedestrian safety. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 61-62)

Disadvantages: (1) Pedestrians with disabilities may experience discomfort while travelling the raised area. (2) The boundary between the street and the sidewalk may be difficult to detect for the visually impaired. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 61-62)

Policy/Regulations: Where there is a need to control traffic speeds and improve visibility of crosswalk. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 61-62)

Dimensions: Crosswalks are to raise 6 inches above roadway grade.

Cost: $5,000 to $20,000 per crosswalk depending on street width and drainage. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 61-62)

Marked Crosswalks

Definition: Marked crosswalks prominently indicate pedestrian roadway crossings by using painted patterns or colored concrete.

Purpose: Marked crosswalks are used to facilitate crossing for the visually impaired, and to remind motorists of potential conflicts with pedestrians.

Guidelines: (1) At signalized intersections, all crosswalks should be marked. (2) At unsignalized intersections, crosswalks should be marked when such marking will: a) Help orient pedestrians who are crossing an intersection b) Show pedestrians the shortest and safest path across the roadway, and c) Position pedestrians where they can best be seen by oncoming traffic. (3) At midblock locations, crosswalks should be marked when: a) There is a special demand for mid-block crossing, or b) There are no nearby marked crosswalks. (4) Use parallel pavement markings for signalized or stop controlled crosswalks. A parallel pavement marking consists of two 1 foot wide stripes placed 10 feet apart (inside dimension) to delineate the outside edges of the crosswalk, parallel to pedestrian travel. Where there is a compelling reason to narrow the crosswalk, the inside dimension between strips may be reduced to 6 feet. (5) Use ladder pavement markings for crosswalks at school crossings, across arterial streets for pedestrian-only signals, at midblock crosswalks, and where crosswalks cross streets not controlled by signals or stop signs. A ladder pavement marking consists of 2 feet wide, 10 feet long bars on 5 feet centers, with the bars placed perpendicular to pedestrian travel. (6) Where the sidewalk corridor width exceeds 12 feet the crosswalks may be wider than the standard width to match the sidewalk corridor. (7) At midblock locations, marked crosswalks are always accompanied by signing to warn drivers of the unexpected crosswalk. (8) The crosswalk should be located to align as closely as possible with the Through Pedestrian Zone of the sidewalk corridor. (9) Where traffic travel lanes are adjacent to the curb, crosswalks should be set back a minimum of 2 feet from the edge of the travel lane. (Portland Pedestrian Design Guide, page C-17)

Advantages: 1) Warns motorists to expect pedestrian crossings. 2) Indicates preferred crossing locations. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 45)

Disadvantages: (1) Without proper surface treatments sidewalks can be slippery. (2) May not be visible to motorists at night. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 45)

Policy/Regulations: (1) A traffic control device should be installed at all intersections, either sign or signal. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110) (2) Provide ADA-compliant wheelchair ramps (two per corner) at all intersections. (3) Provide signal heads (Walk/Don't Walk) at all signalized intersections, except where pedestrian movements are prohibited. (ACSP Design Standards, November 1999, page 70)

Cost: $100 for a regular striped crosswalk, $300 for a ladder stripped crosswalk, and about $3,000 for a patterned concrete crosswalk. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 45)

Sidewalks

Definition: Sidewalks are paved paths that parallel a highway, road, or street intended for pedestrian travel.

Purpose: Sidewalks provide pedestrians a walking area in the right-of-way that reduces pedestrian collisions with motor vehicles.

Guidelines: (1) Continuous walkways are the goal. (2) Sidewalk locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority. (3) Street furniture placement should not restrict pedestrian flow. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 52)

Advantages: Provides adequate walking area alongside a roadway.

Disadvantages: Non-continuous sidewalks pose mobility problems.

Policy/Regulations: (1) Construct sidewalks along all urban area arterial and collector roadways, except freeways. (2) Policy Definition/Intent: TSI Pedestrian Policy #3 supports the construction of sidewalks during roadway construction or reconstruction, the prioritized retrofitting of corner sidewalks with curb ramps, and infill of missing sidewalk sections. (3) Specific design standards for sidewalks along collectors and arterials and local street sidewalk policies and requirements are established by local jurisdictions. (Reference: Based on TPR 660-12-045(3) (b) (B).)

ADA: The design of sidewalks is covered by the ADA Interim Final Rule for State and Local Government Facilities issued by the Architectural and Transportation Barriers Compliance Board on June 20, 1994:

> "a) A minimum clear passage of 36 inches is required; and when public sidewalk width is less than 60 inches, 5-foot-square "passing areas" are required at intervals not to exceed 200 feet. b) There is no limit on running slope or a requirement of intermediate landings ("passing areas") for a public sidewalk when it follows the grade of the street. c) The maximum cross slope of 1:50 is allowed for a sidewalk."

(Architectural and Transportation Barriers Compliance Board, *Interim Final Rule for State and Local Government Facilities, Federal Register*, 59 (121), 36 CFR Part 1191)

Dimensions: Minimum widths: a) Local or collector streets at 5 feet: b) Arterial or major streets at 6 to 8 feet; c) Central Business District areas at 8 to 12 feet. d) Along parks, schools and other pedestrian generators at 8 to 10 feet. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 148) e) Provide an additional 2 feet when the sidewalk abuts a storefront to accommodate window shoppers and to avoid conflicts with doors opening. (AASHTO, July 2004, page 59)

Cost: Concrete curbs and sidewalks cost approximately $15/linear foot for curbing and $11/square foot for walkways. Asphalt curbs and walkways are less costly, but require more maintenance. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 52)

Lighting Improvements

Definition: Lighting improvements are pedestrian-scale (no higher than 10 to 12 feet in height) street lights. Lighting improvements are installed along sidewalks, crosswalks, and streets.

Purpose: Provides additional safety for all roadway users, especially pedestrians. Lighting enhances commercial districts and allows for increased nighttime safety.

Guidelines: (1) Ensure sidewalks and crosswalks are well lit. (2) Install lighting on both sides of wide streets for streets located in central business districts. (3) Use consistent lighting levels for continuous street segments. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 57) (4) Lighting should be adequately spaced to provide a uniform level of light. (AASHTO, July 2004, page 53)

Advantages: Increases ambiance and attractiveness of place. Provides an increased sense of safety from crime and reduces the occurrence of tripping accidents.
(Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 57)

Disadvantages: Increases maintenance and utility costs. Neighboring residents may object to "light pollution".
(Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, Page 57)

Policy/Regulations: (1) Provide street lighting on arterial and collector streets to: a) Enhance safety for all modes of travel b) Illuminate streets and sidewalks but minimize unwanted spillover light, and c) Enhance the overall safety and appearance of the street and its immediate environment. (2) Provide pedestrian-scale lighting, where appropriate, to provide separation from street traffic and human scale spatial definition. Pedestrian-scale street lights should be lower than conventional street lights, spaced more closely, and should provide more illumination of the sidewalk. To provide identity for certain districts, consider special light standards such as antique replicas.
(ACSP Design Standards, November 1999, page 75)

Light Types: "Mercury vapor, incandescent, or less expensive high-pressure sodium lighting is often preferred as pedestrian level lighting."
(Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 57)

Dimensions: Usually 97 feet apart, and 10 to 12 feet high. (Alternative Treatments for At-Grade Pedestrian Crossings, page 44)

Cost: "Varies depending on fixture type and service agreement with local utility." (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 57) The typical cost is $2,000 to $3,000 per streetlight. (Alternative Treatments for At-Grade Pedestrian Crossings, page 44)

Pedestrian Overpasses/Underpasses

Definition: Pedestrian overpasses/underpasses are areas that transverse the roadway without disturbing the flow of either pedestrian or motorist movement.

Purpose: Underpasses/overpasses provide separation between pedestrians and vehicles by providing an unimpeded crossing facility.

Guidelines: (1) Use when busy or high-speed highways, railroad tracks, or natural barriers impede the movement of pedestrians. (2) Must be wheelchair accessible. (3) Overpasses are better when the topography allows for a structure without ramps. (4) Underpasses are more efficient when designed to feel safe, open and accessible. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 58)

Advantages: Provides a crossing facility where other pedestrian crossing options would not be feasible.

Disadvantages: (1) Pedestrians will only use the crossing aid if overpass/underpass is the best option to cross the barrier. (2) The overpass/underpass is often visually intrusive. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 57)

Policy/Regulations: Regulations in the Draft Guidelines for Accessible Public Rights of Way. The American Association of State Highway and Transportation Officials (AASHTO) recommend a railing height of at least 4.5 feet on bridges to protect bicyclists from strong wind gusts. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 57) Overpasses need to either provide elevator access or meet ADA ramp criteria for a maximum slope of 8.33 percent. (AASHTO, July 2004, page 98)

Dimensions: Varies depending on the distance of the barrier impediment. Underpasses should be at least 12 to 16 feet wide, with wider widths suggested for lengths over 60 feet. The vertical clearance should be a minimum of 8 feet, but longer distances may require a vertical clearance of 10 feet. (AASHTO, July 2004, page 98)

Cost: $500,000 to $4 million dollars depending on size, construction materials and land acquisition. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 58)

Traffic Diverters

Definition: A traffic diverter is a concrete island or partition that forces vehicular traffic in a particular direction.

Purpose: To discourage or prevent traffic from cutting through a neighborhood by preventing certain through and/or turning movements.

Guidelines: (1) Evaluate traffic patterns to detect if other streets will be affected by particular diverter. (2) Design diverters to allow emergency vehicles, pedestrians and bicyclists access. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93)

Advantages: Diverts traffic to decrease conflicts and traffic density. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93)

Disadvantages: Doesn't allow motorists to make some desired turns. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93)

Policy/Regulations: Installed where a local or neighborhood street intersects a major street or collector. Make sure local residents can proceed with desired turns. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93)

Dimensions: Four types of diverters can be installed with varying dimensions depending on desired turn lanes. The four diverter types are; a) diagonal, b) star, c) forced turn, d) truncated. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93)

Cost: $15,000 to $45,000 for each diverter, depending on the type and size.
(Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 92-93).

Bicycle Facilities

Bicycle Lanes

Definition: Bicycle lanes are a preferential space for bicycle travel within the street right-of-way. The separate space can be designated by use of asphalt paint or a raised surface.

Purpose: Bicycle lanes help reduce the volume of bicyclists attempting to overtake motorist in narrow or congested areas. Installing bicycle lanes on wide streets encourages lower motor vehicle speeds by narrowing the roadway.

Guidelines: (1) The road or street should be evaluated to determine if bike lanes are appropriate. (2) Provide a smoothly paved surface and keep the bike lane free of debris. (3) Provide adequate space between the bike lane and parked cars so that open doors do not create a hazard for bicyclists. (4) Avoid termination of bike lanes where bicyclists are left in a vulnerable situation. (5) Determine if special signs or markings are necessary for situations such as a high-volume of bike left turns on a busy road (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 72).

Advantages: (1) Improves bicyclist safety along commuter routes, and (2) Creates direct transportation routes unimpeded by motorist and pedestrian travel.

Disadvantages: Can collect debris

Policy/Regulations: (1) A bicycle lane as defined by ORS 801.155 (6) shall be separated from the adjacent roadway by a single, solid eight-inch wide white stripe. (1995 Oregon Bicycle and Pedestrian Plan, Appendix I, page 242) (2) Optional NO PARKING signs (R7-9 and R7-9a) may be installed if problems with parked cars occur; painting curbs yellow also indicates that parking is prohibited. (1995 Oregon Bicycle and Pedestrian Plan, page 145) (3) Stencils should be placed after most intersections; This alerts drivers and bicyclists entering the roadway of the exclusive nature of the bike lanes. Stencils should be placed after every intersection where a parking lane is placed between the bike lane and the curb. Supplementary stencils may also be placed at the end of a block, to warn cyclists not to enter a bike lane on the wrong side of the road. Additional stencils may be placed on long sections of roadway with no intersections. A rule of thumb for appropriate spacing is: multiply designated travel speed (in MPH) by 40. For example, in a 35 MPH speed zone, stencils may be placed approximately every 1400 feet. Metric formula: speed times 7; e.g., appropriate spacing in a 60 km/h zone is approximately 400 m (1995 Oregon Bicycle and Pedestrian Plan, page 146). (4) Bicycle lanes shall be a minimum of 5 feet wide and shall be free from obstacles such as drainage grates and utility covers (ACSP Design Standards, November 1999, page 54).

Dimensions: Bike lanes are typically 4 to 6 feet in width and are designated by striping and/or signs (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 72).

Cost: Installing a bike lane costs $5,000 to $50,000 per mile. It is most cost efficient to create bike lanes during street reconstruction, street resurfacing or at the time of original construction (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 72).

Colored Bike Lanes

Definition: Blue bike lanes are colored zones designating bicycle travel. Colored zones define the boundaries for bicycle travel in shared areas.

Purpose: Colored zones increase awareness of bicycles and safe motorist behavior. A light blue color is used to designate the bike lane because it doesn't have another accepted meaning to motorists, is easily detectable for color-blind individuals, and is usually visible in low-light or wet road conditions. The City of Eugene currently has a blue bike zone near the intersection of River Road and Beltline Highway.

Guidelines: The blue bike lane should be used where the bicyclist travels through (straight ahead) and the motorist crosses the bicycle lane to, (1) exit a roadway, (2) move into a right turn lane, or (3) Merge into the bicyclist's street from a ramp. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 226-229)

Advantages: Thermoplastic color treatment lasts longer than typical painting. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 226-229)

Disadvantages: Painted markings typically don't last longer than two months at high traffic locations. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 226-229)

Policy/Regulations: The blue bike lanes are not compliant with the *Manual on Uniform Traffic Control Devices*, nor is it currently being considered for inclusion. Any jurisdiction deciding to use blue bike lanes should seek experimental approval from the Federal Highway Administration. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 226-229)

Cost: Painted sites cost on average about $90 a site for materials and labor. Thermoplastic sites cost about $2,000 a site for materials and labor (but last considerably longer). (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 226-229)

Turning Lane Treatments (where bike lanes cross or share auto turn lanes)

Definition: When adequate space is not available to the left of a motorist's right-turn lane for a 4 foot bike lane, then the bicyclist must share the turning lane with the motorist.

Purpose: Turning movements are complicated at intersections when bicyclists and motorists traveling at different speeds must share the same lane.

Guidelines: Shared turning lanes are preferred on local streets with posted speeds at or below of 30 mph and traffic volumes of less than 10,000 vehicles per day.

Advantages: (1) Shared turning lanes reduce the impervious roadway area. (2) Reduces the right-of-way width requirement. (3) Could reduce motorist driving speeds as vehicles approach the turn anticipating a bicycle conflict.

Disadvantages: (1) Bicyclists sometimes position themselves beside cars, instead of in front or behind the vehicle. (2) Potential conflicts can occur if vehicles turn right on a red with bicycles positioned beside the car. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 223-225)

Policy/Regulations: The combined bicycle lane/right-turn lane design is shown in the *Oregon Bicycle and Pedestrian Plan* and has been reviewed, but not adopted by the Oregon Department of Transportation's Traffic Control Device Committee. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 223-225)

Dimensions: At a narrow lane-width site the bike lane is 5 feet and the turn lane is 7 feet wide. At a standard lane-width site the bike lane is 5 feet, while the turn lane is about 12 feet wide. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 223-225)

Cost: $1,500 in parts and labor per right-turn lane (note: not per intersection). (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 223-225).

Bicycle Boxes

Definition: The bicycle box is an extension of a bike lane that crosses in front of traffic at the forefront of an intersection. The bicycle box assists bicyclists in changing the side of the street on which they ride.

Purpose: The box enables bicyclists to get ahead of motorist traffic on a red traffic signal indication, and then resume travel before motorists when the traffic signal changes to green.

Advantages: Enables Lessons the number of bicycle conflicts with right-turning motorists (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 238-241).

Disadvantages: Currently, not widely understood by motorists or bicyclists (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 238-241).

Policy/Regulations: The bike box is not compliant with the *Manual on Uniform Traffic Control Devices*, nor is it currently being considered for inclusion. Any jurisdiction deciding to use the bike box should seek experimental approval from the Federal Highway Administration (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 238-241).

Cost: $2,500 in paint and labor per bike box. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 238-241).

Contra-Flow Bike Lanes

Definition: Contra-flow bike lanes counter the normal flow of traffic on one-way streets.

Purpose: Contra-flow bike lanes create specialized on-street lanes for bicyclists. These bike lanes enhance bike route connectivity by reducing out-of-direction riding on a one-way street network.

Guidelines: (1) Install contra-flow lanes on the left side of the street facing the one-way traffic. (2) Provide adequate bike lane width. (3) Avoid situations where there are many driveways, alleys, or streets that would intersect with the contra-flow lane. (4) Determine if there is room for a regular bike lane in the direction of motor vehicle travel on the opposite side of the street. (5) Must be separated from oncoming traffic by a double yellow line; This indicates that the bicyclists are riding on the street legally, in a dedicated travel lane. (6) Any intersecting alleys, major driveways, and streets must have signs indicating to motorists that they should expect two-way bicycle traffic. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 76)

Advantages: (1) A contra-flow bike lane provides a substantial savings in out-of-direction travel. (2) The contra-flow bike lane provides direct access to high use destinations. (3) Improved safety because of reduced conflicts on the longer route. (4) Bicyclists can safely and conveniently re-enter the traffic stream at either end of the section. (5) There is sufficient street width to accommodate a bike lane. (FHWA: Bicycle Lanes, http://safety.fhwa.dot.gov/ped_bike/univcourse/swless19.htm)

Disadvantages: Contra-flow riding places bicycles in a position where motorists do not expect to see them. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 212)

Policy/Regulations: Install only on one-way streets, preferably with one lane. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 212)

Cost: Contras-flow bike lanes cost $5,000 to $50,000 a mile. Additional costs could arise from thermoplastic bike symbols or arrows. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 76)

Bicycle Tracks (also known as Separated Bicycle Lanes or Cycle Tracks)

Definition: Bicycle tracks are dedicated bicycle lanes that have some physical separation or distinction from the roadway.

Purpose: People cite the risk of physical injury and the perception of danger as significant barriers to bicycling. These barriers are particularly acute in urban areas or where traffic speeds are moderate to high. The real and perceived risk is heightened for children, elderly and people with a disability.

Guidelines: Bicycle tracks should be considered in locations where: (1) Traffic speeds are medium to high (greater than 35 mph). (2) There is a high volume of bicycles and automobiles. (3) The bicycle route is used by potentially vulnerable populations, such as children, seniors or individuals who are handicapped. (4) Two-way bicycle tracks should have a center strip or other divider to define the direction of travel. (5) One-way bicycle tracks should have a convenient and accessible route in the other direction to discourage wrong-way travel conflicts. (6) Rumble strips, extruded curbs, or posts are some examples of physical barriers that are a hazard to bicyclists and should be avoided. (7) Street trees and other vegetation are recommended for aesthetics and traffic calming effects. (8) Coloration should be considered in potential conflict areas, where bicycles, motorists and pedestrians share the space. Coloration at the exit points of non-conventional routes such as contra-flow lanes is also recommended. (9) Signage is important where bicycle tracks begin, end or merge with the roadway or onto a shared-use path network. Pavement markings are recommended over post signs (*London Cycling Design Standards 1998,* Chapter 4, pages 61-87).

Advantages: Less physical conflicts between motorists and bicyclists *(London Cycling Design Standards 1998,* Chapter 4, pages 61-87).

Disadvantages: (1) Bicycle tracks are more expensive to install than conventional bike lanes, and once installed they are costly to remove or remodel. (2) Bicycle tracks are not recommended for areas that require frequent snow removal or street sweeping as access by maintenance equipment is limited. (3) Bicycle tracks are difficult to retrofit when the right-of-way is limiting. (4) Retrofitting streets to bicycle tracks may impact street parking and affect access to businesses and homes. Such modifications should receive community input during the planning phase *(London Cycling Design Standards 1998,* Chapter 4, pages 61-87).

Policy/Regulations:

Dimensions: (1) The minimum width for a one-way bicycle track is 4 feet when the track is along the curb. Tracks adjacent to parked vehicles should have a minimum width of 5 feet and ideally 6 feet. (2) Where a path is parallel and adjacent to a roadway, there should be a 5 feet or greater width separating the path from the edge of the roadway, or a physical barrier of sufficient height should be installed (see D.6, Railings, Fences and Barriers) (1995 Oregon Bicycle and Pedestrian Plan, page 117).

Cost: Bicycle track installation and maintenance costs are high compared to conventional bicycle lanes. Incorporating bike track installation to pavement preservation projects or new construction is the most cost effective way to implement this design.

Bicycle Boulevard

Definition: Bicycle boulevards create an arterial for bicyclists by establishing a shared roadway between motorists and bicyclists.

Purpose: In a low-volume, local street corridor bicycle boulevards encourage efficient and safe bicycle movement while decreasing through motor vehicle traffic.

Guidelines: Bicycle boulevards should not share the roadway with large vehicles or bus routes (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 260-263).

Advantages: (1) Most stop signs face most cross-streets, creating two-way stops favoring the bicycle boulevard. (2) Bicycle trip times compare favorably with parallel route options (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 260-263).

Disadvantages: May reduce access for emergency vehicles. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 260-263).

Policy/Regulations: Design systems and facilities that accommodate multiple modes within corridors, where appropriate, and encourage their integrated use in order to provide users with cost-effective choices of travel and shipping within corridors. (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1A.1, page 207)

Cost: Estimates largely depend on the capital improvements needed to divert through motor traffic, calm remaining motor traffic, and create bike route continuity across major streets. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 260-263)

Shared Use Paths (bike and pedestrian)

Definition: Shared use paths are generally separate from the vehicle travel lane and may or may not be adjacent to the street. Shared use paths are intended for bicycle and pedestrian traffic only.

Purpose: To reduce conflicts among user groups and link community destinations.

Guidelines: Shared use paths must provide sufficient access points from the road network. Development of shared use paths must be sensitive to surrounding native landscapes and environment (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 107 and 265).

Advantages: Reduces the amount of land necessary for pedestrian and bicyclist thoroughfares (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 107 and 265) .

Disadvantages: Could cause conflicts between pedestrians and bicyclists because they share a common right-of-way. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 107 and 265)

Policy/Regulations: Make walkways, pedestrian shelters and bikeways an integral part of the circulation pattern within and between communities to enhance safe interactions between motor vehicles and pedestrians and bicyclists (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 2D.1, page 209). Gaining input from future users and engaging the community regarding path design is an important initial process stage.

Dimensions: Minimum width of 10 feet to accommodate two-way traffic. Increase the width to 12 or 14 feet when accommodating heavy traffic. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 107 and 265)

AASHTO recommends a maximum grade of 5% for multi-use paths. The standard cross-slope grade is 2% to meet ADA and drainage requirements. (ODOT Bicycle and Pedestrian Plan, Chapter II.6, page 118).

Cost: Installation costs approximately $250,000 per mile (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 107 and 265.

Shared Use Path Intersection Treatments

Definition: Shared use path intersection treatments are intersection treatments (i.e. signals, asphalt paint, etc.) used where a bicycle/pedestrian path crosses a roadway.

Purpose: Reduce motorist/bicyclist/pedestrian conflicts at crossings where shared use paths intersect motorist roadways.

Guidelines: (1) Where heavy bicycle and pedestrian traffic is intersecting the roadway the shared use path must be given crossing priority. (2) Design paths to minimize number of crossings. (3) Minimize crossing times for shared path users. (4) Curb cuts should be flared to allow bicyclists and people with disabilities easy turning capabilities. (5) Bollards should be installed on wider paths to deter motorized traffic from accessing the trail. (6) Adequate lighting should be installed at intersections to provide safe crossing at night and during hours of low visibility. (7) Install median refuges on wide roadways (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110).

Advantages: Reduced conflict between bicyclists/pedestrians and motorists (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110).

Disadvantages: Increased crossing times may cause some shared path users to cross at inappropriate times. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110)

Policy/Regulations: (1) A traffic control device should be installed at all intersections, either sign or signal (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110). (2) Provide ADA-compliant wheelchair ramps (two per corner) at all intersections. (3) Provide signal heads (Walk/Don't Walk) at all signalized intersections, except where pedestrian movements are prohibited (ACSP Design Standards, November 1999, page 70).

Dimensions: Paved apron should extend 10 feet from the edge of the paved roadway (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110).

Cost: Intersection costs are part of the overall cost of the trail. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 109-110).

Bicycle Parking

Definition: Facilities that allow bicycles to be parked and secured, such as racks, shelters, bike cages, hangers, etc.

Purpose: Providing secure and convenient bicycle parking. Bicycle parking and other end-of-use facilities are a basic requirement to encourage and facilitate the use of bicycles for transportation.

Guidelines: (1) More secure parking equipment should be installed where more long-term parking and theft occurs. (2) Survey bicyclist clubs and general users to determine where more parking facilities should be installed. (3) Bicycle parking should be located close to building entrances (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132).

Advantages: (1) Bike lockers protect bikes from the elements and allow users to leave extraneous gear such as helmets and lights with their bikes. (2) Adequate parking facilities increases bicycle use and promote clean, healthy transportation choices. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132)

Disadvantages: Parking stations located within the pedestrian throughway may increase bicyclist-pedestrian conflicts. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132)

Policy/Regulations: Building codes typically require installation of bike parking at the time of new development or a change of business ownership. Visit http://www.ibike.org/ for additional bicycle regulations and suggestions (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132). Minimum bicycle spaces required by land use type are provided in the ODOT Bicycle and Pedestrian Plan (ODOT Bicycle and Pedestrian Plan, Chapter II.3, page 90).

Dimensions: Varies depending on the number of parking spaces desired during peak parking hours (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132). Spaces should be at least 6 feet long and 2 feet wide. Parking should not be located further than 50 feet from the entrance of the building, and no further than the closest automobile parking space. (ODOT Bicycle and Pedestrian Plan, Chapter II.3, page 88)

Cost: Bike racks cost about $50 to $100 per bike. Bike lockers cost $500 to $1,500 per bike (Bike Safe: Bicycle Countermeasure Selection System, May 2006, pages 131-132).

Traffic Calming Features

Traffic Calming

Speed Humps

Definition: Speed humps are paved (usually asphalt) rises within the street typically spanning the full width of the street. Height usually tapers near the drain gutter to allow bicyclists unimpeded travel.

Purpose: To reduce vehicle speeds on residential streets. Speed humps create designations where motorists must reduce vehicle speed to safely transverse the raised paved area.

Guidelines: (1) Aesthetics can be improved through the use of color and special paving materials. (2) Do not use if on a sharp curve or if the street is on a steep grade. (3) If the street is a bus route or emergency route, the design must be coordinated with operators (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Advantages: (1) Reduce vehicle speeds. (2) Enhance the pedestrian environment (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Disadvantages: (1) Noise may increase, particularly if trucks use the route regularly. (2) May cause drainage problems (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Policy/Regulations: (1) Institute of Traffic Engineers (ITE) proposes a traffic engineering study, including consideration of alternative traffic control measures should precede any installation. (2) Speed humps should only be installed on two-lane residential streets with less than 3,000 vehicles per day, with a posted speed of 30 mph or less. (3) Documented support should be obtained from affected residents before installation (FHWA: A Review of Pedestrian Safety Research in the United States and Abroad, January 2004, page 108).

Dimensions: (1) Speed Humps are approximately 3 to 4 inches high at their center. (2) Speed humps 12 feet in width have a travel speed of 15 to 20 mph, and humps 14 feet in width a travel speed of 15 to 25 mph (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75). 3) Speed humps are spaced at between 300 and 600 feet apart (FHWA: Traffic Calming, http://safety.fhwa.dot.gov/ped_bike/univcourse/swless19.htm).

Cost: Each speed hump costs approximately $1,000 to install (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Speed Tables

Definitions: Speed tables are paved (usually asphalt) rises that are longer and broader than speed humps, sometimes flat on top, within the street. Speed tables typically span the full width of the street. Height usually tapers near the drain gutter to allow bicyclists unimpeded travel.

Purpose: To maintain motorist speed limits without slowing cars significantly.

Guidelines: (1) The speed tables can either be parabolic, making it more like a speed hump, or trapezoidal, which is used more frequently in Europe. (2) Aesthetics can be improved through the use of color and special paving materials. (3) If the street is a bus route or emergency route, the design must be coordinated with operators (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Advantages: (1) Reduces vehicle speeds. (2) Enhances the pedestrian environment. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75)

Disadvantages: (1) Noise may increase, particularly if trucks use the route regularly. (2) May create drainage problems. 3) Could contribute to back problems for motorists if installed incorrectly (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Policy/Regulations: (1) The Institute of Traffic Engineers (ITE) recommends that a traffic engineering study, including consideration of alternative traffic control measures, should precede any installation. (2) Speed tables should only be installed on two-lane residential streets with less than 3,000 vehicles per day, with a posted speed of 30 mph or less. (3) Documented support should be obtained from affected residents before installation. (FHWA: A Review of Pedestrian Safety Research in the United States and Abroad, January 2004, page 108)

Dimensions: A 22 foot table has a design speed of 25 to 30 mph.

Cost: Speed tables cost $3,000 to $15,000 depending on drainage conditions and materials used (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 75).

Traffic Circles

Definition: Traffic circles are intersections with a circular shape and usually a center island. Traffic is allowed to travel in one direction around the center island, but in some cases two-way traffic is allowed. In traffic circles entering vehicles have the right-of-way, and in roundabouts entering vehicles must yield to vehicles already in the circle.

Purpose: To reduce traffic speeds at the center of intersections. Traffic circles help manage large, complex intersections that are difficult for motorists to successfully traverse. Installing traffic circles in place of traffic signals alleviates heavy traffic backup and congestion. Some communities have used traffic circles for creative or unique gateway access points.

Guidelines: (1) Street width and the available right-of-way need to be sufficient to accommodate a properly designed traffic circle or roundabout. (2) Roundabouts have a mixed record regarding pedestrian and bicyclist safety – a low design speed is required. (3) Roundabouts are generally not appropriate for the intersections of multi-lane roads. (4) Roundabouts often work best where there is a high percentage of left-turning traffic. (5) Deflection on each leg of the intersection must be set to control speeds of 15 to 18 mph (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 71).

Advantages: (1) Reduced need for travel lanes frees right-of-way for other purposes, including bicycle and pedestrian facilities. (2) Traffic flows at a more even pace, making it easier for pedestrians to judge crossing movements. (3) Pedestrians have to cross only one or two lanes of traffic at a time, in clearly marked crosswalks. (4) Motor vehicle operators negotiate the intersection at speeds closer to that of bicyclists. (5) Reduced travel lanes allow midblock crossings before and after the intersection (ODOT Bicycle and Pedestrian Plan 2007, Chapter 6, page 9).

Disadvantages: (1) Steady traffic flow can reduce pedestrian crossing opportunities as there are fewer vehicles. (2) Pedestrians must judge their crossing opportunities; most traffic circles or roundabouts do not have signals. (3) Pedestrians with impaired vision may have difficulty finding traffic gaps. (4) Bicyclists sharing the circulatory roadway risk being cut off by vehicles leaving the roundabout in front of them (ODOT Bicycle and Pedestrian Plan 2007, Chapter 6, page 9). (5) Drivers tend to take the shortest path through the traffic circle and when turning left, will sometimes turn before the circle rather than going all the way around it (AASHTO, July 2004, page 43).

Policy/Regulations: (1) Conduct a study of the local traffic conditions. (2) Conduct public forums with local residents to discuss alternative traffic calming solutions (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 226-227).

Dimensions: Varies depending on the number of traffic lanes operating around the roundabout and on the desired circumference of the inner landscaped circle.

Cost: Landscaped traffic circles costs $45,000 to $150,000 for neighborhood intersections. Roundabouts cost about $250,000 for arterial street intersections, not including additional right-of-way acquisition. Traffic circles have lower maintenance costs than traffic signals (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 62).

Chicanes

Definition: Chicanes are raised paved areas that protrude on alternative sides of the roadway. They typically incorporate landscaped features.

Purpose: Chicanes create a horizontal diversion of traffic and can be gentler or more restrictive depending on the desired motorist travel speed.

Guidelines: (1) Maintain good visibility by planting only low shrubs or trees with high canopies. (2) Ensure that bicyclist safety and mobility are not diminished. (3) For traffic calming, the taper lengths may be as much as half of what is suggested in traditional highway engineering (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 73).

Advantages: (1) Maintains mid-block speeds of 25 mph on non-arterial roadways (2) Reduces cut-through traffic (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 240-241).

Disadvantages: May reduce on-street parking (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 73).

Policy/Regulations: Install only on non-arterial streets, usually in residential areas (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 240-241).

Dimensions: Chicane bulb-outs typically extend approximately 13 feet into the street and are spaced 50 to 80 feet apart (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, pages 240-241).

Cost: Landscaped chicanes are $10,000 (set of three chicanes) on an asphalt street and $15,000 to $20,000 on a concrete street. Drainage and utility relocation often represent the most significant costs (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 73).

Chokers (one-way and two-way)

Definition: Chokers are raised areas that protrude on the roadway to create a pinch point along the street.

Purpose: Chokers are used to slow vehicles at mid-points along a roadway or to create a clear transition between a commercial and residential area.

Guidelines: (1) If two travel lanes are maintained on a two-way street and the travel-lane widths are unchanged (at the location of the choker), it will have a minimal effect on speed. (2) Consult with local fire and sanitation departments before setting minimum widths. (3) Ensure that bicyclist safety and mobility are not diminished. (4) This kind of design is usually only appropriate for low-volume, low-speed streets (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71).

Advantages: Creates a narrow pedestrian crossing zone (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71).

Disadvantages: Not appropriate for high-volume or high-speed streets (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71).

Policy/Regulations: Fire districts should participate in lane width reduction programs. Install on non-arterial streets, usually in residential areas (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71).

Dimensions: Reduces the traveling lane to 16 feet (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71).

Cost: $5,000 to $20,000 depending on site conditions and landscaping. (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 71)

Reduced Lane Width

Definition: Reduced lane widths are when a street is physically narrowed by either extending the curb, adding a raised median, allocating excess road space for parking, or adding a bicycle lane.

Purpose: Reducing lane width can reduce vehicle speeds, increase pedestrian safety and allow additional transportation area for pedestrians and bicyclists.

Guidelines: (1) Lane widths can be reduced and excess asphalt can be designated as a bike lane or shoulder. (2) Travel lanes can be removed. (3) On-street parking can be added. (4) Landscaped areas can narrow the roadway. (5) Bike lanes or wide curbs are needed for bicyclists, especially when high volume traffic exists. (6) School bus and emergency vehicle access must be considered (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 53).

Advantages: (1) Reduces the number of collisions between vehicles and pedestrians/ bicyclists (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 53). (2) Narrow streets reduce construction and maintenance costs (AASHTO, July 2004, page 43).

Disadvantages: Lane reduction can divert traffic to other local streets (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 53).

Policy/Regulations: Fire districts should participate in lane width reduction programs. Install on non-arterial streets, usually in residential areas.

Dimensions: Lane widths can be reduced to 10 or 11 feet wide each (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 53).

Cost: Adding striped shoulders or on-street bike lanes costs $1,000 per mile. The cost for re-striping a mile of street for bike lanes or reducing the number of lanes to add on-street parking is $5,000 to $10,000, depending on the number of old lines to be removed. Constructing a raised median or widening a sidewalk costs $100,000 per mile (FHWA: Pedestrian Facilities Users Guide: Providing Safety and Mobility, March 2002, page 53).

Visual Narrowing

Definition: Visually narrowing the roadway is implemented by adding street trees, lighting elements, street furniture and special paving treatments.

Purpose: Visual narrowing encourages motorists to reduce travel speed because the roadway is narrow and has other potential users such as pedestrians and bicyclist.

Guidelines: (1) Maintain adequate sight distances, especially at intersections. (2) Maintain adequate sidewalk clearance for pedestrian volume (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 69 and 102).

Advantages: (1) Aesthetically pleasing and comfortable. (2) Improves social interaction and enhances livability of the street (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 69 and 102).

Disadvantages: (1) Additional cost and maintenance. (2) May cause traffic diversion to other local streets (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 69 and 102).

Policy/Regulations: Traffic studies should determine whether there is excess capacity. Consider school bus and emergency vehicle access during planning phase (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 69 and 102).

Dimensions: Varies depending on the desired width.

Cost: Varies depending on the implemented roadside treatments. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 69 and 102).

Signals

Pedestrian Countdown Signals

Definition: Pedestrian countdown signals provide an indication of crossing time remaining by displaying numerical countdown symbols.

Purpose: Adequately displayed symbols accommodate pedestrians with minor vision impairments, younger pedestrians not familiar with average crossing time intervals and individuals unfamiliar with the local street crossing interval periods.

Guidelines: (1) Signals need to indicate crossing interval time by visual and audible means for visually impaired pedestrians (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 102). (2) Should be used at any crosswalk requiring more than 15 seconds to cross. (3) Should be used near school zones (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 261).

Advantages: Discourages people from crossing at the end of the crossing interval (Alternative Treatments for At-Grade Pedestrian Crossings, page 88).

Disadvantages: (1) Difficult visually impaired individuals to use the crossings without proper audible signals. (2) Confusion has occurred because some models start the countdown at the beginning of pedestrian crossing phase, while others start at the beginning of the clearance interval phase. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 87-88).

Policy/Regulations: As a condition for FHWA approval traffic evaluations must show the effectiveness of the countdown signal. (Ped Safe: Pedestrian Safety Guide and Countermeasure Selection System, September 2004, page 262)

Dimensions: Same as typical crosswalk.

Cost: Ranges from $500 to $800 per signal. (Alternative Treatments for At-Grade Pedestrian Crossings, page 88).

Pedestrian Signals (Pelican)

Definition: Pelican (Pedestrian light controlled) crossings are traffic signals used to control motorists at mid-block crossings to allow crossing of pedestrians. A Pelican signal rests in green, and when a pedestrian/bicyclist presses the signal button the light will turn to yellow then read to allow the pedestrian/bicyclist the opportunity to cross.

Purpose: Allows pedestrian and bicyclists to safely cross the roadway outside of major intersections.

Guidelines: Use where posted speeds are approximately 30 mph or less. (Alternative Treatments for At-Grade Pedestrian Crossings, page 26)

Advantages: (1) Controlled crossing. (2) Reduced vehicle-pedestrian conflicts because crossing is not located at an intersection. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 72-73).

Disadvantages: (1) Some disruption to traffic-flow. (2) Difficult for some visually impaired individuals to use the crossings without proper audible signals (Alternative Treatments for At-Grade Pedestrian Crossings, pages 72-73).

Policy/Regulations: Build, operate and regulate the transportation system so that users feel safe and secure as they travel (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Dimensions: Same as typical crosswalk.

Cost: Range from $50,000 to $75,000 per crossing to install. An additional $4,000 is required in annual operation costs. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 72-73).

Pedestrian Signals (Toucan)

Definition: Toucan (Two can cross) crossings are similar to Pelican signals. Toucan signals are used to control motorists at mid-block crossings for the crossing of pedestrians and bicyclists. The signal shows a red and green person to indicate when a pedestrian can cross, and it also shows a green bicycle to indicate that a cyclist can cross over with the pedestrians.

Purpose: Allows pedestrian and bicyclists to safely cross the roadway outside of major intersections.

Guidelines: Crossing indications are separate for pedestrians and bicyclists. Additional clearance interval time is allocated to bicyclists (Alternative Treatments for At-Grade Pedestrian Crossings, pages 75-77).

Advantages: (1) Controlled crossing for two user groups. (2) Reduced vehicle-pedestrian conflicts because crossing is not located at an intersection (Alternative Treatments for At-Grade Pedestrian Crossings, pages 75-77).

Disadvantages: (1) Some disruption to traffic-flow. (2) Difficult for visually impaired individuals to use the crossings without proper audible signals. (3) Motorist waiting length varies depending on whether pedestrians or bicyclists are crossing (Alternative Treatments for At-Grade Pedestrian Crossings, pages 75-77).

Policy/Regulations: Build, operate and regulate the transportation system so that users feel safe and secure as they travel (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Dimensions: Same as typical crosswalk.

Cost: Range from $75,000 to $100,000 per crossing to install. An additional $4,000 is required in annual operation costs. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 75-77)

Pedestrian Signals (Hawk)

Definition: Hawk (High-intensity activated crosswalk) crossings are traffic signals used to control motorists at mid-block crossings to allow pedestrians and bicyclist to cross the roadway. At the midblock crossing the combination of a flashing beacon and a traffic signal indicates to motorists that pedestrians and/or bicyclists are crossing the crosswalk and have the right-of-way, similar to a school bus flashing warning.

Purpose: Allows pedestrian and bicyclists to safely cross the roadway outside of major intersections.

Guidelines: Allows pedestrians and bicyclists to have the crossing preference, but enables vehicles to proceed after the pedestrian has passed (Alternative Treatments for At-Grade Pedestrian Crossings, pages 77-78).

Advantages: (1) Controlled crossing for two user groups. (2) Reduced vehicle-pedestrian conflicts because crossing is not located at an intersection (Alternative Treatments for At-Grade Pedestrian Crossings, pages 77-78).

Disadvantages: (1) May require driver education to teach drivers how to use the alternating flashing red signals. (2) Some disruption to traffic-flow. (3) Difficult for visually impaired individuals to use the crossings without proper audible signals (Alternative Treatments for At-Grade Pedestrian Crossings, pages 77-78).

Policy/Regulations: Build, operate and regulate the transportation system so that users feel safe and secure as they travel (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Dimensions: Same as typical crosswalk.

Cost: Range from $40,000 to $60,000 per crossing to install. An additional $2,000 is required in annual operation costs. (Alternative Treatments for At-Grade Pedestrian Crossings, pages 77-78).

Bicycle Signals

Definition: Bicycle signals are signals at intersections specifically for bicyclists. Bicycle signals are used where no signalized intersection is provided or where green phase traffic signal extensions are necessary.

Purpose: Bicycle signals provide safe preferential crossing for bicyclists without causing extreme delays for motorists.

Guidelines: (1) Determine where activation devices are needed. (2) Detectors allow bicyclists crossing preference and they prolong the green phase when necessary (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 117).

Advantages: Provides intervals in traffic streams to allow bicyclists to cross streets safely (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Disadvantages: Prolonged bicyclist green phases might cause confusion for motorists expecting shorter intersection waiting periods (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Policy/Regulations: Build, operate and regulate the transportation system so that users feel safe and secure as they travel (1995 Oregon Bicycle and Pedestrian Plan, Appendix D: Oregon Transportation Plan: ACTION 1G.9, page 209).

Dimensions: Same as typical crosswalk.

Cost: Varies depending on size and complexity of intersection. (Bike Safe: Bicycle Countermeasure Selection System, May 2006, page 117).

Audible Pedestrian Traffic Signals

Definition: An audible device included with a crossing signal that produces either a chirp or simulated voice countdown for the benefit of visually impaired pedestrians and other pedestrians crossing a roadway.

Purpose: Audible signals provide crossing assistance to visually impaired pedestrians at signalized intersections.

Guidelines: (1) Audible signals should be activated by push button controls (Portland Pedestrian Design Guide, page C-14). (2) Audible pedestrian chirp or beep must be loud enough for pedestrians to hear over surrounding noise levels.

Advantages: Allows visually impaired pedestrians to identify appropriate crossing intervals (Portland Pedestrian Design Guide, page C-14).

Disadvantages: (1) Intersections that have actuated signal timings, complex traffic patterns, or intermittent or sporadic traffic volume may pose problems for visually impaired pedestrians. (2) Creates additional noise pollution (Portland Pedestrian Design Guide, pages 90-91).

Policy/Regulations: TEA-21 amended Federal Transportation law to direct implementation of audible pedestrian traffic signals where they are beneficial. (Portland Pedestrian Design Guide, pages 90-91) Install audio/tactile pedestrian signal systems in areas with large elderly and disabled populations. Provide pedestrian push buttons (with visual wait signal) at intersections. (*TransPlan* July 2002 Chapter 3, 1.3, pages 94 and 95).

Dimensions: Same as typical crosswalk.

Cost: Approximately an additional $400 to $800 per signal indication (http://www.walkinginfo.org/engineering/pedestrians.cfm, accessed 8/20/07).

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