Update of the AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities

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Disclaimer

Chapter 1: literature review

The following is a compendium of relevant literature that will impact the update to the AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities. Although the Pedestrian Guide was published in 2004, the majority of the writing of the Guide occurred earlier. For this reason, the literature search was conducted for relevant publications/studies that were published after 2000. In a few cases, the list includes earlier research that remains relevant and should continue to be the definitive source for certain aspects of the Guide. The literature review is organized in four categories:

1. Relevant national guidance/policy (non-research related)
2. State design guidance (key resources plus others)
3. Local design guidance (key resources plus others)
4. Pedestrian research

Short summaries are provided for many resources. Where summaries were already available through abstracts written by resource authors or through PBIC's walkinginfo.org website, those summaries were included in their original form or in some cases were adapted for this literature review.

The sources below are numbered sequentially, in order to correspond to the footnotes in Chapter 3.

It is important to note that this team has culled the most important sources that will serve as the best references, rather than include the titles of every document that has been written on this topic in the past ten years. The list below includes over 300 of the most relevant documents for the update to the AASHTO Pedestrian Guide. The order shown below should not be taken as an indication of importance of the source in terms of its use in the upcoming edition of the Guide.

1.1. RELEVANT NATIONAL GUIDANCE AND POLICY

This section provides short summaries of various national design guidance and policy documents that are not addressed in other sections of the literature review. A number of the documents listed below are currently under revision and new editions are likely to be published prior to the development of the next edition of the AASHTO Pedestrian Guide. Changes that are made to these documents could have a significant impact on the content of the Guide.

1.American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets, 5th Edition*, November, 2004 (as updated).

2.American Association of State Highway and Transportation Officials, *A Guide for Achieving Flexibility in Highway Design*, 2004.

3.American Association of State Highway and Transportation Officials, *Roadside Design Guide*, 2002 (as updated in 2010).

4.Federal Highway Administration, *Design Guidelines: Accommodating Bicycle and Pedestrian Travel – A Recommended Approach, A US DOT Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure*, 2002

5.Federal Highway Administration, *United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations*, 2010.

6.Federal Highway Administration, *Designing Sidewalks and Trails for Access – Part 1 of 2, Review of Existing Guidelines and Practices,* 1999.

7.Federal Highway Administration, *Designing Sidewalks and Trails for Access—Part 2, Best Practices Guide*, September 2001.

8.Federal Highway Administration, *Highway Design Handbook for Older Drivers and Pedestrians*, May 2001.

9.Federal Highway Administration, *Manual of Uniform Traffic Control Devices*, 2009.

10.Federal Highway Administration, *Pedestrian Facilities Users Guide*, 2002.

11.Federal Highway Administration, *Roundabouts: An Informational Guide*, 2000.

12.Federal Highway Administration, *Planning Design and Maintenance of Pedestrian Facilities*, 1989.

13.Institute for Transportation Engineers, *Traffic Control Devices Handbook*, 2004.

14.Institute for Transportation Engineers, *Transportation Engineering Handbook*, (as updated).

15.Institute for Transportation Engineers, *Transportation Planning Handbook*, (as updated).

16.Institute for Transportation Engineers, *Urban Street Geometric Design Handbook*, (as updated).

17.Public Rights-of-Way Access Advisory Committee. *Special Report: Accessible Public Rights-of-Way, Planning and Designing for Alterations*. Washington, D.C.: 2007

18.U.S. Access Board, *Americans with Disabilities Act – Architectural Barriers Act Accessibility Guidelines*, 2004. (ADA-ABA-AG)

19.U.S. Access Board, *Draft Public Rights-of-Way Accessibility Guidelines*, November 2005.

20.USDOT Memorandum, *INFORMATION: Public Rights-of-Way Access Advisory*, Federal Highway Administration. January 23, 2006.

21.USDOT, *Transportation for Individuals with Disabilities; Adoption of New Accessibility Standards*. 49 CFR Part 37 [Federal Register: October 30, 2006 (Volume 71, Number 209)]. Effective November 29, 2006.

22.Institute of Transportation Engineers, *Traffic Calming: State of the Practice*, 1999.

23.Easter Seals, *Accessible Pathways to Bus Stops and Transit Facilities: A Process Guide,* 2009.

24.American Association of State Highway and Transportation Officials, *Guide for the Development of Bicycle Facilities*, 1999.

25.Federal Highway Administration, *Selecting Pedestrian Safety Improvements: Crash Types/Countermeasures Matrix* (as updated). Available Online: http://safety.fhwa.dot.gov/saferjourney/library/matrix.htm

26.Federal Highway Administration, *Designing Pedestrian Facilities For Accessibility Course*, Available Online: http://www.in.gov/indot/files/DPFAModule5PedestrianCrossings.pdf, 2008

27.Federal Highway Administration, Signalized Intersections: Informational Guide, 2004.

28. American Association of State Highway and Transportation Officials, *Roadway Lighting Design Guide*, 2005.

29.American Association of State Highway and Transportation Officials, *Highway Safety Manual*, 2010.

30.ITE, *An ITE Proposed Recommended Practice: Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, 2010

31.Federal Highway Administration in collaboration with the University of North Carolina's Highway Safety Research Center, Training Course: *Designing for Pedestrian Safety*, http://www.walkinginfo.org/training/pbic/dps.cfm

32.Federal Highway Administration in collaboration with the University of North Carolina's Highway Safety Research Center, Training Course: *Developing a Pedestrian Safety Action Plan*, http://www.walkinginfo.org/training/pbic/dpsap.cfm

1.2. STATE DESIGN GUIDANCE

This section provides short summaries of key state design guides and lists others that may be relevant. State DOT Design Guides will be particularly important resources for the next AASHTO Pedestrian Guide, because state transportation officials are a primary audience. New pedestrian guides are published and updated by State DOT's each year, therefore it will be necessary for the authors of the next AASHTO Pedestrian Guide to review new Guides in addition to those listed below prior to preparing the revised Guide.

Key Resources

33.California Department of Transportation (Caltrans), *Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers*, July 2005.

This guide synthesizes information on policies, laws, programs, the planning and design process, guidelines, and best practices. The Technical Reference Section includes concept sheets on pedestrian facilities and traffic calming measures. The concept sheets include descriptive text, references, and many useful pictures,

graphics, and tables. Major issues addressed include: analytical tools, crossings, personal mobility devices, signals, sidewalks, work zones, and traffic calming.

34. California Department of Transportation, *Main Streets: Flexibility in Design & Operations*, January 2005.

This booklet provides basic guidelines for creating main streets along state highways. The booklet emphasizes Context Sensitive Solutions (CSS). It includes short descriptions of traffic calming measures appropriate for high speed areas (e.g. reduced lane width or number of lanes, transverse rumble strips, visual cues, roundabouts, synchronized signals, parking, and raised median islands). It also discusses pedestrian facilities, street lighting, furnishings, street landscaping, banners and decorations, and gateway monuments.

35. Research in Progress. California Department of Transportation, Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians, 2010.

36. Connecticut Cooperative Transportation Research Program Project 04-6, *Designing Roads that Guide Drivers to Choose Safer Speeds*, Garrick, Hanson and Ivan, Report No. JHR 09-321, November 2009.

37. District Department of Transportation, *District of Columbia Pedestrian Master Plan 2009*.

This plan includes detailed design guidelines and conceptual drawings for a comprehensive range of pedestrian facilities, and also includes a detailed review of District policies that impact design. It includes a systematic, per topic review of existing policies, state-of-the-practice, and proposed policies, which is then supported by detailed design drawings that illustrate key issues for pedestrian safety and accessibility.

38. Delaware Department of Transportation, *Guide to Accessible Pedestrian Facilities Public Transportation Right-of-Way [DRAFT]*, March 2009.

This guide establishes requirements, guidelines and best practices for the planning, design, construction and maintenance of accessible pedestrian facilities in the public transportation right-of-way. The guide provides guidance on a variety of issues, including sidewalks, driveway crossings, obstructions and protruding objects, curb ramps, detectable warnings, curb ramps, crosswalks, median crossings, mid-block crossings, traffic signals and accessible pedestrian signals, and stop bars.

39. Florida Department of Transportation, *Level of Service Handbook*, 2002.

The Level of Service Handbook discusses the FDOT’s Pedestrian Level of Service Model. The model is based on a weighted valuation of four factors: existence of sidewalk, lateral separation for pedestrians from motorized vehicles, motorized vehicle volumes, and motorized vehicle speeds.

40. Georgia Department of Transportation, *Pedestrian and Streetscape Guide*, September 2003.

This guide focuses on the design of pedestrian environments and streetscape facilities. It offers technical information on "best practices" that apply to situations encountered in project development. It provides a thorough examination of pedestrian characteristics and factors that influence pedestrian travel. The guide supplies an interesting spatial analysis, diagramming the space needs for different types of pedestrians: adults, children, elders, and those with disabilities. It discusses ways to prioritize projects using Geographic Information Systems (GIS), referencing the Latent Demand Model and Portland, OR's Pedestrian Potential Index. The bulk of the guide exists in several toolkits, each devoted to different subjects. The toolkits begin with general design guidelines and move into more specific topics such as accessibility, school zones, trails and paths, sidewalks, crossings, etc.

41. Maryland State Highway Administration, *Accessibility Policy & Guidelines for Pedestrian Facilities along State Highways*, December 2005.

This design guide was developed to assist transportation engineers in designing public sidewalks and crossings to provide accessible routes, defined as continuous routes that are unobstructed and ADA compatible throughout. The guide addresses a number of relevant issues, including sidewalks, ramps, median treatments, crosswalks, mid-block crossings, accessible pedestrian signals , detectible warning devices, and maintenance of pedestrian access during construction.

42. Maryland State Highway Administration, *Bicycle & Pedestrian Design Guidelines*, May 2007.

This guide establishes uniform set of design guidelines for bicycle and pedestrian facilities in Maryland. It addresses a comprehensive range of pedestrian issues, including sidewalk design, intersection design, signs and signals, bus stops, grade separated crossings, work zone accommodation, bridge and interchange access, and other issues. The guide provides a number of useful photographs, tables, and figures, including a decision tree for evaluating whether marked crosswalks at uncontrolled crossing locations are needed and a table suggesting appropriate design treatments based on posted speed, ADT, and number of lanes.

43. Massachusetts Highway Department, *Project Development and Design Guide*, January 2006.

The MassHighway Project Development and Guidebook is a comprehensive project development and Guide for street and highway projects. It establishes a clear project development process and incorporates multi-modalism and context sensitive design into all aspects of this process. The Guide is divided into to three main sections: 1) a project development section addressing project development from planning through construction; 2) a basic design section offering basic guidelines for accommodation of all modes; and 3) a “toolbox” with design solutions and traffic management strategies for unique situations, such as construction zones. It was developed through a collaborative process involving pedestrian advocates, environmentalists, municipal representatives, regional planners, MassHighway employees, and other construction and design professionals.

The Guide includes flexible design standards and integrates of all modes, including pedestrians, into each stage of the project development process. It includes many useful tables and diagrams. Sections of particular interest include those addressing multimodal accommodation in roadway cross-section design and measures for traffic calming and traffic management. The guide also provides a useful typology for making functional design decisions. The typology involves consideration of three variables: area type, roadway type, and access control. The area type variable is more refined than the traditional urban/rural dichotomy and includes nine different categories ranging from natural rural areas to central business districts.

44. New York Department of Transportation, *Highway Design Manual*, March 2006.

Chapter 18 of the Highway Design Manual provides extensive and detailed guidelines for pedestrian facility design. These guidelines are largely conveyed through narrative; however, the chapter also includes a number a number of useful tables, graphs, and figures. Issues addressed include: sidewalks crossings, elevation changes, bus stops and transit stations, special situations (main streets, Central Business Districts, school walking zones, mass evacuations), and pedestrian facility construction and maintenance. Compliance with ADAAG requirements is emphasized throughout.

45. Oregon Department of Transportation, *Oregon Bicycle and Pedestrian Plan [DRAFT]*, July 2007.

This draft is an update of the 1995 Oregon Bicycle and Pedestrian Plan. The update applies to the design sections of the 1995 plan only and includes discussion of context sensitive solutions and many new pedestrian and bicycle treatments (e.g. two-step pedestrian signals and stop bars at mid-block locations

reinforced with “Stop Here” signage). Chapters address walkways, crossings, and intersections, among other issues. Concepts are illustrated by abundant photographs and figures.

46. Pennsylvania Department of Transportation, *Traffic Calming Handbook*, January 2001.

    This handbook addresses a variety of issues related to traffic calming, including: appropriateness, legal authority, liability, funding, impact on emergency services, and the study and approval process. It also provides discussion of a full-range of traffic calming treatments. Discussion of each treatment includes a description and information on appropriate location, speed/volume reductions, approximate costs, considerations, and advantages and disadvantages. Traffic calming treatments and guidelines are illustrated with figures.

47. Vermont Agency for Transportation, *Vermont Pedestrian and Bicycle Facility Planning and Design Manual*, December 2002.

    The Vermont Pedestrian and Bicycle Facility Planning and Design Manual establishes standards for the development, design, construction and maintenance of bicycle and pedestrian facilities. The manual includes chapters addressing pedestrian facilities (sidewalks, walkways, street corners, intersections, and street and driveway crossings), traffic calming measures, traffic control devices, and landscaping.

48. Virginia Department of Transportation, *Guidelines for the Installation of Marked Crosswalks*, February 2005.

    This guide establishes guidelines for the marking of crosswalks at controlled locations, uncontrolled locations (intersections and midblock), and unconventional intersections and locations. It describes various crosswalk treatments and provides guidance on when to use them. Several innovative treatments for uncontrolled crossings are suggested, including animated light emitting diode (LED) signals, pedestrian scramble phases, and “No Right Turn on Red” restrictions.

49. Virginia Department of Transportation, *Traffic Calming Guide for Local Residential Streets*, October 2002 (Revised July 2008)

    This guide establishes traffic calming guidelines for residential streets and collectors, including requirements that must be met before traffic calming measures will be considered by the Commonwealth Transportation Board. The guide offers guidance on which calming measures are appropriate for streets based on traffic volume. For physical traffic calming measures, it provides descriptions, placement guidance, advantages, disadvantages, and cost estimates. The guide also establishes a point system for prioritizing traffic calming projects.

50. Washington State Department of Transportation, *Design Manual*, January 2006 (last modified January 2009).

    Chapter 1510 of the Design Manual addresses pedestrian design considerations. Topics covered include ADA compliance, access control, pedestrian route geometrics, sidewalk/driveway crossings, curb ramps, crosswalks, mid-block crossings, railroad crossings, pedestrian bridges and tunnels, and work zone pedestrian considerations. The material presented is largely narrative but does include photos and figures to illustrate key concepts. Chapter 1310 of the Design Manual provides a pedestrian friendly compound curve right-turn lane.

Other Relevant State DOT Resources

51. Arizona Department of Transportation, *Statewide Bicycle and Pedestrian Plan*, August 2003.
52. California Department of Transportation, *Highway Design Manual*, September 2006.
53. California Department of Transportation, *Complete Streets Implementation Action Plan*¸ February 1, 2010.
54. Colorado Department of Transportation, *Roadway Design Guide*, 2005 (revised April 2006).
55. Connecticut Department of Transportation, *Highway Design Manual*, 2003 (revised December 2006)
56. Florida Department of Transportation, Florida Design Manual, 2009.
57. Florida Department of Transportation, *Intersection Design Guide*, 2007.
58. Kentucky Transportation Cabinet, *Highway Design Guidance Manual*, January 2006.
59. Louisiana Department of Transportation and Development, *Road Design Manual*, August 2006.
60. Maryland Transit Administration, *Maryland Transit Guidelines*, 2002.
61. Michigan Department of Transportation, *Road Design Manual*, revised October 2008.
62. Oregon Department of Transportation, *Highway Design Manual*, 2003.
63. Pennsylvania Department of Transportation and New Jersey Department of Transportation, *Smart Transportation Guidebook*, 2008.
64. Utah Department of Transportation, *Roadway Design Manual*, May 2007 (updated October 2008).
65. Texas Department of Transportation, *Roadway Design Manual*, March 2009.
66. Texas Department of Transportation, *Manual for Walkable Urban Thoroughfares*, 2009
67. Virginia Department of Transportation, *Subdivision Street Design Guide*, 2005.
68. Wisconsin Department of Planning, Pedestrian Policy Plan 2020, March 2002.
69. Wisconsin Department of Transportation, Pedestrian Best Practices Guide, 2011 (draft)
70. Pedestrian Considerations for Temporary Traffic Control Zones, Brochure http://dot.ca.gov/hq/traffops/signtech/signdel/pdf/PedBrochure06.01.10.pdf
71. Connecticut Department of Transportation, Designing Roads to Guide Drivers to Choose Safer Speeds, 2010.

3. LOCAL DESIGN GUIDANCE

This section provides short summaries of key local design guides and lists others that may be relevant. In addition to State DOT's, local transportation officials are a primary audience for the AASHTO Pedestrian Guide, as many aspects of pedestrian facility planning and design fall under the jurisdiction of local DOT's.

Key Resources

This section of the literature review does not attempt to include all local pedestrian plans that have been prepared, rather it lists exemplary plans that include pedestrian design guidance, and/or delve into issues related to local land development ordinances.

72. Chicago Department of Transportation, *Street and Site Plan Design Standards*, April 2007.

    This guide provides detailed standards and guidance for construction in the public right of way. It addresses a wide variety pedestrian design issues, including sidewalk width, corner radii, curb ramps, crosswalks, street furniture, driveway and alley access management, and pedestrian accommodation during construction. Guidelines and standards are tailored to Chicago's dense urban environment.

73.City of Berkeley, *Berkeley Pedestrian Master Plan*, 2010.

Appendix B of the draft Berkeley Pedestrian Master Plan provides pedestrian design guidelines. The guidelines are based on existing guidelines from federal, state, and local sources and innovative best practices. Issues addressed include: sidewalk corridor guidelines, crosswalks, traffic signal enhancements, traffic calming, access to transit stops, guidelines for private development, pedestrian pathways and stairs, and ADA.

74.City of Charlotte, *Pedestrian Master Plan [DRAFT],* February 2009.

Chapter 5 of this plan presents recommendations to update current standards to include best practices for the design of pedestrian facilities, including proposed changes to the Charlotte Land Development Standards and revisions to the Pedestrian Mid-Block Crossing Guidelines. Changes are proposed in areas in a variety of areas, including street design, pedestrian crossings, traffic calming, transit access and curb ramp design.

75.City of Oakland, *Pedestrian Master Plan*, November 2002.

Chapter 5 of this plan discusses pedestrian facility design but does not establish design standards. The chapter is meant to inform designers, planners, and policy makers of available design treatments and best practices. Issues discussed include requirements for sidewalks and utility zones, best practices for crosswalks and corners, and traffic calming. The plan contains many useful graphics.

76.City of Sacramento Public Works Department, *Pedestrian Safety Guidelines*, January 2003.

These guidelines focus on street crossing treatments at controlled and uncontrolled intersections, discussing tools such as pavement marking and signal options and giving attention to roadway design. The guidelines create a four level system to address crosswalk placement for uncontrolled locations as well as a matrix of appropriate treatments for streets with different numbers of lanes, average daily traffic volume (ADT), and posted speed.

77.City of San Francisco, *Better Streets Plan [DRAFT]*, June 2008.

The Better Streets Plan establishes guidelines and standards to guide the design and use of the pedestrian environment. It provides both general guidelines for the pedestrian environment and more specific guidelines for particular street types. The plan includes detailed guidelines and standards for curb lines and related features, such as medians, curb extensions, and crossings, as well as guidelines for individual streetscape elements, such as plantings, lighting, site furnishings and utilities. The plan is notable for the quality and abundance of photographs, figures, and tables used to clarify and summarize key concepts.

78.City of Santa Barbara Department of Public Works, *Santa Barbara Pedestrian Master Plan*, July 2006.

Chapter VIII of the Santa Barbara Pedestrian Master Plan provides pedestrian design guidelines. Issues addressed include: sidewalk corridors, corners, crosswalks, signals, ADA, and transit stops. The plan provides a number of useful photographs, tables, and figures, including a sidewalk zone table showing recommended sidewalk corridor configurations based on land use, street classification, and available public right-of-way, and a crosswalk toolbox table, indicating purpose, location, and guidelines for crosswalk treatments.

79.County of Sacramento Department of Transportation, *Sacramento County Pedestrian Design Guidelines*, February 2006.

This guide addresses all aspects of pedestrian design, including sidewalks, pedestrian-scale lighting, buffer design, solutions for curb ramps, intersection crossings, crosswalk markings, midblock crossings, and other relevant topics. There is also an appendix describing innovative crossing treatments such as in-street yield-to-pedestrian signs, in-roadway warning lights, high intensity activated crosswalk (HAWK) signals, and pedestrian-friendly intelligent (Puffin) signals.

80. Maricopa County, *Pedestrian Policies and Design Guidelines*, April 2005.

This guide establishes minimum standards for pedestrian facilities in Maricopa County. Minimums are organized according to a three-tiered system. The first tier establishes minimums that must be met in order for pedestrian facilities to be safe, the second tier establishes minimums to make the pedestrian area comfortable and encourage more walking, and the third tier establishes minimums for destinations, defined as places where walking is considered a predominant mode of transportation. Minimums are informed by the principle of universal design, or the idea that pedestrian facilities should be designed for maximum ease of use by any pedestrian rather than the average pedestrian.

81. OmniTrans*, Bus Stop Guidelines*, October 2006.

This guide provides recommended criteria and general guidance for the placement and design of transit facilities in the San Bernardino Valley. Issues addressed include bus stop policies, bus stop placement, minimum bus stop elements (including pedestrian connections and curb ramps), and passenger amenities at bus stops, and design parameters.

82. San Diego Association of Governments, *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region*, June 2002.

These guidelines provide an extremely thorough look at how to plan and design for the pedestrian. The plan discusses the land use and community structure elements that affect the pedestrian environment. It contains a comprehensive list of site and design details that includes information on considerations, guidelines, example images, and technical diagrams. The pedestrian measures index is a good tool for identifying appropriate countermeasures to use depending on roadway volume and speed. (From www.walkinginfo.org)

83. Seattle Department of Transportation, *Seattle Pedestrian Master Plan* , September 2009.

This Plan establishes benchmarks and performance measures, and addresses a wide variety of policy issues relevant to pedestrian travel in Seattle. It establishes pedestrian improvement zones through the use of a pedestrian demand model, and provides design guidance.

84. Seattle Department of Transportation, *Director's Rule 04-01 (Re: Installation Criteria & Procedures for Responding to Requests for Safety Improvements regarding Marked Pedestrian Crosswalks)*, 2004.

This rule is based on an FHWA report (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines). While the FHWA recommendations focus on crosswalks at uncontrolled locations, the Seattle policy provides guidelines for marking crosswalks at signalized and non-signalized locations. Based on conclusions from the FHWA study, Seattle's policy begins with the premise that, marked crosswalks are only one of many possible engineering measures. The Seattle policy lists a number of treatments other than marked crosswalks that may be considered prior to installing marked crosswalks, such as raised medians and reducing the effective street crossing distance for pedestrians.

Other Relevant Local Resources

85.City of Charlotte, NC, *Urban Street Design Guidelines*, adopted 2008.
86.City of Boston, MA *Draft Complete Streets Guidelines*, 2010.
87.City of Minneapolis, *Pedestrian Master Plan*, Forthcoming.
88.New York City Department of Transportation, *Street Design Manual*, May 20, 2009.
89.City of Philadelphia *Draft Pedestrian and Bicycle Policy Guidelines*, 2010.
90.City of San Diego, *Street Design Manual*, November 2002.
91.District Department of Transportation, *District of Columbia Traffic Calming Policies and Guidelines*, 2002.
92.Marin County Department of Public Works, *Unincorporated Area Bicycle and Pedestrian Master Plan*, March 2008.
93.Puget Sound Regional Council, *Design Guidelines Manual—Destination 2030 Physical Design Guidelines,* Summer 2003.
94.Tallahassee-Leon County Metropolitan Planning Organization, *Bicycle & Pedestrian Master Plan*, May 2004.
95.Town of Basalt, Colorado, *Complete Streets Design Manual*, October 2005.
96.City of Seattle, *Seattle Right-of-Way Improvements Manual*, 2005.
97.Arlington County, VA , Master Transportation Plan, 2008.
98.Central Savannah River Area Regional Commission's Regional Development Center, *Model Bicycle and Pedestrian Facilities Land Use Regulations*, 2006.
99.City of Portland, OR, *City Code and Charter: Chapter 17.28 Sidewalks, Curbs and Driveways*, (as updated).
100.City of Oakland, *CA, Pedestrian Master Plan*, 2002.
101.City of Boulder, CO, *Transportation Master Plan*, 2002
102.City of Denver, CO, *Pedestrian Master Plan*, 2004

1.4. PEDESTRIAN RESEARCH – PLANNING TOPICS

This section provides short summaries of more than 60 references on pedestrian planning topics that can be used in the update of the AASHTO *Guide for the Planning, Design and Operation of Pedestrian Facilities*. These references include national surveys, planning guidebooks, government reports, and academic studies. Many of the references have been developed since 2003, so most were not considered in the literature review for the existing AASHTO Pedestrian Guide.

Some of these references can be used to update the statistics provided in the Planning Chapter (Chapter 2) of the current AASHTO Pedestrian Guide. Others provide information that can be used to describe broader topics in the Planning Chapter, such as built environment characteristics that make walking safer and more convenient, general pedestrian planning strategies, prioritizing pedestrian projects, pedestrian-friendly site development, safe routes to schools programs, and designing an enjoyable pedestrian environment.

The references in this section are organized into 16 subsections representing major topical areas for research in pedestrian planning.

General Pedestrian Planning Resources

These references are guidebooks and reports that are useful for pedestrian planning. They provide step-by-step guidance on how to develop a pedestrian plan, considerations for the planning process, and ideas for planning recommendations. The AASHTO Pedestrian Guide Planning Chapter should draw planning guidance from these documents, and they should be cited for additional information on pedestrian planning.

103. U.S. Department of Transportation, Federal Highway Administration. *How to Develop a Pedestrian Safety Action Plan*, Available online: **http://safety.fhwa.dot.gov/ped_bike/docs/fhwasa0512.pdf**, March 2009.

How to Develop a Pedestrian Safety Action Plan is designed for state and local agencies to enhance their existing pedestrian safety programs and activities, including identifying safety problems, analyzing information, and selecting optimal solutions. The guide also contains information on how to involve stakeholders, potential sources of funding for implementing projects and how to evaluate projects.

The guide "provides a framework for 1) reviewing pedestrian problem sites, roadway segments, and other targeted areas in an organized manner and 2) selecting and implementing appropriate safety measures" (p. 4). Chapters of the document include Planning and Designing for Pedestrian Safety—The Big Picture, Involving Stakeholders, Collecting Data to Identify Pedestrian Safety Problems, Analyzing Information and Prioritizing Concerns and Selecting Safety Solutions. Case studies from communities throughout the United States are provided to illustrate the concepts in each chapter.

The introduction provides several useful statistics, including: "According to 2000 Census figures, nearly 15 percent of U.S. households do not own a vehicle. Also, 25 to 30 percent of U.S. citizens do not have a valid driver's license. This includes children under age 16, as well as many older and physically-impaired adults. This portion of our population should not be prevented from safe and reasonable opportunities to walk" (p. 3).

The AASHTO Pedestrian Guide should cite this guide as a reference for communities seeking more information about how to develop a systematic approach to pedestrian safety planning.

104. Federal Highway Administration. *A Resident's Guide for Creating Safe and Walkable Communities*, FHWA-SA-07-016, Authors: L. Sandt, R. Schneider, D. Nabors, L. Thomas, C. Mitchell, and R.J. Eldridge, Available online: **http://safety.fhwa.dot.gov/ped_bike/ped/ped_walkguide/index.htm**, February 2008.

A Resident's Guide for Creating Safe and Walkable Communities is designed for local citizens and organizations that would like to learn more about how to improve pedestrian safety in their communities. It provides basic information about the transportation planning process and how to approach local agencies about pedestrian safety issues. It provides several community success stories that highlight successful community-oriented pedestrian safety projects and programs.

The Guide also contains several user-friendly resources, including fact sheets, worksheets, and sample materials. These materials can be adapted to meet the needs of a particular community, or distributed to others working to improve pedestrian safety. The Guide provides a thorough introduction to pedestrian safety and includes many references to other resources and materials for those interested in more in-depth information.

The AASHTO Pedestrian Guide should cite this guide as a reference for readers seeking a resource for residents and citizen groups that are interested in becoming involved in community pedestrian safety efforts.

105. *Model Policy: Model Policy Outline for State Complete Streets Legislation,* National Complete Streets Coalition, Available Online: http://www.completestreets.org/changing-policy/model-policy/model-state-legislation-options/, 2010.

106. *Policy and Planning Strategies to Support Walking: Land Use Policies*, Pedestrian and Bicycle Information Center, Available Online: http://www.walkinginfo.org/develop/policies-land.cfm, 2010.

107. Federal Highway Administration, University Course on Bicycle and Pedestrian Transportation. Available Online: http://www.tfhrc.gov/safety/pedbike/pubs/05085/, 2006.

Pedestrian Travel

The references in this sub-section can be cited to provide a general overview of pedestrian travel in the United States. They include information about pedestrian mode split, trip lengths, trip purposes, and socioeconomic characteristics that can be cited in the AASHTO Pedestrian Guide. Barriers to pedestrian activity are also described.

108. U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, *2008 National Household Travel Survey*, 2009.

The National Household Travel Survey (NHTS) is the most extensive travel survey done in the United States. In 2001, it included more than 70,000 households throughout the country. The survey is given on a rolling basis over a one year period. Each member of a survey household reports all trips that they make on their household's survey day. The 2008 NHTS was given to 155,000 households between April 2008 and May 2009.

The NHTS provides the most accurate assessment of pedestrian mode share at the national level. In 2001, pedestrians accounted for 8.6% of all trips (Note that this figure is weighted to represent the national population. The survey population is slightly different from the population as a whole, so only 7.8% of all trips in the raw NHTS database are made by pedestrians). In 2008, pedestrians accounted for 10.95% of all trips. The NHTS includes pedestrian trips made for all purposes, includes pedestrian trips made to connect to transit modes, and represents pedestrian travel during all seasons of the year. Distance, time, and purpose are reported for all pedestrian trips. The survey also provides information about gender, age, income, household vehicle ownership, and other socioeconomic characteristics of pedestrians. Since it is a national survey, it does not provide pedestrian mode split data for city or neighborhood areas. However, several states and urban regions have paid for "add-on" surveys that may provide additional information about pedestrian travel in local areas.

109. U.S. Department of Transportation, Federal Highway Administration. *Interim Report to the U.S. Congress on the Nonmotorized Transportation Pilot Program: SAFETEA-LU Section 1807*, Volpe National Transportation Systems Center, November 2007.

This report provides an initial assessment of the federal Nonmotorized Transportation Pilot Program (NTPP). The NTPP was established by the Safe, Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in August 2005. This legislation provides $25 million to each of four communities (Columbia, Missouri; Marin County, California; Minneapolis, Minnesota; and Sheboygan County, Wisconsin) to construct community-wide pedestrian and bicycle networks between 2005 and 2009.

At the beginning of the program, walking mode shares were 6.6% in Sheboygan County, 8.6% in Columbia, 11.8% in Marin County, and 17.6% in Minneapolis. Before any improvements were made, researchers estimated that walking for utilitarian purposes already reduced annual automobile miles traveled by approximately 0.7% to 2.8%, depending on the community. This represents a reduction of 109.3 million miles of automobile driving per year in all four communities combined (70 percent of the total reduction in automobile miles traveled was due to walking, so 109.3 million is 70 percent of the 156.1 million-mile reduction reported in the document for walking and bicycling combined). Community-level surveys will be repeated in these four communities in 2010 to assess the impacts of the pedestrian and bicycle improvements. If this assessment is done before the AASHTO Pedestrian Guide is updated, the results can be cited.

110. U.S. Department of Transportation, Federal Highway Administration and National Highway Traffic Safety Administration. *National Bicycling and Walking Study: Ten Year Status Report*, October 2004.

This National Bicycling and Walking Study: Ten Year Status Report discusses progress towards achieving the two goals of the 1994 National Bicycling and Walking Study: 1) Double the percentage of total trips made by bicycling and walking in the United States from 7.9% to 15.8% of all travel trips, and 2) Reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes.

The status report shows that the total number of walking and bicycling trips nearly doubled from 19.7 billion to 38.6 billion trips per year between 1990 and 2001. However, the percentage of trips made by pedestrians and bicyclists only increased from 7.9% percent to 9.5% during that time period (Note that the 9.5% mode share includes 8.6% pedestrian and 0.9% bicycle mode share, calculated from the weighted NHTS sample). “In short, reported bicycling and walking trips have increased significantly, but the number of reported driving trips has increased at a rate that eclipses that of bicycling and walking.” (p. 6)

111. U.S. Department of Transportation. *National Survey of Pedestrian and Bicyclist Attitudes and Behaviors*, National Highway Traffic Safety Administration and Bureau of Transportation Statistics, 2002.

The National Survey of Pedestrian and Bicyclist Attitudes and Behaviors was a random-digit-dialing phone survey administered to 9,616 respondents aged 16 years or older from June 11 to August 20, 2002. Results were weighted to reflect the national population.

According to the survey, 78.7% of the driving-age public walked, ran, or jogged outdoors for five minutes or more at least once during the summer of 2002 (defined as May through August). “This represents approximately 164 million pedestrians age 16 years or older.” (p. 6). Age, gender, and race breakdowns are provided. Survey respondents also reported the primary reason why they didn’t walk. The most common barriers to walking included “disabilities and other health impairments” (24.5% of respondents), “bad weather or wrong season” (22.0%), “too busy/no opportunity” (18.8%), and “other transportation is faster” (4.0%). Only 3.0% of respondents said “no safe place to walk”.

“The average length of a walking trip taken on a typical day during the summer was 1.2 miles. More than one-fourth of trips (26.9%) were shorter than one-quarter of a mile while 14.8% of trips were more than 2 miles in length. Walking trips taken for exercise or recreation averaged 1.9 miles, as compared to 0.8 miles for trips taken for other purposes.” (p. 8).

Facilities used for walking trips (I assume for the majority of the trip) included sidewalks (45.1% of trips), paved roads (not shoulder) (24.8%), shoulders of paved roads (8.4%), unpaved roads (8.0%), bicycle paths/walking paths/trails (5.8%), grass or fields (4.9%)

The survey also captured people's views on how well their community was designed for pedestrian safety. About 74.1% of respondents were "very" or "somewhat satisfied" with how their communities were designed for pedestrian safety. 34.0% of respondents recommended changes to their communities for pedestrians. Many of the people recommending changes (74.7%) suggested providing better pedestrian facilities (e.g., sidewalks, traffic signals, lighting, or crosswalks). Others suggested improving existing pedestrian facilities (12.5%), enforcing laws governing pedestrians (5.1%), making areas for walking safer (4.7%) and changing existing laws governing pedestrians (2.8%).

112. U.S. Department of Transportation, Bureau of Transportation Statistics. "Sidewalks Promote Walking," BTS Issue Brief, Number 12, December 2004.

This issue brief reports the results of a detailed analysis of the relationship between sidewalks and walking activity reported in the 2002 National Survey of Pedestrian and Bicyclist Attitudes and Behaviors.

"Of America's 205 million adults, 86% took walks during the summer months of 2002, and 40% of those walkers walked more than 15 days per month." More adults tend to walk when sidewalks are available (88% of people who stated that sidewalks were available in their communities walked; 84% of people who stated that sidewalks were not available in their communities walked). People who do not walk are more likely than walkers to be dissatisfied with the design of their communities with respect to pedestrian safety. People in communities without sidewalks were three times as likely as respondents in other communities to be dissatisfied.

113. U.S. Department of Commerce, Bureau of the Census. *Census 2000*, 2000.

The U.S. Census provides data on the predominant transportation mode that people use to travel to work (Census 2000 reports this information in Structure File 3). This information is gathered through the Census long form, which is distributed to approximately 1 in 6 households throughout the country.

Census data provide information about walking to work at many geographic levels, from the entire nation to local neighborhoods. In 2000, 2.9% of workers used walking as their primary commute mode. Planners can identify how walking to work rates vary throughout their community using census block group-level data.

The Census is limited because it only reports the most often used, longest-distance journey-to-work mode for workers over age 15 during the Census survey week (last week of March 2000 or March 2010). People who walk to work only one day per week or walk to the bus or train as a part of their journey to work are not counted as walking to work.

114. McDonald, N.C. "Children's Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School," *Transportation*, Volume 35, pp. 23-35, 2008.

McDonald analyzes 2001 NHTS data to show the importance of distance in determining whether or not children walk to school. In the background section she reports that 42% of children in the United States walked to school in 1969, but less than 15% walked to school in 2001. More than 75% of all trips made by children are in automobiles.

"48% of students living less than 1 mile from their school walked compared with a walk rate of 3% for students living more than 1 mile from their school." (p. 28). "A 1-minute increase in walk travel time leads to a 0.2% decline in an individual's probability of walking; a 10% increase in walk travel time leads to a 7.5% decrease in walk mode share." (p. 28). The likelihood of walking to school is higher for students who are older, students with school-aged siblings, and students living in lower-income households. McDonald concludes that shortening the distance between children's homes and schools (e.g., community-based schools) is the most effective strategy for increasing the number of children who walk to school.

Pedestrian Crash Data

The references in this sub-section provide data on pedestrian safety. They include pedestrian crashes and injuries in the United States, crash types, information about crash underreporting and the overall economic cost of traffic crashes. Specific statistics can be cited in the AASHTO Pedestrian Guide.

115. National Highway Traffic Safety Administration. *Traffic Safety Facts: 2007 Traffic Safety Annual Assessment – Highlights*, DOT HS 811 017, August 2008.

The NHTSA Traffic Safety Facts series reports annual traffic injuries and fatalities for each state and the nation as a whole. During 2007, 41,059 people were killed in traffic crashes in the United States. 4,654 (11.3%) of these fatalities were pedestrians. In addition, approximately 2.5 million injuries were reported in official police crash databases in 2007. Approximately 70,000 of these injuries occurred to pedestrians.

116. Stutts, J.C. and W.W. Hunter. "Police-reporting of Pedestrians and Bicyclists Treated in Hospital Emergency Rooms," *Transportation Research Record 1635*, Transportation Research Board, pp. 88-92, 1998.

Stutts and Hunter reviewed cases from eight hospital emergency rooms in three states in the 1990s. The analysis showed that only 56 percent of the pedestrians and 48 percent of the bicyclists treated in emergency rooms were successfully linked to crash records in their respective state motor vehicle crash files. This study looked at only the most serious crashes (involving emergency room treatment). Less-severe crashes may have an even lower rate of reporting accuracy.

This study provides an important caveat about the accuracy of pedestrian crash reporting, and it could be cited when pedestrian crash statistics are reported in the AASHTO Pedestrian Guide.

117. Hunter, W.W., J.C. Stutts, W.E. Pein, and C.L. Cox. Pedestrian and Bicycle Crash Types of the Early 1990s, US Department of Transportation, Federal Highway Administration, FHWA-RD-95-163, June 1996.

This FHWA report summarizes pedestrian crash data gathered from nine states in the early 1990s. It provides detailed descriptions of different types of crashes. It also reports the frequency of these crash types in the nine states that were studied.

118. Blincoe, L., A. Seay, E. Zaloshnja, T. Miller, E. Romano, S.Luchter, and R.Spicer. *The Economic Impact of Motor Vehicle Crashes, 2000*, National Highway Traffic Safety Administration, Report number DOT HS 809 446, 2002.

Traffic fatalities and injuries have significant, long-term impacts on families and friends, injured people's work and social lives, and the economy of the country as a whole. Lost market productivity, property damage, medical treatment, roadway delay, and other impacts of traffic crashes during the year 2000 were shown to cost the U.S. economy approximately $230 billion, or $820 for every resident of the country.

Built Environment Characteristics Associated with Pedestrian Activity

The references in this sub-section provide an overview of characteristics associated with pedestrian activity. By promoting neighborhoods and communities with certain characteristics, planners may be able to increase the amount of walking in a community and make the built environment safer and more enjoyable for pedestrians. Note that the studies are grouped according to convenience/land use characteristics, safety/facility characteristics, comfort/aesthetic characteristics, and socioeconomic characteristics, but many of the studies overlap several categories.

CONVENIENCE/LAND USE CHARACTERISTICS

119. Bowman J.L. and M.E. Ben-Akiva. "Activity-Based Disaggregate Travel Demand Model System with Activity Schedules," *Transportation Research Part A*, Volume 35, pp. 1-28, 2000.

    Bowman and Ben-Akiva summarize 1991 household travel data from the Boston metro area. They analyze travel "tours", or trip chains. This activity-based analysis shows that people tend to walk more when their total tour distance is shorter.

120. Brown, A.L., A. J. Khattak, and D. A. Rodriguez. "Neighborhood Types, Travel and Body Mass: A Study of New Urbanist and Suburban Neighborhoods in the US," *Urban Studies*, Volume 45, Number 4, pp. 963-988, April 2008.

    Brown, Khattak, and Rodriguez compared body mass index and physical activity data from a new urbanist neighborhood (Southern Village) with five traditional suburban neighborhoods in Chapel Hill, NC and Carrboro, NC. They find that household heads of single-family dwellings in the new urbanist neighborhood have lower BMI. This is due partly to the fact that these household heads make more utilitarian trips by walking and bicycling.

121. Cao, X., S.L. Handy, P.L. Mokhtarian. "The Influences of the Built Environment and Residential Self-Selection on Pedestrian Behavior: Evidence from Austin, TX," *Transportation*, Volume 33, Number 1, pp. 1-20, 2006.

    Cao, Handy, and Mokhtarian analyze 1995 data collected from 1,368 respondents in six neighborhoods (traditional vs. suburban) in Austin, TX. The most important factor explaining whether or not people walked for shopping trips is their preference for living in a walkable neighborhood (people who like to walk tend to live in neighborhoods where it is convenient to walk). However, after controlling for this self-selection effect, people report strolling more often in neighborhoods that they perceive to be safer, have more shade, and have less traffic. People report walking to the store more often when there are lower traffic volumes in the neighborhood as a whole and lower traffic volumes on commercial streets. They also walk more when they perceive that there are better pedestrian connections between their homes and neighborhood stores.

122. Cervero, R. and M. Duncan. "Walking, Bicycling, and Urban Landscapes: Evidence from the San Francisco Bay Area," *American Journal of Public Health*, Volume 93, Number 9, September 2003.

    Cervero and Duncan analyzed 7,836 trip records from the 2000 Bay Area Travel Survey to determine which built environment factors were associated with higher levels of walking. The likelihood of walking increased with shorter trip distances, flatter topography, and less rainfall. Employment accessibility and land use diversity have more influence on walking than urban design characteristics. All else equal, people walk more in residential and retail mixed-use environments. Community design characteristics such as intersection configurations and block sizes did not have a significant effect on walking activity.

123. Jonnalagadda, N., J. Freedman, W.A. Davidson, and J.D. Hunt. "Development of Microsimulation Activity-Based Model for San Francisco: Destination and Mode Choice Models," *Transportation Research Record 1777*, 2001.

Jonnalagada et al. analyze work “tour” (e.g., trip-chains that involve stopping at work) data collected from the 2000 Bay Area Travel Survey. Compared with driving, people may be less likely to bicycle and much less likely to take transit and walk on work tours that have a greater number of stops. People are more likely to make entire tours by walking when they take less time, include stops at fewer locations, there is a more connected pedestrian network near the workplace, fewer hills near the workplace, and when they live in a household with fewer automobiles.

124. Krizek, K.J. and P.J. Johnson. “Proximity to Trails and Retail: Effects on Urban Cycling and Walking,” *Journal of the American Planning Association*, Volume 72, pp. 33-42, 2006.

Krizek and Johnson analyze travel behavior data from 1,653 Twin Cities residents aged 20 years or older to see if living close to retail establishments was associated with higher rates of walking (in general, not just to stores). They find that people living within 200 meters of retail establishments have a significantly higher probability of walking than people living more than 600 meters from retail establishments.

125. Purvis, C. *Incorporating Effects of Smart Growth and TOD in San Francisco Bay Area Travel Demand Models: Current and Future Strategies*, Metropolitan Transportation Commission, Available Online: **http://www.mtc.ca.gov/maps_and_data/datamart/research/Incorporating_Smart_Growth_MTC_models.pdf**, 2003.

Purvis explores 2000 Bay Area Travel Survey data from more than 15,000 households in the nine-county San Francisco Bay area. His mode choice models show that people are more likely to walk to work when the walking travel time to work is lower and the employment density near a person’s workplace is higher. People are more likely to walk for shopping when the walking travel time is shorter and a person lives in a household with no automobiles. Children are more likely to walk to elementary school when the walking travel time is shorter and when they live in a household with more people.

126. Saelens, B.E. and S.L. Handy. “Built Environment Correlates of Walking: A Review,” *Medicine & Science in Sports & Exercise*, Volume 40, Number 7S, pp. S550–S566, 2008.

Saelens and Handy conduct a meta-analysis of previous literature reviews and recent studies of the relationship between built environment characteristics and walking. The studies that they review are from 2002 to 2006. They find that, in general, more walking is associated with shorter distance to destinations, mixed land uses, higher residential density, and higher employment density. Proximity to destinations is an important predictor of walking. Aesthetic qualities describing the attractiveness of the built environment do not have a consistent relationship with walking levels across studies. In general, more walking is associated with the availability of sidewalks and the connectivity of the street system. In addition, the characteristics of the built environment that are associated with walking to specific activity destinations (utilitarian walking) may be different than characteristics associated with walking purely for recreation.

127. Schlossberg, M., J. Greene, P.P. Phillips, B. Johnson, B. Parker. “School Trips: Effects of Urban Form and Distance on Travel Mode,” *Journal of the American Planning Association*, September 2006.

Schlossberg et al. compare how 292 children traveled to four different schools in Springfield, OR and Bend, OR in 2004. Two of the schools are in traditional urban areas, and two are in suburban fringe areas. Walking distance was the most significant predictor of walking to school. More students walk home from school than walk to school. The proportion of students walking home from school is high for students living less than one mile from school (52%), moderate for students living between one and 1.5 miles from school (36%), and low for students living more than 1.5 miles from school (4%). The researchers also find that students were more likely to walk to school when the neighborhoods between their home and school had higher intersection density and fewer dead-end streets. Of the 49% of parents who normally drive their children to school, the most common barriers to walking are the convenience (e.g., the ease of dropping child off on the way to work (mentioned by 41% of drivers), the heaviness of the child's backpack (33%), bad weather (30%), dangerous traffic conditions (23%), too far to walk/bike (23%), before/after school activities (21%), afraid of strangers (18%), projects or musical instruments to transport (18%), high-speed vehicles (15%), and lack of complete sidewalks (13%).

128. Research in Progress. Arnold, Lindsay., et al. "Identifying Factors that Determine Bicyclist and Pedestrian Involved Collision Rates and Bicyclist and Pedestrian Demand at Multi-Lane Roundabouts".

SAFETY/PEDESTRIAN FACILITIES

129.Ewing, R. and R. Cervero. "Travel and the Built Environment and Synthesis," *Transportation Research Record 1780*, pp. 87-114, 2001.

Ewing and Cervero review more than 50 studies from the 1990s and early 2000s that test the relationship between the built environment and mode choices. While their results focus on reductions in automobile trips and automobile miles traveled, many of the built environment characteristics are likely to have similar impacts on walking. They find that automobile trips decrease when neighborhoods have higher population density, higher employment density, more retail or service land uses within ¼-mile, and more sidewalks. They also find that vehicle miles traveled to work are lower in neighborhoods with higher population density, higher employment density, better regional accessibility to jobs, greater jobs/population balance, closer proximity to grocery stores, greater mix of land uses, more mixed-use buildings, more four-way intersections, and more intersections per roadway mile.

130.Clifton K.J. and J. Dill. "Women's Travel Behavior and Land Use: Will New Styles of Neighborhoods Lead to More Women Walking?" *Research on Women's Issues in Transportation*, Chicago, IL: Transportation Research Board, pp. 88-99, 2005.

Clifton and Dill analyze 2001 NHTS national data, 2001 NHTS Baltimore-area add-on data, and 1994-1995 Portland regional travel survey data to identify differences in walking and bicycling between women and men. At a national scale, women were more likely than men to cite lack of sidewalks as a problem in their neighborhoods. Of women stating that that the lack of sidewalks in their neighborhood was a significant problem, 34% did not make a walking trip in the last week. Of men stating a similar problem, 23% did not make a walking trip in the last week. This suggests that the lack of good walking facilities may have a greater impact on women than men. The authors conclude that, "Women in new urbanist neighborhoods may walk more than do women in less walkable environments. However, men appear more likely to respond to these environments and walk more than their female counterparts. Land use and urban design may also remove some of the current barriers to women's walking, particularly safety concerns; however, the results indicate that women's ability or inclination to walk may be rooted in other reasons, such as family responsibilities." (p. 89).

131.Forsyth, A., M. Hearst, J.M. Oakes, and K.H. Schmitz. "Does Residential Density Increase Walking and Other Physical Activity?" Urban Studies, Volume 44, Number 4, pp. 679-697, 2007.

Forsyth et al. analyze physical activity survey data from 715 people the Twin Cities region to investigate built environment factors associated with walking. Higher population density is associated with higher

levels of walking for utilitarian purposes (e.g., to destinations), but lower population densities tend to be associated with walking for leisure (e.g., for exercise and recreation, but not to destinations). Total walking measured by the travel diary "was modestly associated with" sidewalks, street lights, and small blocks sizes (Forsyth et al. 2006).

132. Lee, C. and A. Vernez-Moudon. "Physical Activity and Environment Research in the Health Field: Implications for Urban and Transportation Planning Practice and Research" *Journal of Planning Literature*, Volume 19, Number 2, pp. 147-181, 2004.

Lee and Vernez-Moudon review 20 public health studies to identify built environment factors associated with physical activity. Several studies report that walking is the most common type of physical activity. Other studies "help affirm that promoting walking is the most practical way to achieve healthful levels of physical activity" (p. 154). Area characteristics associated with higher levels of physical activity include proximity to local shops and access to other recreational activities. Route characteristics associated with greater levels of physical activity include the presence of sidewalks, pedestrian-friendly signage, street lights, slow ("tamed") traffic, increased visual quality, perceived safety, and convenience. The studies report a number of barriers to physical activity, including long distances between home and activities, lack of safe places and facilities for walking, poor accessibility to recreational facilities, and personal and social barriers. Specific safety barriers include unsafe roadway conditions, perceptions of crime, perceptions of traffic crash risk, concerns about dogs, and concerns about other people. Personal barriers include lack of time, poor health, child care responsibility, and lack of energy. Social barriers include not having company while walking and not seeing other people exercising in the community.

133. Lee, C. and A. Vernez-Moudon. "The 3Ds + R: Quantifying Land Use and Urban Form Correlates of Walking," *Transportation Research Part D*, Volume 11, pp. 204-215, 2006.

Lee and Vernez-Moudon analyzed Seattle GIS data to identify destination, distance, density, and route variables that have a significant association with the likelihood of walking reported by 608 Seattle-area residents. One of the route factors associated with a higher likelihood of walking was longer total sidewalk length within a one kilometer buffer of a person's home.

COMFORT AND APPEAL OF THE PEDESTRIAN ENVIRONMENT

Urban design features affect pedestrians' comfort and impact the desirability of walking. The studies cited below should be considered as the basis for guidance in creating a pedestrian environment that encourages walking.

134. Appleyard, D. "Livable Streets: Protected Neighborhoods?" *The Annals of the American Academy of Political and Social Science*, September 1980.

135. Appleyard, D. and M. Lintell. "The Environmental Quality of City Streets: The Residents' Viewpoint," *Journal of the American Institute of Planners* (Journal of the American Planning Association), Volume 38, Number 2, pp. 84-101, 1972.

136. Ben-Joseph, E. *The Code of the City: Standards and the Hidden Language of Place Making*, Cambridge, MA, MIT Press, 2005.

137. Bosselmann, P., E. Macdonald, and T. Kronemeyer. "Livable Streets Revisited," *Journal of the American Planning Association*, Volume 65, Number 2, pp. 168-180, 1999.

138.Ewing, R., S. Handy, R.C. Brownson, O. Clemente, and E. Winston. "Identifying and Measuring Urban Design Qualities Related to Walkability," *Journal of Physical Activity and Health*, Volume 3, Supplement 1, pp. S223-S240, 2006.

Ewing et al. used an expert panel to develop a framework for evaluating urban design qualities related to walkability. This analysis yielded operational definitions and measurement approaches for "imageability" (quality of a place that evokes feelings and makes it memorable), "visual enclosure" (the degree to which streets are visually defined by buildings, walls, trees, etc.), "human scale" (size and texture of built environment that correspond to the proportion of humans and the speed at which people walk), "transparency" (degree people can see or perceive what is beyond the edge of a street, depending on the design of walls, windows, doors, and fences), and "complexity" (the variety of the physical environment, building architecture, street furniture, and signage).

139.Gehl, J. and L. Gemzoe. *Public Spaces: Public Life*, Copenhagen, Danish Architectural Press, 2004.

140.Gehl, J. *Public Spaces and& Public Life Studies*, City of Adelaide, City Council, Australia, Available online, **http://www.adelaidecitycouncil.com/adccwr/publications/reports_plans/public_spaces_public_life.pdf**, 2002.

Gehl develops several measures of the quality of public spaces for pedestrians and applies these measures in Adelaide, Australia. He counts sidewalk pedestrian volumes at 15 locations (15-minute periods from 10 a.m. to 12 a.m.) and plots hourly distributions for all 15 sites; analyzes pedestrian wait time and walking time to cross the street at traffic signals; identifies locations with push buttons, left-turn slip lanes, driveway crossings of sidewalks; makes qualitative assessments of first-floor facades and maps blocks with good and poor frontages; maps existing public open space, traffic volumes, and parking spaces; maps evening activities (e.g., restaurants, cafés, pubs, clubs, hotels, theaters, cinemas, and other cultural activities in contrast with metal doors over shop fronts); maps streets that are "perceived as unsafe"; maps connections to the river; maps stationary activities (e.g., cultural activities, commercial activities, secondary seating, children playing, people lying down, people seated on outdoor cafes, people seated on benches, and people standing) in 3 plazas and along several streets between 10 a.m. and 8 p.m.

This "humanistic approach to urban design and city planning" emphasizes that streets are places for people to walk and enjoy spending time (p. 7). This is a stark contrast to the goal of reducing traffic congestion and moving people and vehicles from place to place as quickly as possible. "The traffic in good public spaces will primarily be dominated by walking, cycling and limited vehicular traffic" (p. 10).

141.Hooker, S.P., D.K. Wilson, S.F. Griffin, B.E. Ainsworth. "Perceptions of Environmental Supports for Physical Activity in African American and White Adults in a Rural County in South Carolina," *Preventing Chronic Disease*, Available online: http://www.cdc.gov/pcd/issues/2005/oct/05_0048.htm.

Hooker et al. report the results of a random-digit-dialing phone survey of 1,165 adults in a rural South Carolina county. They find that white adults who perceive their neighbors to be more physically active were twice as likely to meet daily physical activity recommendations as white adults who do not perceive their neighbors to be active. Also, white adults who perceived their neighborhoods to have less crime in were more likely to meet daily physical activity recommendations than white adults who perceived more crime in their neighborhoods.

142.Jacobs, A.B. *Great Streets*, Cambridge, MA: MIT Press, 1993

143.Lynch, K. *A Theory of Good City Form*, Cambridge, MA: MIT Press, 1981.

144.Southworth, M. “Designing the Walkable City,” *Journal of Urban Planning and Development*, Volume 131, Issue 4, pp. 246-257, December 2005.

Southworth defines “walkability” as “the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network.” (p. 247-248). Characteristics of a walkable environment include: a connected walking path network that provides access to places where people want to go; safe and comfortable routes for people with varied ages and varying degrees of mobility; public spaces that are attractive and engaging to be in (street trees and other landscape elements); pedestrian street spaces that provide a visual connection with the life of the place; pedestrian network that links seamlessly with other transit modes, minimizing automobile dependence; a pathway system that supports walking for utilitarian purposes and for pleasure, recreation, and health.

145.Southworth, M. and E. Ben-Joseph. *Streets and the Shaping of Towns and Cities*, Washington, DC: Island Press, 2003.

146.Baker, Linda. “Walking Wins Out: Pedestrian Streets are in Style Again”, *Planning*, May/June 2010.

147.Ewing, Reid and Steven J. Brown. “Traffic Calming Progress Report: What European Cities Can Teach Us”, *Planning*, November 2009.

148.Knack, Ruth Eckdish, AICP. “Dan Burden’s Sidewalk-Level View of the World”. *Planning*¸ January 2008.

149.Walljasper, Jay. “Brave New Non Motorized World”. *Planning*, December 2008.

SOCIOECONOMIC CHARACTERISTICS

150.Handy, S. *Critical Assessment of the Literature on the Relationships Among Transportation, Land Use, and Physical Activity*, Transportation Research Board Special Report 282, Available online: **http://trb.org/downloads/sr282papers/sr282Handy.pdf**, 2005.

Handy provides an excellent review of previous studies of the relationship between the built environment and physical activity (summary provided on p. 61-62, p. 67-68). Her review cites several studies that have included socioeconomic characteristics to control for mitigating influences on walking mode choices.

151.Shriver, K. “Influence of Environmental Design on Pedestrian Travel Behavior in Four Austin Neighborhoods,” *Transportation Research Record 1578*, Transportation Research Board, 1997.

Shriver’s study compares reported pedestrian activity in four Austin, TX neighborhoods. Two of the neighborhoods are “traditional” and two are suburban. Data were gathered through 214 intercept surveys. “In the physically accessible neighborhoods, walks are predominantly short and frequent utilitarian trips that involve more secondary activities. Activity in the less accessible neighborhoods is characterized by longer, less frequent recreational walks that involve fewer secondary activities” (p. 64). “The importance of walking in general and for specific purposes also varies with the relative levels of environmental variables. In the traditional neighborhoods, walkable distances, access to transit, shops, and work are more important, as is the opportunity to be outdoors. In the modern neighborhoods,

walkway continuity, trees, and interesting things to look at are more important environmental attributes, as is the opportunity to maintain health" (p. 64).

Pedestrian Walking Speeds

These references are recent studies of pedestrian walking speeds. They can be used in the section of the AASHTO Pedestrian Guide that discusses walking speeds.

152. Knoblauch, R.L., M.T. Pietrucha, and M. Nitzburg. "Field Studies of Pedestrian Walking Speed and Start-Up Time," *Transportation Research Record 1538*, Transportation Research Board, 1996.

> Knoblauch, Pietrucha, and Nitzburg provide one of the first in-depth studies of pedestrian walking speeds for different groups of people. Over 7,000 pedestrian crossings were observed at 16 crosswalks at signalized intersections in Richmond, VA, Washington, DC, Baltimore, MD, and Buffalo, NY. Data collectors timed pedestrian crossings with stopwatches and made an assessment of whether a pedestrian was older than age 65. "The 15th-percentile walking speed for younger pedestrians (ages 14 to 64) was 1.25 m/sec (4.09 ft/sec); for older pedestrians (ages 65 and over) it was 0.97 m/sec (3.19 ft/sec). For design purposes values of 1.22 m/sec (4 ft/sec) for younger pedestrians and 0.91 m/sec (3 ft/sec) for older pedestrians are appropriate. Results also indicated that walking rates are influenced by a variety of factors, including the functional classification and vehicle volumes on the street being crossed, the street width, weather conditions, the number of pedestrians crossing in a group, the signal cycle length, the timing of the various pedestrian-signal phases, whether right turn on red is allowed, pedestrian signals, medians, curb cuts, crosswalk markings, stop lines, and on-street parking. However, for each of these factors, the effect on crossing speeds, although statistically significant, is not meaningful for design" (p. 27).

153. Gates, T.J., D.A. Noyce, A.R. Bill, and N. Van Ee. "Recommended Walking Speeds for Timing of Pedestrian Clearance Intervals Based on Characteristics of the Pedestrian Population," *Transportation Research Record 1982*, Transportation Research Board, 2006.

> Gates et al. observe 1,947 pedestrian crossings at 11 intersections in Madison, WI and Milwaukee, WI. "A multifactor analysis of variance indicated that pedestrian walking speed depended on age and disability, traffic control condition, and group size. Pedestrians older than 65 were the slowest of all age groups, with mean and 15th percentile walking speeds of 3.81 and 3.02 ft/s, respectively, and typically would not be accommodated by pedestrian clearance intervals based on the commonly used 4.0-ft/s walking speed. Adult-assisted children and physically disabled persons had crossing speeds similar to those of persons older than 65. Groups of pedestrians crossed 0.4 to 0.6 ft/s slower than individuals. On the basis of data reported here, a 3.8-ft/s walking speed is recommended for timing pedestrian clearance intervals (flashing don't walk indication) at locations with normal pedestrian demographics (downtown areas, shopping areas, most neighborhoods, school areas) and locations where the age or physical disability status of the pedestrian population is unknown. When the proportion of pedestrians over the age of 65 is equal to or exceeds 20%, 30%, 40%, 50%, and 100% of the total pedestrians at a location, walking speeds of 3.6, 3.5, 3.4, 3.3, and 2.9 ft/s, respectively, are recommended for pedestrian clearance timings. Walking speeds of 4.0 ft/s are appropriate only for locations with very few older pedestrians, assisted children, and disabled persons, such as college campuses.

154. Montufar J., J. Arango, M. Porter, and S. Nakagawa. "Pedestrians' Normal Walking Speed and Speed When Crossing a Street," *Transportation Research Record 2002*, Transportation Research Board, 2007.

Montafur et al. account for age, gender, and seasonality (e.g., weather effects) on pedestrian walking speeds. They examine both pedestrian walking speed along sidewalks (e.g., normal walking speed) and pedestrian walking speed while crossing the street (e.g., crossing walking speed) at/near eight intersections in Winnipeg. A total of 1,792 pedestrians were observed. The research found that "in all cases the normal walking speed is less than the crossing walking speed. It also found that younger pedestrians walk faster than older pedestrians, regardless of the season and gender, and females walk slower than males, regardless of the season and age. Furthermore, both younger and older pedestrians have a greater normal walking speed in summer than in winter but a lower crossing walking speed in winter than in summer" (p. 90). "The average crossing walking speeds for younger and older pedestrians are 1.61 m/s (5.28 ft/s) and 1.36 m/s (4.46 ft/s), respectively. The 15th percentile walking speeds for younger and older pedestrians are 1.33 m/s (4.36 ft/s) and 1.08 m/s (3.54 ft/s), respectively. Unlike the case for normal walking speed, there is virtually no practical difference in the crossing walking speed between winter and summer for both age groups. The 15th percentile walking speeds in winter are 1.06 m/s (3.48 ft/s) for older pedestrians and 1.33 m/s (4.36 ft/s) for younger pedestrians. In summer, the 15th percentile walking speed for younger pedestrians is the same as that in winter, and for older pedestrians it is 1.08 m/s (3.54 ft/s). Female pedestrians walk slower than male pedestrians, regardless of the season and age. Ninety percent of younger pedestrians are properly accommodated when a design value of 1.2 m/s (4.0 ft/s) is used. If a design value of 1.2 m/s (4.0 ft/s) were used as recommended in the current Canadian and U.S. MUTCDs, nearly 40% of older pedestrians would be excluded in the design process on the basis of their crossing walking speed. With the proposed amendment to the U.S. MUTCD to lower the walking speed to 3.0 ft/s (0.91 m/s), this proportion decreases to approximately 10%" (p. 97).

Safety Analysis/Audits

These references provide practical guidance on how to analyze pedestrian crash data and identify specific locations for pedestrian safety treatments. They may be useful references to cite in the AASHTO Pedestrian Guide for readers seeking additional details about pedestrian crash and pedestrian risk mapping applications.

This section also includes tools and approaches for evaluating the quality of local pedestrian environments. They range from simple checklists to complex audit instruments. Some require minimal field data collection, while others require extensive data collector training and monitoring. Most of the methods provide data that can be analyzed using geographic information systems.

155. Zegeer, C., D. Henderson, R. Blomberg, L. Marchetti, S. Masten, Y. Fan, L. Sandt, A. Brown, J. Stutts, and L. Thomas. *Evaluation of the Miami-Dade Pedestrian Safety Demonstration Project*, National Highway Traffic Safety Administration, June 2008.

Crash-based analysis was used in Miami-Dade County, Florida, as part of a study conducted by the University of North Carolina and the Miami-Dade County MPO for the National Highway Traffic Safety Administration (NHTSA). The study involved first identifying high pedestrian crash locations and zones (i.e., neighborhoods) and then analyzing them to determine the primary crash causes, related pedestrian and motorist behaviors, and pedestrian characteristics (age, ethnic groups) to assist with countermeasure selection. Pedestrian crash data were analyzed from 1996 through 2001, and GIS crash density mapping identified four zones in the county with very high concentrations of pedestrian crashes. Between 2002 and 2004, 16 different types of specific safety treatments were implemented in these zones, primarily involving educational programs, supplemented with enforcement and engineering measures. Countermeasures included educational programs in elementary schools, educational posters

on transit vehicles, materials and meetings held at senior centers, radio and television messages, enforcement programs related to motorist yielding to pedestrians, and a variety of engineering measures (e.g., signing timing changes, school zone improvements). A time-series analysis of the program showed that it reduced pedestrian crashes in the county by between 8.5% and 13.3%, which represented 180 fewer pedestrian crashes per year.

156.Schneider, R.J., A.J. Khattak, and C.V. Zegeer. "Method of Improving Pedestrian Safety Proactively with Geographic Information Systems: Example from a College Campus," *Transportation Research Record 1773*, Transportation Research Board, 2001.

Schneider, Khattak, and Zegeer map the locations of five years of police-reported pedestrian crashes to identify "hot spots", or locations with high concentrations of crashes in the UNC-Chapel Hill campus area. They supplement these reported crash data with information about locations where campus students, staff, and faculty perceive high-levels of crash risk. Geographic information systems are used to map locations with high reported or perceived pedestrian crash risk. These maps provide a basis for selecting locations for specific pedestrian safety treatments, including extending sidewalks, constructing median islands, installing high-visibility pedestrian warning and crossing signs, and other engineering, education, and enforcement crash countermeasures.

157.U.S. Department of Transportation, U.S. Environmental Protection Agency, National Center for Safe Routes to School, and Pedestrian and Bicycle Information Center. *Walkability Checklist: How Walkable is your Neighborhood?* Available online: **http://drusilla.hsrc.unc.edu/cms/downloads/walkabilitychecklist.pdf**, 2007(?).

This Walkability Checklist provides a simple framework for residents to evaluating neighborhood pedestrian conditions. It is designed for parents to use with their children. The form provides spaces for users to provide a qualitative rating (1, worst to 6, best) for the condition and connectivity of sidewalks, ease of street crossings, driver behavior, and overall enjoyment of walking along a local route.

The AASHTO Pedestrian Guide could cite this checklist as a reference for community members seeking an easy tool to evaluate neighborhood walking conditions.

158.Nabors, D., M. Gibbs, L. Sandt, S. Rocchi, E. Wilson, and M. Lipinski. *Pedestrian Road Safety Audit Guidelines and Prompt Lists*, Federal Highway Administration, FHWA-SA-07-007, Available online: July 2007.

A road safety audit (RSA) is a formal safety examination of a future roadway plan or project or an in-service facility that conducted by an independent, experienced multidisciplinary RSA team. The Pedestrian Road Safety Audit Guidelines and Prompt Lists developed for the Federal Highway Administration provides transportation agencies and teams conducting an RSA with a better understanding of the needs of pedestrians of all abilities.

The Guide has two primary sections: Knowledge Base and the Field Manual. The Knowledge Base section discusses the basic concepts with which the RSA team should be familiar before conducting an RSA. It includes useful background information on the characteristics of pedestrians, barriers to pedestrians, factors that contribute to pedestrian crashes, and crash data analysis. The Field Manual section includes guidelines and prompt lists. The guidelines provide detailed descriptions of potential pedestrian safety issues, including universal considerations (e.g., general pedestrian needs, pedestrian facility connectivity and convenience, traffic, behavior, construction, and the needs of children) and considerations for specific types of locations, including street segments, roadway crossings, parking areas/adjacent developments, and transit areas. The prompt lists are a general listing of potential pedestrian safety issues that can be used during an RSA.

159. Leslie, E., N. Coffee, L. Frank, N. Owen, A. Baumane, and G. Hugo. "Walkability of Local Communities: Using Geographic Information Systems to Objectively Assess Relevant Environmental Attributes," *Health & Place*, Volume 13, pp. 111-122, 2007.

Leslie et al. describe the development of a walkability index called the Physical Activity in Localities and Community Environments (PLACE) approach. Originally implemented in Australia, it is proposed for studies of the relationship between the built environment and pedestrian activity in the United States. The index focuses on land use and urban design characteristics, including dwelling density, connectivity of streets (intersection density), land use mix, and net retail area. The reliability if this index was tested in Australia.

160. Parks, J.R. and J.L. Schofer. "Characterizing Neighborhood Pedestrian Environments with Secondary Data," *Transportation Research Part D*, Volume 11, pp. 250-263, 2006.

Parks and Schofer develop measures to quantify the quality of neighborhood pedestrian environments and test these measures in the Chicago area. Their methodology relies only on secondary data, which requires less time and labor to collect than primary field observations. The variables included in their neighborhood pedestrian environment rating include network design features (block length, number of census blocks per mile, and density of four-way intersections), pedestrian facilities (feet of sidewalk per foot of roadway) and roadside built environment features (average building setbacks per block and feet of on-street parking per foot of roadway). These features showed a high correlation with expert qualitative assessments of neighborhood walkability.

161. Schlossberg, M. and N. Brown. "Comparing Transit-Oriented Development Sites by Walkability Indicators," *Transportation Research Record 1887*, Transportation Research Board, 2004.

Schlossberg and Brown develop walkability indices for transit-oriented development sites in Portland, OR. Three primary methods were used: network classification, pedestrian catchment areas, and impedance-based intersection intensities. Network classification evaluates the types of street classifications (arterial vs. minor streets) and patterns of these roadway types within one mile of a transit station. Pedestrian catchment areas evaluate the total roadway and pedestrian network distance required to reach a transit station compared with straight-line distance. Impedance-based intersection intensities evaluate the density of four-way versus other types of intersections and dead-end streets. In addition, intersections along busy arterial roadways and freeway crossings are given higher impedance values (because they are less pedestrian-friendly).

162. Clifton, K.J., A.D. Livi Smith, and D. Rodriguez. "The Development and Testing of an Audit for the Pedestrian Environment," *Landscape and Urban Planning*, Volume 80, pp. 95–110, 2007.

Clifton, Livi Smith, and Rodriguez describe the Pedestrian Environmental Data Scan (PEDS). This pedestrian audit tool evaluates the following characteristics of roadway or trail segments: adjacent land uses, slope, pedestrian facility type, pedestrian facility material, pedestrian obstructions, sidewalk buffer, sidewalk completeness, sidewalk connectivity, sidewalk condition, road condition, number of lanes, posted speed limit, on-street parking, off-street parking lot spaces, driveways and curb cuts, traffic control devices, crossing aids in segment, lighting, aesthetics (garbage cans, benches, water fountains, bicycle parking, street vendors), wayfinding, number of trees, degree of enclosure, power lines, cleanliness, building setbacks, bicycle lanes, and transit facilities. It also includes a subjective assessment of the quality of a roadway.

The article provides a very useful comparison of PEDS with other existing pedestrian environmental audit tools. It describes the design of the PEDS instrument, the creation of training and supporting materials, and how the tool can be integrated into handheld technology, such as a portable data assistant. The article also describes how PEDS was tested for reliability between different data collectors. Authors state that "the PEDS audit methodology provides a comprehensive method to evaluate pedestrian environments for academics involved with transportation and physical activity research as well as practitioners seeking to an assessment tool for prioritizing investments."

SUITABILITY ANALYSIS TOOLS

163. Landis, B.W., V.R. Vattikuti, R. M. Ottenberg, D.S. McLeod, and M. Guttenplan. "Modeling the Roadside Walking Environment: Pedestrian Level of Service," *Transportation Research Record 1773*, Transportation Research Board, 2001.

The segment Pedestrian Level of Service (Segment Pedestrian LOS) model assesses the level of safety perceived by pedestrians while walking along a roadway segment (e.g., between intersections). Data for the model were collected from 75 participants who walked along street segments in Pensacola, FL. The factors included in the segment Pedestrian LOS model are: Presence and width of sidewalk; Width of buffer between sidewalk and roadway; Percentage of street segment with on-street parking (considered as a buffer between moving traffic and pedestrians); Presence and spacing of street trees; Width of the outside motor vehicle travel lane; Width of shoulder or bike lane; Peak 15-minute traffic volume; Total number of through-traffic lanes; Average speed of motor vehicle traffic.

There are a number of issues that should be considered when applying the segment Pedestrian LOS model. The Segment Pedestrian LOS model represents the comfort level of a hypothetical "typical" pedestrian. Therefore, some pedestrians may feel more comfortable and others may feel less comfortable than the Segment Pedestrians LOS grade for a roadway. The model represents the average Segment Pedestrian LOS over the entire length of the segment. There may be specific locations where the sidewalk narrows or the on-street parking is not present, but the model considers the typical, or average, characteristics of the segment. The model is not a crash prediction model. While the Segment Pedestrian LOS model represents the perceived level of safety of a typical pedestrian, changes in Segment Pedestrian LOS grades cannot be used to predict increases or decreases in reported crashes. Roadway grade (steepness) is not included in the model. Steep grades can make it more difficult for pedestrians to travel along a roadway. However, the scientific studies that were conducted to develop the Segment Pedestrian LOS model did not identify roadway steepness as a factor that influenced the perceived level of safety of bicyclists or pedestrians. The Segment Pedestrian LOS model is very sensitive to the presence of sidewalks and traffic volumes. For example, on roadways with high traffic volumes, increases in sidewalk width, buffer width, and street trees tend to cause only small changes to the Pedestrian LOS grade. However, when considered individually, these roadway design changes all improve the pedestrian environment.

164. Petritsch, T.A., B.W. Landis, P.S. McLeod, H.F. Huang, S. Challa, C.L. Skaggs, M. Guttenplan, V. Vattikuti. "Pedestrian Level of Service Model for Urban Arterials with Sidewalks," *Transportation Research Record 1982*, Transportation Research Board, 2006.

Petritsch et al. developed a model of pedestrian perceptions of safety walking along urban arterials based on real-time perception data from approximately 100 participants (half who participated in the roadway facility LOS study and half who participated in the intersection LOS study) in Sarasota, FL. This model accounts for both segments and intersection crossings in a roadway corridor. The Urban Arterial Pedestrian Level of Service (Urban Arterial Pedestrian LOS) is based on the following factors: Traffic volumes on the adjacent roadway (average 15-minute volume); Density of conflict points along the

facility (total width of crossings at conflict locations--sum of the crossing widths of all driveways and intersections (feet per mile) along the corridor).

165.Petritsch, T.A., B.W. Landis, P.S. McLeod, H.F. Huang, S. Challa, and M. Guttenplan. "Level of Service Model for Signalized Intersections for Pedestrians," *Transportation Research Record 1939*, Transportation Research Board, 2005.

Petritsch et al. developed a perception-based intersection pedestrian level of service model (Intersection Pedestrian LOS). The study involved having 100 participants walk through 23 intersections in Sarasota, FL with a variety of design characteristics (21 had traffic signals) and grade them according to their real-time perception of safety on an A (best) through F (worst) scale. Study participants were also asked to rate video clips of a variety of intersection crossings. The final Intersection Pedestrian LOS model uses the following factors: Number of right-turn-on-red vehicles plus the number of motorists making a permitted left turn in a 15-min period (decreases pedestrian comfort); Traffic volume in the outside through lane of the street being crossed during a 15-minute period multiplied by the midblock 85th percentile speed of the traffic on the street being crossed (decreases pedestrian comfort); Number of lanes being crossed by the pedestrian (decreases pedestrian comfort); Average pedestrian delay before being able to cross (average of all legs of the intersection) (decreases pedestrian comfort); and Number of right-turn slip lanes at the intersection (decreases pedestrian comfort at low volumes but increases pedestrian comfort at high volumes).

166.US Department of Transportation, Federal Highway Administration. Pedestrian and Bicyclist Intersection Safety Indices: Final Report, Authors: D.L. Carter, W.W. Hunter, C.V. Zegeer, R. Stewart, and H. F. Huang, Pedestrian and Bicycle Information Center, Available online: **http://www.tfhrc.gov/safety/pedbike/pubs/06125/06125.pdf**, 2006.

FHWA developed the Pedestrian Intersection Safety Index (PISI) to evaluate pedestrian safety at intersections. The PISI is based on the opinions of 76 pedestrian safety experts who viewed video clips from 68 intersection crosswalks. Factors in the model include: Presence of traffic-signal control (positive effect on perception of safety); Presence of stop-sign control (positive effect); Number of through lanes on street being crossed (negative effect); 85th percentile speed of street being crossed (negative effect); Traffic volume on street begin crossed times presence of traffic-signal control (negative effect); Volume of traffic during 15-minute period divided by number of through lanes on intersection approach (negative effect).

167.Chu, X. and M.R. Baltes. Pedestrian Mid-block Crossing Difficulty, National Center for Transit Research, University of South Florida, Prepared for Florida Department of Transportation, Available online: **http://www.dot.state.fl.us/Planning/systems/sm/los/pdfs/pedestrian.pdf**, 2001.

Chu and Baltes developed a mid-block pedestrian crossing difficulty model. They gathered data about the difficulty of crossings from participants in Hillsborough County, FL and Pinellas County, FL. The factors used to evaluate pedestrian crossing difficulty include: Roadway traffic volume, number of turning vehicles, average vehicle speed, roadway crossing width, width of raised median, width of painted median, presence of a marked crosswalk, presence of a pedestrian signal (signalized mid-block crossing), adjacent traffic signal cycle length, and signal spacing.

168.Transportation Research Board. *Highway Capacity Manual 2000*, Washington, DC, 2000 (as updated; Note – new addition expected to be published in late 2010 or early 2011).

Based on the research of Fruin (1971), Pedestrian LOS was measured in terms of the amount of space available per pedestrian on sidewalk segments and crosswalk queuing areas. More crowded areas received lower level of service grades. The Pedestrian LOS concept was expanded in Chapter 19 of the 2000 HCM to include off-street pathways, intersection crossings, and travel along urban sidewalk segments. Like sidewalks and crosswalk queuing areas, off-street pathways are still assessed according to crowding. However, intersection crossing Pedestrian LOS is based on the average delay time before a pedestrian can cross the street (includes both signalized and unsignalized crossing locations), and a new measure of sidewalk Pedestrian LOS is based on the average pedestrian walking speed on each block.

A number of researchers have challenged the concept of capacity- and speed-based Pedestrian LOS measures because they give the highest grade (no crowding or slowing due to crowding) to almost all sidewalks in the United States. For that reason, the new HCM will cover pedestrian LOS both in terms of capacity as well as the comfort of the environment. This is a considerable change that should be reflected in the next edition of the AASHTO Pedestrian Guide.

169. Dowling, R., D. Reinke, A. Flannery, P. Ryus, M. Vandehey, T. Petritsch, B. Landis, N. Rouphail, and J. Bonneson. *Multimodal Level of Service Analysis for Urban Streets*, National Cooperative Highway Research Program Report 616, Transportation Research Board, Available online: **http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_616.pdf**, 2008.

Multimodal Level of Service (Multimodal LOS) measures are based on user perceptions of the street, from the perspective of a pedestrian, bicyclist, transit user, and automobile driver. Most of the original pedestrian, bicycle, transit, and automobile level of service models were originally developed for the Florida Department of Transportation. The Multimodal LOS approach recommends evaluating roadway corridors on A (best) to F (worst) scales for all of these types of users. One limitation of this approach is that the level of service grades for each mode cannot be compared directly to evaluate tradeoffs. For example, increasing Automobile LOS from “C” to “B” may or may not be equivalent to increasing Pedestrian LOS from “C” to “B”.

The multimodal pedestrian level of service model (MMLOS Pedestrian LOS) is the minimum score of a density-based pedestrian LOS model or the weighted average of street segment, intersection, and mid-block crossing pedestrian LOS models. The density-based pedestrian model is the same as the Pedestrian LOS model described in the HCM (TRB 2000). Note that this model will only have the minimum LOS score in locations where crowding causes pedestrians to travel more slowly. The other three models consider the following factors:

Segment model: Width of outside lane, shoulder, and/or bicycle lane; On-street parking occupancy; Presence and spacing of street trees; Presence and width of buffer between street and sidewalk at edge of roadway; Presence and width of sidewalk; Traffic volume on street (peak 15-minute period); Number of motor vehicle through-lanes; Average motor vehicle speed on roadway.

Intersection model (only computed for signalized intersections): Number of right-turns on red and permitted left turns during a 15-minute period; Midblock 85th percentile speed on cross street (speed limit is a proxy); Traffic volume in outside lane of cross street; Number of lanes on cross street; Average crossing delay (seconds); Number of right-turn slip lanes at the crossing

Mid-block crossing model (difficulty of crossing the street between signalized intersections, based on Chu and Baltes (2001)): Delay waiting for safe gap to cross (depends on average vehicle flow rate, average vehicle length, average vehicle speed, number of lanes, and lane widths); Delay diverting to nearest signalized intersection to cross (depends on block length, signal cycle length, and signal green time).

GUIDANCE FOR PEDESTRIAN FACILITY SELECTION

170. U.S. Department of Transportation, Federal Highway Administration. *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, FHWA-SA-04-003, September 2004.

> PEDSAFE describes of 49 engineering, education, and enforcement pedestrian crash countermeasures. Countermeasure categories include pedestrian facility design, roadway design, intersection design, traffic calming, traffic management, signals and signs, and other measures. The description of each countermeasure includes the purpose and general cost of the treatment as well as considerations for applying the treatment. The document includes approximately 75 case studies illustrating how many of the pedestrian crash countermeasures have been used in different communities. PEDSAFE also includes background chapters about pedestrian planning and pedestrian safety statistics.

171. U.S. Department of Transportation, Federal Highway Administration. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*, FHWA-RD-04-100, Authors: Zegeer, Charles V., J. Richard Stewart, Herman Huang, and Peter Lagerwey, Available online: **http://www.tfhrc.gov/safety/pubs/04100/index.htm**, 2001.

> The FHWA Crosswalk Study analyzed pedestrian crash risk at 1000 marked and 1000 unmarked crosswalks at uncontrolled crossing locations in 30 cities throughout the United Sates. This study provides recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations. Crossing locations are classified into the following three categories based on the roadway motor vehicle ADT, posted speed limit, number of travel lanes, and presence of a raised median:
>
> "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, and other factors may be needed at other sites. It is recommended that a minimum utilization of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) be confirmed 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 by 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" (p. 54).

172. Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E.S. Park, J. Whitacre, N. Lalani, D. Lord. *Improving Pedestrian Safety at Unsignalized Crossings,* Transit Cooperative Research Program Report 112, National Cooperative Highway Research Program Report 562, Transportation Research Board, Available online, **http://www.trb.org/news/blurb_detail.asp?id=6630**, 2006.

> This NCHRP Report analyzes the effectiveness of a variety of pedestrian crossing treatments that can be used at unsignalized intersections along high-volume, high-speed roadways. The report finds that the effectiveness of particular treatments varies depending on the characteristics of the roadway environment. Traffic speed and number of travel lanes are particularly important variables to consider when selecting treatments.

The researchers evaluated the following types of treatments: Half signals (Half); HAWK signal beacon (HAWK); Midblock pedestrian signal (Msig); Smart pedestrian warning, where an overhead pedestrian sign and two yellow flashing beacons are passively activated by an approaching pedestrian (OfPa), Overhead flashing beacons, where an overhead pedestrian sign and two yellow flashing beacons are activated when a button is pushed by the pedestrian (OfPb); Pedestrian crossing flags (Flag); High-visibility markings and signs (HiVi); In-street pedestrian crossing sign (InSt); and Pedestrian median refuge island (Refu). Several criteria were used to evaluate these treatments, including the percentage of motorists yielding to pedestrians and the percentage of pedestrians looking for traffic before entering the roadway. Generally, a greater percentage of motorists yielded for all treatments when there were fewer roadway lanes and lower speed limits. On higher-speed, multi-lane streets, traffic signals, such as midblock pedestrian signals and HAWK signals were the only treatments that had high rates of motorist yielding.

Appendix A includes guidelines for selecting pedestrian crossing treatments for unsignalized intersections and midblock locations. Worksheets are provided, one for streets where peak-hour traffic travels more than 35 miles per hour, and one for streets where peak-hour traffic travels less than 35 miles per hour. The worksheets include pedestrian volumes, roadway traffic volumes, and pedestrian delay. There are also flow charts provided to help guide planners and engineers toward appropriate crossing treatments.

The study recommended changes to the MUTCD pedestrian signal warrant: "The basis for the proposed pedestrian warrant revisions is that the number of pedestrians waiting to cross a street should be no greater than the number of vehicles waiting to cross or enter a street. Once this basis has been accepted, then the existing vehicle-based warrants can be used to derive comparable warrants for crossing pedestrians. The net effect of the proposed revisions is as follows: (1) the pedestrian warrant will be slightly easier to meet with lower pedestrian volumes on streets with high vehicle volumes, and (2) the pedestrian warrant will be slightly more difficult to meet on streets with low vehicle volumes." (p. 59-60).

The study also documented pedestrian crossing speeds.

Pedestrian Demand Analysis

The studies in the section below describe tools for estimating levels of pedestrian activity in different parts of a community. Tools range from latent demand, which provides a relative ranking of potential pedestrian activity, to models of actual pedestrian volumes along street segments and at intersection crossings. These tools can be useful for estimating pedestrian activity levels in different parts of a community, prioritizing pedestrian projects, and safety analysis.

173. Clifton, K.J., C.V. Burnier, S. Huang, M.W. Kang, and R.J. Schneider. "A Meso-Scale Model of Pedestrian Demand," Paper presented at the 4th Joint Meeting of the Association of Collegiate Schools of Planning and the Association of European Schools of Planning, Chicago, IL, July 6-11, 2008.

Clifton et al. present a model that estimates pedestrian volumes on sidewalk segments and crosswalks. To overcome the lack of fine-grained detail in standard transportation planning model Traffic Analysis Zones (which are generally between 0.5 square miles and 2 square miles), Clifton uses Pedestrian Analysis Zones as her unit of analysis (land uses present in the buildings on each street block face). Pedestrian trips are estimated according to 14 different trip purposes. Like many automobile regional demand models, the model accounts for pedestrian trip origins and destinations (e.g., land uses on each block face) and route impedances (e.g., roadway width, volume, speed, and traffic signals). Two case studies in Maryland showed that the pedestrian volumes estimated by the model were within four percent of actual pedestrian counts on links in the network. However, the method required extensive data and computing time, and the case study applications were both limited to areas of approximately 10 square miles.

174. Pulugurtha, S.S. and Repaka, S.R. "Assessment of Models to Measure Pedestrian Activity at Signalized Intersections," *Transportation Research Record 2073*, pp. 39-48, 2008.

Pulugurtha and Repaka develop pedestrian volume models based on pedestrian crossing data from 176 signalized intersections in Charlotte, NC. Data were collected over 12-hour periods (7 a.m. to 7 p.m.) in 2005. Models were estimated to predict pedestrian volumes during specific time periods (7 a.m. to 8 a.m., 10 a.m. to 11 a.m., 12 p.m. and 1 p.m., and 5 p.m. to 6 p.m., and the entire day, 7 a.m. to 7 p.m.). Variables were tested within 0.25-mile, 0.5-mile, and 1-mile buffers. Factors associated with higher pedestrian volumes included in the full day model include more population within all three buffer distances, more bus stops within all three buffer distances, more employment within 0.25-mile, more "urban" residential land uses within 0.25-mile and 1-mile, not having single-family residential land uses within 0.5-mile, and not having mixed land use within 0.25-mile.

175. Schneider R.J., L.S. Arnold, and D.R. Ragland. "A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes," *Transportation Research Record: Journal of the Transportation Research Board*, Volume 2140, pp. 13-26, 2009.

Schneider, Arnold, and Ragland developed a pilot model that can be used to estimate weekly pedestrian intersection crossing volumes based on the population living within ½-mile, employment within ¼-mile, commercial properties within ¼-mile, and presence of a regional transit station within 1/10-mile. The model is based on pedestrian counts at 50 arterial and collector roadway intersections in Alameda County, CA, and these four factors accounted for approximately 90% of the variation in pedestrian activity between the 50 sites (the pedestrian count methodology is described below). While sidewalks, median islands, and other roadway design features have been shown to make conditions safer for pedestrians, these characteristics did not have a significant effect on pedestrian volumes in this study. Collecting counts at more intersections may increase the impact of these factors in future pedestrian volume models. However, land use factors appear to be the most important predictors of pedestrian activity at specific locations. This model requires additional validation testing and refinement, but it is designed with a simple structure. Its four variables are based on readily-available census, land use, and transit data. The model can be implemented by practitioners using geographic information systems and a basic spreadsheet program.

176. Raford, N. and D. Ragland. "Space Syntax: Innovative Pedestrian Volume Modeling Tool for Pedestrian Safety," *Transportation Research Record 1878*, pp. 66-74, 2004.

Raford and Ragland describe an application of the Space Syntax model on 7,000 street segments and 670 intersections in Oakland. The model explains 77 percent of the variance in pedestrian counts that were provided for the study. Special software, such as Fathom Visibility Graph Analysis Software (Intelligent Space Partnership 2000), is used to calculate variables such as field of view, number of turns, and other factors before pedestrian volumes can be estimated. The applications of Space Syntax pedestrian modeling in the literature have been in dense urban environments. Model estimates tend to become less accurate in areas with suburban character.

177. Goodman, D., R. Schneider, and T. Griffiths. "Put Your Money Where the People Are," *Planning*, June 2009.

Goodman, Schneider, and Griffiths provide practical advice about several methods to prioritize pedestrian projects in local or regional communities. Prioritization methods include pedestrian infrastructure needs assessments, pedestrian crash analysis, latent demand analysis, and pedestrian volume modeling. Communities often use a combination of these tools to develop priorities for pedestrian projects. In addition, public input is an essential component of all prioritization processes. The article provides examples from Alexandria, Virginia; Sacramento, California; Seattle, Washington; Miami-Dade County, Florida; Charlotte, North Carolina; and Alameda County, California.

178. Parisi, David. "Forecasting Pedestrian and Bicycle Travel Demands Using Travel Demand Model and Mode Share/Trip Length Data", Pedestrian and Bicycle Information Center. Available Online: http://www.walkinginfo.org/library/details.cfm?id=4461.

Site-Based Pedestrian Trip Generation

The studies in this section describe methods of adjusting existing traffic impact assessments to account for pedestrian trips. These approaches are relatively new, but are essential tools for planning new developments that provide safe and convenient opportunities for walking. It may be useful for the AASHTO Pedestrian Guide to discuss pedestrian trip generation along with site development issues.

179. Nelson/Nygaard Consulting Associates. Crediting Low-Traffic Developments: Adjusting Site-Level Vehicle Trip Generation Using URBEMIS, San Francisco, CA, August 2005.

While working for the California Department of Transportation, Nelson/Nygard developed a method to calculate automobile trip reduction factors when conducting traffic impact assessments. The methodology allows planners to reduce automobile trip projections from the Institute of Transportation Engineers *Trip Generation Manual* by up to 55 percent in areas with high residential density, nine percent in areas with a good mix of employment and housing, two percent if a development is served by nearby local retail, 15 percent in locations with nearby transit service, and nine percent if the development is surrounded by pedestrian and bicycle facilities. While the trip reduction factors are not based on empirical studies, they begin to address the limitation of the existing automobile trip generation approach, which only provides estimates for automobile trips, and is only based on studies of developments in suburban and exurban areas.

180. California Department of Transportation. *Trip-Generation Rates for Urban Infill Land Uses in California: Phase 2, Data Collection*, Prepared by Kimley-Horn and Associates, Inc., Economic & Planning Systems, and Gene Bregman & Associates, June 2009.

This ongoing effort by the California Department of Transportation has documented trip generation for infill developments. This research has evaluated pedestrian and bicycle trip generation rates at a sample of sites in San Francisco, Oakland, Berkeley, San Diego, and Los Angeles, CA.

Safety in Numbers

"Safety in numbers" is the concept that an increase in the number of pedestrians or bicyclists using a roadway segment or crossing an intersection reduces the risk of any pedestrian or bicyclist being injured in a crash, independent of all other changes to the local environment. The studies below provide evidence of the "safety in numbers" phenomenon.

181.Jacobsen, P.L. “Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling,” *Injury Prevention*, Volume 9, pp. 205-209, 2003.

Jacobsen compared pedestrian and bicycle injury and fatality rates with measures of pedestrian and bicycle use in 68 California cities, 47 Danish towns, and 14 European countries. In aggregate, he determined that communities with twice as much walking as other communities tend to have only 32 percent more pedestrian injuries. This result is surprising because, all else equal, a community with twice as much walking would be expected to have twice as many (100 percent more) pedestrian injuries than other communities. Jacobsen hypothesizes that the “safety in numbers” effect is due to motorists becoming more aware of pedestrians and driving more carefully near pedestrians when more pedestrians are present. However, more research is needed to determine specific causes that lead to lower injury rates in communities with more walking. Note that this study used aggregate data at the city or country level and did not control for automobile traffic volumes, roadway characteristics, or pedestrian and driver behaviors.

182.Geyer, J., N. Raford, T. Pham, and D.R. Ragland. “Safety in Numbers: Data from Oakland, California,” *Transportation Research Record 1982*, pp. 150-154, 2006.

Geyer et al. analyzed pedestrian risk at 247 intersections in Oakland, CA. Pedestrian crash risk at each intersection was calculated as the annual number of pedestrian crashes reported between 2000 and 2002 divided by the estimated annual pedestrian crossing volume at each intersection. Pedestrian volumes were estimated from a Space Syntax model. The analysis revealed that intersections with twice as many pedestrians tended to have only 53 percent more reported crashes (rather than 100 percent more crashes, as would be expected if there were a linear relationship). One advantage of this study is that it found a “safety in numbers” effect while controlling for automobile volumes and intersection characteristics (e.g., number of lanes, traffic control, marked versus unmarked crosswalks, median type, and neighborhood type). The authors offer several hypotheses for the “safety in numbers” effect. First, more pedestrians in an area may influence drivers to drive more carefully around pedestrians. Second, more pedestrians in an area may change pedestrian behavior so that pedestrians have less risky interactions with moving vehicles. Third, intersections that have higher pedestrian volumes may have different physical characteristics than lower-volume intersections that were not measured in this study (in this case, there may be lower risk due to unmeasured physical characteristics, such as curb radii and traffic signal cycle length, rather than pedestrian volume). Finally, pedestrians may simply choose to walk more in locations where pedestrian risk is lower. While this study overcomes several limitations of previous research, the authors emphasize the need to identify the causal mechanisms behind “safety in numbers.”

Safe Routes to School

As Safe Routes to Schools programs have expanded throughout the country, it is important for the AASHTO Pedestrian Guide to address issues related to children walking to school. These guidebooks and studies described below provide practical guidance for communities seeking to establish new programs and examine the characteristics of children walking to school.

183.Pedestrian and Bicycle Information Center. *Safe Routes To School Guide,* National Highway Transportation Safety Administration, Federal Highway Administration, Centers for Disease Control and Prevention, and Institute of Transportation Engineers, 2008.

The Safe Routes to School Guide is an excellent resource for communities and schools working on Safe Routes to Schools programs. It provides background information about the decline in walking to school in the United States, health risks of this decline, and an overview of safe routes to school programs. The guide includes steps for developing a program and provides guidance on engineering, enforcement, encouragement, education, and evaluation components. Brief case studies are provided to show how these approaches have been used successfully in different communities.

184. McMillan, T., K. Day, M. Boarnet, M. Alfonzo, C. Anderson. "Johnny Walks to School - Does Jane? Sex Differences in Children's Active Travel to School," *Child Youth Environment*, Volume 16, pp. 75-89, 2006.

McMillan et al. surveyed parents/caregivers of third- through fifth-grade students in 10 California communities to determine how children travel to school and factors that determine this mode choice. They find that boys are 40 percent more likely to walk to school than girls. The decision to allow children to walk to school is significantly associated with the lifestyle of the caregiver. If a child's caregiver walks frequently, they tend to walk to school more often.

"When caregivers put a higher premium on the convenience of driving to school, had more household income and, surprisingly, as children aged, the likelihood of walking/bicycling to school decreased. Conversely, a supportive family atmosphere for active travel, living within one mile of school and more walking on the part of the surveyed caregiver increased the likelihood of a child walking/bicycling to school" (p. 83).

185. Schlossberg, M., J. Greene, P.P. Phillips, B. Johnson, B. Parker. "School Trips: Effects of Urban Form and Distance on Travel Mode," *Journal of the American Planning Association*, September 2006.

186. McDonald, N. "Children's Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School," *Transportation*, Volume 35, Number 1, pp. 23-35, 2008.

187. United States Environmental Protection Agency, *Travel and Environmental Implications of School Siting,* Available Online: http://www.epa.gov/smartgrowth/pdf/school_travel.pdf, 2003.

Complete Streets and Roadway Design

The complete streets concept is important because it emphasizes including pedestrians (as well as other roadway users) in all phases of transportation project development, including planning, programming, design, engineering, construction, maintenance, and performance monitoring. Many states, regions, and localities have adopted "Complete Streets" policies during the last five years. The references below may be useful to cite in the AASHTO Pedestrian Guide. Recent research on roadway lane widths is included in this section because lane widths are an important factor to consider when allocating roadway space to serve all roadway users, including pedestrians.

188. LaPlante J. and B. McCann. "Complete Streets: We Can Get There from Here," *ITE Journal*, p. 24-28, May 2008.

LaPlante and McCann provide a good explanation of the "complete streets" concept. This may be a useful resource to cite in the AASHTO Pedestrian Guide.

189.Potts, I.B., D.W. Harwood, and K.R. Richard. "Relationship of Lane Width to Safety on Urban and Suburban Arterials," *Transportation Research Record 2023*, Transportation Research Board, 2007.

Potts, Harwood, and Richard examine crash data from urban and suburban arterial roadways in Michigan and Minnesota. The researchers found that there was no increased risk of crashes for 10-foot lanes versus 12-foot lanes on urban and suburban arterial roadways, except special cases, such as four-lane undivided roadways. "Geometric design policies should provide substantial flexibility for use of lane widths narrower than 3.6 m (12 ft)" (p. 63).

190.Institute for Transportation Engineers and Congress of New Urbanism. "Designing Walkable Urban Thoroughfares: A Context Sensitive Approach": An ITE Recommended Practice, 2010.

The ITE Recommended Practice, *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*, advances the successful use of context sensitive solutions (CSS) in the planning and design of major urban thoroughfares for walkable communities. It provides guidance and demonstrates for practitioners how CSS concepts and principles may be applied in roadway improvement projects that are consistent with their physical settings. The report's chapters are focused on applying the principles of CSS in transportation planning and in the design of roadway improvement projects in places where community objectives support walkable communities-compact development, mixed land uses and support for pedestrians and bicyclists, whether it already exists or is a goal for the future.

This document was produced in cooperation with the Federal Highway Administration, the Environmental Protection Agency and in partnership with the Congress for the New Urbanism.

Hansen, Gilbert and Norman Garrick. "Variation in Free Flow speed due to Roadway Type and roadside Environment" *Transportation Research Board Annual Meeting 2007 Paper #07-3136*, Transportation Research Board, 2007.

191.Petritsch, Theodore A. , P.E., PTOE. "The Truth About Lane Widths", Pedestrian and Bicycle Information Center, Available Online: http://www.walkinginfo.org/library/details.cfm?id=4348.

192.Levinson, H.S., "Streets for People and Transit", *Transportation Quarterly,* Transportation Research Board, 1986.

193.Rosales, Jennifer. "Road Diet Handbook". Northwest Transportation Conference. February 7, 2008. Available Online: http://egov.oregon.gov/ODOT/TD/TP_RES/docs/2008NWTC/2008_presentations/7A_3_rosales.pdf .

Transit Access Planning

Many people walk to access bus and rail services. The critical linkage between pedestrian and transit modes require coordination between transit agencies, transportation agencies and developers and other entities that design and/or maintain roadways, sidewalks, trails and other pedestrian ways+. The AASHTO Pedestrian Guide should include information describing how to make pedestrian access to transit safer and more convenient. The references below are the most current available on this topic.

194. Federal Highway Administration. *Pedestrian Safety Guide for Transit Agencies*, FHWA-SA-07-017, Authors: D. Nabors, R. Schneider, D. Leven, K. Lieberman, C. Mitchell, Available online: **http://safety.fhwa.dot.gov/ped_bike/ped/ped_transguide/**, February 2008.

 Many transit passengers access rail and bus services as pedestrians. Therefore, it is essential to provide safe and convenient pedestrian pathways near transit stops and stations. The FHWA Pedestrian Safety Guide for Transit Agencies was developed "to provide transit agency staff with an easy-to-use resource for improving pedestrian safety" (p. 2). The guide includes an overview of safety issues associated with transit access, descriptions of engineering, education, and enforcement strategies that have been implemented by transit agencies and local communities to improve pedestrian safety, and references to other publications and guidebooks about pedestrian safety.

Pedestrian Data Collection

Having good data on pedestrian activity, pedestrian facilities, pedestrian safety, and pedestrian characteristics is important for many aspects of pedestrian planning. Planners may wish to track changes in pedestrian activity in their communities over time, document exposure for safety analysis, evaluate the condition and connectivity of pedestrian facilities, and evaluate pedestrian performance measures. In many cases, planners need to collect data to make these assessments. It may be helpful for the AASHTO Pedestrian Guide to provide a brief paragraph on the importance of using practical methods to collect consistent and reliable data.

195. US Department of Transportation, Federal Highway Administration. Pedestrian and Bicycle Data Collection in United States Communities: Quantifying Use, Surveying Users, and Documenting Facility Extent, Authors: R. Schneider, R. Patten, J. Toole, and C. Raborn, Available online: **http://www.walkinginfo.org/rd/planning.cfm#data**, January 2005.

 The Federal Highway Administration developed more than 25 case studies to illustrate pedestrian and bicycle data collection approaches being used throughout the United States. Categories of data collection included quantifying use, surveying users, and documenting the extent of facilities.

 This document may be a good reference to cite in the AASHTO Pedestrian Guide. Many practitioners are looking for guidance on how to collect pedestrian counts, evaluate sidewalks and roadway crossings, and identify the types of people who are walking in their communities.

196. Schneider, R.J., L.S. Arnold, and D.R. Ragland. "A Methodology for Counting Pedestrians at Intersections: Using Automated Counters to Extrapolate Weekly Volumes from Short Manual Counts," Transportation Research Record: Journal of the Transportation Research Board, Volume 2140, pp. 1-12, 2009.

 Schneider, Arnold, and Ragland developed a consistent methodology for collecting pedestrian volumes at intersections. They used this methodology to collect pedestrian crossing counts at 50 arterial and collector roadway intersections throughout Alameda County, CA. After extrapolating the two-hour counts to weekly pedestrian volumes (accounting for time of day, weather conditions, and land use effects on pedestrian volume patterns), they developed a model to estimate typical weekly pedestrian volumes at 7,500 intersections throughout Alameda County.

1.5. PEDESTRIAN RESEARCH – DESIGN TOPICS

General References

197. "Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes," *Issue Briefs*, FHWA-SA-014, Federal Highway Administration, 2008.

This issues brief documents estimates of the crash reduction that might be expected if a specific countermeasure or group of countermeasures is implemented with respect to pedestrian crashes. The crash reduction estimates are presented as Crash Reduction Factors (CRFs). As some studies reviewed included bicycle crashes in their analysis, some of the crash reduction estimates include bicyclists. Traffic engineers and other transportation professionals can use the information contained in this issue brief when asking the following types of question: Which countermeasures might be considered at the signalized intersection of Maple and Elm streets, an intersection experiencing a high number of pedestrian crashes? What change in the number of pedestrian crashes can be expected with the implementation of the various countermeasures?

This publication is important, since it provides a compilation of some of the best research results available on the effects of various roadway treatments on pedestrian crashes, which is expressed in terms of crash reduction factors.

198. Campbell, B. J., Zegeer, C. V., Huang, H. H., and Cynecki, M. J. "A Review of Pedestrian Safety Research in the United States and Abroad," FHWA-RD-03-042, McLean, Va., Federal Highway Administration, 2004.

The purpose of this report is to provide an overview of research studies on pedestrian safety in the United States; some foreign research also is included. Readers will find details of pedestrian crash characteristics, measures of pedestrian exposure, and specific roadway features and their effects on pedestrian safety. Such features include crosswalks and alternative crossing treatments, signalization, signing, pedestrian refuge islands, provisions for pedestrians with disabilities, bus stop location, school crossing measures, reflectorization and conspicuity, grade separated crossings, traffic-calming measures, and sidewalks and paths. Pedestrian educational and enforcement programs also are discussed.

This summary of the best available research on pedestrian facilities will be useful and help guide the discussions on many of the facilities that are discussed in the new Guide.

199. Zegeer, C. V., Stutts, J. C., and Huang, H. "Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. Volume 10: A Guide for Reducing Collisions Involving Pedestrians," *NCHRP Report 500*, Transportation Research Board, 2004.

The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities by 5,000 to 7,000. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This tenth volume of NCHRP Report 500, "Guidance for Implementation of the AASHTO Strategic Highway Safety Plan," provides strategies that can be employed to reduce the number of collisions involving pedestrians. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

This Guide will also be useful in providing updated information on the various types of countermeasures for improving pedestrian safety, including some of the factors that need to be considered to insure that the countermeasures are most effective in where and how they are used.

200. Harkey, D.L., Srinivasan, R., Baek, J., Council, F.M., Eccles, K.A., Lefler, N.X., et al. "Accident Modification Factors for Traffic Engineering and ITS Improvements," NCHRP Report, Number 617, Transportation Research Board, 2008.

This report presents the findings of a research project to develop accident modification factors (AMFs) for traffic engineering and Intelligent Transportation Systems (ITS) improvements. AMFs are a tool for quickly estimating the impact of safety improvements. The report will be of particular interest to safety practitioners responsible for programming and implementing highway safety improvements.

This document provides an important perspective on the expected reductions in all types of crashes as a result of implementing various types of treatments. This is important, since the new AASHTO Pedestrian Guide needs to consider the safety and mobility of all road users.

201. Harwood, D.W., Bauer, K.M., Richard, K.B., Gilmore, D.K., Graham, J.L., Potts, I.B., et al. "Methodology to Predict the Safety Performance of Urban and Suburban Arterials," NCHRP Project 17-26, National Cooperative Highway Research Program, 2007.

The Transportation Research Board (TRB) and the American Association of State Highway and Transportation Officials (AASHTO) have begun a major initiative to develop a Highway Safety Manual (HSM). The HSM began from recognition of the fact that, for safety to receive proper consideration in the highway project development process, analysts need tools to make quantitative statements about the safety effects of proposed projects or design alternatives. The key components of the HSM will be: Part I—Introduction and Fundamentals; Part II—Knowledge; Part III—Predictive Methods; Part IV—Safety Management of a Roadway System; and Part V—Safety Evaluation. HSM Part III will consist of chapters that provide safety prediction methodologies for specific types of highway facilities. The TRB Task Force plans that the first edition of the HSM should include safety prediction methodologies for rural two-lane highways, rural multilane highways, and urban and suburban arterials. These methodologies would address the safety performance of both roadway segments and at-grade intersections on these facility types. A prototype chapter on rural two-lane highways for use in HSM Part III has already been developed to illustrate the potential format and scope for such chapters. This report presents research results which document the development of a draft HSM chapter presenting a safety prediction methodology for urban and suburban arterials. This is the first safety prediction methodology developed specifically for the HSM. This report presents the results of the literature review, the survey of potential HSM users, the recommended structure of the safety prediction methodology, and the recommended work plan for the methodology development. Chapter 1 of this report provides an introduction to the report. Chapter 2 presents information related to the safety performance of urban and suburban arterials, including the results of the literature review and an HSM user survey. Chapter 3 summarizes the recommended structure for the safety prediction methodology. Chapter 4 presents the development of the project database. Chapter 5 documents the development of the base models and adjustment factors used in the HSM methodology, while Chapter 6 documents the accident modification factors (AMFs) used in the methodology. The HSM methodology is summarized in Chapter 7. Chapter 8 presents the results of a validation study in which the safety prediction methodology was applied to sites in jurisdictions other than those used in its development. Chapter 9 presents the conclusions and recommendations of the research. Appendix A presents the results of the survey of state and local highway agencies, MPOs, and TRB Task Force members. Appendix B presents a draft of HSM Chapter 10 which incorporates the safety prediction methodology.

This report was conducted as a part of the HSM effort, and it provides important insights regarding the roadway and geometric features that most affect pedestrian crashes at signalized intersections, including the proximity of an intersection to a bus stop.

202. Nabors, D., Gibbs, M., Sandt, L., Rocchi, S., Wilson, E., Lipinski, M. “Pedestrian Road Safety Audit Guidelines and Prompt Lists,” FHWA-SA-07-007, Federal Highway Administration, 2007.

A road safety audit (RSA) is a formal safety examination of a future roadway plan or project or an in-service facility that is conducted by an independent, experienced multidisciplinary RSA team. All RSAs should include a review of pedestrian safety; however, some RSAs may be conducted to improve an identified pedestrian safety problem. The Pedestrian Road Safety Audit Guidelines and Prompt Lists provides transportation agencies and teams conducting an RSA with a better understanding of the needs of pedestrians of all abilities. The Guide has two primary sections: Knowledge Base and the Field Manual. The Knowledge Base section discusses the basic concepts with which the RSA team should be familiar before conducting an RSA, such as understanding the characteristics of all pedestrians, analyzing pedestrian crash data, pedestrian considerations in the eight-step RSA process, and use of the Guide. The Field Manual section includes the guidelines and prompt lists. The guidelines provide detailed descriptions of potential pedestrian safety issues while the prompt lists are a general listing of potential pedestrian safety issues. The guidelines and prompt lists will help familiarize RSA teams with potential pedestrian issues and help them identify specific safety concerns related to pedestrian safety throughout the RSA process.

This is a relatively new FHWA publication that is important for the new AASHTO Pedestrian Guide, since it provides a detailed methodology for use by local and state officials in assessing a roadway section for deficiencies and needs for improving the pedestrian environment.

203. Staplin, L., Lococo, K., Byington, S., and Harkey, D.L. “The Highway Design Handbook for Older Drivers and Pedestrians,” FHWA-RD-01-103, McLean, VA: Federal Highway Administration, 2001.

This project updated, revised, and expanded the scope of the *Older Driver Highway Design Handbook* published by FHWA in 1998. The resulting document incorporates new research findings and technical developments; extensive feedback from state, county, and municipal engineers who reviewed and applied recommendations from the earlier version of the Handbook; and recommendations with supporting background material for aspects of modern roundabouts and highway-rail grade crossings, two elements which were not covered in the 1998 publication. Recommendations geared to use of highway facilities by pedestrians also receive greater emphasis. Guidance on how and when to implement the included recommendations has been added, as well as codes which indicate at a glance the relationship of each recommendation with standard design manuals including the *MUTCD* and the *AASHTO Green Book*.

204. “Crash Reduction Factors for Traffic Engineering and Intelligent Transportation System ITS Improvements: State-of-Knowledge Report,” *NCHRP Research Results Digest*, Number 299, Transportation Research Board, 2005.

This digest provides interim results from NCHRP Project 17-25, "Crash Reduction Factors for Traffic Engineering and ITS Improvements." The digest summarizes the current status of crash reduction factors for a variety of treatments, provides a summary of the "best available" crash reduction factors, and discusses the relationship between this study and other ongoing research studies that are either documenting or developing additional factors.

205.Pecheux, K.K., Bauer, J.K., Miller, S., Relpho, J.A., Saporta, H., Erickson, S., et al. "Guidebook for Mitigating Fixed-Route Bus-and-Pedestrian Collisions," *TCRP Report*, Number 125, Transportation Research Board, 2008.

This report will be of interest to public transportation systems that provide fixed-route bus services and their communities. This Guidebook will assist small, medium, and large transit agencies and their community members in better understanding bus-and-pedestrian collisions and in determining preventative or remedial strategies for reducing the frequency and severity of these types of collisions. The Guidebook is divided into four parts. Part I discusses how to mitigate the four most common collision types and circumstances. Part II presents a variety of mitigation strategies with detailed information for over 80 applications of the strategies. Part III contains 14 case studies, which provide in-depth examples for the best documented applications. Part IV presents a discussion of important considerations for improving pedestrian safety around transit buses.

206.Antonucci, N.D., Hardy, K.K., Slack, K.L., Pfefer, R., and Neuman, T.R. "NCHRP Report 500 Volume 12: A Guide for Addressing Crashes at Signalized Intersections," Washington, D.C., Transportation Research Board, National Research Council, 2004.

The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities by 5,000 to 7,000. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This tenth volume of NCHRP Report 500, "Guidance for Implementation of the AASHTO Strategic Highway Safety Plan," provides strategies that can be employed to reduce the number of collisions involving pedestrians. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

207.Petritsch, T.A., et al. "Level-of-Service Model for Pedestrians at Signalized Intersections," *Transportation Research Record: Journal of the Transportation Research Board, Number 1939*, 55-62, 2005.

This paper documents a study performed to develop a level-of-service (LOS) model that accurately represents pedestrians' perceptions of crossings at signalized intersections. This model incorporates perceived safety and comfort (i.e., perceived exposure and conflicts) and operations (i.e., delay and signalization). Data for the model were obtained from an innovative Walk for Science field data collection event and video simulations. The data consist of (*a*) participants' perceptions of safety, comfort, and operations as they walk through selected signalized intersections and (*b*) the design and operational characteristics of these intersections. The resulting model provides a measure of the pedestrian's perspective on how well an intersection's geometric and operational characteristics meets his or her needs. The pedestrian LOS model for intersections described in this paper is based on Pearson correlation analyses and stepwise regression modeling of approximately 800 combined real-time perceptions (observations) from pedestrians walking a course through signalized intersections in a typical U.S. metropolitan area. The resulting general model for the pedestrian LOS at intersections is highly reliable, has a high correlation coefficient (R^2 = .73) with the average observations, and is transferable to the majority of metropolitan areas in the United States. Primary factors in the pedestrian LOS model for intersections include right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, midblock 85th percentile speed of the vehicles on the street being crossed, number of lanes being crossed, pedestrian's delay, and presence or absence of right-turn channelization islands.

208.Schneider, R.J., Ryznar, R.M., and Khattak, A.J. "An Accident Waiting to Happen: A Spatial Approach to Proactive Pedestrian Planning," *Accident Analysis & Prevention*, Volume 36, Number 2, pp. 193-211, 2004.

A pedestrian injury occurs every 6 minutes and a pedestrian fatality every 107 minutes in the United States. About 75,000 pedestrian crashes occur in the U.S. every year. This study has two objectives: to determine if perception data can add important information for a proactive approach to crash avoidance; and, to analyze the factors from both geographic distributions through a1 regression analysis.

209.Retting, R. A., Ferguson, S. A., and McCartt, A. T. A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes. *American Journal of Public Health*, Volume 93, Number 9, pp. 1456-1463, 2003.

We provide a brief critical review and assessment of engineering modifications to the built environment that can reduce the risk of pedestrian injuries. In our review, we used the Transportation Research Information Services database to conduct a search for studies on engineering counter-measures documented in the scientific literature. We classified countermeasures into 3 categories--speed control, separation of pedestrians from vehicles, and measures that increase the visibility and conspicuity of pedestrians. We determined the measures and settings with the greatest potential for crash prevention. Our review, which emphasized inclusion of studies with adequate methodological designs, showed that modification of the built environment can substantially reduce the risk of pedestrian--vehicle crashes.

210.Shinar, D. "Pedestrians," Traffic Safety and Human Behavior. Amsterdam: Elsevier, 2007.

Traffic crashes have become the epidemic of the third millennium a seemingly necessary evil that accompanies increasing levels of motorization. In this comprehensive book, Dr David Shinar provides a theoretical framework and a critical evaluation of the most recent research findings to comprehend the complexity of traffic safety and the central role that drivers, motorcyclists, and pedestrians play in it. In approximately 800 pages with over 250 graphs and tables, Shinar covers the key issues that relate human behavior to traffic safety.

211.Lobb, B. "Trespassing on the Tracks: A Review of Railway Pedestrian Safety Research," *Journal of Safety Research*, Volume 37, Number 4, pp. 359-365, 2006.

Train-pedestrian collisions have been shown to be the leading cause of fatality in train-related accidents worldwide, yet there is remarkably little research in this area. Method: In this paper, the major types of railway transportation accident research are briefly highlighted to indicate the general context of research concerning train-pedestrian collisions, which are then reviewed. Themes emerging from the diverse research are identified, the various strategies that have been proposed for prevention of railway pedestrian accidents are discussed, and the empirical evidence for their efficacy examined in the light of the much more extensive literature on road pedestrian accidents. Finally, it is proposed that application of current theory in behavioral and cognitive psychology may usefully inform future research in transportation safety.

212.Erke, A. and Elvik, R. "Making Vision Zero Real: Preventing Pedestrian Accidents and Making Them Less Severe," Oslo, Norway: Institute of Transport Economics, 2007.

This report describes the risk of injuries and accidents for cyclists and pedestrians, variables that affect the risk of accidents, and countermeasures to reduce the severity and probability of these accidents. The risk of accidents to pedestrians is about 10 times greater than the risk to motor vehicle occupants. When one or more of the risk factors to accidents (poor pedestrian visibility, vehicle speed, cyclists in road traffic) are reduced, safety measures are effective in reducing the risk for cyclist and pedestrian accidents. Accident risk would be decreased if people walked and cycled more, even though that might increase the total number of cyclist and pedestrian accidents. Increased walking and cycling would also lead to a more equitable distribution of rates of injury between motorized and non-motorized road users.

213.Ray, B., Kittelson, W., Knudsen, J., Nevers, B., Ryus, P., Sylvester, K. “Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections: Supplement to NCHRP Report 613,” NCHRP Web Document, Number 124, Transportation Research Board, 2007.

This project identified and evaluated treatments and developed guidelines for reducing vehicle speeds on approaches to high-speed intersections (approach speeds of 45 mph or greater). Phase I involved conducting a literature search and state agency survey to obtain information about speed reduction treatments currently being used throughout the nation, developing a testing plan for conducting treatment testing, and creating a framework for the research guidelines. Phase II involved conducting field testing of three types of treatments (transverse pavement markings, rumble strips, and dynamic warning signs) at ten sites in Oregon, Washington, and Texas, and developing a set of Guidelines for applying speed reduction treatments. The research focused on geometric design treatments and considered traffic signs and pavement markings on signalized, unsignalized, and roundabout intersections. The treatments investigated were: reduced lane width, visible shoulder treatments, speed tables, rumble strips, roadway environment, approach reverse curvature, roundabouts, splitter islands, wider longitudinal pavement markings, transverse pavement markings, and dynamic warning signs. Speed reduction treatments were investigated to determine their applicability, key features, speed effects, safety benefits, multimodal impacts, and maintenance issues. A survey of state highway agencies provided information about the types of speed reduction treatments that are currently being used and the agencies' estimated effectiveness of each treatment. The research team coordinated with state agencies to identify candidate treatment testing sites and conduct a treatment selection and implementation process. Before-and-after testing was conducted using tape switches to estimate the effectiveness of each type of treatment installed. Transverse pavement markings were installed at five sites in Oregon. Dynamic warning signs were installed at two sites in Washington and Texas. Rumble strips were installed at three sites in Texas. As a final research product, the research team wrote this report to assist roadway planners, designers, and operators as they consider and select appropriate speed reduction treatments at intersections located in high-speed environments. The application of these treatments most often applies to existing intersections that experience undesirably high speeds; however, the information is also relevant to new intersection designs. These guidelines provide relevant information about the effects of speed, the conditions that may contribute to undesirably high speeds at intersection approaches, and the state of the practice related to speed reduction treatments used in the U.S. and abroad, including their effectiveness and implementation considerations. The guidelines also provide insights on the relationship between speed and facility operations. The guidelines provide users with information about speed, speed considerations at intersections, and the potential application of treatments to affect speed. Additional research is needed to fully understand the effects that speed reduction treatments and reduced speed may have on safety.

214.Hunter, W. W., Stutts, J. S., Pein, W. E., and Cox, C. L. "Pedestrian and Bicycle Crash Types of the Early 1990's," FHWA-RD-95-163, McLean, Va., Federal Highway Administration, 1996.

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 with particular attention to roadway and locational factors. Five thousand pedestrian-motor vehicle crashes and 3,000 bicycle-motor vehicle crashes were coded in a population-based sample drawn from the states of California, Florida, Maryland, Minnesota, North Carolina, and

Utah. Nearly a third of the pedestrians were struck at or near [within 16 m (50 ft) of] an intersection. Midblock events were the second major pedestrian crash type grouping, representing over a fourth (26%) of all crashes. The bicycle-motor vehicle crash types distributed as: (1) parallel paths - 36%, (2) crossing paths - 57%, and (3) specific circumstances - 6%. Most frequent parallel path crashes were motorist turn/merge into bicyclist's path (34.4% of all parallel path crashes), motorist overtaking (24.2%), and bicyclist turn/merge into motorist's path (20.6%). Most frequent crossing path crashes were motorist failed to yield (37.7% of crossing path crashes), bicyclist failed to yield at an intersection (29.1%), and bicyclist failed to yield midblock (20.5%). Future safety considerations should be systemwide and include an examination of intersections and other junctions, well designed facilities, and increased awareness of pedestrians and bicyclists by motor vehicle drivers.

This report identifies the specific types of pedestrian crashes that are most prevalent and most likely to be in need of preventive measures in certain situations. The new Guide should include such information so the users will be more aware of these issues.

215. Neuman, T. R., Pfefer, R., Slack, K. L., Hardy, K. K., Harwood, D. W., Potts, I. B., Torbic, D. J., and Rabbani, E. R. "NCHRP Report 500 Volume 5: A Guide for Addressing Unsignalized Intersection Accidents," Washington, D.C., Transportation Research Board, National Research Council, 2003.

The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities by 5,000 to 7,000. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This fifth volume of NCHRP Report 500, "Guidance for Implementation of the AASHTO Strategic Highway Safety Plan," provides strategies that can be employed to reduce the number of unsignalized intersection collisions. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

216. "Pedestrian and Bicyclist Intersection Safety Indices: User Guide," McLean, VA: Federal Highway Administration, 2007.

The primary objective of this study was to develop safety indices to allow engineers, planners, and other practitioners to proactively prioritize intersection crosswalks and intersection approaches with respect to pedestrian and bicycle safety. The study involved collecting data on pedestrian and bicycle crashes, conflicts, avoidance maneuvers, and subjective ratings of intersection video clips by pedestrian and bicycle experts. There were a total of 68 intersection crosswalks selected for the pedestrian analysis from the cities of Philadelphia, PA; San Jose, CA; and Miami-Dade County, FL. The bicycle analysis included 67 intersection approaches from Gainesville, FL; Philadelphia, PA; and Portland and Eugene, OR. Prioritization models were developed based on expert safety ratings and behavioral data. Indicative variables included in the pedestrian safety index model included type of intersection control (signal or stop sign), number of through lanes, 85th percentile vehicle speed, main street traffic volume, and area type. Indicative variables in the bicycle safety models (for through, right-turn, and left-turn bike movements) included various combinations of: presence of bicycle lane, main and cross street traffic volumes, number of through lanes, presence of on-street parking, main street speed limit, presence of traffic signal, number of turn lanes, and others. Through this User Guide, practitioners will be able to use the safety indices to identify which crosswalks and intersection approaches have the highest priority for in-depth pedestrian and bicycle safety evaluations and subsequently use other tools to identify and address potential safety problems.

The information from this User Guide should be considered when discussing intersection safety for pedestrians in the new AASHTO Pedestrian Guide. It provides a methodology to help predict pedestrian crash risk and therefore has implications concerning designing new intersections as well as retrofitting existing intersections.

217.Potts, I., Stutts, J., Pfefer, R., Neuman, T.R., Slack, K.L., and Hardy, K.K. 2004. “NCHRP Report 500 Volume 9: A Guide for Addressing Accidents Involving Older Drivers,” Washington, D.C., Transportation Research Board, National Research Council.

The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities by 5,000 to 7,000. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This fifth volume of NCHRP Report 500, "Guidance for Implementation of the AASHTO Strategic Highway Safety Plan," provides strategies that can be employed to reduce the number of unsignalized intersection collisions. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

218.Forbes, G. "Synthesis of Safety for Traffic Operations: Final Report," Ottawa, Ontario, Canada, Transport Canada, 2003.

This Synthesis presents the best available evidence respecting the safety impacts of traffic operations and control strategies for Canadian practitioners. Only research and studies that report on crash occurrence, crash severity, or crash surrogates with a proven correlation to crashes are included. Each study is critically reviewed to determine the accuracy of the results, and the particular situation in which they are applicable. The Synthesis is not all-inclusive and will be outdated by ongoing research in the road safety field. The practitioner should keep abreast of recent developments in the traffic operations-safety knowledge base. Overall the Synthesis should be used by the road safety professional to practice evidence-based road safety, and in pursuing the Canadian vision of making Canada's roads the safest in the world.

Midblock or Section

219.Huang H. F., & Cynecki, M. J. “The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior,” Report Number FHWA-RD-00-104. McLean, VA: Federal Highway Administration, 2001.

Traffic calming treatments may benefit pedestrians who are crossing the street by slowing down vehicle traffic, shortening crossing distances, and enhancing motorist and pedestrian visibility. 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 intersection 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.

220.Bacquie, R., Egan, D., and Ing, L. "Pedestrian Refuge Island Safety Audit," Monterey, Calif., Presented at 2001 ITE Spring Conference and Exhibit, 2001.

Public agencies are aware of the growing need to better accommodate the safety and security of pedestrians in the roadway environment. The use of refuge islands by themselves or in conjunction with pedestrian crossovers has greatly enhanced safety in Toronto, Canada. Over the past ten years there have been more than 60 islands implemented in the city of Toronto and surrounding jurisdictions. Officials in the City of Toronto initiated a review of the operation of the islands to gain insight into design issues and safety implications since the use of pedestrian refuge islands (PRI) and split pedestrian crossovers (SPXO) are becoming a more common roadway element. It has become important to document standard practices, deficiencies and the effectiveness of the islands in order to provide a basis for a comprehensive audit of the islands practices and operational experiences. It is expected that the use of islands will encourage pedestrian crossing of major roads at locations other that signalized intersections. The benefits of the islands in terms of the simplifying the crossover maneuver for pedestrians is weighted against a potentially more aggressive pedestrian behavior and likelihood of increases in pedestrian crossing activity and the resultant exposure to conflict with vehicles. This paper will review the conditions of implementation of islands that may be beneficial or problematic.

221.Kamyab, A., Andrle, S., Kroeger, D., Heyer, D.S. “Methods to Reduce Traffic Speed in High-Pedestrian Rural Areas,” *Transportation Research Record Number 1828*, pp. 31-37, 2003.

Many Minnesota counties are faced with the problem of high vehicle speeds through towns or resort areas that have significant pedestrian traffic. The impact of speed reduction strategies in high-pedestrian areas in rural counties of Minnesota was investigated. Speed data were collected at two selected study sites under their existing conditions ("no-treatment" or "before" condition) and after the proposed speed reduction strategies were installed. Second "after" data conditions were collected to study the short-term and long-term impact of the implemented strategies. The traffic-calming techniques employed at the Twin Lakes site consisted of removable pedestrian islands and pedestrian crossing signs. A dynamic variable message sign that sent a single-word message ("Slow") to motorists traveling over the speed limit was installed at the Bemidji site. The research study shows that the traffic-calming strategy deployed in Twin Lakes was effective in significantly reducing the mean speed and improving speed limit compliance in both the short term and long term. Despite proven effectiveness, the deployed speed reduction treatment in Bemidji Lake failed to lower the speed at the study site. The single-word message on the sign and the location of the sign, as well as a lack of initial enforcement, were the primary reasons for such failure.

222.King, M.R., Carnegie, J.A., Ewing, R. “Pedestrian Safety Through A Raised Median and Redesigned Intersections,” *Transportation Research Record Number 1828*, pp 56-66, 2003.

Documentation was done on the effect of a raised median, signalized and redesigned intersections, curbs, and sidewalks on vehicle speed, pedestrian exposure risk, driver predictability, and vehicle volume along a four-lane suburban roadway in central New Jersey. The analysis used both quantitative tools (speed and volume counts, timing runs) and qualitative methods (pedestrian tracking, video, before-and-after photography). The results are that the 85th-percentile vehicle speed fell by 2 mi/h and pedestrian exposure risk decreased by 28%. Also, the median allows pedestrians to cross one direction of traffic at a time and signals, curbs, median, redesigned intersections, and striping patterns work together to manage driver behavior. In regard to vehicles, it was found that vehicle volumes were not affected and that vehicle speeds acted independently of vehicle volumes. A collision analysis projected a savings of $1.7 million over the next 3 years in direct and indirect costs. The goal of the report was to produce a simple and straightforward analysis tool for similar projects in the area. Some of the benefits of roadway projects such as these can be quantified numerically, whereas others rely on qualitative analyses. For example, before-and-after speeds are easily gathered and compared, whereas before-and-after pedestrian behavior at the raised median requires a more in-depth approach made easier by digital cameras. Together, before-and-after data and before-and-after imaging present a more holistic picture of the benefits and limitations of a project.

223. Petritsch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S., Skaggs, C.L., et al. "Pedestrian Level-of-Service Model for Urban Arterial Facilities with Sidewalks," *Transportation Research Record*: Journal of the Transportation Research Board Number 1982, 84-89, 2006.

This paper documents a study sponsored by the Florida Department of Transportation to develop a level-of-service (LOS) model that represents pedestrians' perceptions of how well urban arterials with sidewalks (a combination of roadway segments and intersections) meet their needs. The model incorporates traffic volumes on the adjacent roadway and exposure (i.e., crossing widths) at conflict points with intersections and driveways. Data were obtained from Walk for Science, an innovative field data collection event, and consist of participants' perceptions of how well urban arterials with sidewalks meet their needs as pedestrians. The pedestrian LOS model for roadway facilities described here is based on Pearson correlation analyses and stepwise regression modeling of about 500 combined real-time perceptions (observations) from pedestrians walking a course along streets in a typical U.S. metropolitan urban area. Study participants represented a cross section of age, gender, walking experience, and residency. Although further hypothesis testing may be conducted in a future study, the resulting general model for the pedestrian LOS of urban arterials with sidewalks has a high correlation coefficient (R2=.70) with the average observations and is transferable to a significant number of metropolitan areas in the United States. The study reveals that traffic volumes on the adjacent roadway and the density of conflict points along the facility are the primary factors in the LOS model for pedestrians traveling along urban arterials with sidewalks.

224. Sandt, L.S. and Zegeer, C.V. "Characteristics Related to Midblock Pedestrian–Vehicle Crashes and Potential Treatments," *Transportation Research Record: Journal of the Transportation Research Board, Number 1982*, pp. 113-121, 2006.

Reducing pedestrian crashes is a top priority for transportation professionals. Pedestrian crashes at midblock locations occur frequently and need further investigation. The purpose of this exploratory study is to understand the characteristics of midblock pedestrian crashes to determine appropriate safety treatments. The primary objective was to compare midblock and intersection crashes in light of their roadway characteristics, environment, and characteristics of the involved parties to provide information on the most common factors related to midblock crashes. Databases from Kentucky, Florida, and North Carolina were used to determine which crash variable categories have significantly higher proportions at midblock locations as opposed to intersections. The distribution of crashes was compared across the two groups. The results of a t-test determined the significance of differences of means observed between the two crash groups. Several variables (such as lighting conditions and divided versus undivided roads) are similarly distributed among midblock and intersection crashes. Furthermore, the study highlighted the categories within the variables tested with significantly higher proportions in midblock crashes as opposed to intersection crashes in one or more of the databases. These include two-lane roads, younger male pedestrians involved in the crash, residential land use patterns, and rural crash locations. This paper identifies areas and variables where further research is appropriate, particularly with respect to determining safety treatments for midblock locations.

225. Rasanen, M., Lajunen, T., Alticafarbay, F., Aydin, C. "Pedestrian Self-Reports of Factors Influencing The Use of Pedestrian Bridges," Accident Analysis & Prevention, Volume 39, Issue 5, pp. 969-973, September 2007.

The study was designed to find out factors that influence use/non-use of pedestrian bridges. The use rate of five pedestrian bridges was observed in the central business district (CBD) of Ankara. After the observations, a survey was conducted among pedestrians using those bridges and crossing contrary to safe practice under them at street level (n = 408). In the present data, the use rate of pedestrian bridges varied from 6 to 63%. The frequent use of the bridge when crossing the road concerned, and seeing bridge use as time saving and safe in general were positively related to respondents' bridge use. Frequent visits to CBD decreased the likelihood of using the bridge. Other factors accounted only for a small proportion of variance in bridge use. The study suggests that bridge use or non-use is a habit and not coincidental behavior. For increasing the pedestrians' bridge use, escalators seem to be a good solution, but traffic signals under a bridge may deteriorate the use rate. In addition, increasing the number of legs leading to the bridge may not increase the use rate. The use rate is likely to improve, if the safety benefits and convenience of using the bridge without considerable time loss are clearly visible to pedestrians.

226. Guttenplan, M., Crider, L.B., Petritsch, T.A., Landis, B.W., McLeod, P.S., Munroe, M. "Updating Multimodal Level of Service Calculations to Incorporate Latest FDOT Research Since 2001," University of Florida, Gainesville; Florida Department of Transportation, 2008.

The Florida Department of Transportation (FDOT) has developed, through 8 years of research, Level of Service (LOS) tools for use in multimodal planning. The models have been developed by a series of "Ride or Walk for Science" events, getting feedback in real world situations from user perspectives on how well a facility serves their needs. The multimodal LOS models have been scientifically calibrated and validated to reflect the level of comfort, safety and convenience that a pedestrian, bicyclist, or transit user experiences on a particular roadway. This research effort utilized experts in the transportation planning field and practitioners, who would ultimately be using the tools, to give recommendations for their incorporation into the FDOT 2002 Quality/Level of Service handbook and Art_Plan software. Experts tested the models in a two-day workshop, using data generated on 6 Florida facilities, and applying it to a spreadsheet of all the LOS models. They were asked to examine the sensitivities of the models, and look for any deficiencies. Recommendations were made on ways to "tweak" the models to reflect better sensitivity as well as ways that FDOT could publicize and implement a plan for their use. By developing tools to measure and model the needs of pedestrians, bicyclists, transit riders, as well as those of motor vehicle drivers, Florida DOT has been in the forefront of a shift in transportation planning and design. It could not come at a more critical time in our state and nation's history, with the importance of health and physical activity, safe routes for school children, and the price of gasoline influencing the transportation choices of everyday citizens.

227. Leden, L., Wikstrom, P., Garder, P., and Rosander, P. "Safety and Accessibility Effects of Code Modifications and Traffic Calming of An Arterial Road," Accident Analysis & Prevention, Volume 38, Number 3, pp. 455-461, 2006.

The European Road E12 through the community center of Storuman, Sweden was reconstructed in 1999 and 2000. Pedestrian walkways, traffic islands, chicanes of a type referred to as "Danish buns", a roundabout and a two-directional cycle track along the E12 were installed. The purpose of the reconstruction was to improve safety for pedestrians and bicyclists, primarily for children, the elderly and the disabled, and to reduce the barrier effect of the E12 thoroughfare. In May 2000, the code governing the conduct of drivers at marked crosswalks in Sweden became stricter to improve safety and mobility for pedestrians. The combined effect of reconstructions and change of code was analyzed. Traffic behavior was studied at the intersection where the roundabout was constructed. Yield behavior towards pedestrians changed significantly. The difference was even greater with respect to yielding to child bicyclists – from 6% before to 84% after – even though the code change only related to pedestrians. Crash data analysis suggests a minor increase in fall injuries after reconstructions and change of code.

Measures of speed, behavioral studies, questionnaires, face-to-face interviews and crash data analysis suggest that safety has increased not only along the E12 but also along adjacent roads. The final conclusion is that a bypass is not needed in a case like Storuman. Traffic calming of the main arterial through the town seems sufficient.

228.Cheong, A. M., D. R. Geruschat, and N. Congdon. Traffic Gap Judgment in People with Significant Peripheral Field Loss. *Optometry and Vision Science*. 2008 Jan; 85(1):26-361:

Purpose: Subjects with significant peripheral field loss (PFL) self report difficulty in street crossing. In this study, we compared the traffic gap judgment ability of fully sighted and PFL subjects to determine whether accuracy in identifying crossable gaps was adversely affected because of field loss. Moreover, we explored the contribution of visual and nonvisual factors to traffic gap judgment ability. METHODS: Eight subjects with significant PFL as a result of advanced retinitis pigmentosa or glaucoma with binocular visual field <20 degrees and five age-matched normals (NV) were recruited. All subjects were required to judge when they perceived it was safe to cross at a 2-way 4-lane street while they stood on the curb. Eye movements were recorded by an eye tracker as the subjects performed the decision task. Movies of the eye-on-scene were made offline and fixation patterns were classified into either relevant or irrelevant. Subjects' street-crossing behavior, habitual approach to street crossing, and perceived difficulties were assessed. RESULTS: Compared with normal vision (NV) subjects, the PFL subjects identified 12% fewer crossable gaps while making 23% more errors by identifying a gap as crossable when it was too short ($p < 0.05$). The differences in traffic gap judgment ability of the PFL subjects might be explained by the significantly smaller fixation area ($p = 0.006$) and fewer fixations distributed to the relevant tasks ($p = 0.001$). The subjects' habitual approach to street crossing and perceived difficulties in street crossing ($r > 0.60$) were significantly correlated with traffic gap judgment performance. CONCLUSIONS: As a consequence of significant field loss, limited visual information about the traffic environment can be acquired, resulting in significantly reduced performance in judging safe crossable gaps. This poor traffic gap judgment ability in the PFL subjects raises important concerns for their safety when attempting to cross the street.

229.Geruschat, D. R., S. E. Hassan, K. A. Turano, H. A. Quigley, and N.G. Congdon. “Gaze Behavior of the Visually Impaired during Street Crossing,” *Optometry and Vision Science*. 2006 Aug; 83(8):550-8.

PURPOSE: This study explored the gaze patterns of fully sighted and visually impaired subjects during the high-risk activity of crossing the street. METHODS: Gaze behavior of 12 fully sighted subjects, nine with visual impairment resulting from age-related macular degeneration and 12 with impairment resulting from glaucoma, was monitored using a portable eye tracker as they crossed at two unfamiliar intersections. RESULTS: All subject groups fixated primarily on vehicles and crossing elements but changed their fixation behavior as they moved from "walking to the curb" to "standing at the curb" and to "crossing the street." A comparison of where subjects fixated in the 4-second time period before crossing showed that the fully sighted who waited for the light to change fixated on the light, whereas the fully sighted who crossed early fixated primarily on vehicles. Visually impaired subjects crossing early or waiting for the light fixate primarily on vehicles. CONCLUSIONS: Vision status affects fixation allocation while performing the high-risk activity of street crossing. Crossing decision-making strategy corresponds to fixation behavior only for the fully sighted subjects.

230.Hassan, S. E., D. R. Geruschat, and K. A. Turano. “Head Movements While Crossing Streets: Effect of Vision Impairment,” *Optometry and Vision Science, 82*(1), 2005: 18-26.

BACKGROUND: Crossing the street is an activity that requires gathering information over a large area. The challenge in safely crossing a street is to acquire the necessary information for a decision of when to cross within a limited window of time. The purpose of this study was to compare the head movement

behavior of visually impaired pedestrians with fully sighted pedestrians at two types of complex intersections: a plus intersection and a roundabout. METHOD: We measured the head movement behavior of 12 subjects with normal vision, 11 subjects with age-related macular degeneration (AMD), and 10 subjects with glaucoma as they approached and crossed at the two intersections. The primary measures were the percentage of time the head was directed to the left, center, or right and the frequency of head turns. We compared measures across groups and relative to three criteria of head movement behavior for maximizing street-crossing safety. RESULTS: Crossing the street can be divided into three phases: walking to the curb, standing at the curb, and crossing the street. We found that while moving, the majority of subjects directed their head to the center. This was true at the plus intersection and roundabout. Group differences were found in the frequency of head turns at the plus intersection, with the AMD pedestrians having a lower frequency of head turns compared with the fully sighted pedestrians. However, the frequency of head turns increased for all the groups during the last 4 seconds before crossing, with the frequency being the greatest during the last second. Numerous subjects had head movements consistent with pedestrian safety, although there were subjects in each group who failed to demonstrate maximum safety. More of the visually impaired pedestrians exhibited less safe head movement behavior than the fully sighted pedestrians. CONCLUSIONS: The effects of visual impairment on head movement behavior were associated with pedestrian safety at critical moments in the street-crossing process. Mobility training programs aimed at teaching safe head movement behavior for street crossing could help to increase the safety of visually impaired pedestrians.

231. Wall Emerson, R. and D. Sauerburger. Detecting Approaching Vehicles at Streets with No Traffic Control Journal of Visual Impairment and Blindness. 2008; 102(12): 747.

This study assessed the ability of people with visual impairments to reliably detect oncoming traffic at crossing situations with no traffic control. In at least one condition, the participants could not hear vehicles to afford a safe crossing time when sound levels were as quiet as possible. Significant predictors of detection accounted for a third of the variation in the detection time.

232. Wiener, W., K. Naghshineh, B. Salisbury and J. Rozema. "The impact of hybrid vehicles on street crossings." Review, 38, 2006: 65–78.

The authors had three purposes: (a) to compare the sound output of a Toyota Corolla, a vehicle powered by an internal combustion engine (ICE) with that of a hybrid vehicle (Prius) under conditions of acceleration and approach in relation to the potential decision of a pedestrian who is visually impaired to begin to cross the street, (b) to determine the differences in sound output of the hybrid car when accelerating at different speeds, and (c) to measure the distances from which a person could measure and detect the sound of a hybrid vehicle. They describe the experiments they conducted to obtain the relevant data and conclude that when waiting to cross an intersections without traffic light control, a pedestrian who is visually impaired should be able to detect equally well both the hybrid and the ICE vehicle approaching from a distance.

Geometric Features

233. Bennett, S., R. L. Kirby, and B. Macdonald. "Wheelchair Accessibility: Descriptive Survey of Curb Ramps in an Urban Area," *Disability and Rehabilitation: Assistive Technology*, 2009 Jan; 4(1):17-23

Purpose. To determine the extent to which curb ramps in an urban area met a set of wheelchair accessibility guidelines. *Method*. For each of 79 intersections in an urban area, we collected data about eight accessibility characteristics, based on existing guidelines. A total score (0–8) was calculated for each intersection, based on the number of criteria met. *Results*. Of the 79 intersections assessed, 98.7% had curb ramps. Of the curb ramps, 53.8% provided direct lines of travel from the sidewalks to the crosswalks, 93.6% were ≥915 mm in width, 43.6% had ramp slopes ≤4.8° (1:12), 57.7% had gutter counter-slopes of ≤2.9° (1:20), 26.9% had smooth transitions (≤13 mm) from the curb ramps to the gutters, 85.9% were free from irregularities and 100% were free from drainage grates. The mean (±SD) total score was 5.6 (±1.1). Only 2.6% of the intersections met all eight criteria. *Conclusions*. Although curb ramps were usually present at intersections, only a small proportion of them met all of the accessibility criteria evaluated. This finding has implications for those responsible for installing and maintaining curb ramps and suggests that wheelchair users and their caregivers should learn the wheelchair skills needed to overcome such accessibility barriers.

234.Stollof, E. "Developing Curb Ramp Designs Based on Curb Radius ," *ITE Journal*, *75:4*, 2005, 26-32. http://www.ite.org/membersonly/itejournal/pdf/2005/JB05DA26.pdf

At a workshop on wayfinding at intersections, participants were charged with developing design schemes for intersections with curb radii of 10 feet, 25 feet, 30 feet and 40 feet. The objective was to plan for as much redundancy in cueing—tactile and audible—as possible.

235.Schroeder, B.J., Rouphail, N.M., & Emerson, R.S.W. "Exploratory Analysis of Crossing Difficulties for Blind and Sighted Pedestrians at Channelized Turn Lanes," *Transportation Research Record: Journal of the Transportation Research Board, Number 1956,* pp. 94-102, 2006.

This paper presents the findings from a paired comparison study of blind and sighted pedestrians judging crossing opportunities in traffic from the roadside at three channelized turn lane (CTL) locations. It is motivated by the belief that the geometric nature of CTL facilities and the lack of signal control at the pedestrian crossing are factors that may negatively affect the delay and safety for blind pedestrians. Pedestrians waiting at the curb must judge the traffic moving in a circular motion, and they must deal with a significant amount of background traffic (i.e., noise) present at the main intersection. The findings show that crossings at all CTL crossing locations are significantly more difficult for blind pedestrians than for sighted pedestrians. Blind pedestrians tend to face a greater risk and a greater amount of delay. Furthermore, the research shows that conflicting traffic flow in the turn lane has a significant effect on crossing performance for both pedestrian groups; however, the effect of noise-generating background traffic on blind pedestrian crossings is not significant. The study also concludes that for this experiment the location of the crosswalk (in the center of the turn lane or at the downstream end) does not have a significant effect on crossing judgment performance.

236.Jenness, J. & J. Singer. *Visual Detection of Detectable Warning Materials by Pedestrians with Visual Impairments: Final Report*, Washington, DC: Federal Highway Administration, 2006. http://www.access-board.gov/research/dw-fhwa/report.htm

Detectable warnings are walking surfaces that are primarily intended to provide a tactile cue to pedestrians who are visually impaired. They are installed at locations such as the edge of a train platform or at the transition between the sidewalk and the street . The tactile properties of detectable warnings result from a grid of small, truncated (flat-topped) domes across the warning surface. This pattern has been standardized by the U.S. Access Board and testing has shown that the pattern can be detected underfoot or by cane without causing a tripping situation or obstructing wheelchairs. Despite the proven tactile benefits of detectable warnings, little research has been conducted to evaluate the visual detectability of various detectable warning materials. Detectable warnings that provide salient visual cues in addition to tactile cues may help many pedestrians with visual impairments to locate curb ramps from a greater distance than is possible using the tactile cues alone. Some pedestrians may use them to orient to a curb cut or ramp at the end of a crosswalk. The objectives of this study were (1) to determine which detectable warning colors and patterns are visually detectable and conspicuous to pedestrians with visual impairments and (2) to provide recommendations related to color, pattern, and luminance contrast of detectable warnings for placement on sidewalks.

237. Davis, G.A. “A Case Control Study of Speed and Crash Risk Technical Report 2: Bayesian Reconstruction of Traffic Accidents and the Casual Effect of Speed in Intersection and Pedestrian Accidents,” Minneapolis, MN: University of Minnesota, Minneapolis, 2006.

Traffic accident reconstruction has been defined as the effort to determine, from whatever evidence is available, how an accident happened. Traffic accident reconstruction can be treated as a problem in uncertain reasoning about a particular event, and developments in modeling uncertain reasoning for artificial intelligence can be applied to this problem. Physical principles can usually be used to develop a structural model of the accident and this model, together with an expert assessment of prior uncertainty regarding the accident’s initial conditions, can be represented as a Bayesian network. Posterior probabilities for the accident’s initial conditions, given evidence collected at the accident scene, can then be computed by updating the Bayesian network. Using a possible worlds semantics, truth conditions for counterfactual claims about the accident can be defined and used to rigorously implement a “but for” test of whether or not a speed limit violation could be considered a cause of an accident. The logic of this approach is illustrated for a simplified version of a vehicle/pedestrian accident, and then the approach is applied to determine the causal effect of speeding in 10 actual accidents.

238. Johnson, R.S. “Pedestrian Safety Impacts of Curb Extensions: A Case Study,” Salem, OR: Oregon Department of Transportation Research Unit, 2005.

This report documents a case study evaluating motorist yielding behavior at a crosswalk in Albany, Oregon. In 2003 the City of Albany installed curb extensions, continental markings and advance stop bars at several uncontrolled intersections along the U.S. Highway 20 one-way couplet. The City of Albany requested that an evaluation be conducted to determine if the pedestrian safety improvements functioned as intended. Since the installation in 2003, there had been no data collection effort on the operation of these features. The focus of this study was the intersection of 4th Avenue and Lyon Street because the nearside crosswalk had a curb extension on only one side of the street, thus allowing for an analysis of motorist behavior toward pedestrians crossing from either the side with the curb extension or the side without. Specifically, this study examined the average number of vehicles that passed between the time a pedestrian arrived at the crosswalk to the time they were able to cross, the percent of vehicles that yielded at the advance stop bar, and the percent of pedestrian crossings in which a vehicle yielded.

239. Leden, L., Garder, P., and Johansson, C. “Safe Pedestrian Crossings for Children and Elderly,” Accident Analysis & Prevention, Volume 38, Number 2, pp. 289-294, 2006.

In May 2000, the Swedish code governing the conduct of drivers at marked crosswalks became stricter with the intent to improve safety and mobility for pedestrians. A crash analysis based on a macro study of all of Sweden suggests that the injury risk in marked, not reconstructed, crosswalks increased by 27% for pedestrians and 19% for bicyclists. The reason for this may be that pedestrians get a false sense of safety with the new code. Reconstructions aiming at lowering speeds are indeed needed for the change of code to be positive. The 90-percentile speed should not exceed 30 km/h or safety will deteriorate.

However, low speed by itself may not guarantee optimal safety. Safety can be further improved at sites, which already have been reconstructed to ensure low speeds. Results based on field data collected at sites close to schools in Malmö, Trollhättan and Borås in Sweden, and in-depth studies and other analyses of Finnish and Swedish police-reported crashes, suggest that safety of children and elderly is further improved at sites where visibility, orientation and clarity are sufficient. Also, marking crosswalks may increase yield rates (expected improvement 6%) towards pedestrians; and speed cushions situated at a longer distance from the marked crosswalk increase yield rates towards pedestrians and cyclists compared to speed cushions closer by.

240.Kwan, I. and Mapstone, J. “Interventions for Increasing Pedestrian and Cyclist Visibility for the Prevention of Death and Injuries,” Cochrane Database of Systematic Reviews, Volume 4, 2006.

This document provides a systematic review of the literature in the area of increasing pedestrian and cyclist visibility to prevent deaths and injuries. The authors note that pedestrians and cyclists are often killed or seriously injured in traffic crashes, especially in the developing world where walking and bicycling are essential modes of transportation. Even in developed countries, such as the United Kingdom, one in three road traffic fatalities is a pedestrian or cyclist. Usually, in these crashes, drivers fail to see the pedestrian or cyclist until it is too late. The authors looked for studies which showed how effective visibility aids are for protecting pedestrians and cyclists. They included primarily randomized controlled trials, which compares two similar groups of people who only differ on the issue being studied. The authors did not find any studies which compared number of crashes but they did find 37 studies which compared driver detection of people with or without visibility aids. These studies showed that fluorescent materials in yellow, red and orange improved driver detection during the day; while lamps, flashing lights and retroreflective materials in red and yellow or in a 'biomotion' configuration helped at night. The authors conclude by noting that although these visibility measures help drivers see pedestrians and cyclists, more research is needed to determine whether the increased visibility actually does prevent deaths and serious injuries. The article includes a summary of the 37 research studies, including summary statistics and descriptive studies of the outcomes where appropriate.

241.*Wheelchair Safety at Rail Level Crossings Taskforce: Report to the Minister for Transport*, Victorian Department of Infrastructure, March 2002.

Traffic Control Devices

GENERAL

242.Lalani, N. "Alternative Treatments for At-Grade Pedestrian Crossings," Washington, D.C., Institute of Transportation Engineers, 2001.

A recent research study funded by the Federal Highway Administration examined marked crosswalks at uncontrolled locations that did not have stop signs or traffic signals. It found that providing marked crosswalks resulted in increased pedestrian collisions compared with not providing marked crosswalks on multilane roads with more than one lane in each direction and average daily volumes of 10,000 or more vehicles per day. On roads with one lane in each direction and less than 10,000 vehicles per day, the study found no difference in pedestrian collisions between marked crosswalks and unmarked crosswalks at uncontrolled intersections. Due to a need to clarify this information, the Institute of Transportation Engineers Pedestrian and Bicycle Task Force prepared this report, summarizing various studies on pedestrian crossings. The report and describes over 70 treatments, including pedestrian refuge islands, in-roadway raised pavement markers (with and without internal illumination), high-intensity lighting, curb extensions, pedestrian railings, in-roadway signings, overhead standard pedestrian warning signs, high-visibility markings, flashing beacons, pavement surfacing, special approach markings, lane reductions, double-posting of signs, and flags. Treatments at signalized intersections and mid-block pedestrian signals are also presented. The report also summarizes treatments used by public agencies for local residential streets with lower traffic volumes and speeds. Some examples of these treatments at marked crosswalks include raised crosswalks, narrower travel lanes, and speed cushions.

243. Jagannathan, R. & Bared, J.G. “Design and Performance Analysis of Pedestrian Crossing Facilities for Continuous Flow Intersections,” Transportation Research Record: Journal of the Transportation Research Board, Number 1939, pp. 133-144, 2005.

Although concepts of the continuous flow intersection (CFI) have been around for approximately four decades, minimal or no literature describing studies that have analyzed pedestrian traffic performance at these intersections is available. Several studies have reported on the qualitative and quantitative benefits for the vehicular traffic performance of CFIs in comparison with the benefits for the vehicular traffic performance of conventional intersections but have provided minimal or no discussion about pedestrian traffic performance. As a novel intersection design, many important considerations are required to design pedestrian accesses and crossings at CFIs without compromising pedestrian safety and vehicular traffic performance. In this paper, the design methodologies for providing pedestrian access and related pedestrian signal timings are discussed. Modeling was conducted on three typical geometries for CFIs with base signal timings optimized for vehicular traffic performance. The results indicate an acceptable pedestrian level of service of B or C on the basis of the average delay per stop experienced by any pedestrian for pedestrian crossings at the typical CFI geometries modeled. All pedestrians served at the CFIs are accommodated within two cycles for a typical signal cycle length ranging from 60 to 100 s.

244. Turner, S., Fitzpatrick, K., Brewer, M., & Park, E.S. “Motorist Yielding To Pedestrians at Unsignalized Intersections: Findings From A National Study on Improving Pedestrian Safety.” *Transportation Research Record: Journal of the Transportation Research Board, Number 1982*, pp. 1-12, 2006.

This paper evaluates engineering treatments that can be used to improve the safety of pedestrians crossing in marked crosswalks on busy arterial streets. The research team collected extensive data at 42 study sites in different regions of the country to gauge the effectiveness (as measured by motorist yielding or stopping) of various engineering treatments. Motorist yielding data were collected for crossing pedestrians from the general population as well as for crossings staged by the research team. In preliminary analyses, the treatments were grouped into three categories based on function and design: (a) red signal or beacon devices, (b) "active when present" devices, and (c) enhanced and high-visibility treatments. The authors found the red signal or beacon devices to be the most effective, with yielding rates exceeding 94% for all study sites. Other treatments had various rates of motorist yielding, and several variables (number of lanes and speed limit in particular) were statistically significant in predicting motorist yielding. Most treatments in the other two categories had statistically similar motorist yielding levels. An implementation matrix (currently being finalized by the research team) is recommended to assist in selecting appropriate crossing treatments for streets with known road widths, traffic volumes, and pedestrian volumes. It is recommended that engineers include red signal or beacon devices in their toolboxes to improve pedestrian crossing safety along busy arterial streets.

245. Hua, J., et al. “San Francisco Pedsafe II Project Outcomes and Lessons Learned,” Transportation Research Board, 88th Annual Meeting, 2009.

This paper presents the project outcomes and lessons learned from San Francisco PedSafe, a comprehensive pedestrian safety planning and engineering project funded by the Federal Highway Administration. It evaluates the effectiveness of the Phase I pedestrian safety plan targeted to higher-injury areas and the Phase II implementation of a range of mostly low-to-moderate-cost innovative safety improvements. A total of 13 countermeasures (comprised of nine general engineering countermeasures and four Intelligent Transportation Systems (ITS) countermeasures) were implemented by the San Francisco Municipal Transportation Agency (SFMTA) and evaluated by the University of California Berkeley Traffic Safety Center (TSC) over a three-year period (2004-2007). Regarding the effectiveness of the 13 countermeasures, six were considered generally successful; three were considered less successful; and four were considered inconclusive. The six most successful

countermeasures included: flashing beacons (with automated and push button actuation), in-street pedestrian signs, video detection to adjust signal timing, pedestrian head starts (leading pedestrian intervals), portable changeable message speed limit signs, and “Turning Traffic Must Yield to Pedestrians” signs. A summary of countermeasure evaluation results is also reported. This paper describes the methodology of countermeasure evaluation, including video data, tools used in data analysis, the advantages and limitations of this method, and possible improvements. In addition, general lessons learned of countermeasure implementation, as well as recommendations for further research is also described.

246.Roudsari, B., Kaufman, R., Koepsell, T. “Turning at Intersections and Pedestrian Injuries,” Traffic Injury Prevention, Volume 7, Number 3, pp. 283-289, 2006.

Research evaluating the association of precrash vehicle movement (right-turn, left-turn, straight) with the severity of pedestrian injury is presented in this article. The authors examined comprehensive data on pedestrian, vehicle, and injury-related characteristics. The research is based on the Pedestrian Crash Data Study (PCDS) conducted by the National Highway Traffic Safety Administration between 1994 and 1998. The authors used a logistic regression model that considered the vehicle type, age of pedestrians, and the intermediate effect of impact speed. Results showed that in a total of 255 collisions studied, 48% of pedestrians were injured in straight movement accidents, 32% in right-turn accidents, and 10% in left-turn accidents. Pedestrians in 60% of the left-turn accidents and 67% of right-turn accidents were struck from their left sides. In straight movement accidents, pedestrians shared a 50% likelihood of being struck from either the left- or the right-side of the street.

SIGNS

247.Huang, H. F., Zegeer, C. V., Nassi, R., and Fairfax, B. “The Effects of Innovative Pedestrian Signs at Unsignalized Locations: A Tale of Three Treatments,” FHWA-RD-00-098, McLean, Va., Federal Highway Administration, 2000.

A variety of advisory and regulatory signs are used in conjunction with marked crosswalks to improve their visibility and increase the likelihood that motorists will yield to pedestrians. This paper evaluates three such devices: (1) an overhead CROSSWALK sign in Seattle, Washington; (2) pedestrian safety cones (with the message, "STATE LAW- YIELD TO PEDESTRIANS IN CROSSWALK IN YOUR HALF OF THE ROAD") in New York State and Portland, Oregon; and (3) pedestrian-activated "STOP FOR PEDESTRIAN IN CROSSWALK" overhead signs in Tucson, Arizona. The signs were used under different traffic and roadway conditions. The New York cones and Seattle signs were effective in increasing the number of pedestrians who had the benefit of motorists stopping for them. At one location in Tucson, the overhead sign resulted in increased motorists yielding to pedestrians. The signs in Seattle and Tucson were effective in reducing the number of pedestrians who had to run, hesitate, or abort their crossing. None of the treatments had a clear effect on whether people crossed in the crosswalk. These devices by themselves cannot ensure that motorists will slow down and yield to pedestrians. It is essential to use these devices together with education and enforcement. Traffic engineers can use other measures as well, including designing "friendlier" pedestrian environments at the outset.

248.Strong, C. & Kumar, M. “Safety Evaluation of Yield-To-Pedestrian Channelizing Devices: Final Report.” Federal Highway Administration, 2006.

In 2004, there were 4,641 highway fatalities recorded in the United States involving pedestrians. Statistics in Pennsylvania follow suit,, showing that a significant number—150 in 2004—of highway accident fatalities are pedestrians. To address these safety challenges in an economical way, the Pennsylvania Department of Transportation (PennDOT) has purchased hundreds of yield-to-pedestrian

channelizing devices (YTPCD) to remind motorists of the need to yield right-of-way to pedestrians. More than 1,300 of the devices that have been distributed to municipalities within the state are placed prior to a painted marked crosswalk, in the center of the road, in hopes of improving motorist awareness of pedestrians who may be crossing. With PennDOT having made a significant commitment to these low-cost devices, it is important to know how effective they may be, and where they would be most effective. This project will involve field testing of YTPCD implemented at locations throughout Pennsylvania representing a mix of development and traffic patterns. The research will result in an assessment of the safety benefit of these devices through surrogate measures, and will provide recommendations regarding their future usage in Pennsylvania.

249. Retting, R. A., Nitzburg, M. S., Farmer, C. M., and Knoblauch, R. L. "Field Evaluation of Two Methods for Restricting Right Turn on Red to Promote Pedestrian Safety," *ITE Journal*, Volume 72, Number 1, pp. 32-36, 2002.

Throughout the U.S., with the exception of New York City, right turn on red (RTOR) is usually allowed unless otherwise prohibited by a posted traffic sign. State RTOR laws require that drivers come to a complete stop and yield to approaching traffic before turning on red. Although a number of potential benefits emanate from the practice of RTOR, including reduced emissions and/or traffic delays, RTOR increases the risk of crashes and injuries, especially in urban areas. Following adoption of national RTOR policy, significant increases in pedestrian and bicycle crashes were reported at signalized intersections. This is due to the fact that many drivers do not come to a stop before turning right on red; this is both a traffic violation and a potential safety concern.. Another negative impact of RTOR is that drivers often fail to stop at the marked stop line, thereby blocking the pedestrian crosswalk while waiting to turn. This can impede movement and cause pedestrians to walk outside of designated crosswalks. RTOR can be prohibited either at all times, during certain hours, or when pedestrians are present. Relatively little is known about the operational and safety effects of prohibiting RTOR when pedestrians are present as compared with unconditional RTOR restrictions or restrictions confined to specified hours. The aim of this study was to evaluate 2 methods for restricting RTOR at urban intersections: traffic signs restricting RTOR at specified times, and highly visible traffic signs restricting RTOR when pedestrians are present.

250. Lord, D. "Synthesis on the Safety of Right Turn on Red in the United States and Canada," Washington, D.C., 82nd Transportation Research Board Annual Meeting, 2003.

The aim of this project consisted of obtaining and analyzing crash statistics and to survey transportation professionals and experts on issues related to the right turn on red (RTOR) maneuver in United States and Canada. The Province of Quebec is the only jurisdiction that does not allow RTOR at signalized intersections. The report has been requested by the Quebec DOT for the proposed legislation related to the introduction of the RTOR in Quebec. The outcome of this study shows that RTOR is not a dangerous maneuver at signalized intersections for either vehicles or pedestrians in most circumstances.

251. Banerjee, I. and Ragland, D.R. "Evaluation of Countermeasures: A Study on the Effect of Impactable Yield Signs Installed at Four Intersections in San Francisco." Transportation Research Board 86th Annual Meeting, 2007.

The present study evaluated the effect of impactable signs that used the yield-symbol as approved by the National Committee on Uniform Traffic Control Devices (NCUTCD) in the 2003 Manual of Uniform Traffic Control Devices (MUTCD). Impactable yield signs are low-cost signs constructed of flexible material. The signs were installed in the medians adjacent to crosswalks at selected non-signalized intersections to instruct drivers to yield the right-of-way to pedestrians. This paper examines the effect on safety characteristics of the intersections of these signs at three stop-sign controlled intersections in San Francisco over two follow up periods. Since these signs were installed recently, there were no post-

installation crash data for comparison with the pre-installation crash data. As such, surrogate measures, including (a) driver yielding behavior, (b) conflicts among drivers and pedestrians crossing the intersection, (c) waiting time for pedestrians, and (d) time taken by pedestrians to cross a given crosswalk were documented. Previous studies have indicated that impactable yield signs are effective in increasing the rate of drivers yielding to pedestrians. Video recordings were taken at the intersection pre- and post-installation to observe any changes in behavior. Analyses of these recordings yielded data for baseline and the first and second follow-up periods respectively. Testing the first and second follow-up data against the baseline data reveal that, a substantial increase in yielding behavior by drivers occurred immediately after installation as well as during the second follow-up period. No significant effect was observed in any other variables.

252. Ellis, R., Van Houten, R., and Kim, J-L. "In-Roadway "Yield to Pedestrians" Signs: Placement Distance and Motorist Yielding," Transportation Research Record, Number 2002, pp. 84-89, 2007.

Motorists often fail to yield to pedestrians in marked crosswalks at uncontrolled locations. Several studies, including a recent NCHRP and TCRP study, have demonstrated that the use of in-roadway signs can significantly increase the percentage of motorists yielding to pedestrians at uncontrolled marked crosswalks. The 2003 edition of the Manual of Uniform Traffic Control Devices includes two in-roadway signs that may be installed at uncontrolled locations but does not give precise directions on where to place the sign in relation to the crosswalk. The purpose of the present FHWA study was to compare the effect of placing these signs at the crosswalk, 20 ft in advance of the crosswalk, 40 ft in advance of the crosswalk, and at all three locations on driver yielding behavior. A counterbalanced multielement design was used in this experiment. This design involves the installation of the sign at several different locations in advance of the crosswalk to determine if there is an optimum location for sign placement. After the collection of baseline data at all three crosswalks on Collins Avenue in Miami Beach, Florida, the research team placed the sign at each of the three distances in advance of the crosswalk at each crosswalk location as well as at all three locations together in randomized blocks of trials to control for order effects. The data showed that the sign produced a marked increase in yielding behavior at all three crosswalks and that installation of the sign at the crosswalk line was as effective as or more effective than installation of the sign 20 or 40 ft in advance of the crosswalk. The data also indicated that placement of the sign at all three locations at once was no more effective than placement of the sign at the crosswalk line. These data suggest that the in-roadway sign is likely effective because the in-roadway placement is particularly salient to drivers. Because drivers frequently struck the signs on Collins Avenue, it is recommended that these signs be placed on median islands whenever possible to extend their useful lives.

253. Murphy, B. and Hummer, J. E. "Development of Crash Reduction Factors for Overhead Flashing Beacons at Rural Intersections in North Carolina," Transportation Research Board Annual Meeting, 2007.

The purpose of this project is to develop crash reduction factors for overhead flashing beacons at rural two-way stop sign-controlled intersections in North Carolina. Overhead flashing beacons are a common countermeasure used in North Carolina to help alleviate crash problems at intersections where drivers have difficulty recognizing the stop-control condition. The goal of this analysis is to develop crash reduction factors that reflect North Carolina conditions and decision making. Thirty-four treatment sites were chosen for analysis. Each treatment site was a rural four-leg intersection with no turn lanes and two-way stop control. Each treatment site had at least 3 years of after-period crash data available. Several methodologies were used to calculate the crash reduction factors. The biggest threats to the validity of the analysis that must be accounted for at the 34 treatment sites in this study were regression to the mean and the increase in traffic volumes. Regression to the mean is a significant threat as each treatment site was chosen because of its crash history. The increase in traffic volumes was also a concern

because of the long duration of before-and-after periods at each site. Empirical Bayes before-and-after techniques were used to overcome the threat of regression to the mean. One hundred and seventy reference sites were chosen and the method of sample moments was carried out to calculate the necessary parameters. A linear assumption was used to account for the increase in traffic flow. On average, all categories of crashes studied decreased in the after period.

254. Strong, C. and Bachman, D. "Safety Evaluation of Yield-to-Pedestrian Channelizing Devices," Transportation Research Board 87th Annual Meeting, 2008.

Approximately 10 percent of Pennsylvania's annual highway fatality victims are pedestrians, and a significant number of pedestrians are also injured every year. To improve pedestrian safety at a relatively low cost, the Pennsylvania Department of Transportation has a program to provide Yield-to-Pedestrian Channelizing Devices (YTPCD) to municipalities. YTPCD are placed on the centerline of a roadway in advance of marked crosswalks to remind motorists of the necessity of yielding to pedestrians. This paper summarizes an evaluation of these devices that focused on examining motorist and pedestrian behavior. Behavioral data were collected at five sites in each of four different community types (urban, suburban, small city and college town) before and after installation of those devices. Sites included crosswalks at unsignalized intersections and mid-block locations, with and without the devices, to measure both direct and potential spillover effects. Data were analyzed with respect to three hypotheses: whether motorists were more likely to yield to pedestrians, whether pedestrians were less likely to yield to motorists (implying greater pedestrian security), and whether pedestrians were more likely to use crosswalks. The analysis generally showed statistically significant support for all three hypotheses, suggesting improvements in pedestrian safety. The effects were more evident at intersections than at mid-block crossings, and did not appear to be related to community type. Spillover effects were comparable at intersections, but less pronounced at mid-block crossings. The paper recommends consideration of YTPCD where local design conditions and pedestrian safety concerns warrant, and provides recommendations for future research.

SIGNALS

255. Huang, H. F. and Zegeer, C. V. "An Evaluation of Illuminated Pedestrian Push Buttons in Windsor, Ontario," FHWA-RD-00-102, McLean, Va., Federal Highway Administration, 2001.

At many intersections, pedestrians must push buttons to activate the Walk phase. However, they often do not know whether the button has been pressed and whether it is functional. If the Walk phase does not appear soon after the button has been pressed, they may believe that the button does not work and start crossing early, while the steady Don't Walk is still being displayed. When a pedestrian presses an illuminated push button, a light near the button turns on, indicating that the Walk phase has been activated and will appear. The objective of this study is to evaluate the effects of illuminated push buttons on pedestrian behavior. In general, illuminated push buttons did not have a statistically significant effect on how often the pedestrian phases were activated, how many people pushed the button, how many people complied with the Walk phase, or such pedestrian behaviors as running, aborted crossings, and hesitation before crossing. Only 17% and 13% of pedestrians pushed the button in the "before" and "after" periods, respectively. In both the before and after periods, someone pushed the button in 32% of signal cycles with pedestrians. The majority of pedestrians (67.8% with, and 72.3% without illuminated push buttons) who arrived when parallel traffic had the red and who pushed the button complied with the Walk phase.

256. Hughes, R., Huang, H., Zegeer, C. V., and Cynecki, M. J. "Evaluation of Automated Pedestrian Detection at Signalized Intersections," FHWA-RD-00-097, McLean, Va., Federal Highway Administration, 2000.

Automated pedestrian detection systems provide the means to detect the presence of pedestrians as they approach the curb prior to crossing the street, and then "call" the Walk signal without any action required on the part of the pedestrian. The objective of the present study was to evaluate whether automated pedestrian detectors, when used in conjunction with standard pedestrian push buttons, would result in fewer overall pedestrian-vehicle conflicts and fewer inappropriate crossings (i.e., beginning to cross during the Don't Walk signal). "Before" and "after" video data were collected at intersection locations in Los Angeles, California (infrared and microwave), Phoenix, Arizona (microwave), and Rochester, New York (microwave). The results indicated a significant reduction in vehicle pedestrian conflicts as well as a reduction in the number of pedestrians beginning to cross during the Don't Walk signal. The differences between microwave and infrared detectors were not significant. Detailed field testing of the microwave equipment in Phoenix revealed that fine tuning of the detection zone is still needed to reduce the number of false calls and missed calls.

257. Fitzpatrick, K., Turner, S., Brewer, M., Carlson, P., Ullman, B., Trout, N., et al. “Improving Pedestrian Safety at Unsignalized Crossings,” TCRP Report 112/NCHRP Report 562. Washington, D.C.: Transportation Research Board, 2006.

This report will be of interest to state, county, and city traffic engineers; transit agencies; roadway designers; and urban planners, as well as consultants for these groups and agencies. This material provides considerable information and useful guidance for improving pedestrian safety at unsignalized crossings. The report presents the edited final report and Appendix A, Guidelines for Pedestrian Crossing Treatments. Appendixes B through O of the contractor's final report are contained in TCRP Web-Only Document 30/NCHRP Web-Only Document 91, available on the CRP website. The objectives of the research were to (1) recommend selected engineering treatments to improve safety for pedestrians crossing high-volume and high-speed roadways at unsignalized locations, in particular those locations served by public transportation, and (2) recommend modifications to the Manual on Uniform Traffic Control Devices (MUTCD) pedestrian traffic signal warrant.

This study has important implications concerning the effects and use of various types of engineering treatments at unsignalized pedestrian crossings which should be mentioned in the new AASHTO Pedestrian Guide.

258. Eccles, K. A., Tao, R., and Mangum, B. C. “Evaluation of Pedestrian Countdown Signals in Montgomery County, Maryland,” Washington, D.C., 83rd Transportation Research Board Annual Meeting, 2004.

Pedestrian countdown signals installed at five intersections in Montgomery County, Maryland, were evaluated with a before-and-after study. The effect of the countdown signals on pedestrian and motorist behavior was determined by observing the signal indication when pedestrians entered the intersection, the number of pedestrians remaining in the intersection at the release of conflicting traffic, conflicts between pedestrians and motor vehicles, and vehicle approach speeds to the intersections. On the basis of the observational study, the pedestrian countdown signals did not have a negative effect on pedestrian behavior. The vehicle speed observations found that pedestrian countdown signals had no effect on vehicle approach speeds during the pedestrian clearance interval (i.e., flashing "Don't Walk" indication). Pedestrian behavior observations found that although 2 of the 20 crosswalks experienced a statistically significant decrease in the number of pedestrians who entered on "Walk," 6 crosswalks experienced a significant increase. Additionally, none of the intersections had a significant increase in the number of phases with pedestrians remaining in the intersection at the release of conflicting traffic. The observational study of conflicts found a significant decrease in pedestrian-motor vehicle conflicts after the installation of the pedestrian countdown signals at four of the intersections at which conflicts were

observed. A survey of pedestrians was also conducted. Results of the survey indicated that, generally, pedestrians are aware of the countdown signal and understand the countdown indication.

259. Van Houten, R., Retting, A. R., Farmer, C. M., and Van Houten, J. “Field Evaluation of a Leading Pedestrian Interval Signal Phase at Three Urban Intersections,” Transportation Research Record, Number 1734, pp. 86-92, 2000.

About 37 percent of pedestrian injury crashes and 20 percent of fatal pedestrian crashes occur at intersections. Many conventional counter-measures include traffic control devices that either increase pedestrian attention to potential vehicle-pedestrian conflicts or encourage drivers to yield to pedestrians. A noteworthy limitation of these warning and prompting messages is their reliance on a voluntary behavioral response. Public education and enforcement campaigns have also generally not produced tangible and long-lasting safety benefits. This research, conducted at three urban intersections, examined the influence of a 3-s leading pedestrian interval (LPI)—a brief and exclusive signal phase dedicated to pedestrian traffic—on pedestrian behavior and conflicts with turning vehicles. The introduction of a 3-s LPI reduced conflicts between pedestrians and turning vehicles and reduced the incidence of pedestrians yielding the right-of-way to turning vehicles.

This article shows the safety benefit to pedestrians of certain types of traffic signal timing (i.e., LPI timing), topics that should be discussed in the new AASHTO Pedestrian Guide.

260. Schrock, S.D. and Bundy, B. “Pedestrian Countdown Timers: Do Drivers Use Them to Increase Safety or Increase Risk Taking?" Transportation Research Board 87th Annual Meeting, 2008.

Pedestrian countdown timers (CDTs) are promoted as a means of improving pedestrian safety at intersections. However, there are concerns that drivers view the timers while approaching the intersection and use the information to drive more aggressively - an unintended consequence that may have adverse safety impacts. Pedestrian CDTs have been in widespread use in Lawrence, Kansas for three years, and so any novelty effect should have passed, allowing for an accurate analysis of the long-term effects of the devices on traffic. Four intersections along an arterial corridor in Lawrence were studied – two with CDTs and two without. Continuous speed data were collected on approaching traffic and analyzed to determine if there were changes in speed between 400 ft (121.92 m) upstream from the intersection (the point when the CDT information could be read by drivers) and the intersection stop bar. Additionally, the ultimate decision of the drivers (whether they stopped or not) were recorded. Analysis revealed that drivers were significantly less likely to increase their speed in order to reach the intersection before the beginning of the red phase when CDTs were present, and some drivers began to slow to a stop before the beginning of the amber phase when CDTs were present. These findings indicate that drivers use the information provided from pedestrian CDTs to improve their driving decisions; even though the CDT information was not intended to be used by drivers, it appears that they are indeed doing so in a way that results in safer driving actions.

261. Shurbutt, J., Van Houten, R., and Turner, S. “An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks,” Transportation Research Board 87th Annual Meeting, 2008.

This study examined rapid-flash in three experiments. In Experiment 1, three sites were selected each with four-lanes. A Fourth site included a mid-block crossing at the point where the roadway transitioned from two southbound lanes to one lane and from two northbound lanes to one lane. Data were collected in a multiple baseline ABCBC reversal design. Baseline data were collected in the absence of the crossing aid. Following baseline, the system was evaluated by alternating between two and four beacon systems. Results showed a dramatic increase in motorist yielding behavior over baseline for two beacons and a

significant increase with a four-beacons system over a two-beacon system. Data also show that yielding distances increased. The second experiment compared a traditional pedestrian over-head yellow beacon, a yellow beacon side mounted system and the LED rapid flash system. The results showed that the yellow flashing beacons produced a minimal increase in yielding while the rapid flashing beacon produced a marked increase in yielding behavior. A third experiment examined the effectiveness of the rapid-flash yellow beacon system with short- and long-term follow up data at 18 sites. Results indicated that the effects of the system were maintained over time.

262. Van Houten, R., Ellis, R., and Marmolejo, E. "The Use of Stutter Flash LED Beacons to Increase Yielding to Pedestrians at Crosswalks," Transportation Research Board 87th Annual Meeting, 2008.

Motorists often fail to yield to pedestrians in marked multilane crosswalks at uncontrolled locations. Several studies have demonstrated that the use of advance yield markings along with a "Yield Here to Pedestrians" sign can reduce the incidence of multiple-threat crashes but have only a small effect on overall driver yielding behavior. A low-cost alternative to increase driver yielding is the use of amber light-emitting-diode (LED) flashers with an irregular flash pattern. As part of an FHWA cooperative agreement to evaluate intelligent transportation system treatments, amber LED flashers with an irregular flash pattern were installed at two multilane crosswalks in Miami–Dade County, Florida, in an experiment to increase yielding behavior. A reversal design was employed in this experiment to demonstrate experimental control at each site. This design involves alternating sessions with and without the devices activated. The results showed that the LED flashers installed on the pedestrian sign produced a marked increase in yielding behavior at both crosswalks and that similar data were collected from staged pedestrians and local residents using these crosswalks. Data also indicated that the use of the device produced a reduction in evasive conflicts between drivers and pedestrians at both sites and a reduction in the percentage of pedestrians trapped in the crosswalk at the center of a road without a median island. A second experiment evaluated the effects of illuminating the departure area with LED lighting when the system was activated at night. This treatment did not produce a further increase in yielding. The LED stutter-flash beacons likely overshadowed the effect of the pad lighting.

263. Nambisan, S.S., Pulugurtha, S.S., and Karkee, G. "An Evaluation of the Effectiveness of an In-pavement Flashing Light System," Transportation Research Board 85th Annual Meeting, 2006.

Strategies used to enhance pedestrian safety on roadways include the in-pavement flashing light system. These lights are alert both motorists and pedestrians. While the system has been deployed in some locations, limited documentation exists in the literature on systematic evaluations of the effectiveness of these installations. An evaluation of the effectiveness of an in-pavement flashing light system is summarized in this paper. The measures of effectiveness (MOEs) used are yielding behavior of motorists, vehicle speeds, yielding distance from the crosswalk, and conflicts. A "before and after" study strategy was used. Statistical tools such as the test for two proportions and the Welch-Satterthwaite t-test have been used to evaluate the significance of the difference in the MOEs between the two study periods. The study corridor was a relatively low volume roadway located on Burkholder Boulevard in the City of Henderson, Nevada, USA. The results show that the installation of the in-pavement lighting system increases the yielding behavior of motorists significantly ($P<0.001$). The vehicular speeds were decreased when pedestrians were waiting at the curb to cross and when they were crossing ($P<0.001$). The yielding distances were different at a 90 percent confidence level. Motorists yielded to pedestrians on an average about 10 feet upstream from the yield markings and the yielding distances were consistent in both directions. However, no significant difference was found when conflicts were evaluated between the two study periods. These lighting systems thus are beneficial in improving safety for motorists and pedestrians at low traffic volume.

264.Houton, R.V., Ellis, R., & Kim, J. “Effects of Various Minimum Green Times on Percentage of Pedestrians Waiting for Midblock “Walk” Signal,” Transportation Research Record, Number 2002, pp. 78-83, 2007. (note: the HAWK was included as “pedestrian hybrid beacon”, in the 2009 MUTCD, Chapter 4F).

Pedestrians often do not wait for the "Walk" sign at signal-controlled midblock crossings. Many factors may contribute to this phenomenon, but one variable could be the waiting time. One study has shown that as the waiting time for an elevator in university buildings was systematically increased; more people took the stairs rather than the elevators. It is likely that the major reason why people try to cross against the signal at midblock signal-controlled crosswalks when there are gaps in traffic in the first half of the roadway is the length of the average waiting time. It is common to have minimum green times of 1 min or more on a main line with a signal-controlled midblock crosswalk. Arriving early in a cycle, a pedestrian may become frustrated and attempt to cross a street with fast, heavy traffic. The purpose of this study was to determine the effect of waiting time on pedestrian signal compliance at two midblock crosswalks in Miami-Dade County, Florida. One crosswalk traversed an arterial multilane road with two-way traffic, and the second crosswalk traversed a multilane road with one-way traffic. At both crosswalks the minimum green time varied between 30 and 120 s. The results indicated that the rate of pedestrian compliance decreased as the minimum green time was increased and that the rate of compliance dropped more rapidly as the minimum green time was increased at the location with the lower average daily traffic and one-way traffic. The data also showed that the percentage of pedestrians trapped at the centerline increased with an increased minimum green time.

265.Lu, G. & Noyce, D.A. “Intersection Signal Systems with Intelligent Pedestrian Accommodation: Dynamic Pedestrian Timing,” 88th Annual Transportation Research Board Meeting, 2009.

Perhaps the most critical issue facing urban transportation engineers is the optimization of signalized intersections, with the goal of increasing both safety and efficiency for all modes without additional infrastructure. Furthermore, accommodating pedestrians at high volume intersections is becoming more challenging as increasing vehicular and pedestrian demand requires more green time. To safely accommodate pedestrians, the Highway Capacity Manual prescribes that the parallel vehicular green must be at least equivalent to “WALK” plus the “pedestrian clearance interval (PCI)”. A fixed walking speed is used to calculate the PCI. Despite its effectiveness, this practice is not optimal from both operations and safety perspective since some pedestrians walk more slowly or quickly than the design 4.0 feet/second pedestrian. Variability in the required PCI is not captured in the current design process. A problem also arises when the required PCI length exceeds the parallel vehicular green requirement. Additional green for longer PCI is unnecessary for vehicular flow efficiency and takes green time away from the conflicting phase(s), potentially increasing intersection delay. In this research, the concept of dynamic PCI timing in traffic signal operations was explored. Two signal systems, the extended NEMA system and a fuzzy logic controller (FLC), were developed and evaluated, with dynamic PCI control, against current signalization methods. Both the extended NEMA and FLC proved to significantly improve operations with most cases evaluated. This research shows that traffic signal control can remove the dependence on a design walking speed and the ongoing debate on what this speed should be. Given there are reportedly 325,000 signalized intersections in the U.S., the potential impact of this research could be significant in traffic safety and operational efficiency.

266.Acharjee, S., Kattan, L., & Tay, R. “A Pilot Study on Pedestrian Scramble Operations in Calgary,” Transportation Research Board, 88th Annual Meeting, 2009.

The City of Calgary has implemented a pilot test of the pedestrian scramble operation (also known as Barnes Dance) at two intersections in the downtown area. Pedestrian scramble is an exclusive pedestrian signal phase where traffic on all four directions is stopped and pedestrians are allowed to make lateral as

well as diagonal crossing. The purpose of this paper is to evaluate the pilot project to determine the effect of this new operation on pedestrian safety. Two Poisson regression models were developed to model the number of conflicts and violations. Our results showed that the number of pedestrian-vehicle conflicts decreased significantly but the number of pedestrian violations increased significantly after implementation of the scramble operation. Our analysis also revealed that 13% of the total violations were 'safe side' crossings (concurrent to the vehicle movement) and about 40% of total violations were beginning of flashing don't walk phase (within 2-3 sec) and were able to cross safely within the pedestrian phase. Survey was also conducted to monitor public perception and the results showed a generally positive attitude towards this new signal operation.

267.Fayish, A.C. and Gross, F. "Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method," Transportation Research Board, 88th Annual Meeting, 2009.

There is a need to investigate strategies to reduce pedestrian-vehicle crashes at intersections. The leading pedestrian interval (LPI) has been recommended as one strategy for reducing pedestrian-vehicle crashes at signalized intersections; however, there has been limited research to quantify the safety effects of the LPI. Site characteristics, traffic volumes, pedestrian volumes, and crash data were obtained for 10 signalized intersections where the LPI was implemented in State College, Pennsylvania. Similar data were obtained for 63 reference sites within the State College area. An empirical Bayes approach was incorporated in a before-after study design to evaluate the safety effectiveness of the LPI implementations. The aggregate analysis indicated a 37 percent reduction in pedestrian-vehicle crashes, which is significant at the 90 percent confidence level. A disaggregate analysis indicated that crash reductions are significantly greater at intersections with larger pedestrian volumes. Given the low-cost of this strategy, a modest reduction in crashes is needed to justify their use. Based on the estimated safety effectiveness, the necessary crash reduction is easily achievable.

268.Fitzpatrick, K. and Park, E.S. "Safety Effectiveness of the HAWK Pedestrian Treatment," Transportation Research Board, 88th Annual Meeting, 2009.

The HAWK beacon device is a pedestrian-activated beacon located on the roadside and on mast arms over the major approaches to an intersection. It was created in Tucson, Arizona and is currently used at more than 60 locations. The HAWK head consists of two red lenses over a single yellow lens and shows a red indication to the motorists when activated which creates gaps for pedestrians to use to cross the major roadway. This paper documents a before-after study of the safety performance of the HAWKs. The evaluations compared the crash prediction for the after period had the treatment not been applied to the observed crash frequency for the after period with the treatment installed using an empirical Bayes method. Crash types examined included all, severe, pedestrian, rear-end, and angle crashes. The evaluation used data for 21 HAWK sites and 71 reference sites and found the following statistical significant changes in intersection related crashes after the HAWK beacon was installed: 28 percent reduction in all crashes and 58 percent reduction in pedestrian crashes.

This study has important implications concerning a new type of traffic signal technology that has been shown to benefit pedestrian and motor-vehicle safety, in terms of crash reduction. This new device is in the 2009 MUTCD and should be included in the new AASHTO Pedestrian Guide.

269.Retting, R. A., Chapline, J. F., and Williams, A. F. "Changes in Crash Risk Following Re-timing of Traffic Signal Change Intervals," Accident Analysis and Prevention, Volume 34, Number 2, Oxford, N.Y., Pergamon Press, pp. 215-220, 2002.

More than 1 million motor vehicle crashes occur annually at signalized intersections in the United States. The purpose of this study was to estimate potential crash effects of modifying the duration of traffic signal change intervals to conform with values associated with proposed recommended practice published by the Institute of Transportation Engineers. A sample of 122 intersections was identified and randomly assigned to experimental and control groups. Of 51 eligible experimental sites, 40 (78%) needed signal timing changes. For the 3-year period following implementation of signal timing changes, there was an 8% reduction in reportable crashes at experimental sites relative to those occurring at control sites. For injury crashes, a 12% reduction at experimental sites relative to those occurring at control sites was found. Pedestrian and bicycle crashes at experimental sites decreased 37% relative to controls.

270. Lenne, M.G., Corben, B.F., and Stephan, K. "Traffic Signal Phasing at Intersections To Improve Safety for Alcohol-Affected Pedestrians," Accident Analysis & Prevention, Volume 39, Number 4, pp. 751-756, 2007.

Alcohol-affected pedestrians are among the highest-risk groups involved in pedestrian casualty crashes. This paper investigates the opportunities to use a modified form of traffic signal operation during high-risk periods and at high-risk locations to reduce alcohol-affected pedestrian crashes and the severity of injuries that might otherwise occur. The 'Dwell-on-Red' treatment involves displaying a red traffic signal to all vehicle directions during periods when no vehicular traffic is detected, so that drivers approach high-risk intersections at a lower speed than if a green signal were displayed. Vehicle speed data were collected before and after treatment activation at both a control and treatment site. Speed data were collected both 30 m prior to and at the intersection stop line. The treatment was associated with a reduction in mean vehicle speeds of 3.9 kph (9%) and 11.0 kph (28%) at 30 m and stop line collection points, respectively, and substantial reductions in the proportion of vehicles travelling at threatening speeds with regard to the severity of pedestrian injury. Other important road safety concerns may also benefit from this form of traffic signal modification, and it is recommended that other areas of application be explored, including the other severe trauma categories typically concentrated around signalized intersections.

271. Harkey, D.L., D. L. Carter, J. M. Barlow, and B. L. Bentzen. *Accessible Pedestrian Signals: A Guide to Best Practice.* National Cooperative Highway Research Program Web-Only Document 117A, Washington, D.C. 2007.

NCHRP Web-Only Document 117A: Accessible Pedestrian Signals: A Guide to Best Practice is designed to serve as a companion resource document to a one-day training course on accessible pedestrian signals. NCHRP 3-62 has resulted in revisions to APS specifications in the 2009 MUTCD. This document provides extensive information on the specifications and installation, as well as chapters explaining techniques and strategies used by pedestrians who are blind or visually impaired. An appendix to Web-Only Document 117A includes an accessible pedestrian signals intersection prioritization tool and instructions on how to use the tool.

272. Harkey, D.L., D. L. Carter, J. M. Barlow, B. L. Bentzen, L. Myers and A. Scott. *Guidelines for Accessible Pedestrian Signals, Final Report.* Contractor's Final Report for NCHRP Project 3-62, National Cooperative Highway Research Program Web-Only Document 117B, Washington, D.C., 2007.

NCHRP Web-Only Document 117B: Guidelines for Accessible Pedestrian Signals (Final Report) provides details on research that determined optimal specifications for accessible pedestrian signals (APS) and that resulted in the APS intersection prioritization tool.

273. Ashmead, D.H., R. S. Wall, B. L. Bentzen, and J. M. Barlow. "Which Crosswalk? Effects of Accessible Pedestrian Signal Characteristics," *ITE Journal*, 74-9, 2004: 26-31.

Pedestrians who are blind, and blindfolded, sighted pedestrians judged which crosswalk had the audible walk signal at a simulated 90 degree four leg intersection. Factors varied were speaker positioning, mode (both ends simultaneously, alternating, far end only), and number of crosswalks signaled. Results indicate that speakers should be close to the curb and adjacent to the crosswalk they serve. Judgments are more accurate if signals come from the far end without simultaneous sound from the near end; however, several implementation issues in that arrangement are not yet resolved. Signaling two parallel crosswalks does not appear to cause problems.

274.Bentzen, B. L., J.M. Barlow, and T. Bond. "Challenges of Unfamiliar Signalized Intersections for Pedestrians who are Blind: Research on Safety," *Transportation Research Record: Journal of the Transportation Research Boar*d, *1878,* 2004*:* 51 -57.

Pedestrians who are blind or visually impaired often travel in areas that are unfamiliar to them and cross at signalized intersections. This paper is the first of several papers reporting the results of testing street crossing by pedestrians who are blind, at complex, unfamiliar, signalized intersections without accessible pedestrian signals. The focus of this paper is on descriptive analysis of broad measures of safety, orientation and need for assistance in crossing. Objective data on 12 measures of street crossing performance was obtained at four intersections (two in each of two cities). In each city, 16 participants who were blind crossed at unfamiliar complex signalized intersections without accessible pedestrian signals. Results confirm that pedestrians who are blind have considerable difficulty locating crosswalks, aligning to cross, determining the onset of the walk interval, maintaining a straight crossing path, and completing crossings before the onset of traffic perpendicular to their path of travel. Accessible pedestrian signals will be installed at the four intersections, and post-installation data will be used to determine recommendations for accessible pedestrian signal characteristics and installation.

275.Bentzen, B.L., A. C. Scott, and J. M. Barlow. "Accessible Pedestrian Signals: Effect of Device Features," *Transportation Research Record: Journal of the Transportation Research Board, No. 1982*, 2006: pp. 30-37.

The U.S. Access Board's *Draft Guidelines for Accessible Public Rights-of-Way* recommends the use of pushbutton-integrated accessible pedestrian signals (APS). This research compared the effect of specific features of pushbutton-integrated APS on the ability of blind pedestrians to locate and correctly use pushbuttons, and to cross accurately during the pedestrian phase. A fast tick WALK signal promoted the fastest onset of crossing when compared to speech messages and bird calls, and is therefore the preferred signal. However, speech WALK indications are needed where two APS are mounted on the same pole. Although variations in the standard features made little difference to users who were thoroughly familiar with devices, empirical evidence from participants with less knowledge of the devices as well as subjective data, lead to the recommendation for APS devices which include: a pushbutton locator tone, a rounded pushbutton with an activation tone/message, a tactile arrow incorporated into the pushbutton itself, responsiveness to ambient sound, and a pushbutton information message and beaconing in response to an extended button press.

276.Bentzen, B.L., J. M. Barlow and L. Franck. "Speech Messages for Accessible Pedestrian Signals," *ITE Journal, 74-9, 2004:* 20-24.

Accessible pedestrian signals may have speech messages that inform users of the presence of the walk interval for a crosswalk. They also may have pushbutton information messages that identify the intersection and the crosswalk and provide information about signalization and geometry. This feature includes recommendations for the content and structure of these speech messages.

277.Carter, D.L., D. L. Harkey, B. L. Bentzen, and J. M. Barlow. "Development of an Intersection Prioritization Tool for Accessible Pedestrian Signal Installation," *Transportation Research Record: Journal of the Transportation Research Board, No. 1982*, 2006: pp. 13-20.

278. Marston, J.R. and R. G. Golledge. *Towards an Accessible City: Removing Functional Barriers for the Blind and Vision Impaired: A Case for Auditory Signs.* Final Report submitted to the University of California Transportation Center. University of California Berkeley: University of California Transportation Center. 2000. Although increased complexity in intersection design and signal timing has improved intersection service to vehicle traffic, it has created additional challenges to pedestrians who are blind or who have low vision. Safe and independent crossings for pedestrians who are blind or who have low vision may require installation of accessible pedestrian signals (APS) at some complex signalized intersections. APS provide an audible and sometimes a tactile indication when the walk signal is on to cross the street. The goal of this study was to create a tool to prioritize locations for the installation of APS. To develop the prioritization tool, various characteristics of the intersection and the individual crosswalk were assigned point values which indicated their relative effect on the need for APS at the crosswalk. For example, a point is assigned if the crossing is interrupted by a median; two points are assigned if there is a channelized turn lane. Field tests were conducted in which sites were ranked in order of their need for APS. The rankings were done separately by transportation engineers using the prioritization tool and by expert judgment of Orientation and Mobility specialists and pedestrians with visual impairments. The point values of the prioritization tool were modified based on the comparison to the expert judgment rankings. The final, calibrated tool provides practitioners with the means to take observable characteristics of a pedestrian crossing and produce a score that reflects the relative crossing difficulty for pedestrians who are blind, thus enabling prioritization of APS installations.

This study examined the effect that use of Remote Infrared Signage Systems (in particular the Talking Signs® - TS® - product) has on performance of blind or vision impaired people when undertaking a variety of bus user tasks. These tasks included finding a suburban bus stop, identifying a specific bus and boarding it, disembarking at the downtown terminal and finding the entrance, traversing the terminal and learning the location of facilities located therein, and, simulating the exiting of a bus, navigating through the terminal, exiting via a different door and searching for the boarding area of an express bus about 120' away on the frontal street, (the bus transfer task). In addition, use of TS® was perceived to reduce stress, anxiety, and difficulty of the various tasks associated with use of public transit. And, in post-task evaluations, participants on average strongly agreed that, if the TS® were made permanent on all buses and at the terminal, they would use public transit much more than they do now. They also supplied recommendations as to where TS® could be located throughout the city to make it truly accessible for all their regular activities.

279.Noyce, D. A., and B. L. Bentzen. "Determination of Pedestrian Pushbutton Activation Duration at Typical Signalized Intersections," *Transportation Research Record: Journal of the Transportation Research Board, No. 1939,* 2005. pp. 63−68.

Recent advances in pedestrian pushbutton design, led by the development of accessible pedestrian signals (APS), have created a new method of communicating traffic control information to pedestrians. Some APS devices have beaconing features and/or verbal (speech) message capabilities obtained by pressing and holding the pedestrian pushbutton for approximately three seconds. Other features, such as the extension of the walk interval, may also be activated with an extended pushbutton press. Recent research has suggested that three seconds may be excessive since holding the pushbutton this long is hard for some users. Additionally, most pedestrians may not hold the pushbutton for this length of time.

The problem lies in determining how long the APS pushbutton should be pressed for a pushbutton information message and/or special accessibility features. The primary objective of this research was to develop a time distribution of typical pedestrian pushbutton activation durations. Data was obtained by attaching a voltage recorder to the pedestrian pushbutton circuit inside traffic signal controllers at eight locations, in three cities, in Wisconsin and Massachusetts. This device recorded the amount of time, to the nearest 1/100th of a second that each pedestrian pushbutton was pressed. A total of 1,439 pushbutton presses were recorded. The average pushbutton press duration was 0.2 seconds. Over 95 percent of all pushbutton presses recorded were less than 1.0 seconds. Only four presses exceeded 3.0 seconds. The results show that the duration of an extended pushbutton press to obtain additional crossing information can be reduced to approximately one second without a significant number of false calls. A one second press will minimize the effort required for pedestrians to actuate special accessible features, while minimizing unnecessary noise and vehicular traffic disruption.

280. Scott, A.C., Barlow, J. M., Bentzen, B.L., Bond, T.L.Y. and Gubbe, D. "Accessible Pedestrian Signals at Complex Intersections: Effects on Blind Pedestrians," *Transportation Research Record: Journal of the Transportation Research Board,* No. 2073, pp. 94–103.

Pedestrians who are blind or visually impaired often cross at unfamiliar signalized intersections. This paper reports the results of research on street crossings by these pedestrians at complex intersections, before and after the installation of accessible pedestrian signals (APS). Objective data on measures of street crossing performance by sixteen participants who were blind was obtained at two intersections. The analysis includes broad measures of crossing timing, orientation, and independence. After installation of APS, delay in beginning crossing was reduced by approximately 2 seconds. Post-installation, there was significant improvement in beginning to cross during WALK, completing crossings before the onset of perpendicular traffic, locating the crosswalk, aligning to cross, and in independence, at pedestrian-actuated crossings.

281. Scott, A.C., L. Myers, J. M. Barlow, and B. L. Bentzen. "Accessible Pedestrian Signals: The Effect of Pushbutton Location and Audible WALK Indications on Pedestrian Behavior." *Transportation Research Record: Journal of the Transportation Research Board, No. 1939*, 2005. pp. 69-76.

Pushbutton-integrated Accessible Pedestrian Signals (APS) provide audible information from the pushbutton housing regarding both the location of the pushbutton and the onset of walk intervals. APS systems must provide clear, unambiguous information as to which crosswalk has the walk interval. Pushbuttons in the United States, including pushbutton-integrated APS, are inconsistently located, and APS do not use consistent sounds to convey the WALK indication. The present research (NCHRP Project 3-62) investigated the effects of pushbutton placement and type of audible WALK indication on visually or cognitively impaired participants' ability to determine which of two streets had the WALK signal. Participants performed this task most quickly and most accurately when each pushbutton-integrated APS was mounted on its own pole, the poles were placed along the outer line (farthest from the center of the intersection) of the associated crosswalk, each pole was located within a few feet of the curb, and the audible WALK indication from each APS was a fast tick (percussive sound) at 10 repetitions per second. Results further indicate that where two pushbuttons are installed on a single pole, verbal WALK messages (e.g., "Seventh; walk sign is on to cross Seventh.") result in greater accuracy than two different sounds (fast tick and cuckoo) to signal the two crossings.

282. Wall, R.S., D. H. Ashmead, B. L. Bentzen, & J. Barlow. "Directional Guidance from Audible Pedestrian Signals for Street Crossing," *Ergonomics*. Vol. 47, (12), 2004. pp. 1318 – 1338.

Typical audible pedestrian signals indicate when the pedestrian walk interval is in effect but provide little, or even misleading information for directional alignment. In three experiments, blind and blindfolded

sighted adults crossed a simulated crossing with recorded traffic noise to approximate street sounds. This was done to investigate how characteristics of signal presentation affected usefulness of the auditory signal for guiding crossing behavior. Crossing was more accurate when signals came only from the far end of the crossing rather than the typical practice of presenting signals simultaneously from both ends. Alternating the signal between ends of the crossing was not helpful. Also, the customary practice of signaling two parallel crossings at the same time drew participants somewhat toward the opposite crossing. Providing a locator tone at the end of the crossing during the pedestrian clearance interval improved crossing accuracy. These findings provide a basis for designing audible pedestrian signals to enhance directional guidance. The principal findings were the same for blind and sighted participants and applied across a range of specific signals (e.g. chirps, clicks, voices).

283. Williams, M. D., Van Houten, R., Ferraro, J., and Blasch, B. (2005). "Field Comparison of Two Types of Accessible Pedestrian Signals," *Transportation Research Record: Journal of the Transportation Research Board, No. 1939*, 2005, pp 91-98.

The effects of two types of accessible pedestrian signals on the street crossing behavior of 24 totally blind participants were directly compared in this research. One accessible pedestrian signal (APS) used a sound generator and vibrating hardware, which were integrated into the pedestrian push button (Polara). These sounds were heard from the near vicinity of the push button, and a different message or repetition rate was used to indicate the WALK interval. The second APS used pulsing LEDs to illuminate the message in the pedestrian signal head to transmit a message to a hand held receiver carried by the blind traveler (Relume). The hand held receiver provided a "Walk" or "Wait" message designated by variable tones, which was only audible to the user. A control condition consisted of crossing without any APS device. Data were collected on: crossing speed; latency from the start of the walk and entering the crosswalk; the number of cycles missed; and accuracy of the crossing. A within subjects design was employed with crossing randomized for condition, direction of crossing. The treatments were placed at two adjacent intersections for the first half of the participants and then switched for the second half of the participants to eliminate a location effect. Results indicated that the time to cross the street was significantly shorter when participants used the hand held device then when they used the audible push button device or crossed without any APS. There was no significant difference in crossing time between the audible push button device and the control condition. Crossing time with the audible push button device did not differ significantly from crossing time without any APS device. Latency to start crossing was significantly faster when participants used the handheld device than either the audible push button or when crossing without an APS in the control condition. The audible push button device was also associated with a significantly faster latency than the control condition. Data on the accuracy of the crossing indicated much greater variation in crossing accuracy with the audible push button device than with the hand held device or control condition. The number of missed cycles was significantly lower with both APS devices than when the person crossed without an APS and there was no difference between either APS device. An equal percentage of participants (45%) favored each of the two APS devices and 5% preferred both equally while 5% favored crossing without either of the APS devices.

MARKINGS

284. Knoblauch, R. L. and Raymond, P. D. "The Effect of Crosswalk Markings on Vehicle Speeds in Maryland, Virginia and Arizona," FHWA-RD-00-101, Great Falls, Va., Federal Highway Administration, 2000.

A before/after evaluation of pedestrian crosswalk markings was performed in Maryland, Virginia, and Arizona. Six sites that had been recently resurfaced were selected. All sites were at uncontrolled intersections with a speed limit of 56 km/h (35 mi/h). Before data were collected after the centerline and edgeline delineation was installed but before the crosswalk was installed. After data were collected after the crosswalk markings were installed. Speed data were collected under three conditions: no pedestrian present, pedestrian looking, and pedestrian not looking. All pedestrian conditions involved a staged pedestrian. The results indicate a slight reduction at most, but not all, of the sites. Overall, there was a significant reduction in speed under both the no pedestrian and the pedestrian not looking conditions. It appears that crosswalk markings make drivers on relatively low-speed arterials more cautious and more aware of pedestrians.

285.Zegeer, C. V., Stewart, R., Huang, H., and Lagerwey, P., Feaganes, J., and Campbell, B.J. "Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines," FHWA-HRT-04-100, McLean, Va., Federal Highway Administration, 2005.

Pedestrians are legitimate users of the transportation system, and they should, therefore, be able to use this system safely. Pedestrian needs in crossing streets should be identified, and appropriate solutions should be selected to improve pedestrian safety and access. Deciding where to mark crosswalks is only one consideration in meeting that objective. The purpose of this study was to determine whether marked crosswalks at uncontrolled locations are safer than unmarked crosswalks under various traffic and roadway conditions. Another objective was to provide recommendations on how to provide safer crossings for pedestrians. This study involved an analysis of 5 years of pedestrian crashes at 1,000 marked crosswalks and 1,000 unmarked comparison sites. All sites in this study had no traffic signal or stop sign on the approaches. Detailed data were collected on traffic volume, pedestrian exposure, number of lanes, median type, speed limit, and other site variables. Poisson and negative binomial regressive models were used. 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 multilane 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 multilane roads, compared to roads with no raised median. Older pedestrians had crash rates 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.

This is an important study on the safety of marked vs. unmarked crosswalks under various traffic and roadway conditions, which has been influencing agency policies for not only crosswalk markings, but also providing other types of pedestrian safety enhancements at unsignalized crossings.

286.Knoblauch, R. L., Nitzburg, M., and Seifert, R. F. "Pedestrian Crosswalk Case Studies: Richmond, Virginia; Buffalo, New York; Stillwater, Minnesota," FHWA-RD-00-103, McLean, Va., Federal Highway Administration, 2001.

The objective of this research was to determine the effect of crosswalk markings on driver and pedestrian behavior at unsignalized intersections. A before/after evaluation of crosswalk markings was conducted at 11 locations in 4 U.S. cities. Behavior observed included: pedestrian crossing location, vehicle speeds, driver yielding, and pedestrian crossing behavior. It was found that drivers approach a pedestrian in a crosswalk somewhat slower, and that crosswalk usage increases after markings are installed. No evidence was found indicating that pedestrians are less vigilant in a marked crosswalk. No changes were found in driver yielding or pedestrian assertiveness. Overall, it appears that marking pedestrian crosswalks at relatively low-speed, low-volume, unsignalized intersections is a desirable practice, based on the sample of sites used in this study.

287.Nitzburg, M. and Knoblauch, R. L. “An Evaluation of High-Visibility Crosswalk Treatment - Clearwater Florida,” FHWA-RD-00-105, McLean, Va., Federal Highway Administration, 2001.

A novel overhead illuminated crosswalk sign and high-visibility ladder style crosswalk were evaluated in Clearwater, Florida. Using an experimental/control design, the effect of the novel treatments on driver and pedestrian behavior was determined. A significant 30 percent to 40 percent increase in daytime driver yielding behavior was found. A smaller (8 percent) and statistically insignificant increase in nighttime driver yielding behavior was observed. A large (35 percent) increase in crosswalk usage by pedestrians was noted along with no change in pedestrian overconfidence, running, or conflicts. It was concluded that the high-visibility crosswalk treatments had a positive effect on pedestrian and driver behavior on the relatively narrow low-speed crossings that were studied. Additional work is needed to determine if they will also have a desirable effect on wider, higher-speed roadways.

288.Van Houten, R., Malenfant, J. E., and McCusker, D. “Advance Yield Markings: Reducing Motor Vehicle-Pedestrian Conflicts at Multilane Crosswalks with Uncontrolled Approach,” Transportation Research Record, Number 1773, pp. 69-74, 2001.

Motorists yielding to a pedestrian at the crosswalk line can screen the view of the pedestrian crossing in front of them. This places the pedestrian at risk from vehicles approaching in adjacent travel lanes. An experiment was conducted in which advance yield markings and a symbol sign prompting motorists to yield to pedestrians at the markings were placed at several intersections. Their effects on pedestrian safety at multilane crosswalks with pedestrian-activated yellow flashing beacons were evaluated. Motorist and pedestrian behaviors measured throughout the experiment included the following: occurrence of motor vehicle—pedestrian conflicts that involved evasive action, distance before the crosswalk that motorists stopped when yielding to pedestrians, and percentage of motorists yielding to pedestrians. The introduction of the markings and the sign 10 m before the crosswalk increased the distance in front of the crosswalk that motorists yielded to pedestrians and it markedly reduced the percentage of motor vehicle-pedestrian conflicts. Placing markings 15 m and 25 m in advance of the crosswalk produced similar benefits, demonstrating that treatment effects can be produced over a wide range of values.

289.Mitman, M.F., Ragland, D.R., and Zegeer, C.V. “The Marked Crosswalk Dilemma: Uncovering Some Missing Links in a 35-Year Debate,” Transportation Research Board 87th Annual Meeting, 2008.

Primarily in response to several landmark safety studies, and as an official or unofficial policy, many agencies across the United States have elected to remove marked crosswalks at uncontrolled intersections or have shown resistance to installing them in the first place. This approach results in unacceptable pedestrian mobility restrictions, yet such restrictions are often not considered in policy making. As such, there is a need for roadway system owners to develop strategic safety guidelines to address the marked-crosswalk dilemma. Since 2005, the Traffic Safety Center at the University of California, Berkeley, in a study funded by the California Department of Transportation, has focused on developing a better understanding of driver and pedestrian behavior and safety in both marked and unmarked crosswalks in an effort to recommend more informed crosswalk policies. The study was designed to fill key gaps in the literature by analyzing pedestrian and driver behavior and knowledge of right-of-way laws regarding marked and unmarked crosswalks. The study also focused on driver and pedestrian behavior in multiple-threat scenarios, the most common type of pedestrian collisions at uncontrolled intersections. Results are summarized from field observations of driver and pedestrian behavior at marked and unmarked crosswalks on low-speed two-lane and multilane roads. The behavioral observations are interpreted in light of findings reported by Mitman and Ragland from surveys and focus groups regarding driver and pedestrian knowledge of right-of-way laws. The discussion

concludes with recommendations for a comprehensive crosswalk safety policy to strategically address crash risk at uncontrolled crosswalks.

290. Nambisan, P.E., Shashi, S., Vasudevan, V., Dangeti, M., and Virupaksha, V. "Advanced Yield Markings and Pedestrian Safety: Analyses of Use With Danish Offsets and Median Refuge Islands," Transportation Research Board, 87th Annual Meeting, 2008.

This paper summarizes an evaluation of the effectiveness of advanced yield markings in improving pedestrian safety when used with Danish offsets and median refuge islands. These countermeasures were deployed in combinations in two stages. The evaluations are based on field observations by trained observers at sites located in the Las Vegas metropolitan area, Nevada. Observational data were collected at one uncontrolled intersection, and one mid-block site. Motorist and pedestrian behaviors were observed, and various measures of effectiveness were used to evaluate the effectiveness the countermeasures. The results show that both sites experienced an increase in pedestrians' observing behavior and an improvement in motorists' yielding behavior. Also, a reduction in the number of pedestrians trapped in the roadway was observed at one of the study sites. The high visibility crosswalk and advance yield markings at the mid-block location showed positive safety benefits in motorists' and pedestrians' behaviors. The findings from this study could be used to enhance pedestrian safety on arterial roadway in other cities.

291. Hakkert, A. S., Gitelman, V., and Ben-Shabat, E. "An Evaluation of Crosswalk Warning Systems: Effects on Pedestrian and Vehicle Behaviour," Transportation Research Part F: Traffic Psychology and Behaviour, 54, pp. 275-292, 2002.

This paper presents a field experiment using a warning system at an uncontrolled pedestrian crosswalk to evaluate the effects of the device on pedestrian and vehicle behaviors. The system detects pedestrians near the crosswalk and uses flashing lights embedded in the pavement adjacent to a marked crossing as a warning for drivers. The devices were installed at four urban locations and a before/after comparison of road users' behavior was conducted. Results showed that, under certain conditions, the device can bring about a decrease of 2-5 kph in average vehicle speeds near the crosswalk zone. The device led to an increase in the rate of yielding to pedestrians to about 35 percent at the beginning of crossing and 70 percent in the middle of the crossing. Vehicle-pedestrian conflicts in the crosswalk zone were reduced to a rate of less than 1 percent and the share of pedestrians crossing outside the crosswalk was reduced up to 10 percent. Pedestrians in general kept to the same levels of crossing caution as before the installation. Overall results suggest that the system seems suitable for urban road sections (rather than junctions) with uncontrolled pedestrian crossings. Suitable locations are those where: (1) average speeds are over 30 kph; (2) the rate of giving way to pedestrians is low; and (3) there is either intensive pedestrian flow through the crosswalk, or the site is characterized by a high rate of conflicts in the crosswalk zone or a high share of pedestrian crossings outside the crosswalk area.

292. Abdelghaney, A. "Above-Ground Actuated Yellow Crosswalk Lights at Uncontrolled Pedestrian Crossings," University of Alaska, Fairbanks Department of Civil and Environmental Engineering and Alaska Department of Transportation and Public Facilities Research and Technology Transfer, 2005.

There has been a significant amount of studies that investigated a wide variety of measures, devices, and treatments that improve pedestrian safety at different locations (sidewalks, intersection crossing, and midblock crossing). These measures can be classified into three main categories: Physical separation, time separation; Warning; and Traffic Calming Measures. The focus of this study is limited to investigating the effectiveness of flashing lights in increasing pedestrian safety and reducing traffic accidents at uncontrolled pedestrian crossings. This study reviews the experimental research and test cases that investigate the effectiveness of the above-ground flashing beacons as a warning device at

uncontrolled crosswalks. In particular, it investigate the usefulness of the above-ground flashing beacons in reducing traffic speeds at pedestrians crosswalks, increasing the percentage of motorists that are yielding to pedestrians, reducing conflicts between motorists and pedestrians, reducing accidents, and increasing pedestrians safety. This study also reviews the comparisons between the effectiveness of the above-ground flashing beacons and the in-pavement flashing lights as warning devices for motorists at uncontrolled crosswalks.

Illumination

293. Gibbons, R. B., Edwards, C. J., Williams, B., and Andersen, C. K. “Informational Report on Lighting Design for Midblock Crosswalks,” FHWA-HRT-08-053, McLean, VA: Federal Highway Administration, 2008.

This report provides information on lighting parameters and design criteria that should be considered when installing fixed roadway lighting for midblock crosswalks. The information is based on static and dynamic experiments of driver performance with regard to the detection of pedestrians and surrogates in midblock crosswalks. Experimental condition variables included lamp type (high-pressure sodium and metal halide), vertical illuminance level, color of pedestrian clothing, position of the pedestrians and surrogates in the crosswalk, and the presence of glare. Two additional lighting systems, a Probeam luminaire and ground-installed LEDs, were also evaluated. The research found that a vertical illuminance of 20 lx in the crosswalk, measured at a height of 1.5 m (5 ft) from the road surface, provided adequate detection distances in most circumstances. Although the research was constrained to midblock placements of crosswalks, the report includes a brief discussion of considerations in lighting crosswalks colocated with intersections.

294. Wilken, D., Ananthanarayanan, B., Hasson, P., Lutkevich, P. J., Watson, C. P., Burkett, K., et al. “European Road Lighting Technologies,” Report Number FHWA-PL-01-034. Washington, D.C.: Federal Highway Administration, 2001.

The objective of this scanning tour was to gather information from European transportation ministries and lighting professionals regarding cutting-edge research and technologies in highway and roadway lighting systems, including tunnel illumination, sign lighting, and all methods used to design roadway lighting systems. Some of the information could provide a basis on which to update the American Association of State Highway and Transportation Officials' "Informational Guide for Roadway Lighting." In April 2000 the scan team visited Finland, Switzerland, France, Belgium, and the Netherlands. Based on its observations, the panel developed specific recommendations for the U.S. lighting community in such areas as visibility design technique; dynamic road lighting; pavement reflection factors; master lighting plans; lighting techniques for roundabouts, crosswalks, and pedestrian areas; energy-absorbing poles; signs; and equipment quality level and maintenance.

295. Gibbons, R. B. and Hankey, J. M. “Influence of Vertical Illuminance on Pedestrian Visibility in Crosswalks,” Transportation Research Record 1973, pp. 105-112, 2006.

This project investigated the lighting levels required for crosswalk illumination. The current European methods for lighting suggest a crosswalk lighting level of 40 vertical lux for ensured safety. Two major questions were studied: the required vertical illuminance level for adequate pedestrian visibility and the selection of an object that could act as a surrogate for the pedestrian. The vertical illuminance was determined from an experiment that measured the visibility of pedestrians at lighting levels of 5, 20, 40, and 60 vertical lux. During the experiment, a crosswalk scene was presented to the participants and the time taken for identification of an object was measured. In addition to the lighting level, the conditions used in the experiment were lamp type (metal halide versus high-pressure sodium), the presence of glare, the use of overhead lighting, and the type of pedestrian clothing (white, black, and denim). The study found that a lighting design level of 20 vertical lux is likely adequate for proper pedestrian visibility. Except in selected cases, the lamp type was not significant. The impact of glare was not influenced by the lighting design. Three surrogate objects were developed for the experiment and were tested in the same manner as the pedestrians. The surrogates used were an extruded octagon, a cylinder, and a cylinder with a ball on top. These surrogates were selected to allow easy lighting design calculations while best representing a pedestrian. The experiment found that all surrogates performed equally well and that the surrogate can be chosen on the basis of the ease of calculation. It is recommended that a cylinder be used as a pedestrian surrogate.

296. Yi, P., John, L. J., Dissanayake, S., and Zang, Y. "Impact of Highway Illumination on Traffic Fatality in Various Roadway and Environmental Conditions," Transportation Research Record, 2002

This paper investigates the impact of roadway illumination on traffic fatalities over a large geographic area. This research develops a systematic approach to assess the quality of service provided by the existing lighting system to traffic safety. Other factors, such as roadway design, traffic, and environmental conditions at the time of crash, can also be considered in the study.

297. Edwards, C.J. and Gibbons, R.B. Relationship of Vertical Illuminance To Pedestrian Visibility in Crosswalks. Transportation Research Record, Number 2056, pp. 9-16, 2008

Twenty-six participants evaluated a series of crosswalk lighting designs by visually detecting objects at each crosswalk location while traveling in a moving vehicle. The research was performed on a closed test track under nighttime conditions while the participants were driving an SUV with regular halogen headlamps. The conditions included several vertical illuminance levels (6, 10, 20, and 30 lux), varied luminaire types [highpressure sodium (HPS) and metal halide (MH)], and various target object types (pedestrian and surrogate objects). Only one age group of participants (66 years and older) was used for the study, with equal representation of males and females. The participants were asked to detect objects at each crosswalk location when they were confident an object was present. The results indicated that object detection distances changed on the basis of vertical illuminance level, luminaire type, and object type. Object detection distance for HPS was greatest at 30 vertical lux and for MH at 20 vertical lux. However, these results were moderated by the clothing color of the target object. When object color was considered, pedestrians in white clothing were identified earlier under the HPS lighting condition at 20 lux. Under the MH configuration, denim-clothed objects were detected earlier than black-clothed objects, especially at the 20-lux lighting level. The results suggest that a vertical illuminance level of 20 lux at crosswalk locations provides adequate levels for target object detection. In addition to benefiting from vertical illuminance, target objects that wore white clothing had detection distances superior to other object types of different clothing colors. Recommendations for crosswalk lighting configurations are further discussed.

298. Nambisan, S.S., et al. "Effectiveness of Automatic Pedestrian Detection Device and Smart Lighting on Pedestrian Safety," Transportation Research Board, 88th Annual Meeting, 2009.

This paper summarizes an evaluation of the effectiveness of an automatic pedestrian detection device and a smart lighting system in improving pedestrian safety. These countermeasures were deployed at a mid-block location in the Las Vegas metropolitan area in Nevada. The evaluations are based on field observations of pedestrian and motorist behaviors before and after the installation of the countermeasures. Their effectiveness was evaluated using the following measures of effectiveness: percent of pedestrians who looked to their left and right before and while crossing, percent of pedestrians who changed their course of action, percent of pedestrians trapped in the middle of the road, percent of motorists who yielded to pedestrians, the distance from the crosswalk at which motorists yielded to pedestrians, and delays. The results show an increase in pedestrians' observational

behavior and an improvement in motorists' yielding behavior. Also, a reduction in the number of pedestrians trapped in the roadway was observed. Overall, the installation of the automatic pedestrian detection device and the smart lighting showed positive safety benefits for motorists' and pedestrians' behaviors at the test location. The findings from this study could be used to enhance pedestrian safety on arterial roads in other cities with similar demographic characteristics and traffic conditions.

299.Sullivan, J. M. and Flannagan, M. J. "The Role of Ambient Light Level in Fatal Crashes: Inferences from Daylight Saving Time Transitions," Accident Analysis and Prevention, Volume 34, Number 4, pp. 487-498, 2002.

The purpose of this study was to estimate the size of the influence of ambient light level on fatal pedestrian and vehicle crashes in three scenarios. The scenarios were: fatal pedestrian crashes at intersections, fatal pedestrian crashes on dark rural roads, and fatal single-vehicle run-off-road crashes on dark, curved roads. Each scenario's sensitivity to light level was evaluated by comparing the number of fatal crashes across changes to and from daylight saving time, within daily time periods in which an abrupt change in light level occurs relative to official clock time. The analyses included 11 years of fatal crashes in the United States, between 1987 and 1997. Scenarios involving pedestrians were most sensitive to light level, in some cases showing up to seven times more risk at night over daytime. In contrast, single-vehicle run-off-road crashes showed little difference between light and dark time periods, suggesting factors other than light level play the dominant role in these crashes. These results are discussed in the context of the possible safety improvements offered by new developments in adaptive vehicle headlighting.

300.Sullivan, J.M. and Flannagan, M.J. "Determining The Potential Safety Benefit of Improved Lighting in Three Pedestrian Crash Scenarios," Accident Analysis & Prevention, Volume 39, Number 3, pp. 638-647, 2007.

The influence of light level was determined for three pedestrian crash scenarios associated with three adaptive headlighting solutions—curve lighting, motorway lighting, and cornering light. These results were coupled to corresponding prevalence data for each scenario to derive measures of annual lifesaving potential. For each scenario, the risk associated with light level was determined using daylight saving time (DST) transitions to produce a dark/light interval risk ratio; prevalence was determined using the corresponding annual crash rate in darkness for each scenario. For curve lighting, pedestrian crashes on curved roadways were examined; for motorway lighting, crashes associated with high speed roadways were examined; and for cornering light, crashes involving turning vehicles at intersections were examined.

In the curve analysis, lower dark/light crash ratios were observed for curved sections of roadway compared to straight roads. In the motorway analysis, posted speed limit was the dominant predictor of this ratio for the fatal crash dataset; road function class was the dominant predictor of the ratio for the fatal/nonfatal dataset. Finally, in the intersection crash analysis, the dark/light ratio for turning vehicles was lower than for nonturning vehicles; and the ratio at intersections was lower than at non-intersections.

Relative safety need was determined by combining the dark/light ratio with prevalence data to produce an idealized measure of lifesaving potential. While all three scenarios suggested a potential for safety improvement, scenarios related to high speed roadway environments showed the greatest potential.

301.Langham, M. P. and Moberly, N. J. "Pedestrian Conspicuity Research: A Review," Ergonomics, 464, pp. 345-363, 2003.

This review sets out to evaluate the ways in which pedestrian conspicuity has been defined and measured and to consider the various scenarios in which studies of pedestrian conspicuity have been conducted. Research from the psychological and human factors literature is reviewed, in addition to relevant studies on conspicuity that fall outside the scope of applied psychology. Methodological differences between these studies are compared and their ecological validity in terms of the real-world context of pedestrians at risk from vehicles is discussed. The authors argue that there have been many methodological differences in pedestrian conspicuity studies, but that this may not necessarily be problematic when investigating a phenomenon with multiple causal factors. However, suggestions are made for improving ecological validity and establishing a more unified framework for future research in this area.

Sidewalks, Walkways, and Paved Shoulders

302. McMahon, P. J., Zegeer, C. V., Duncan, C., Knoblauch, R. L., Stewart, J. R., & Khattak, A. J. "An Analysis of Factors Contributing To "Walking Along Roadway" Crashes: Research Study and Guidelines for Sidewalks and Walkways," Report Number FHWA-RD-01-101. McLean, VA: Federal Highway Administration Office of Safety, 2001.

There are a variety of factors widely acknowledged to have an impact on the risk of pedestrian/motor vehicle crashes. The factors that have been most extensively researched are the geometric characteristics of the road, including the presence of sidewalks. However, in relevant epidemiological research, factors related to demographics and neighborhood characteristics have been alluded to, but not sufficiently researched. 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. This report also documents the results of a behavioral evaluation of new sidewalk in SeaTac, Washington (Appendix A). Recommended guidelines and priorities for sidewalks and walkways are given in Appendix B.

303. Access Board. *Proceedings of Workshop on Tolerances for Surface Smoothness, Flatness, and Slope.* U.S. Access Board. April 23, 2007: Ballast, D.K. "Initiative on Dimensional Tolerances in Construction Surface Compliance Design Issues"; Cyrtmus, C.D. "Constructability Considerations in Walking/ Rolling Surfaces"; Erik Wolf, E., Cooper, R.A., Pearlman, J. Fitzgerald, S. and A. Kelleher. "Longitudinal Assessment of Vibrations During Manual and Electric Powered Wheelchair Driving Over Selected Sidewalk Surfaces." http://www.access-board.gov/news/tolerances-workshop.htm

A workshop was held to identify strategies and considerations for developing this guidance on construction tolerances, particularly those pertaining to the slope, flatness, and smoothness of ground and floor surfaces. Participants included representatives from various trade associations, professional societies, government agencies, and research organizations. Discussion focused on available measurement protocols for surface flatness, smoothness and slope in relation to construction materials and methods. Papers presented at the workshop addressed design issues, construction considerations, and findings from a study of the physical effects of wheelchair travel over uneven surfaces. Participants

identified ways to advance work on establishing appropriate tolerances and measurement protocols and promoting best practices through various trade and professional associations, including the Construction Specifications Institute, the American Institute of Architects, and the American Concrete Institute, among others.

304.Kockelman, K., L. Heard, Y-J Kweon, and T.W. Rioux. "Sidewalk Cross-Slope Design: Analysis of Accessibility for Persons with Disabilities," *Transportation Research Record No.1818*, *Journal of the Transportation Research Board*, 2002, pp. 108-118.

Current and proposed Americans with Disabilities Act (ADA) guidelines offer no specific guidance on acceptable maximum cross slopes where constraints of reconstruction prohibit meeting the 2-percent maximum cross-slope requirement for new construction. Two types of sidewalk test-section data across a sample of 50 individuals were collected, combined with an earlier sample of 17 individuals, and analyzed here, with an emphasis on cross slopes. These examined heart-rate changes and user perception of discomfort levels, and they relied on a random-effects model and an ordered-probit model, respectively. Model estimates were used to deduce critical or unacceptable cross slopes for critical conditions and critical populations of persons with disabilities. Predicted values for the most severe or constrained cases ranged from 5.5 to 6 percent cross-slope. These cases included 5 percent primary slope (main grade) and 45-ft long sections; and they were traversed by cane/crutch/brace and manual wheelchair users up to 80 years of age. When primary slopes were reduced to 0 percent in the perception estimates, the critical cross slopes for the critical case rose to 6 percent. For most other persons with disabilities, the critical cross slopes ranged from 6 to 9 percent or more. These values substantially exceed the ADA Accessibility Guidelines' 2-percent maximum-cross-slope standard for public sidewalks.

305.Levinson, H. S., Gluck, J.S., Barlow, J.M., Eck, R., and Hecker, W.F. "Driveway Design Practices, Issues, and Needs." *Transportation Research Board 87th annual meeting compendium of papers.* CD-Rom, Transportation Research Board, Washington, D.C. 2008.

Driveways are an important and growing component of highway transportation systems. They have grown in number and complexity as urbanized areas have expanded. This paper traces their development and identifies key geometric issues and elements. It presents the salient results of a comprehensive agency-practice survey and literature review. Finally, it suggests possible areas for further research. A key finding is to design driveways in a multi-modal context that provides for safe and convenient movement by motor vehicles, bicycles, and pedestrians.

306.Gattis, J.L., Levinson, H., Gluck, J.S., Barlow, J.M., Eck, R., Hecker, W.F. Multimodal Driveway Design. Transportation Research Board 89th Annual Meeting Compendium of Papers DVD. Transportation Research Board, Washington, D.C. 2010.

Driveways are the link between public roadways and the abutting activities that they serve. Driveways serve a wide range of activities in a variety of contexts. Driveway design guidelines traditionally focused on accommodating motor vehicles, but in recent years, there has been growing emphasis on a broader range of issues, such as better managing access, and accommodating all modes, including pedestrians and bicyclists. How well driveways are designed affects the safety and mobility of not only motorists, but also bicyclists and pedestrians. This paper draws from research performed on NCHRP Project 15-35, Geometric Design of Driveways. It discusses multi-modal driveway design considerations and provides design guidelines that recognize the needs of pedestrians (including those with disabilities, and transit users) and bicyclists.

307.Scott, A. C. *Review and Report on "Sidewalk Cross-Slope Design: Analysis of Accessibility for Persons with Disabilities" (Kockelman, Heard, Kweon, and Rioux),* US Access Board, September 2004.

This report is a review of "Sidewalk cross-slope design: Analysis of accessibility for persons with disabilities" (Kockelman, Heard, Kweon, & Rioux, 2001). The various statistical techniques used are explained and information about the more basic statistical techniques upon which they are built is provided. A discussion of the appropriateness of the analyses and approaches selected, and critical analysis of the data reported describes several concerns. There are a number of specific concerns described regarding the representativeness of the sample, procedures, and calculation of results.

308.Steinfeld, E., Maisel, J. & Feathers, D. *Standards and Anthropometry for Wheeled Mobility*. Buffalo, NY : Center for Inclusive Design and Environmental Access (IDEA), School of Architecture and Planning, The State University of New York. July, 2005. http://www.ap.buffalo.edu/idea/Anthro/FinalAccessReport.pdf

Space requirements for accommodating wheeled mobility devices and their users in the built environment are key components of standards for accessible design. These requirements typically include dimensions for clear floor areas, maneuvering clearances, seat and knee clearance heights, as well as some reference dimensions on wheeled mobility device sizes. Recent research from four countries was reviewed and compared with their prevailing accessibility standards to identify needs for improving standards. Findings from ongoing anthropometry research on wheeled mobility in the U.S. were used for evaluating the adequacy of existing U.S. accessibility standards. Preliminary analysis suggests that the U.S. standards, which are based on research conducted in the 1970s, need to be updated to address advances in wheeled mobility technology and changes in user demographics. The analysis highlights the importance of integrating research with standards development, organizing international collaborations, and developing international standards.

309.Stollof, E. "Wayfinding at Intersections: Efforts Toward Standardization—A Joint Workshop of the Institute of Transportation Engineers and the U.S. Access Board," *ITE Journal*, *75:4*, 2005, 20-25. http://www.ite.org/membersonly/itejournal/pdf/2005/JB05DA20.pdf

At a recent workshop on wayfinding at intersections, participants recommended steps toward standardizing intersection design to optimize directional cueing for pedestrians who do not use visual cues when crossing streets.

Roundabouts

310.Rodergedts, L., Miranda, B., Wemple, E., Myers, E., Kyte, M., Dixon, M., et al. "Roundabouts in the United States," NCHRP Report, Number 572, Transportation Research Board, 2007.

Based on a comprehensive evaluation of roundabouts in the United States, this report presents methods of estimating the safety and operational impacts of roundabouts and updates design criteria for them. The report will be useful to geometric designers and traffic engineers who are considering improvements to an intersection.

311.Flannery, A. and Elefteriadou, L. "A Review of Roundabout Safety Performance in the United States," 69th Annual Meeting of the Institute of Transportation Engineers, 1999.

Roundabouts are a new form of at-grade intersection design that have been popular in Europe and Australia for many years as an alternative to two-way stop control and signalized intersections. While roundabout use is limited in the United States as of 1998, many local and state officials are planning or implementing roundabouts as a part of their roadway system. The benefits of roundabouts, in comparison to traditional forms of intersection design, include improved safety performance, reduced delay and community enhancement. This study addresses the safety performance of single lane roundabouts in the United States.

312. Persaud, B.N., Retting, R.A., Garder, P.E., and Lord, D. “Observational Before-After Study of the Safety Effect of U.S. Roundabout Conversions Using the Empirical Bayes Method,” Transportation Research Record, Number 1751, 2001.

Modern roundabouts are designed to control traffic flow at intersections without the use of stop signs or traffic signals. U.S. experience with modern roundabouts is rather limited to date, but in recent years there has been growing interest in their potential benefits and a relatively large increase in roundabout construction. This interest has created a need for data regarding the safety effect of roundabouts. Changes in motor vehicle crashes following conversion of 23 intersections from stop sign and traffic signal control to modern roundabouts are evaluated. The settings, located in seven states, are a mix of urban, suburban, and rural environments with the urban sample consisting of both single-lane and multilane designs and the rural sample consisting of only single-lane designs. A before-after study was conducted using the empirical Bayes procedure, which accounts for regression to the mean and traffic volume changes that usually accompany conversion of intersections to roundabouts. For the 23 intersections combined, this procedure estimated highly significant reductions of 40 percent for all crash severities combined and 80 percent for all injury crashes. Reductions in the numbers of fatal and incapacitating injury crashes were estimated to be about 90 percent. In general, the results are consistent with numerous international studies and suggest that roundabout installation should be strongly promoted as an effective safety treatment for intersections. Because the empirical Bayes approach is relatively new in safety analysis, the potential of this methodology in the evaluation of safety measures is demonstrated.

313. Persaud, B.N., Retting, R.A., Garder, P.E., and Lord, D. “Crash Reduction Following Installation of Roundabouts in the United States,” Arlington, VA, Insurance Institute for Highway Safety, 2000.

Almost half of all motor vehicle crashes that result in injuries occur at intersections. In the United States, traffic signals and stop signs are the primary devices used to regulate traffic flow at intersections to prevent collisions between conflicting traffic movements. Throughout the rest of the world, modern roundabouts have become increasingly popular as an alternative to intersections with traffic signals and stop signs. They are seldom used in the United States. The present before-and-after study was designed to better estimate the nature and magnitude of crash reductions following installation of modern roundabouts in the United States. It included a greater number of intersections and employed more powerful statistical analysis tools than the simple before-and-after comparisons used in prior studies. An empiric Bayes procedure was used to estimate changes in motor vehicle crashes following conversion of 24 intersections from stop sign and traffic signal control to modern roundabouts. There were highly significant reductions of 38% for all crash severities combined and of 76% for all injury crashes. Reductions in the number of fatal and incapacitating injury crashes were estimated at about 90%.

314. U.S. Access Board. *Pedestrian Access to Modern Roundabouts: Design and Operational Issues for Pedestrians who are Blind*. http://www.access-board.gov/research/roundabouts/bulletin.htm

Recent research sponsored by the Access Board, the National Eye Institute, and the American Council of the Blind suggests that some roundabouts can present significant accessibility challenges and risks to the blind user. This bulletin: summarizes orientation and mobility techniques used by pedestrians who are blind in traveling independently across streets; highlights key differences between roundabouts and traditional intersections with respect to these techniques; suggests approaches that may improve the accessibility of roundabouts to blind pedestrians; and encourages transportation engineers and planners to implement and test design features to improve roundabout accessibility.

315.*NCHRP 3-78a Crossing Solutions for Pedestrians with Vision Disabilities at Roundabouts and Channelized Right Turn Lanes*. Final report, June 2010.

316.Geruschat, D. R., and S. E. Hassan. "Driver Behavior in Yielding to Sighted and Blind Pedestrians at Roundabouts," *Journal of Visual Impairment & Blindness*, 2005: 99, 286–302.

This study evaluated drivers' behavior in yielding the right-of-way to sighted and blind pedestrians who stood at different stopping distances from the crosswalk lines at entry and exit lanes at two different roundabouts. The findings demonstrate that drivers' willingness to yield to pedestrians is affected by whether they are attempting to cross at the entry or exit to the roundabout and the speed of the moving vehicle.

317.Guth, D., D. Ashmead, R. Long, R. Wall, and P. Ponchillia."Blind and Sighted Pedestrians' Judgments of Gaps in Traffic at Roundabouts," *Human Factors*, 47, 314 –331.

This paper reports two experiments about street crossing under conditions of free flowing traffic, with a focus on modem roundabout intersections. Experiment 1 was conducted at three roundabouts varying in size and traffic volume. Six totally blind and six sighted adults judged whether gaps in traffic were long enough to permit crossing to the median (splitter) island before the next vehicle arrived. Gap distributions and measures of judgment quality are reported. Overall, blind participants were about 2.5 times less likely to make correct judgments than sighted participants, took longer to detect crossable gaps, and were more likely to miss crossable gaps altogether. However, the differences were significant only at the two higher volume roundabouts. In Experiment 2, we evaluated the response of drivers to pedestrians with and without mobility devices (i.e., long canes, dog guides). The experiment was conducted at a single-lane roundabout, a midblock crossing, and a two-way-stop-controlled intersection. Site-specific characteristics appeared to have a greater impact on drivers' yielding than did a mobility device. Actual or potential applications of this research include the development of methods for assessing pedestrian safety and driver behavior as well as identifying intersections that may require modification in order to be accessible to blind pedestrians.

318.Inman, V. and G. W. Davis. *Synthesis of Literature Relevant to Roundabout Signalization to Provide Pedestrian Access: Final Report*, Access Board, January 11, 2007. http://www.access-board.gov/research/roundabouts-signals/report.htm

The primary objective of this paper is to review the key issues in signalization of roundabouts, where the purpose of the signals is to provide pedestrian access, with particular attention to access for persons with severe vision loss. Although roundabouts are infrequently signalized to provide access to pedestrians, roundabouts crosswalks have been signalized where heavy pedestrian flow would otherwise cause long vehicle delays, where unbalanced traffic volumes require metering to create gaps for entering vehicles, and where signals were needed to accommodate rail transit. This report summarizes topic areas that address issues of signalization of roundabouts to provide pedestrian access. These topic areas include: pedestrian crosswalk types, crosswalk location, traffic signals configurations at roundabout pedestrian crossings, crossing requirements of blind pedestrians, accessible pedestrian signals, pedestrian signal warrants and the effect of traffic signals on roundabout operations.

319.**Inman, V.W., G.W. Davis, and D. Sauerburger.** Pedestrian Access to Roundabouts: Assessment of Motorists' Yielding to Visually Impaired Pedestrians and Potential Treatments To Improve Access. FHWA–HRT–05–080, Available Online: http://www.tfhrc.gov/safety/pedbike/pubs/05080/, 2006.

This report describes two related studies intended to address double-lane roundabout accessibility issues for visually impaired pedestrians. The first study was conducted on a closed course to evaluate the feasibility of a pavement treatment to alert blind pedestrians when vehicles have yielded to them. The second study examined drivers' yielding behavior at a two-lane roundabout and the effectiveness of the same roadway treatment in an operational environment. In the first study, there were two experimental conditions: a control condition and a treatment condition in which rumble strip-like devices were placed on the roadway surface. Seven individuals who have severe visual impairments participated. Participants stood at a crosswalk and used hand signals to indicate when they detected vehicles stopping or departing after a stop. Compared to the control condition, the sound strips treatment increased the probability of detecting stopped vehicles, and decreased by more than a second the amount of time needed to make a detection; however, the treatment did not reduce the number of false detections. False detections could result in the pedestrian crossing when moving vehicles are approaching the crosswalk. The second study was an experiment conducted at an operating roundabout. In that environment the rumble strip-like treatment was not effective, probably because the majority of vehicles stopped in the circular roadway before crossing over the rumble strips. A Yield to Pedestrians, State Law sign that was placed in the roundabout exit between the two travel lanes resulted in an increase in drivers' yielding from 11 percent of vehicles in the control condition to 16 percent in the experimental condition. It was concluded that the treatments explored in these studies do not appear promising for double-lane roundabouts, but should be explored further to see if they might work at single-lane crossings.

320.Schroeder, B. J., N. M. Rouphail and R. Wall. "Exploratory Analysis of Crossing Difficulties for Blind and Sighted Pedestrians at Channelized Turn Lanes," *Journal of the Transportation Research Board, No. 1956*. October 2006.

This paper presents findings from a paired comparison study of blind and sighted pedestrians judging crossing opportunities in traffic from the roadside at three channelized turn lane (CTL) locations. It is motivated by the belief that the geometric nature of CTL facilities and the lack of signal control at the pedestrian crossing are factors that may negatively impact the delay and safety for blind pedestrians. Pedestrians waiting at the curb have to judge traffic moving in circular motion, while they must deal with a significant amount of background traffic (i.e. noise) present at the main intersection. The findings show that crossings at all CTL crossing locations are significantly more difficult for blind pedestrians than for sighted pedestrians. Blind pedestrians tend to face a greater risk and a greater amount of delay. The research furthermore shows that conflicting traffic flow in the turn lane has a significant effect on crossing performance for both pedestrian groups; however, the effect of noise-generating background traffic on blind pedestrian crossings is not significant. The study also concludes that for this experiment the location of the crosswalk (in the center of the turn lane or at the downstream end) does not have a significant effect on crossing judgment performance.

321.Schroeder, B.J., N. M. Rouphail, and R. G. Hughes. "Toward Roundabout Accessibility—Exploring the Operational Impact of Pedestrian Signalization Options at Modern Roundabouts," *Journal of Transportation Engineering*. Volume 134, Issue 6, 2008. pp. 262-271.

This paper explores the use of pedestrian signalization options for crosswalks at one- and two-lane roundabouts to enable these facilities to be accessible to pedestrians with vision impairments. Motivated by uncertainties about the safety of roundabouts for blind pedestrians, audible pedestrian signals hold promise for safely regulating the interaction of vehicles and pedestrians at these facilities. However, the use of pedestrian signals at roundabouts is controversial because of the potential for queue spillback into the circulating lane and delays to vehicular traffic. The objective of this work is to quantify *pedestrian-induced* delays and queuing impacts of a pedestrian signal placed at the busiest approach of a modern roundabout. The analysis is performed using a calibrated microsimulation model and includes assessment of innovative solutions for crossing geometry and phasing scheme at one-lane and two-lane roundabouts. The results suggest that the impact of pedestrian signals at roundabouts is greatest as vehicle volumes approach capacity, but that vehicle delay and queuing can be mitigated through innovative signal configurations. The findings are important in light of recent discourse concerning the accessibility of roundabouts to pedestrians with vision impairments that may ultimately move towards a requirement for signalization for certain facility types.

Interchanges and Freeways

322. Brandenburg, S. "Balancing ADA Requirements, Alternative Modes, and Interchange Capacity," ITE 2004 Annual Meeting and Exhibit. Washington, D.C. Institute of Transportation Engineers, 2004.

This paper describes how traditional interchange designs have focused on maximizing vehicular capacity to deliver vehicles to the freeway efficiently while minimizing driver delays. Many of the design features of high capacity interchanges, such as uncontrolled two-lane entrances to freeway on-ramps, create undesirable crossings for pedestrians and bicyclists but are needed to accommodate high traffic volumes. With the focus of "smart growth" planning in the transportation industry, a greater emphasis is being placed on alternative modes of travel in our interchange designs. Alternative interchange designs need to be developed, researched, and implemented to better accommodate pedestrians and bicyclists. This paper discusses the disadvantages of current interchange designs for pedestrians and bicyclists and summarizes alternative designs that accommodate vehicles, pedestrians, and bicyclists while also complying with Americans with Disabilities Act (ADA) standards. The focus is a recent case study addressing alternative configurations for uncontrolled two-lane entrances to freeway on-ramps conducted for the Interstate 80 (I-80) and Douglas Boulevard interchange in Roseville, CA. Although uncontrolled two- lane entrances are needed to accommodate high vehicular volumes during peak travel times, these ramp entrances have safety issues regarding the visibility of pedestrians and bicyclists. The case study of the I-80/Douglas Boulevard interchange two-lane loop on-ramp used the VISSIM microscopic simulation software program to test various design alternatives. The simulations of the interchange alternatives allowed the decision makers at the City of Roseville and the California Department of Transportation (Caltrans) to visualize the interchange operations and the interaction between vehicles, pedestrians, and bicyclists traveling through the interchange. The analysis methodology and results are presented as part of the case study. The alternative interchange design was ultimately approved by Caltrans and is currently under construction.

323. Ferrara, T.C. "Statewide Safety Study of Bicycles and Pedestrians on Freeways, Expressways, Toll Bridges, and Tunnels" Report Number FHWA/CA/OR-01/20 San Jose, CA: Mineta Transportation Institute, San Jose State University, 2001.

Currently, 948 of the total 4,224 miles of freeway in California are open to bicycles. Often, bicyclists need access to freeways to reach their destinations. Current Caltrans policy states, "when a suitable alternative route does not exist, a freeway shoulder may be considered for bicycle travel." As a multimodal agency, Caltrans should make some modest efforts to accommodate bicycle travel on freeways in prudent circumstances.

The purpose of this study is to attempt to clarify some of the issues pertaining to bicycles on freeways. Specifically, the goal of this project is to "develop policy recommendations, guidelines, and policies for bicycle and pedestrian use of freeways, expressways, tunnels, and toll bridges in California."

324.Stanek, D. “Innovative Diamond Interchange Designs: How to Increase Capacity and Minimize Cost,” ITE District 6 Annual Meeting. Portland, OR Institute of Transportation Engineers, 2007.

Congestion at a freeway interchange is often a critical bottleneck for an arterial corridor. The most common design – the diamond interchange– has a limited capacity at the ramp terminal intersections, especially when the intersections are close together and the turning volumes are high. To address these problems, traffic engineers have developed the following innovative diamond interchange designs: the single-point interchange, roundabouts at the ramp terminal intersections, and the diverging diamond interchange. The single point interchange combines the two ramp terminal intersections for a standard diamond interchange into a single intersection that is located typically at the freeway overcrossing or undercrossing. Modern roundabouts with yield control reduce the need for left- turn storage at the ramp terminal intersections. The diverging diamond interchange provides a crossover for the local street through traffic so that both left and right turns onto the freeway on- ramps do not cross opposing through traffic. With these three designs, the interchange would nearly maintain its existing footprint so that the right-of-way impact is reduced compared to typical high volume configurations such as the partial cloverleaf interchange or interchanges with direct connector ramps.

This paper compares and contrasts the advantages and disadvantages of the three innovative diamond interchange designs according to traffic operations, traffic safety, and construction cost. Using a case study, the three innovative designs are applied to demonstrate these advantages and disadvantages.

325.Research in Progress: “Bicycle and Pedestrian Friendly Crossings at Freeway Interchanges,” Texas Department of Transportation.

Bicycle and pedestrian travels have played historic roles in transportation. Bicycling is widely associated with the energy efficiency, cost effectiveness, health benefits and environmental advantages. The reduction in motor vehicle trips creates additional capacity and reduces physical wear on roadways which both contribute to longer life and increased value of those assets. Bicyclists and pedestrians often have difficulty mixing with modern modes of transportation because travel behaviors of bicyclists and pedestrians are quite different with motorists. The goal of this research is to identify a design guideline to provide safe and efficient movement of bicycles and pedestrians crossing freeway interchanges. The research entails the following specific objectives: (1) Identify behaviors of bicyclists and pedestrians when crossing freeway interchanges; (2) Identify facilities that are suitable for bicycle and pedestrian crossings at freeway interchanges; (3) Develop systematic guidelines for bicycle and pedestrian crossings at interchanges. Through this research, travel behaviors of bicyclists and pedestrians crossing freeway interchanges will be carefully studied through field surveillance and synthesis of successful practices. The TSU Mobile Van with Autoscope cameras is an effective tool for monitoring and collecting on-site, real time traffic data at any location, and will be employed in field surveillance. Guidance on bicycle and pedestrian friendly crossings at freeway interchanges will be synthesized.

326. Research in Progress. Reynolds, J. and Mitman M. “Accommodating Cyclists at Interchange” . One of the greatest challenges in planning for all modes is at freeway on and off ramps. Varying speeds, weaving, and competition for driver attention combine to create barriers to bicycling and walking. In many communities, these barriers eliminate critical connections between neighborhoods, reducing transportation choices for residents. The ITE Bicycle and Pedestrian Council has taken on the challenge of assembling a set of recommended treatments at these choke points. In a series of workshops held at the ITE International Conference and the Transportation Research Board meeting, the Council received feedback from transportation professionals about the

specific design challenges and potential solutions. This presentation will review the recommendations from those workshops including a set of design principles and conceptual treatments for common on and off ramp

327. Kielian, J. “Context-Sensitive Design Resolves Interchange Problems,” Better Roads. Volume 75, Number 3, pp. 60-62, 64, 2005.

New York State Department of Transportation's (NYSDOT) Long Island Expressway (LIE) Capacity Improvement Project aims to improve the interchange between the LIE and Cross Island Parkway (CIP) in Queens, New York, and was the last link in the LIE capacity (high-occupancy vehicle lane) improvement. Planning of the LIE/CIP interchange had to take Alley Pond Park and residential areas nearby into consideration. Two existing loop ramps were replaced by direct connector ramps, making it safer and adding 12 acres of land to be reintegrated into the park. As part of the project, the Tulip Tree Trail was reconstructed in the park, as well as extensive re-landscaping which included two new ponds, new wetland vegetation, and reforestation with native species. The LIE improvement project reduced traffic volume on the LIE South Service Road, and since completion has seen smoother traffic on the LIE, and increased motorist and pedestrian safety.

CHAPTER 2: SURVEY RESULTS

This chapter summarizes responses from an Internet survey about the existing AASHTO Pedestrian Guide and how it might be improved. Four hundred ninety-eight individuals responded to the survey, which included a combination of multiple choice and open-ended questions. The multiple choice questions were designed to establish basic information about the respondents, including their profession, their level of experience with pedestrian projects, where they most often did their work, the frequency with which they used the AASHTO Pedestrian Guide, and their general attitudes toward its content. The open-ended questions were designed to elicit more specific information on practices to be avoided in pedestrian planning and what should be changed, added, or deleted from each section of the AASHTO Pedestrian Guide. The complete survey questionnaire is included in the Appendix.

This summary is structured much as the survey itself. The first section addresses responses to questions regarding profession, experience, and primary work location. The second section addresses responses to questions regarding Guide usage. The third section covers responses to questions about Guide content, including the overall strength and weakness of specific sections, changes that should be made, and new issues that should be addressed. (Only respondents who indicated they had used the Guide more at least twice in the last year were asked these questions, since it was assumed that answering them would require some familiarity with the Guide.) The fourth section addresses responses to a question on minimum clear width for sidewalks. The fifth section covers common practices to be avoided in pedestrian planning, design, and operation. Finally, the sixth section includes respondents' final comments and suggested changes.

2.1. PROFESSION, EXPERIENCE, AND PRIMARY WORK LOCATION

PROFESSION

The majority of respondents identified themselves as either engineers (44.8%) or planners (29.2%).

What is your primary profession?		
Answer Options	**Response Percent**	**Response Count**
Architect	0.2%	1
Landscape Architect	4.0%	20
Engineer	44.9%	224
Planner	29.1%	145
Advocate	8.0%	40
Professor	1.4%	7
Student	1.2%	6
Other (please specify)	11.2%	56

Those who chose "other" listed a number of responses, including:

- Accessibility Specialist
- ADA Coordinator
- ADA Specialist
- Architectural Design Drafter
- Bicycle and Pedestrian Coordinator
- Business Analyst
- City Council Member
- Computer Programmer
- Disability Management Counselor
- Environmental Psychologist

- Government Regulator
- Highway Technician
- NEPA Practitioner
- Non-traditional Highway Grant Administrator
- Pedestrian Specialist
- Program Manager
- Public Administrator
- Public health professional
- Public outreach consultant
- Researcher at HHS
- Safety consultant
- Safety Specialist
- SRTS Coordinator
- Student and walking advocacy non-profit board member
- Teacher
- Transportation Enhancement Coordinator
- Transportation planning intern
- Transportation Program Specialist
- Writer, author, advocate

Over half of all respondents worked for state departments of transportation, and 12.7% worked for city or county governments. No other work setting category exceeded 10% of respondents.

For what agency/company do you work? Or: What best describes your work setting?		
Answer Options	**Response Percent**	**Response Count**
Federal Agency	4.2%	21
State Department of Transportation	53.7%	268
Metropolitan Planning Organization	5.0%	25
City or County Government	12.8%	64
Private Consulting Firm	9.4%	47
University	3.4%	17
Non-Profit/ Advocacy Organization	7.6%	38
Other (please specify)	3.8%	19

Those who chose "other" listed a number of responses, including:

- non-motorized transportation pilot project
- provincial transportation agency
- Publishing company, for profit
- State Government
- Google
- Private industry
- Major container port
- Public Transit Agency

- Transit
- Dental office
- Regional Council of Government
- City advisory committee
- Independent Practitioner
- Provincial Department of Transportation
- City advisory Board member
- R&D
- self-employed
- public improvement district
- Non-profit research and education organization

EXPERIENCE

Most respondents (53.5%) had less than 10 years of experience on pedestrian projects, and 33.5% had less than 5 years of experience.

Please indicate your level of experience working on pedestrian projects:		
Answer Options	**Response Percent**	**Response Count**
0-5 years	33.5%	167
6-10 years	20.2%	101
11-15 years	12.6%	63
16-20 years	11.6%	58
21+ years	22.0%	110

Most respondents (74.7%) were also members of professional and/or advocacy groups that in some way addressed pedestrian issues. Many were members of multiple groups.

Of which organization(s) are you a member? (Check all that apply)		
Answer Options	**Response Percent**	**Response Count**
AASHTO Committee	19.2%	96
Institute of Transportation Engineers	18.0%	90
American Society of Civil Engineers	9.8%	49
American Society of Landscape Architects	3.0%	15
American Institute of Architects	0.8%	4
American Public Works Association	2.8%	14
Association of Pedestrian and Bicycle Professionals	20.8%	104
American Planning Association	17.2%	86
America Walks	4.2%	21
Rails to Trails Conservancy	7.4%	37
Local pedestrian advocacy group	23.0%	115
None	25.3%	126

PRIMARY WORK LOCATION

The vast majority of respondents (96.6%) worked primarily in the United States and its territories, although Canada, Italy, China, Syria, United Arab Emirates, and Afghanistan were also represented. The highest number of responses came from the two most populous states, California (11.9%) and New York (9.2%). However, less populous states, such as Maryland (5.4%), Oregon (5.0%), Virginia (4.2%), Washington (3.8%), and Delaware (2.9%), were also well represented. The only state not represented at all was Oklahoma.

In what state do you primarily do your work?		
Answer Options	**Response Percent**	**Response Count**
Alabama	1.0%	5
Alaska	0.2%	1
Arizona	0.6%	3
Arkansas	2.1%	10
California	11.9%	57
Colorado	1.5%	7
Connecticut	1.5%	7
Delaware	2.9%	14
District of Columbia	2.1%	10
Florida	2.5%	12
Georgia	0.6%	3
Guam	0.2%	1
Hawaii	0.8%	4
Idaho	0.8%	4
Illinois	2.1%	10

Indiana	1.0%	5
Iowa	1.0%	5
Kansas	0.6%	3
Kentucky	0.2%	1
Louisiana	1.0%	5
Maine	0.2%	1
Maryland	5.4%	26
Massachusetts	1.5%	7
Michigan	1.5%	7
Minnesota	2.5%	12
Mississippi	1.0%	5
Missouri	1.9%	9
Montana	1.0%	5
Nebraska	1.7%	8
Nevada	2.1%	10
New Hampshire	1.7%	8
New Jersey	2.1%	10
New Mexico	2.1%	10

New York	9.2%	44
North Carolina	1.0%	5
North Dakota	0.6%	3
Ohio	0.8%	4
Oklahoma	0.0%	0
Oregon	5.0%	24
Pennsylvania	2.9%	14
Puerto Rico	2.7%	13
Rhode Island	0.4%	2
South Carolina	0.8%	4
South Dakota	0.8%	4
Tennessee	0.4%	2
Texas	4.6%	22
Utah	1.0%	5
Vermont	1.3%	6
Virginia	4.2%	20
Washington	3.8%	18
West Virginia	1.3%	6

Wisconsin	1.0%	5
Wyoming	0.6%	3

2.2. GUIDE USAGE

Most respondents (71.3%) used the AASHTO Pedestrian Guide at least twice a year; however, a substantial percentage (28.8%) had used the Guide rarely or never.

How often do you use the AASHTO Pedestrian Guide?		
Answer Options	**Response Percent**	**Response Count**
Every day	2.1%	10
Once a week	5.6%	27
Once or twice a month	21.5%	104
A couple of times per year	42.2%	204
Rarely or never	28.6%	138

Respondents who reported their work setting as "state department of transportation" were most likely to use the Guide on a regular basis. Over eighty percent (80.6%) of state department of transportation employees used the Guide at least a couple of times per year.

Those who did not use the Guide offered a variety of reasons for not using it. The most common reason was: “I wasn’t aware the Guide existed” (31.0%).

Why don't you use the Guide on a regular basis? (Check all that apply)		
Answer Options	**Response Percent**	**Response Count**
I wasn't aware that the Guide existed.	31.0%	40
I don't have access to a copy of the Guide.	27.9%	36
The content of the Guide is not useful.	1.6%	2
I use other resources instead of the AASHTO Pedestrian Guide.	28.7%	37
I don't often work on pedestrian projects.	29.5%	38
Other (please specify)	14.7%	19

Those who chose “other” offered a variety of additional reasons for not using the Guide. Examples include:

- My role doesn't require the details that the manual provides
- The guide is expensive.
- We have our own code. AASHTO used as additional reference
- Just started work as a Transportation Program Specialist a week ago!
- Not relevant to my type of involvement in ped projects
- I usually work on bicycle projects

Those who used the Guide at least a couple of times a year were asked for what primary purpose they used the guide. The most common answers were design (40.9%), planning (24.2%), and plan review (19.0%).

For what primary purpose do you use the AASHTO Pedestrian Guide? (Check one)		
Answer Options	**Response Percent**	**Response Count**
Design	40.9%	139
Planning	24.1%	82
Plan Review	19.4%	66
Expert Witness	0.6%	2
Advocacy	8.8%	30
Other (please specify)	6.2%	21

Those who chose "other" identified a variety of other primary purposes. Examples include:

- Traffic Operations & Safety Studies
- Research
- Training others
- Reference
- ADA Coordination
- Questions regarding AASHTO vs. Government policy

Those who used the Guide rarely or never were asked to choose five planning and design topics they thought a pedestrian guide ought to include. The most popular planning topics were “site planning/design to accommodate pedestrian access” (65.2%), “pedestrian connections to transit” (56.3%), and “pedestrian level (or quality) of service” (56.3%)

Planning Topics		
Answer Options	**Response Percent**	**Response Count**
Pedestrian demand	49.1%	55
Prioritizing pedestrian projects	49.1%	55
Pedestrian level (or quality) of service	56.3%	63
Site planning/design to accommodate pedestrian access	65.2%	73
Pedestrian connections to transit	56.3%	63
Other planning topics (please specify)	17.0%	19

Those who selected “other planning topics” suggested the following:

- Shared facilities Planning (cyclists, boarders, wheelchairs)
- I'm answering this question under the assumption that it refers specifically to the AASHTO Pedestrian Design Guide, not a more generic "pedestrian guide", which should cover all of the planning topics listed.
- Implementation - i.e., methods to advance projects through construction.
- Accommodating pedestrians in old neighborhoods without sidewalks
- How to cost effectively accommodate peds while still moving traffic.
- Alternatives to sidewalks(walkways)particularly in rural towns
- Land use that makes cars unnecessary. In dense, walkable areas, cars are more of a liability than benefit, and walking or biking is quicker and more convenient.

- Reference to the AASHTO Guide Specs mentioned in last slide, for bridges located in State Right-of-Way
- Relationship of pedestrian facilities to bicycle facilities (shared vs. separate.)
- Analysis of the human factors involved in the choice to walk...e.g. slower speed traffic higher ped use
- Pedestrian requirements for Complete Streets
- role of urban design/open space network in generating pedestrian demand
- lighting of crosswalks and other structures at night
- Access for People with Disabilities
- Safety, Feeling Safe, Safe routes for children (to school, friends, community centers, etc.), continuity (enabling people to get useful places by walking)
- local street connectivity
- Pedestrian priority streets.
- How to safely incorporate pedestrian facilities into all roadway projects--there is a perception that people won't walk along busy roadways so sidewalks are not always provided with road construction projects. However, when not provided we find that instead of avoiding these roadways, pedestrians still travel along them, but do so in unsafe places like in the roadway or along drainage ditch.
- Accommodating pedestrians on rural roads

Respondents were also asked to select from a list of design and operation topics. The most popular of these were “geometric design of intersection to accommodate pedestrians” (67.3%), “sidewalk design” (65.5%), and “mid-block/uncontrolled intersection design to accommodate pedestrians” (58.4%).

Design / Operation topics		
Answer Options	**Response Percent**	**Response Count**
Sidewalk design	65.5%	74
Traffic calming/traffic management	46.9%	53
Geometric design of intersections to accommodate pedestrians	67.3%	76
Signal design to accommodate pedestrians	58.4%	66
Midblock/uncontrolled intersection design to accommodate pedestrians	55.8%	63
Design for universal access	33.6%	38
Maintenance of pedestrian traffic in work zones	41.6%	47
Maintenance of pedestrian facilities	38.9%	44
Other design/operation topics (please specify)	14.2%	16

Those who selected “other design/operation topics” suggested the Guide include these topics:

- Winter maintenance
- Design exceptions for allocation of highway sections for bikes and vehicles
- land uses compatible with pedestrian uses

- I'm answering this question under the assumption that it refers specifically to the AASHTO Pedestrian Design Guide, not a more generic "pedestrian guide", which should cover all of the design topics listed.
- connecting neighborhoods for pedestrian access
- Pre-fabricated ped bridges are cheaper, but....
- Minimum pedestrian accommodation required in various contexts: rural, suburban, urban, interchanges, etc.
- Shared space and the role of uncertainty as a safety device (self-reinforcing streets)
- Educating motorists on the need to respect peds (such as not stopping in crosswalks when waiting for a green light)
- Legal requirements for maintenance
- Accommodating pedestrian access around freeway interchanges; multi-use trail design
- Sidewalk cost estimation methods. Other than "sidewalk design", all above design topics should be in *other* manuals. This should not be ghettoized in the Pedestrian reference.
- Share space
- At grade crossings with high speeds
- Safety of peds at night for roads without sidewalks
- Traffic signal timing strategies to reduce speeds

2.3. GUIDE CONTENT

This section covers responses to questions regarding the content of the existing Guide and what ought to be added, deleted, or changed when the Guide is updated. Again, individuals who indicated they rarely or never used the Guide were not asked these questions, since it was assumed that familiarity with the Guide would be necessary to answer them.

Survey questions addressing the content of the existing Guide fell into two categories: 1) general questions about Guide content addressing new issues that should be included and changes that are needed and 2) specific questions about Guide content addressing the relative strength or weakness of specific sections and how they could be improved.

GENERAL QUESTIONS ON GUIDE CONTENT

Respondents were asked two general content questions:

1. What are the top NEW ISSUES in pedestrian planning, design or operation that the next edition of the AASHTO Pedestrian Guide should address?; and
2. What are the top three CHANGES that are needed to the current content of the Guide?

Respondents identified a number of new issues for inclusion in the next Guide in response to the first question. The largest number of responses centered on the issue of accessibility.

What are the top NEW ISSUES in pedestrian planning, design or operation that the next edition of the AASHTO Pedestrian Guide should address?	
Most Common Issue Areas	**Responses**
Accessibility, compliance with ADAAG and PROWAG	46
Complete Streets	15
Pedestrian accommodation on multi-use trails	13
New pedestrian signal technologies (e.g. the HAWK signal)	10
Pedestrian accommodation in roundabouts	8
Pedestrian accommodation for seniors	7
Shared streets	6
Demand forecasting/modeling	5
Pedestrian level of service	5
Midblock crossings	5

Pedestrian Accommodation in Work Zones	4
Public Health	4
Warrants for pedestrian facilities	4

A relatively large number of responses to the second question about what should be changed in the current edition of the Guide also centered on accessibility, suggesting improved or expanded treatment of the issue.

What are the top three CHANGES that are needed to the current content of the Guide?	
Most Common Issue Areas	**Responses**
Accessibility, compliance with ADAAG and PROWAG	16
Add index	5
Roundabouts	5
Sidewalk width	5
Warrants for pedestrian facilities	5
Maintenance of pedestrian facilities	3
Other “E’s”	3
Pedestrian signals	3
Ramps	3

Shoulders	3

SPECIFIC QUESTIONS ON GUIDE CONTENT

Respondents were asked specific questions on Guide content by chapter and section. For Chapter 1, respondents were asked to evaluate the overall sufficiency of the content and to provide suggestions for improvements. For the remaining chapters, respondents were asked to identify the weakest and the strongest sections and to consider whether specific content in each section ought to be changed, added, or deleted.

CHAPTER 1

Most respondents (79.1%) felt that the content of Chapter 1 was sufficient. The 20.9% of respondents who did not offered a number of comments about potential changes, including:

- Addition of Planning Regulations and Guidelines may be helpful.
- Needs to include the latest guidance for ADA design in the public right of way. Even though the guidelines are still draft, they are considered by FHWA to be the currently recommended best practices and the state of the practice for areas not currently addressed in the present ADAAG standards.
- Historical updates re: transportation bills
- Add explanation of and reference to PROWAG
- More detail on ADA requirements in the Public Right of Way
- Include updated references to selected guidance and include a reference to the ADAAG Public Rights-of-Way Accessibility Guidelines.
- Update to tie to sustainability and air quality
- A mention or discussion on the Civil Rights law (DOJ) and how the rights of people with disability are entitled to equal treatment. IE it is a law not just good practice.
-
- Page 2: Update TEA-21 reference.
- Page 5: Update as appropriate the referenced "draft" 2002 guidelines for the ADAAG.
- Almost every aspect of this chapter needs to be updated and expanded. FHWA has a "policy" on incorporating pedestrian facilities not just guidance. Complete streets should be defined and tied to pedestrian facilities and accessibility. This is the best chapter where arguments can be made to include pedestrian facilities. The rest of the guide really tells you how to plan and design them after a decision has been made to include them. The MUTCD

has included significant changes on pedestrian-related topics. ADA language, although a good summary here, needs to be updated.

- Emphasize the primacy of pedestrian circulation
- Reference could be added to include the Access Board's Public Right of Way Accessibility Guidelines (http://www.access-board.gov/prowac/draft.htm), which FHWA described as the state of the practice (http://www.fhwa.dot.gov/environment/bikeped/prwaa.htm) and the Access Board's special report on Planning and Design for Alterations (http://www.access-board.gov/prowac/alterations/guide.htm).
- There should be more narrative to emphasize the importance of walking as the baseline for community transportation and how it can be integrated with other modes. Also there should be something to introduce the need for data collection to support facility planning.
- Needs to be updated to address greater expectations and numbers (volumes) from vulnerable road users. Deal with greater types of small vehicles (for example: Segway)
- Re-write Section 1.3.5 to highlight subareas of the text and make them easier to find: For example "Transition Plan", "Public Right-of-Way Design Standards", etc.
- Update Reference and Resources to the AASHTO Green Book, MUTCD and the Access Boards Revised Draft Guidelines for Accessible Public Right of Way (PROWAG) dated November 23, 2005, which has been recommended by FHWA Memorandum dated January 23, 2006 as a Best Practice.
- References and Resources need to be updated for the AASHTO Green Book, MUTCD and Revised Draft Guidelines for Accessible Public Right of Way dated November 23, 2005.
- Sec 1.1 - FHWA Design Guidance regarding “exceptional circumstances” is misstated in a way that implies that there may be more than 3 conditions that would qualify as "exceptional circumstances". The FHWA guidance says, “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”. Recommend revising page 2, par 4, 1st sentence to read: “…walking facilities will be incorporated into all new or reconstruction transportation projects in all urbanized areas unless one or more of three conditions are met:”, and delete the next sentence.
- include reference to new AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets--2009; and--stress--that state laws and requirements MAY be more stringent than Federal guidelines and requirements. Ideally, Sect. 4.5 should include a list of state requirements and resources.

CHAPTER 2:

The section of Chapter 2 identified as strongest by the largest percentage of respondents was the “Characteristics of Pedestrians” section (25.9%). The section identified as weakest by the largest percentage of respondents was the “Other Programs to Increase Pedestrian Safety” section (32.5%).

Comments regarding potential changes to the “Pedestrian Activity in the America” section included:

- This section can be made much briefer; it should just establish the importance of walking as a mode of travel.
- Many people going to work in very congested cities prefer to use public transit and walk to and from the transit stops. I did not see any statement regarding them.
- Page 7, Section 2.1.1: Is more current data available than the referenced 1990 survey? Also for the percentage of walking and biking trips by children (dated 1995)?
- It would be nice to address statistics on walking and the decline in numbers (especially for key groups i.e. children). There should also be an emphasis that walking is more than just transportation, in terms of playing a role in addressing physical activity needs that can result in healthier communities.
- Need to address the latent demand for trips other than in cars and transit. Alternate very low speed modes of travel would likely increase rapidly if more and better facilities were provided. At the start of the previous century automobile users had to lobby hard to get accepted seriously by the various levels of governments (to speeds higher than 10 mph, to pave more roads, to build more & better intercity highways).
- At the beginning of the twenty-first century, the pendulum is swinging in the reverse direction. New technology is allowing light electric very low speed vehicles. Also vulnerable road users are demanding more attention and better facilities for those traveling at speeds between less than 15 mph.
- Include pedestrian activity in "non-America"--either w/photos and/or web links. These examples may be more beneficial than simply explaining what is done in the United States (is this "America"?) which is often non-exemplary. Inclusion of non-America would also broaden the appeal of this document to nations outside the United States which replicate the poor design of ped facilities used in "America" such as Canada, Australia and in many European suburbs.

Suggested changes to the “Characteristics of Pedestrians” section included (note – some of these are suggestive and unless supported be research or regulations they should be considered “brainstorming”):

- This should focus more on design issues. Walking speed, specific characteristics of those with disabilities as relates to design. I cannot imagine that anyone reads this text.
- How about pedestrians with temporary impairments due to alcohol, drug, etc.?
- 2.2.1 - walking speeds. What effect do temperature, rain, snow, and ice have on walking speeds? Do peds walk slower when it's cold or hot? or both? How much faster/slower? If it's enough, states with climates with extreme temperatures may want to investigate different standards than the national ones.
- Page 10, Section 2.2.1: Walking speed in the latest revision of the MUTCD at 3.5 ft./sec.
- wide range of disabilities and/or handicaps

- I would identify more about general users and needs, and introduce the concept of level of service as it relates to walking.
- Book should not be limited to pedestrians. There is a case to provide transportation facilities for mixed modes or semi-segregated modes where travel would be 15 mph or less.
- Exhibit 2-1 contains mostly negative, subjective pedestrian characteristic stereotypes. It should describe both abilities and limitations of pedestrians. Characteristics keyed to age should be presented as a continuum. People who are 66 years old have different characteristics than people who are 90.
- This section needs to include needs of all pedestrians (not just ambulatory peds) such as school children (K-2nd grade, 3rd-5th grad, middle school, high school, college), peds not familiar w/surroundings (visitors or non-English speaking residents), and peds to/from transit facilities such as bus stops.

Comments regarding potential changes to the “Pedestrian Planning Strategies” section included:

- This section could be revised to focus on the complete streets approach.
- A good addition could be a brief discussion on FHWA-recommended Pedestrian Safety Action Plan (PSAP). Also, how planning can lead to actual implementation is very critical to the success of any plan.
- More on transit interface, particularly accessibility to the transit stop for at least a quarter-mile radius and the need for arterial street crossing wherever there is a transit stop.
- Add a section that shows how pedestrian walking routes should be explicitly considered in community planning - walking distances or times and catchment areas for various land uses (employment, shopping, social services, schools) and how the layout of the streets or the provision of other pedestrian features (short-cuts, crossings, etc.) can shorten walking times or enlarge the catchment area
- Need to spend more time concerning planning for sidewalks and off road paths along existing motorist facilities and the effects of: not being able to acquire more right of way, not being able to divert ditches, not having the money to extend culverts resulting in moving the sidewalk closer to the travel way, right of way encroachments caused by handrails, etc.
- best design practices, when and where topics, proactive
- Their needs to be a subsection on "Pedestrian Dominant Corridors" that apply to CBD's, walking districts, some high density residential areas where pedestrian activity comprises the overwhelming majority of traffic movement within that corridor (it goes up to 95% of all surface/street level transportation trips in some CBD's). To quote the 1998 ITE Report Design & Safety of Ped Facilities, page 7: "The need exists to establish guidelines for highway design that would apply where pedestrians represent the primary mode of traffic." (note: this concept is reflected in the approach described as “Total Street Capacity on page 150).
- This section lacks a detailed account of how to develop a free-standing community-based pedestrian plan.

- This is very dry and a limited discussion of the basic need for planning, there need to be some examples of how pedestrian planning should integrate at all levels and disciplines (planning for land use, transit, utilities, schools, public services, to name just a few). There should be more emphasis on qualitative planning at the local level with public engagement/walking audits.
- The Transportation Engineer should be more aware of and be ready to plan & build facilities that will adaptable to potential demand from emerging technologies in light, very low speed vehicles which could mix with pedestrians and cyclists. All these modes could be grouped into one common group called vulnerable road user modes (compared to traditional modes such as cars, trucks, and transit vehicle which are much heavier and travel at 30 mph or higher speeds).
- "Urban" communities has a specific connotation and users of the guide need to understand how this applies to suburban environments which often pose the greatest challenges.
  2.3.4 refers to roadways changing from open ditches to C&G as an opportunity to add sidewalks. However, Low Impact Development utilizes swales and engineered soils and C&G often is automatically added to sidewalk projects, greatly adding to the cost (along with appurtenant structures, drainage, etc). More discussion of sidewalks without C&G needs to be included.
  This section also notes the requirement to add curb ramps during resurfacing projects, however it is not clear how this applies when sidewalks don't exist or in areas where sidewalks are not needed (rural areas for example). More detail is needed since ADA creates many misunderstandings.
- Section 2.3: Recommend expanding discussion of the importance of walkway connectivity and the exponential effect that filling sidewalk gaps can have on pedestrian mobility and levels of pedestrian trips.

Comments regarding potential changes to the “Pedestrian-Friendly Site Development” section included:

- I am not sure, but it might be a good idea to add a discussion on Context Sensitive Solutions here.
- Curb extension graphic is poor quality - the graphic can be better (not as dark and faded)
- Reference some of the contemporary practices including placemaking and reclaiming underutilized street right of way such as is taking place in NYC.
- Same comments as previous sections: Expand to all modes that travel at less than 15 mph.
- Ordinances need to address connectivity to adjacent development and land uses, as well as major barriers such as arterials that often fragment the pedestrian environment. Too often the site development is just that, limited to the site itself and not looking beyond the boundaries of the development.
  Retrofit policies should also be included to ensure that rural or low-density suburban areas that become increasingly urban are retrofitted to ensure connectivity and safety for pedestrian mobility. Context sensitive solutions also need to be employed and applied to

roadway operations so that the roads (often arterials) are functioning appropriately for the urbanized environment. Too often they become dangerous high volume and high speed barriers (when not choked with congestion) to pedestrians in an otherwise urbanized environment.

- Recommend including examples of "good" pedestrian wayfinding signs and bus stop design (adequate clearances for peds and transit vehicles).

Comments regarding potential changes to the “School Site Planning and Design” section included:

- Eliminate this and refer readers to Safe Routes to Schools references. There is nothing "meaty" in here that warrants inclusion.
- Any scope of touching on other Es under Planning?
  Traffic control - Phoenix has a unique 15 mph portable rollout sign used during school sessions with/without enforcement.
- Page 31, Section 2.5: With the passage of SAFETEA-LU and Safe Routes to School programs, there may be more current information relating to this topic.
- Needs to have drop-off/pick-up addressed specifically, since drop-off/pick-up by parent drivers is the single greatest hazard that students walking face. There is info at http://www.saferoutesinfo.org/guide/dropoff_pickup/index.cfm. Walking school buses should also be mentioned, and there is a separate document available, at http://www.saferoutesinfo.org/guide/walking_school_bus/index.cfm.
  I would suggest that pedestrians should receive priority over other modes immediately around schools, because: schools are an attractor of use, students are more vulnerable than many other pedestrians, drop-off/pick-up traffic makes school areas less safe than other areas, and students have a right to walk to school.
- There should be consideration of a companion guide that addresses the broader big-picture issues with school location decisions, land use and bussing. Could partner with Safe Routes to develop larger guidance for local officials to address more than simple treatments and geometrics.
- Same comments as previous sections: Expand to all modes that travel at less than 15 mph (skateboarders, in-line skaters, scooters?)
- Sect. 2.5.5 (SRTS) should include additional examples and/or links to successful programs or resources.
- Section 2.5 - School site planning and design -- not robust enough.

Comments regarding potential changes to the “Neighborhood Traffic Management and Traffic Calming” section included:

- Eliminate this and refer readers to Traffic Calming resources. Keep in this document only the information that is specific to pedestrians - raised crosswalks, median refuge
- Can you produce better quality drawings on Exhibit 2-9?

- In section 2.6, page 38, it is stated that traffic calming devices such as curb extensions are not applied to arterial streets, but EXHIBIT 2-14 shows a street with a traffic volume of an arterial or at least collector. If a curb extension is built on the shown street, there will be no continuous clearance for a bicyclist. Page 39 states that traffic calming techniques should not be hazardous to bicyclists, but in practice they do reduce cyclist maneuvering room. It is claimed that curb extensions can slow down traffic, but a curb extension which still allows the cyclist and car to travel side-by-side would not be seen by a car driver as enough of a hazard to get the car to reduce speed.
- There should be more detailed coverage of collector and arterial roundabouts, as these are becoming more and more common, with a clear distinction between these and neighborhood roundabouts. Roundabouts, though they apparently always increase vehicle safety, can increase or decrease pedestrian safety, depending on the details of design, and so should be addressed in more detail.
- This is a good section, should continue to expand the tool box with new treatments. May be useful to address roundabouts and ADA issues as there seems to be a great deal controversy to consider.
- Same comments as previous sections: Expand to all modes that travel at less than 15 mph (skateboarders, in-line skaters, scooters?)
- The crash survivability table needs to be included (from page 50) and needs to be more prominent. This should be an attention-grabbing image that conveys the importance of speed management in areas frequented by pedestrians.
  The Guide should also provide at least a little more guidance on considerations for various traffic calming measures, as well as speaking to the importance of balancing safety with the overwhelming emphasis on throughput.
- Section 2.6, first paragraph, last sentence states that the techniques discussed are applicable for residential neighborhoods and urban areas but generally not for arterial streets. This statement may not fully reflect that some of the techniques discussed in 2.6 (roundabouts, gateway treatments, curb extensions, and street narrowing) are used on arterials and in nonresidential areas, and could discourage the reader from considering them on arterials and in nonresidential settings. 2.6 should identify which techniques are appropriate for various street classifications/land use contexts. Road diets should be included and cross referenced to the road diet discussion later in the Guide.
- More examples of traffic calming needed.

Comments regarding potential changes to the “Other Programs to Increase Pedestrian Safety” section included:

- This should be in the intro section - introduce the 4 'E's" and then indicate that this document focuses upon Engineering.
- I think you should expand education and enforcement programs with some useful guidance.
- This obviously needs to be updated with so much happening recently in the field.

- This section is weak. There need to be specific examples of education programs directed at various audiences, including children (beyond that in the school section), elderly, drivers and bicyclists.
- Should include programs and designs that encourage other modes than cars.
- This section does not have much content. Additional examples and/or links to successful programs or resources.

Respondents made the following comments on potential additional content for Chapter 2:

- Highway Capacity Manual has section on pedestrian platooning. Would be interesting to consider discussion in this document.
- Impacts of hybrid cars to visually impaired pedestrians.
  Access/impacts for visually impaired pedestrians at roundabouts.
- The greatest pedestrian need in America today is to connect the population centers with jobs and shopping at the commercial fringes of our towns and cities, where often there is no continuous sidewalk at all. Every dollar spent on expensive curb extension and other such projects detracts from this goal. We have serious budget problems and AASHTO should not highlight expensive construction of dubious benefit such as curb extensions.
- More emphasis on connectivity and the need to fill gaps with simple solutions. Perhaps introduce some connectivity analysis tools.
- What does the future hold? What are the trends?
- ITE's Traffic Calming: State of the Practice (1999) and the FHWA-published PEDSAFE should be listed in 2.8. FHWA's "PEDSAFE" publication and the workshop materials for "Planning and Designing for Pedestrian Safety" (created by UNC Traffic Safety Center for FHWA) should be consulted for revisions to this chapter.

CHAPTER 3:

The section of Chapter 3 identified as strongest by the largest percentage of respondents was the "Sidewalk Design" section (50%). The section identified as weakest by the largest percentage of respondents was "Midblock Crossings" section (25%).

Comments regarding potential changes to the "Designing Roadways to Accommodate Pedestrians" section included:

- On page 49, attributes should include "Visibility". Poor pedestrian visibility at night is the root cause of many nighttime fatalities in the nation.
- More on speed management, and in Exhibit 3-1 the 20 mph bar should go to 5% (not 15%).
- Page 50, Section 3.1.1: Updated information for the NCHRP project 3-72.

- Detailed discussion on the types of constraints planner and designers have to contend with when identifying road segments for pedestrian facilities
- Update and incorporate some of the current model design practices including CSS design for urban thoroughfares. Consider some example cross sections that address the concept of Complete Streets.
- A complete streets policy should be the norm, with only rare exceptions.
- Shelters weather for vulnerable road users such as covered sidewalks.

Comments regarding potential changes to the “Sidewalk Design” section included:

- Too difficult to get the info that you really want - where are sidewalks recommended and how wide should they be. Putting the information in tabular form would be good. I especially like Figure 3-4 in the ITE Recommended Practice, Design and Safety of Pedestrian Facilities (March 1998).
- Can you produce a better sketch on Exhibit 3-9?
- Change ADAAG references to PROWAG, and make appropriate corrections, such as running grade can now match the adjacent street grade. Surface treatments should be revised to reflect current smoothness requirements (no more stamped concrete). References to shared use paths should reflect latest AASHTO Bike Guide.
- Page 54, Section 3.2: Is the referenced 1996 study the most current?
- Passing Zones: FHWA has guidance in the Designing Sidewalks and Trails for Accessibility that provides information about how often (every 200 feet or less) and size (60"x60") that should either be adopted or other guidelines should be determined by AASHTO.
  Sidewalk vs. Off Road Path: The distinction between sidewalk and off road path is not as pronounced when a determination is made that the off road path is a side path. Most of the Transportation Enhancements that we have are "sidewalks" next to a facility with no curb. In our division, we have determined that a sidewalk is behind a curb and an off road path (side path) is not behind the curb.
  Curbed vs. Non-curbed facility: Most of the sidewalk design is focused on curbed facilities. As mentioned, we use the off road and shared use path design guidelines when there is no curb. A 5' distance from the edge of the pavement is given as the minimum distance. However, this does not take into account the speed of the motorist facility. More information is needed on how to design for a non-curbed facility with speed taken into account especially when a sidepath is being considered.
- Need to add something about when fencing/barrier is needed next to the back of a sidewalk adjacent to a slope. Guidance on acceptable fence design is needed.
  Driveway design should be expanded to make sure that the preferred design is to carry the concrete sidewalk material through driveways rather than stop it at the driveway edge. Also, need to clarify that crosswalks do not need to be marked every time a sidestreet is crossed.

- The buffer area suggested on page 49 is too wide. Wide buffers make it difficult to complete a crossing from one side of the street's sidewalk to the other, or to transition from a parked car to the sidewalk if the buffer is wet/muddy/snow-filled. Wide buffers add to project cost. Wide buffers between sidewalk and roadway would in many cases be better used to construct a wide shoulder on the roadway for bicyclists to have clearance alongside the motorists.
  Also, the current guide recommends wider than 5 feet clearance on arterials, but in suburban/fringe commercial areas 5 feet is enough, and wider than 5 feet gives the sidewalk the "empty" feel decried in another spot in the manual. We do need sidewalks but 5 feet enough to recommend everywhere, including arterials and bridges. Local planners of course can recognize where more is needed (some downtowns) but the recommendation of more than 5 on bridges and arterials adds to cost.
- It would be advantageous to incorporate the recommendations of the NCHRP study of the geometric design of driveways into the discussion of how sidewalks through driveways should best be done.
- Increase sidewalk width to 5', the current standard of 4' is not big enough for pedestrians with children or strollers or two adults walking that want to talk to each other.
- Emphasize the Pedestrian Accessible Route as a direct smooth path with minimum clearance of at least 6' in commercial districts. Again bare minimum sidewalk width should be 5' with 6' as recommended practice. 4' does not encourage walking or create a sense of comfort and safety for pedestrians.
- Covered sidewalks to shelter pedestrians from weather.
- Curb ramp design seems to be a major source of problems, both in terms of appropriate ramps, and issues such as level landings.
- 3.2.2, Rural Roadways, par 2, first sentence, change "pedestrian access route" to "pedestrian path" and "must" to "should." A pedestrian “access route” must meet ADAAG, but that’s not possible if it’s shared with a stopped or disabled vehicle. This is consistent with AASHTO Green Book.
  3.2.3, First sentence states, “The minimum clear width for a sidewalk is 1.2 m [4 ft], not including any attached curb, and all sidewalks must be constructed with at least this clear width.” This sentence is inconsistent with Section 2.2.2, which notes that 2 people walking side by side or passing one another require 4.67 ft of space; does not state that 4’ is an ADAAG minimum, not the width needed for ped safety and mobility; and doesn’t reflect US DOT, FHWA, ITE, AASHTO Green Book and HCM guidance. Recommend revising Section 3.2.3 and other sections (incl 3.2.8) to identify ADAAG minimum and revise guidance to reflect nationally recognized guidance.
  3.2.3.1st par, 2nd sentence & p 63, section 3.2.9, par 2, add that a passing space of 5’ X 5’ must be at intervals of no more than 200 ft, per ADAAG and the Draft Guidelines for Accessible Public Rights of Way (DGPROW).
  3.2.4 Using “desirable” and “should” in the same sentences muddles the meaning of the

guidance. Use one or the other, but not both.
The presence of fences, bushes or other lateral obstructions reduces the usable clear width. The recommended minimum clear width should be increased by 1' next to any continuous lateral obstruction to account for shy distance. Example: Min clear width with no lateral obstructions should be 5' but with fences, railings or bushes on both sides needs to be 7'.

- Are there any more recent studies?
  Need to update language, references, data and requirements for ADA needs.
  Provide results where experiments/studies/research are mentioned
- p.54 Adequate Width says 2 people should be able to pass another person comfortably. Based on the Spatial Needs section 2.2.2 on p. 11, adequate width would require 7.5 to 8 feet of width. This "standard" is never referenced again nor tied to any of the minimum sidewalk widths in section 3.2.3. The "adequate width" reasoning should be used to set a minimum clear width of 8 feet for downtown commercial streets. p. 58 Sidewalk width standards are presented as referring to minimum clear widths yet some of the language seems fuzzy and unclear as to whether it really means just the clear width or the total sidewalk width. In particular, the last sentence of the second paragraph in section 3.2.3 should specify clear width, rather than just sidewalk width. p. 59 Exhibit 3-6 is not drawn to scale. If the indicated shy distance is 2 feet, then the 3 people on the sidewalk are squeezed in a width of approximately 4' 6". That is highly unlikely, according to the Spatial Needs standard that 2 people need 4.67 feet to pass one another. And indeed it just looks wrong. Three people would not typically crowd over onto the parking meter while leaving a full 2 feet from the wall. P.59 the need for cafes, vendors, and newsstands to provide extra space on sidewalks for customers and waitstaff as well as the sidewalk furniture itself should be separated from shy distance.
- Sec 3.2.5 and/or 3.2.13. Should make reference to (1) new AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets, 2009; (2) sidewalk clearance space required for ADA lifts on buses and/or LRT vehicles with DIFFERENT lift locations (not all lifts are on the front door), and (3) internal bike racks which also require approx. 9-ft of sidewalk space that is free of any sidewalk obstructions.
  Sec 3.2.9. Should include guidelines for height of ped barriers.
  This section should also include guidelines (or resources which discuss) recreational trails.

Comments regarding potential changes to the "Intersection Design" section included:

- Good. Also, more guidance regarding curb ramp design - innovative ways to design curb ramps that put the pedestrian in line with the crosswalk, even in tight right of way situations. This is a big struggle for engineers.
- Roundabout discussion should be fleshed out, updated.
- Any advanced tools, e.g. lighted crosswalk?
- Strengthen the guidance at expressway ramps to further discourage free-flow ramps in any urban setting. Update roundabout discussion to include most recent findings on multi-lane

roundabouts, particularly for the visually impaired. Again refer to PROWAG instead of ADAAG, and eliminate Diagonal Ramp as an approved disabled ramp alternative.

- Add a section on pedestrian accommodation through interchanges
- The section on Roundabouts needs to be expanded and updated.
  The section on Midblock Crossing has a graphic (3-35) that needs updating. A recent FHWA course suggests that staggering the crossing island so that the pedestrian is facing the oncoming traffic is better for both the pedestrian and the driver. Also these islands need to have Detectable Warnings included in their design.
- More guidance on when to use what features, give ADT and speed related guidance.
- Pages 76, 78, 79: Update referenced NCHRP projects.
- Add some of the information from Charlie Zegeer's study of midblock crosswalks, especially what additional treatments are needed for differing traffic volume, speed and roadway cross section elements e.g. lighting, ped refuges, etc.
- The techniques that are needed when designers are confronted with the approach roadways coming in at significant grades. How much of the intersection is it reasonable to mandate 'must stay flat' for accessibility and other minimally adequate pedestrian accommodation?
- Information on how to handle an intersection that is not at right angles.
- Continue to expand consistent with new tools available, keep emphasis on shortest crossing distance and geometric tools to accomplish this.
- Channelized right-turn slip lanes deserves a much more in-depth treatment. The "old" design with a radius turn encourages drivers to take the turn at maximum speed and directs their attention onto traffic and away from pedestrians. In my town, nearly all of the intersection pedestrian crashes are related to these turn lanes. As such, I think it is important to acknowledge that the "old" design may need to be changed even if no other change is happening. In other words, correction of these hazards should not await roadway reconstruction. The "new" design with a slight angle, that is both signed and designed for vehicles to yield to other traffic and to pedestrians (and bicycles) should be diagrammed, with explicit text about why these are safer than the old design.
- Section 3.3.2 Curb Extension Design
  Recommend changing existing bullets to read:
  • Reduce the crossing time and distance for pedestrians
  • Improve sight lines between pedestrians and motorists
  • Prevent parked cars from blocking sight lines between motorist and pedestrians and encroaching into pedestrian paths
  Recommend adding the following bullets:
  • Curb Extensions can be used to mitigate increased crosswalk distances caused by large curb radius. This will require the crosswalk to be moved back away from the intersection.
  • The shoulder width at a curb extension should be consistent with adjacent curb extensions.

• Driveways should not be located within a curb extension.
• When curb extensions are added, drainage inlets at the beginning and end of the curb extension are necessary because the flow line around the curb extension will be higher than the original gutter flow line. This is due to the crown of the roadway.
• For maximum visibility, the min length of a curb extension should be 20 ft between the centerline of the curb returns.
Sec 3.3.5, p.85, part 1, last sentence (& Exhibit 3-28), recommend changing "2 ft wide" (detectible warnings) to "minimum 2 ft depth." This is the current design per FHWA and consistent with DGPROW.

Comments regarding potential changes to the "Midblock Crossings" section included:

- FHWA has issued interim approval for rapid rectangular flashing beacons; these would be worth discussing.
- Newer developments, such as, two-stage crosswalk, hybrid pedestrian crossing beacon (commonly known as HAWK) can be added (provided these types of experimental measures are MUTCD-compliant prior to publication of this Guide).
- Much more on unsignalized ped crossings (both midblock and intersections), particularly as they relate to bus stops. The new uses of actuated ped beacons (HAWK and stutter-flash LEDs) either goes here or under operations, but it all needs to be tied together somehow.
- More discussion, ADT, speed, etc.
- Page 91, section 3.4.1: Update MUTCD referenced walking speed.
- Beware of advocating narrowing the road width that we do not squeeze bicyclists and motorists into the same lane.
- Broader need to update with effective tools and treatments. There should be an emphasis on the need to create crossing opportunities, so many practitioners see that a crosswalk alone is not sufficient and decide to discourage crossing instead of seeking more appropriate tools or changes to the roadway to accommodate pedestrians. The new HAWK signal and median treatments provide a great toolbox and should be more widely utilized.
- Should include (1) minima dimensions for medians and (2) "Z" mid-block crossings requiring peds to face on-coming traffic.

Comments regarding potential changes to the "Grade-Separated Crossings" section included:

- A discussion on most likely scenarios (with photos) where grade-separation would be cost-beneficial might be a good idea.
- Emphasize the cost and unsuitability of most grade-separated crossings, particularly when at-grade signalized (signal or beacon) options could work better and cheaper.
- The use of ped overpasses should be discouraged when the length of the ramps are excessive. Some formula for consideration of excessive should be given consideration. There are many pedestrian overpasses in the country which are not use because of the length of

the ramps. This is a waste of money. Is a facility which costs 1 million dollars to build but no one uses better than a facility that costs 3 million dollars that is extensively used by pedestrians?

- Emphasis should always be on the convenience of crossing and thus grade separation considered in context with all options given the expense and potential for inconvenience to the pedestrian.
- We need a strong statement that all bridges must meet ADA-ABA requirements.
- Sec 3.5.2 should identify the meaning of "moderate-to-high" pedestrian demand. Numeric examples would be beneficial in various locations (e.g. Manhattan or a Sports Arena--w/very high ped volumes vs. suburban Reno, NV with virtually non-existent ped volumes).

Respondents made the following comments when asked about potential new content for Chapter 3:

- Please keep section on rural facilities - this has been useful to us.
  Good visual graphics. However in some cases the parameters exceed the PROWAG guidance. Would be good to be consistent.
- Discuss the importance of pedestrian access routes (PAR) with regards to sidewalks.
- Handrails: Handrails are only mentioned when considering ADA requirements for running slope. However, handrails are not mentioned concerning cross sections which cannot accommodate a 5' distance between the edge of the sidewalk and a slope greater than three to one. Actually, nothing is mentioned about what to do if you cannot get the 5' distance.
- Eliminate the bridge barrier requirements on page 63. Barriers make it difficult to cross the street, to transition from parked car to sidewalk, and they add to project costs. We even see in Pennsylvania guard rails which meet the barrier and therefore cut off the sidewalk! So people climb with difficulty over the barrier or cross the bridge in the street!
  On any road where traffic goes less than 50 mph, a vertical curb should be enough to mark the end of the roadway. Curb and sidewalk would be a benefit to expand pedestrian connections instead of the guard rails used in Pennsylvania on hilly areas.
- Pedestrian and ADA compliant facility design features that expedite mass evacuation on foot should "at least" be mentioned, and sources referenced for further info.
- Discussion of the merits of providing barrier medians where non-intersection pedestrian crossing movements are a problem.
- It would be nice to see guidance on conversion of streets and rights of way to pedestrian plazas or even temporary public uses "Sunday streets". Many communities have so much roadway that is under-utilized by automobile travel, they should be encouraged to get the most out of the public resource and need assistance designing for this.
- All bridges are essential links that must include provisions for pedestrians.
- Section on lighting is deceptively short on material. To encourage very low speed modes (such as pedestrians but also other modes such as in-line skaters, segway users, skateboarders and so on...) of travel, more lighting should be provided than only at certain

spots such as intersections and mid-block crossings. For sidewalks that are used by very high pedestrian volumes, large curb extensions are needed to accommodate pedestrians waiting for the traffic signal to change.

- The content in Chapter 3 is well organized and understandable. However, references and resources need to be updated.
- The content in chapter 3 is understandable and easy to follow. However, references and resources need to be updated.

CHAPTER 4:

The section of Chapter 4 identified as strongest by the largest percentage of respondents was the "Pedestrian Signals" section (52.2%). The section identified as weakest by the largest percentage of respondents was "Maintenance of Pedestrian Traffic in Construction Zones" section (38.6%).

Comments regarding potential changes to the "Pedestrian Signals" section included:

- Needs to include more information on APS, particularly the need the new PROWAG guidance relative to APS and newest versions of APS available. Should include some discussion of the challenges for the visually impaired posed by modern signals with ever changing phasing and timing. Should discuss innovative ped signal treatments, especially the HAWK. Stress the points made about the safety comparisons of exclusive ped signals and concurrent ped signals. Our state (CT) suffers from a proliferation of exclusive signals.
- There is room for adding newer developments, such as, HAWK. Follow-up with the upcoming version of MUTCD.
- Needs to be brought up-to-date with the new MUTCD, including new ped signal walking speed calculations and the across-the-board requirement for countdown clocks. New ped signal warrants in the MUTCD and include the new HAWK signal warrants.
- What is all inclusive for all signalization for pedestrians, when and where. This should not be a guess.
- On page 105 it states that many "do not understand meaning" of "Don't walk" --more likely local people realize that unless you get to the intersection early and push the button, you won't get a signal, but you can cross anyway on a "Don't walk" if you are going with the side street green. In general, it's better to have side street signaling timed to allow a pedestrian to cross, rather than rely on button-pressing which many don't come early enough to the intersection to do.
- Include the anticipated MUTCD pedestrian signal timing revision (from 4.0 to 3.5 feet/second), and countdown signals which have become universally adopted. Include HAWK signals and other pedestrian signal innovations that has or are being mainstreamed since the early 2000's.
- Update to current Federal standards pertaining to pedestrian signals

- Need more information regarding pedestrian detectors--both conventional push buttons and newer technology bona-fide detecting detectors. The geometry of making the push button accessible and convenient should be expanded upon in somewhat greater detail.
- Include all types of available signals current available.
- Great stuff already here, let's get into the HAWK and other controls that are state of practice.
- I would recommend that the Pedestrian Countdown Clock become the preferred standard Signal, rather than an Innovative Signal Option mentioned on page 106. It communicates to the Pedestrian the amount of time remaining to cross the intersection much better than the Walking Person and the Upraised Hand Signal.
- Existing document should include new material to be included in the next edition of MUTCD.

Comments regarding potential changes to the "Pedestrian-Related Signing" section included:

- Follow-up with the upcoming version of MUTCD.
- Include FYG sign color for school and some ped signing.
- Include signing revisions since the early 2000's - including in-road (pedestrian) signing - which was totally omitted from the current version of the AASHTO pedestrian guide.
- Update (in 2010) to current FHWA MUTCD signing standards
- Guide signing that serves only/chiefly pedestrians needs to be discussed in greater detail, in particular means of making it more accessible to those with vision impairments.
- Emphasize placement and appropriate use of signage, also address context of signage and paint and other treatments. There could be a great deal more developed about wayfinding and pedestrian-appropriate signage (size and placement).
- Short on pedestrian directional signs.
- This section may need to be updated based on the revised MUTCD.
- Existing document is merely limited to ped signs in the MUTCD. Next edition should be expanded to include "design criteria" for ped-based signs--in particular wayfinding signs. These criteria may include the appropriate: use of contrasting colors, use of placement and design of arrows, correct size based on distance to be read by peds, should not be seen by or conflict w/signs intended for motorists, optional use of Braille, ID state guidelines may be more restrictive than federal guidelines.

Comments regarding potential changes to the "Sidewalk Maintenance" section included:

- Follow-up with the upcoming version of MUTCD.
- Page 116, Section 4.3.1: Second paragraph; Adjacent property owners; (change semi-colon to comma).
  Page 117, Section 4.3.2: Change the word "regarding" to "regrading".
- Accountability, who owns, who is responsible.

- An extensive amount of additional guidance from the local, state and federal levels since the early 2000's.
- Is there an annual budget amount per mile of sidewalk that would aid governments in calculating what they need to set aside?
- Examples of successful maintenance programs
- It would be nice to see a section about creative strategies for achieving maintenance, so many communities struggle with how to fund this.

Comments regarding potential changes to the “Maintenance of Pedestrian Traffic in Construction Work Zones” section included:

- A couple of images from MUTCD would be nice.
- Check out Chapter 6 of the MUTCD for latest on ped provisions in works zones. Strengthen the guidance to avoid having peds cross the street for a sidewalk blockage; prefer eliminating a parking lane or even one lane of moving traffic.
- In referencing the MUTCD, perhaps add diagrams that show typical sidewalk detours for common situations, or case studies
- This section needs to be more comprehensive.
- More detail is needed, especially on design details to maintain an accessible route through a work zone, including detour signs, detectable channelization and guidance on audible information.
- Training and accountability to construction workers.
- An extensive amount of additional guidance from the local, state and federal levels since the early 2000's. A big issue in NYS is how to address pedestrian oriented work zone measure in locations without sidewalks and/or shoulders (some of which may still have significant pedestrian activity).
- Update to current ADA requirements
- This is one of the biggest areas for potential improvement. Provide suggested policies for tolerable length of time to block a sidewalk before a detour is required. Common sense rules like don't block the walkway on one side of a street if the other side is already closed.
- Details on how to handle pedestrians in construction work zones, maybe the standards or where to look for standards in all States.
- This should be greatly expanded and possibly include a companion/field guide for this issue. There is very little compliance with appropriate maintenance of ped facilities, particularly from an ADA standpoint.
- I would recommend mentioning the (FHWA) Final Rule on Work Zone Safety and Mobility, 23 CFR 630 Subpart J. This rule, referred to as Work Zone Safety and Mobility, applies to State and local governments that receive Federal-aid highway funding.
- We would like to see illustrations for do's and don'ts for the situations described in the guide.

- Need more detail for maintenance of pedestrian traffic in work zones. Recommend deleting “Construction” from title of 4.4, since it applies to both construction and maintenance work zones.   Please provide figures and photos of work zone provisions for typical and more challenging situations.

Respondents made the following comments when asked about potential new content for Chapter 4:

- Good information on timing signals and accommodating pedestrians in work zones. Would be good to mention newly developed devices that can be used in work zones. Would be good to include some pictures of these devices and the latest in good examples.
- I'd like to see one of the pedestrian characteristics noted earlier in the guide addressed with a specific recommendation here. It is stated that walking speeds decrease with age. I'm wondering about the warrants for a pedestrian signal and/or timing guidelines for census tracts or blocks with a certain percentage of people over the age of 65 or some sort of threshold. Or the presence of a senior housing complex. Why make special treatments only for school crossings? Just a thought.
- Pedestrian oriented operational measures during a sudden catastrophic event (such as walk out zones, pick-up points, holding areas, temporary use of highway ramps, clearing debris from major crossings, pedestrian use of contraflow facilities, etc. should "at least" be mentioned, and sources referenced.
- Suggest a note to utilize new development or change in land use to require that old-style driveways be replaced with new as a part of the requirements of development.
- Need throughout the entire guide a better reference library to create a 'one stop shop' for busy planners and designers to know where to get the latest state level information.

2.4. MINIMUM CLEAR WIDTH OF SIDEWALKS

The Guide currently recommends 4’ minimum clear width for sidewalks, with 5’ passing spaces at regular intervals so that two wheelchairs can pass one another. Respondents were asked whether they felt it provided adequate minimum clear width for sidewalks. In general, opinion was evenly split on the issue of whether four feet is an adequate clear width for sidewalks, with slightly more respondents indicating that four feet is inadequate (107 versus 97 respondents). Among those respondents with more than ten years of experience in pedestrian design, the differences were greater: 61 respondents indicated that a 4’ width is inadequate, while only 37 respondents said it is sufficient.

In Chapter 3 (p.58), the Guide recommends 4' minimum clear width for sidewalks, with 5' passing spaces at regular intervals so that two wheelchairs can pass one another. Do you feel this is an adequate minimum clear width for sidewalks?

Answer Options	Response Percent	Response Count
Yes	40.8%	97
No	45.0%	107
I don't know	14.3%	34

Those who disagreed with the existing guidance were asked what the minimum clear width should be. Five feet was the most common response overall. However, those with more than ten years of experience in pedestrian design were somewhat more likely than those with less experience to favor a 6’ minimum, with 38.8% favoring this option compared to 33.3% overall.

What should the minimum clear width of a sidewalk be?		
Answer Options	**Response Percent**	**Response Count**
3'	0.0%	0
5'	52.0%	53
6'	33.3%	34
Other (please specify)	14.7%	15

Most of those who selected “other” either suggested widths greater than 6’ or that sidewalk minimums be context-sensitive (e.g. wider in central business districts than in suburban residential areas). Here are some sample comments:

- 5' outside of commercial zones; 6' in commercial zones
- 2 meters
- 10'-12'
- Wide enough for peds & bicyclists to meet & pass
- 5' minimum with 6' recommended
- 6 feet in residential zones, 8 feet Clear Width in commercial zones
- Depends on setting. The first draft of the Guide had this discussion but it was deleted in the final draft.
- 6 feet or greater when possible - based on street furniture, planting areas, etc. that typically narrow the PROW.
- It depends on the setting (urban CBD or suburban dead end road.
- Wide enough for two people to pass, and accommodate outdoor cafe seating too
- 8'
- 8 foot because of others (skateboarders, segways,...etc)
- Clear width should be calculated as "5 foot design clear width" PLUS "sampled intrusion distance (SID)", where SID is determined by conducting a statistical survey of 100 randomly sampled intrusions in the municipality in question where overgrowth, parked cars, telephone poles, or other temporary & permanent obstacles reduce the effective sidewalk width.
- 8 ft. We should be looking at all users including bikes. Also big crowds of peds near schools.
- 8 feet, meets ADA requirements for transit stops

2.5. PRACTICES TO BE AVOIDED

Respondents were also asked about common practices to be avoided. Responses from those who had used the Guide at least once in the past year included:

- Fast intersections with wide radii
  Diagonal curb ramps
  Lack of landscape strip
- Not enforcing the amount of clear space--i.e. light poles, street furniture, newspaper/magazine stands, illegal dumping, illegal parking of mopeds on sidewalks...
  Pedestrians lack understanding of laws, symbols, or signs.
  Skewed intersections or curb ramps not aligned with the crosswalk can make it difficult for people with disabilities.

- Having a standard sidewalk width and applying it everywhere without regard to expected usage. Thinking that traffic calming equals pedestrian improvements. Implementing traffic calming in a timid way - bulbouts that don't protrude out enough, for example. Simplistic design of curbramps, meeting the standards but creating very difficult situations for blind or low vision pedestrians. Thinking that safe ped crossings equal exclusive ped phases. Never weighing pedestrian needs against vehicle needs, but considering ped accommodations a nice add-on after all vehicle needs are satisfied.
- Not considering all possible issues related to safe and efficient movement of pedestrians.
- Assuming that pedestrians only want to walk - the sidewalks are also places where people meet, eat, socialize and gather.
- Looking ONLY to colleagues for inspiration, feedback, comment, and critique.
  Too many are unthinkingly agile --so they ignore the patterns and difficulties of groups of peds.:
  people using guide dogs
  adults walking with pre-schoolers
  people using walkers
  school groups walking to / from an activity.
  Sidewalk widths, signal timing, ease of reading signage all need to be previewed to reps. for groups such as these.
- Make sure there is a need. Joint usage on/below structures requires cost/maintenance agreements.
- Starting the planning of pedestrian facilities after other planning has already been done. Pedestrian planning needs to be done upfront and included in land use planning and site design. It should not be an add-on consideration.
  The impacts of project phasing need to be fully evaluated. Sometimes it is better to work to construct pedestrian improvements completely than to phase them in order to do a quick fix.
- Sidewalks that are too narrow
- Do not wait until the project is advanced to consider pedestrian. Always at least consider pedestrians at the project concept stage. This applies to other non-motorized modes.
- Need to do more site-specific geometric design for pedestrian facilities (in the past, this has been an afterthought in the design process).
  Need to better consider pedestrian generators and future pedestrian traffic volumes and demographics in designing facilities.
- Failure to recognize that the forthcoming increase in bicycle-pedestrian interactions on sidewalks, road shoulders and trails/sidewalks not parallel to a roadway but designed & built for multi-use (bicycle, pedestrian, wheelchair, etc.) point to point travel.
- Not including pedestrian accommodations in initial planning/design and having to add in/retrofit later.

- Ensure enough ROW is available when early in the project to permit adequate ramps in the space available.
- Neglecting or overlooking opportunities to connect communities or fill in gaps in the system.
- Should not put off road paths next to non-curbed roadways using any of the minimum distances shown in the current Guide. There should be limited use of pedestrian facilities in areas such as this. High speed roadways with no curb should have much more stringent setbacks from the edge of pavement if they are to be used at all.
- The idea or policy that sidewalks should be provided everywhere should be avoided. The FHWA Guidance that pedestrians be accommodated on all new and improved transportation facilities unless there are exceptional circumstances not to is not good stewardship.
- I would like to see some very strong language in opposition to providing exclusive ped phase signals (all stop or ped scramble). Wherever I have seen these used, both peds and drivers get frustrated with having to wait so long and many peds just pick a gap and go).

  Many jurisdictions feel like they have to mark crosswalks wherever a sidewalk crosses a side street, no matter how minor. Some guidance on when this would be appropriate would be helpful.

  Many jurisdictions really like the idea of brick patterned and colored crosswalks. I would appreciate additional guidance about when these can work and their negative impact on crosswalk visibility. Maybe some additional assessment of what style of crosswalk marking offers the highest visibility.

  It would also be nice to have some discussion about the whole "false sense of security" argument against marking crosswalks.
- Choosing project locations where it is not feasible to make the pedestrian facility ADA compliant

  Building sidewalks adjacent to steep ditch slopes
- Avoid making street widths narrower--traffic calming is expensive and does not live up to the speed slowing promises made by its advocates. Making streets narrower causes problems for bicyclists and emergency vehicles (when they need regular traffic to pull curbside and let them pass, they cannot where these concrete obstructions are built)
- 1. Demanding pedestrian traffic data where no pedestrian facilities exist.

  2. Obstruction in sidewalk right-of-way due to the poor or careless execution of contract plans.

  3. Narrow sidewalks that are less than 5 feet (needed for 2 wheelchairs to pass each other).

  4. No buffer zone between busy/high speed arterial and sidewalk curbing.

  5. Discontinuous sidewalk segments and poor/off-set connections that are simply poor engineering.

  6. Poor drainage and vegetation control practices at the bottom of a curb ramp or bus stop/shelter.

  7. Steep cross slopes, and not carrying the sidewalk (at-grade) across driveways or loading

zones.
8. Inaccessible crosswalks and crosswalk pedestrian activation buttons. Many, many others........

- Do not wait until the project is advanced to consider pedestrians. Always at least consider pedestrians at the project concept stage. This applies to other non-motorized modes.
- Assuming that it is a good idea to accommodate pedestrians on all streets, not matter what function they fulfill and no matter what alternatives exist or don't exist for pedestrians and/or other modes--in particular freight. Pedestrians have requirements that can be fulfilled on many streets. We need to start protecting major truck streets, even if that means making a conscious decision not to provide pedestrian facilities on some streets because they have heavy truck traffic and accommodating peds would reduce their ability to carry freight. This is especially true in manufacturing-industrial centers. There's a limited amount of infrastructure that has the geometry to safely and efficiently accommodate trucks.
- Avoid prioritizing pedestrian improvements by public comment or engineering guidance alone (do use estimated demand and safety data).
  Avoid design of utility lines after sidewalk installation.
- Generous corner radii and free flow right turn lanes.
  Wide streets without medians to allow two stage crossings for pedestrians.
- Public comment
- Diagonal curb ramps
  implementing one size fits all solutions
  focusing on routes instead of networks
  not maintaining appropriate clear zones
- Letting public opinion override engineering judgment and standards
  Letting elected officials override engineering judgment and standards
  Wasting tax payer $$$ on frivolous calming if there are excess funds near the end of the fiscal year.
- Designs under estimate the impact of time & distance on pedestrians willingness to walk http://metroped.org/bpi/time_dist.htm
- When in conjunction with roadways, planning the pedestrian environment AFTER the roadway is one of the biggest mistakes. Likewise, with site plans that add the sidewalk into the leftover spaces instead of planning for pedestrians up front. Allowing substandard sidewalk, ramps and drive aprons because it's easier than planning and maintaining it.
- Failure to place flat 'plateaus' ('plateaux?') in long grades of sidewalks.
  Not making the walkway at intersections flat enough to accommodate the minimal ramps and push-button access.
  Recommend that agencies have clear guidance for the placement of truncated domes at driveways. I recommend that detectable warnings only be used where the driveway is a defacto street with most of the operational characteristics of a street (significant traffic volumes, signal or stop sign, etc.).

- Planners' assumptions that no one walks to and from destinations or rides their bikes. As such General Plans are often vague in regard to providing for solutions and facilities. Complete Street is a beginning in changing this trend. CS needs to be implemented, and enforced, in all states.
- Our contacts in the blind community have complained about the "chirping" at some signals. They say that it makes it difficult to hear the traffic and they are forced to rely on it rather than their own training and judgment.
- Avoid closing crosswalks.
- I believe that all cross walks should be marked with pavement markings. Here in Santa Fe, we have many cross walks without markings. Drivers have more respect for pedestrians in marked crossings.
- Sidewalks that lead to nowhere. For instance, requiring a developer to put a sidewalk on their frontage only, if this doesn't connect to anything. ADA says we need to tie the sidewalk back into the roadway. However, this now encourages an uncontrolled pedestrian crossing.
- There is a need to consider the pedestrian first and then consider the other elements, so many roadways are constructed with walking as an afterthought. If walking needs are considered up front it is much easier to ensure the space and geometric design that makes walking integrate safely with driving, transit and biking. It would be good to address transit pedestrian facility design in some section, there are so many examples of disconnect here.
- Failing to consider a complete streets policy.
  2. Failing to enforce policies or ordinances to keep protruding objects, branches, and brush out of pedestrian ways (whether or not there is a constructed sidewalk).
- Pedestrian traffic is often ignored (most often in rural and suburban settings) or is considered as an after-thought.
- Common practice is to design the roadway first, with auto ramps, turns, curvature and corner radii, and then fit sidewalks in "around the edges". This results in circuitous, confusing pedestrian paths.
- Placing only one curb ramp for two crossing instead of one curb ramp for each crossing.
- Political decisions that predetermine the right of way constraints to work with on local street improvement projects.
- 1. Reliance on ped-actuated signals at areas with short crossing exposure and high ped volumes. It simply creates an opportunity to ticket peds for crossing when they otherwise should have the ROW. It also increases the likelihood that peds will cross against the signal since it often results in delay (wait for next signal cycle).
  2. Use of short walk intervals to maximize auto movements. Similar to above it puts ped at disadvantage and often results in illegal crossings.
  3. Traffic signals with protected phases and no opportunity to have a walk phase. Typically located on T-intersection where minor leg has protected right/left leaving ped with no crossing opportunity.

- Avoid setting speed limits or designing in a way that results in traffic speeds over 35 mph on urban streets used by pedestrians, due to high pedestrian fatality rates from higher speed collisions and the difficulty for peds of crossing high-speed roadways. Instead, use design and operational techniques that induce drivers to travel at no more than 35 mph on arterial streets and slower on connectors and local streets, and on arterials in pedestrian-oriented settings.
  Avoid requiring abutting property owners to maintain sidewalks (snow/ice removal, vegetation clearances, debris), while the owner DOT maintains the streets. This is inequitable to pedestrians.
  Avoid the perception or reality of political decisions that predetermine the right of way constraints on local street improvement projects, before the width needed for the road and sidewalk zone is determined.
- Design: Sidewalks on one side of the road in suburban areas.
  (2) Design: Push buttons that are placed too far from crosswalk or path of travel.
  (3) Design: Installing guy wires, poles, signal supports in middle of sidewalk.
  (4) Design: multiple driveways to a facility.
  (5) Design: (urban) lack of street-level-only set-backs for building which create sheltered sidewalks along building facades
  (6) Operation: cut back vegetation and/or landscaping to enhance visibility of ped in crosswalk.
  (6) Operation: install warning signs of end of sidewalk or path of travel ahead--some locations are not always obvious.
  (7) Operation: to facilitate traffic flows at an intersection, peds are required to use many xwalks (to other side of street and back).
- Penalizing vehicular traffic. The benefits/usage of bike/ped facilities is typically overestimated and the negative impact on vehicular traffic underestimated, this leads to less overall mobility and environmental impacts.
  I think that usage forecasts need to account for weather - i.e. Minneapolis in winter and Houston in summer will see less bike/ped traffic and it is way too cold/hot. I would pick a couple of cities with these temperature/humidity/snow conditions and monitor over the course of 1 year.
- Midblock crossings.

Responses from those who used the Guide rarely or never included:

- Interchange designs with high speed ramps.
  Closing crosswalks at signalized intersections.
- sidewalks immediately adjacent to curb; diagonal ramps; push button activation REQUIRED for walk signal;
- Lack of clear, easy accessibility to transit.

- Lack of sidewalks in new residential areas
  Poor maintenance
- Including ADA Ramps on projects when there is no pedestrian traffic in the area. Focus your funding on need. Prioritize your projects with that in mind.
- Getting rid of marked pedestrian crossings. Not having marked crossings often enough for convenient, safe access for pedestrians. Not including pedestrian crossings with refuges in mid-block situations.
  Planning to meet unreasonable vehicle LOS that necessitates widening of roads and intersections -- leading to off-peak high capacity and high vehicle speed situations.
- Not using inclusive design, assuring that projects will not only meet state and federal access codes/regs but are truly accessible for everyone
- Designers overlook pedestrian planning in general and when they do remember they don't consider the elderly or the handicapped.
- Corner intersection ramps that dump wheelchairs and ramp-users diagonally into street. Often a cost cutting measure to build 4 ADA ramps instead of 8 that are properly aligned with each street crossing.
- That traffic calming is a one size fits all solution and that some treatments are "unsafe" when the facts don't bear that out. I think that many "practices" get published and re-published without actual knowledge of whether or not a particular treatment is beneficial or harmful. "Doing something" is sometimes worse than "doing nothing".
  Also, pedestrian issues, in my view, tend to get marginalized because they are treated as "separate" and therefore not fully integrated into the planning, design, construction process. Also, there is often a disconnect between "design guidance" and the MUTCD.
- Any lack of clarity or lack of consistency in pedestrian design & operation from state to state.
- Ignoring other forms of transportation that use the same sidewalks. Ignoring trends, i.e. use of the facilities by joggers and recreational walkers.
- 1. Excessively-wide streets that facilitate/encourage high-speed motor vehicle traffic, discourage driver awareness of pedestrians, and make crossings difficult and unsafe (BOTH excessive lane width and excessive number of automobile lanes...over-capacity). In other words, there should be an even stronger discussion of overall roadway design and facilitation of motor vehicle movement and how pedestrians are impacted.
  2. Excessively-wide turning radii at intersections.
  3. Not providing adequate crossing facilities at mid-block pedestrian crossings (as we know from the FHWA Zegeer study, marked crosswalks are not good enough on many arterial roadways--need HAWK and other types of pedestrian signals, median islands, curb extensions, etc., depending on roadway characteristics and context).
  4. Not providing (enough) buffer space between sidewalk and roadway.
  5. Sidewalks only on one side of the roadway.

- Not requiring it to be incorporated in all roadway projects, regardless of cost (should shift towards complete streets approach to transportation)
- Pedestrian planning must be followed through by implementation. Guides should discuss methods that communities can use to facilitate/ensure construction of pedestrian facilities. Should consider taking a stronger stance on recommending sidewalks for all residential developments above 4 d.u./acre. As it is now, most communities aren't even aware that FHWA has set this density as a (very weak) threshold for requiring sidewalks on both sides of the street. Sidewalks should be considered an integral part of the road's cross-section, not an "add-on."
- Sidewalk gaps, lack of public input, not retrofitting or redesigning of older neighborhood sidewalks
- Sidewalks adjacent to traffic with no separation; sidewalks are often blocked on garbage day with garbage cans requiring pedestrians to step into the street to walk around. Blocks that are too long; houses too far apart. Steep driveways that are hard for pedestrians to access the front porch of homes; no provision for steps makes it very slippery and a fall hazard.
- We can't neglect motorized vehicles when designing pedestrian friendly facilities. We need to accommodate both. While working for Departments of Transportation our primary goal tends to be moving vehicles (cars, trucks, etc.). While understanding we need to be concerned and focused on all modes of transportation, including pedestrians, we need to make sure there is a balance. We find that communities want us to consider pedestrians over vehicles, yet as the DOT we need to keep vehicles moving.
- Hiring engineers/planners who drive everywhere should be avoided.
- Considering pedestrian facilities as an after-thought. Pedestrian facilities need to be considered early in a project.
- Location of utilities with respect to future pedestrian access should be considered. (i.e. avoid placing utility pole in middle of sidewalk or placing sidewalk in middle of utilities) Avoid assumption that handicap ramp standard details are the answer for all situations. Design of these facilities is often needed to "do it right"
- Involving the State early on, when on State right-of-way. 2. Political pressure to lower structural design standards for an individual location. 3. Not considering life-cycle cost, maintenance needs, and increased risk when spanning over the traveling public.
- Concluding that pedestrians are not present, therefore ped accommodation is unnecessary.
  Closing crosswalks with little, no or poor justification.
  Complete lack of planning, counting, route information - i.e. failure to study or understand ped needs.
  Insufficient crossing opportunities.
  Failure to minimize pedestrian delay at signalized intersections.
  Failure to provide immediate response to ped push buttons at signalized intersections.
  Deterioration of walking environment/ped safety in service of motor vehicle "capacity" at intersections (read dual turn lanes, turn pockets, right on red, etc.)

Failure to plan for maximizing walking trips - land use, roadway design etc.
Failure of designers, planners etc to actually take a walk and see what it's like.
Use of Design "standards" and minimum dimensions - as the minimum "allowed" is what will get built.

- Multi-use trails are not appropriate in high-traffic (bike or ped) locations. These should be forgone in favor of separate, off-road pedestrian and bicycle facilities. The German model (e.g., as in Berlin) is especially good here.
  Traditional button-activated crosswalks often give drivers a license to speed by, ignoring pedestrians waiting on the curb (or jaywalking.) Where appropriate, other mechanisms should be used (e.g., informative crosswalks (like those in Halifax, NS) with buttons that change the light from unlit to flashing yellow with audible alarms to wake up drivers to the pedestrians that they must always, by law, yield to; or motion-activated crosswalks.)
  Crosswalk buttons should always trigger a solid red light, even when the signal is flashing yellow/red late at night. (Most lights deactivate the buttons, which makes crossing very dangerous, given the low-light conditions and expectation of most drivers not to have to stop.)
  Low-volume residential streets should not be overbuilt. Most should be barely wide enough for two cars to pass (so that one must pull over to let the other by), be heavily planted with trees, and, in rural areas, should not include curbs or sidewalks. This will calm traffic tremendously and attract pedestrians.
  Cobblestones, dirt roads, and the like should be considered. They are hands-down the best traffic calmers I have ever seen. (They make drivers slow down out of SELF-interest: nobody wants to chip the paint on his car.)
- Demand-triggered traffic lights are an offense to pedestrians and bicyclists. All traffic lights should give pedestrians a walk phase at the same time as vehicles have their green light.
- Do not go by level of service. This is what is wrong with our highways. Treat every urban roadway equally by including a sidewalk on both sides of the street for balanced pedestrian access. We do not build roadways with only one travel lane so why do we do this with sidewalks?
- At a full intersection with 4 crossing areas for peds, cities sometimes close 1 crosswalk to maximize motor vehicle throughput. This could require a pedestrian to use 3 crosswalks to get across 1 street. I think this should be avoided, as hazard to pedestrians is increased so cars can be accommodated.
- Avoid placing "street furniture," tree grates, parking meters, lampposts, and roadside signs within the 5' minimum clear width of sidewalks.
- Type of tree that is planted along the sidewalk where most often buckling of the sidewalk occurs.
- Failure to recognize that pedestrians will take the most direct route if the planned route is more that slightly less convenient - i.e. failure to formalize the foot trails. [This often leads to pedestrians adopting unsafe paths of travel.]

Failure to recognize the needs of ALL elderly and/or handicapped pedestrians. All too often the pedestrian infrastructure will guide handicapped pedestrians into unsafe routes [i.e. single curb cuts placed on the tangent to the corner curb to save the extra cost of two curb cuts that direct the pedestrian to a path that is at right angles to the traffic flow. [I have seen this practice direct a blind pedestrian diagonally across an intersection on a path that intersects the flowing traffic instead of a path that is parallel to the flowing traffic! [Sighted pedestrians intervened and prevented an accident!]

- Building sidewalks where use would be very limited, no one to maintain and shoulder would suffice and be easier to maintain and accommodate cyclists.
  Placing sidewalks along a highway with a 1-2 foot buffer, not enough to store snow and place signs therefore makes snow removal on SW more difficult and sign placement awkward.
  Mid block crossings on multi lane highways. Dangerous for Peds and vehicles, tried and had to signalize because of safety issues.
- Stop advocating vertical separation on bridges between pedestrians and motorists. If there is no vertical barrier on the street before and after the bridge, then the bridge also does not need a barrier. The barrier hinders movement and raises project cost needlessly.
  Also, buffer zone between sidewalk and road is not as important as maintaining a wide outside lane for bicyclists.
- The situation regarding pedestrian/vehicle conflict which arises when traffic signals indicate that pedestrians can walk and cars can turn. It is frustrating to both the pedestrian and to the vehicle traffic that must both use the finite time to clear an intersection. Pedestrians should have their time and vehicular movement should have its time, removing conflicts and potentially harmful consequences when people are impatient.
- Waiving sidewalk requirements; requiring sidewalks on only one side of streets; installing single diagonal intersection curb ramps.
- Over design of streets with emphasis on vehicle speed. While statistically urban surface trip speeds average between 21 and 26 mph there is still a tendency to design for 35-45 mph 85th percentile speeds and ignore the access needs of drivers and pedestrians. This does not increase overall trip speeds, but does make access for both vehicles and pedestrians more difficult. Many urban street designers attempt to make arterials make up for the lack of limited access routes for cross town traffic, then when accident frequency goes up at intersections they install traffic signals and are back to slow speeds on streets obviously designed for higher speed driving, which increases the incidence of aggressive behavior.
- There is no requirement by cities to install sidewalks. This needs to change. It’s a mess when someone wants something other than a sidewalk like a multi-use path, equestrian path...etc.
- #1. Overuse of signage as a safety device (diminishing returns with added signage and leads to visual clutter)
  #2. Over-reliance on suburban standards in urban settings. I work for an urban jurisdiction

and it is painful how often we must comply with standards that do not make sense in many cases. We either need our own set of standards (top 20 cities work together) or there needs to be more flexibility in allowing experimental status projects.
#3. Traffic-calming as a residential tool only. It's time to expand onto other streets where our policy goals call for slow speeds and where our actual speed limits are being violated on a regular basis. If we are signing for 30, we should be designing for 30.
#4. Inattention to lighting. If it's a priority pedestrian space, lighting levels should be at pedestrian scale. Opportunities to replace cobrahead lighting should be seized more often.
#5. Lack of integration with other common goals - urban forestry, natural drainage, urban design. Single-purpose utilitarian designs, even if they are aimed at ped safety, should not be acceptable in this age of Complete Streets and sustainability agendas.
#6. To piggyback on previous, a big pitfall is that the funding sources for ped projects often do not "count" or provide room for any additional features. If we are serious about Complete Streets, our grants and funding sources should be as well.

- After-the-fact pedestrian planning, where pedestrianism is clearly an afterthought.
- Sticking up a sign that has a pedestrian crosswalk symbol, does not absolve the authorities from thinking they have made a safe crosswalk.
  Avoid placing the walk button on the signal if it is 10 ft away from the crosswalk.
- The use of Roundabouts.
  The use of poorly designed traffic "bumps" for traffic calming that jar both drivers and passengers.
- Sidewalks are often closed when there is any construction either with sidewalks themselves or nearby. These projects sometimes last for weeks or months.
  Often resources are directed at repairing small sidewalk defects instead of extending sidewalks.
  Sidewalks are often built adjacent to roadways. This feels unsafe to pedestrians and often is. Too often it leads to local maintenance crews piling winter snow on the sidewalk.
- Determining need vs. wish for accommodations along a stretch of highway that is under construction.
- About the question, I can't have some idea at once.
- No comment
- I would like to see pedestrian signals evolve to say walk without the necessity for pedestrian actuation. It seems reasonable to expect that whenever a light changes, enabling pedestrians to cross the ped signal should automatically come on. Many times when a ped doesn't get to the actuation button in time to trigger the crossing signal, but technically the pedestrian can cross, automobile drivers do not yield because they think without the walk signal a pedestrian cannot cross. Basically, pedestrian actuation at timed, signalized intersections sends the incorrect message to drivers and gives pedestrians lower priority than drivers. Crossings are still too unsafe in many urban contexts. Anything that can be

done to make them safer and send the message to drivers that they have to be careful is a good thing.

- Freeway interchanges are a constant headache for pedestrians. Even in urban areas, pedestrian access from one side to another is often precluded - often creating the "Great Wall" that separate communities and job opportunities for those who may be transit dependent. Also, too often pedestrians are forced to navigate three sides of a dangerous intersection to cross a single interchange ramp (even when the ramp does not employ a high-speed taper). Interchanges are typically planned to optimize only the motorized mode to the exclusion of all other modes (e.g. pedestrians, cyclists and transit users).
  Other conflicts are:
  Double (and triple) right and left turns that reduce visibility of pedestrians (and create a very wide, hostile pedestrian crossing).
  Controlled intersection spacing of busy arterial streets in excess of 1 mile. Out of direction pedestrian travel should not need to exceed 1/4-mile in an urbanized, active area.
- Traffic signals that assume no peds are in the vicinity unless a button is pushed should be banned. It can delay ped travel for minutes or prompt dangerous crossings against the signal.
  On-ramps should be crossable by peds by putting in speed humps in advance of the highway/freeway ramp. Ramps are already engineered to allow cars to get up to merging speed. These limitations cause pedestrians to go out of direction and delay their travel by several minutes.
  Bridges sometimes are built too avoid lift spans for boat navigation; however, this requires a ped to climb essentially over the mast of a ship (in terms of elevation). There should be guidance how ped demand is affected by a sloping bridge vs. a flat bridge so that communities can decide what bridge is best.
- Not providing crossings at all legs of an intersection.
  Providing meandering sidewalks in locations where walking is primarily for transportation.
  Insufficient crossing times.
  Lack of median refuges on multilane roads.
  Sidewalks on only one side of bridges.
- Design:
  Whether it is a sidewalk or a recreation trail, the cross slope can determine how easily usable a path of travel is for people who depend on wheelchairs or crutches. A perfectly flat surface is impractical since pooling of rain water must be avoided, but water will run down the slightest incline. A cross slope of 1:50 is recommended.
  Anyone who is in doubt of this comment should try to maneuver a wheelchair over a cross slope of 1:40 or more to get a better understanding of why this is important.
- Technocratic decision making
  1) Reification of the problem
  2) Self-deception and fantasy

4) Believing the objections that people put forth as though they are real
5) Expecting home-owners to pay for maintenance
6) Push-button control of traffic signal ped phases
7) Not listening to articulate NFB (National Federation of the Blind) blind people
8) Not aligning curb ramps to be parallel with the path of travel!

- When developing a shared space, being certain that there is a visual and tactile safe space for pedestrians, particularly those with visual impairments. At roundabouts, that crossings are signalized for pedestrians. The signals should only interrupt traffic flow when activated by a pedestrian and should only impact the one crossing.
- Don't place the pedestrian facility too close to the travelway such that snow and ice removal from the roadway impacts the pedestrian facility.
  Design of pedestrian facilities generally does not take in to consideration the actual maintenance of the facility. Designers can design great things that can be a burden to maintain.
  Funding of pedestrian facilities needs to come from some source other than roadway tax dollars. Too many pedestrians want the facilities but don't want to pay anything for them. They expect the drivers of motor vehicles to pay for them.
- The installation of mid-block crossings on high volume roadways.
- assuming that a pedestrian traffic count indicates what the actual need is
- Equating current levels of use with actual potential demand since current use is invariably hindered by existing policies and practices.
  Use of a safe-crashing approach to vehicle roadway design invariably impedes adjacent pedestrian use and should be avoided.
- Local officials and agencies are hesitant to adopt a "complete streets" policy, or one that requires an accommodation of "all" users because they fear that it will require putting paved sidewalks along all roadways including rural highways and other areas that don't make sense. Guidance from AASHTO about when sidewalks and safe crossings should (or better, must) be included in design (either according to the functional classification of the roadway, AADT, population density, or surrounding land development context) would help guide agencies to provide pedestrian accommodations in appropriate situations (rather than an all or nothing approach that unfortunately seems to govern some agencies).
- Road construction should come after sidewalk construction so that pedestrian access to existing businesses is not blocked for the entire construction period.
- Parking lot "pad sites" in retail areas are always difficult for pedestrians to access
  Business "parks" that are totally auto dependent, and disconnected from service areas
  Gated communities (feh!)
- Not making ped considerations up front design factors.
  Assuming that just a sidewalk of some sort means that walking and the needs and desires of pedestrians are being taken into consideration.

Not taking into consideration that poor design inhibits pedestrians which is a self-fulfilling prophesy.

- Only looking at urban areas and forgetting about rural areas and newly constructed developments with no sidewalks and streetlights. Forgetting about transit stops. Only constructing sidewalks on the outside of the shopping centers and not constructing sidewalks to connect all stores and connections into the parking lots. Not tightening up parking lots so cars can't speed. Not having traffic control on roads to slow down traffic.
- Not thinking like pedestrians and too much focus on the aesthetics rather than the most practical and direct route peds might use.
  More focus on the user types with focus on age and walking ability.
- Stop advocating curb extensions which are expensive and reduce the clearance space of bicycles alongside motor vehicles.
  Separation space between sidewalk and roadway is not anywhere near as important as HAVING a sidewalk and HAVING enough roadway space for bicycles and motorists side-by-side.
  Following current AASHTO recommendations to have separation has in practice resulted in roads where bicycles have no clearance side-by-side in the road. Such separation is a waste of space. Better to have space for bikes and cars side by side than to have the sidewalk and roadway separated by several feet of grass.

2.6. FINAL COMMENTS

Finally, respondents were asked whether they had any final comments or additional suggested changes. Responses from those who used the Guide at least a couple of times a year included the following:

- Cannot stress enough the importance of the new document incorporating the latest guidance for ada design in the public right of way. As signals get more complicated, it gets very difficult for individuals with low or no vision to get the cues they need to cross the street. APS is essential and around here, it is not being included in new signal systems. Curb ramps that direct the ped into the middle of the intersection exacerbate the difficulties. Also, it is important for the new document to recognize that some of those who use it will be searching to understand how they consider the needs of peds in a project being built after a complete streets policy is adopted. Would be helpful if the new guide directly addresses designing for complete streets.
- I just noticed that sight lines are discussed in section 3.1.4 (on a preceding page, I mentioned this as something that should be addressed)--I had been looking for this information in sections 3.3 and 3.4 and not found it. Might be helpful to relocate, or provide more internal cross-references.
- This Guide lacks in a comprehensive alphabetical index by keywords. Suggest adding an index at the end.

- Warrants on need.
- If possible, the new AASHTO Ped Guide should not be published until the ADA Public Right of Way rule is finalized. An update from the Access Board said progress is being made, and the rule could be finalized within the near future.
- The guide is a valuable resource for me. I wish more people knew of its existence (at least in Canada). Some of the recommendations are buried in paragraphs so more highlights, lists or tables could make it easier to find recommendations.
- Many general updates to new codes and regulations.
  expand on the intersections of roads and pedestrian trails/paths
  more information on street crossings on rural roads with no dedicated pedestrian infrastructure
- There should be some additional information on pedestrian bridges.
- It should be made available online for ease of access and to allow for updates to be made without distribution of entire hard copy manual.
- In general, this is a good document that has been useful to us in developing our state's design guidance.
- The issue usually arises as to how to marry new curb radii standards, placement of crosswalks and its relation to the distance of the stop bar to the signal. Often the stop bar dictates the location of the crosswalk and therefore the location of the curb cut which is not always the best location. How do you decide on who trumps who?
  Also, perhaps site specific sections or links to the background information other than just siting the Agency or Reference; (page 116, 4.3.1, end of 3rd par. "The US DOJ has stated...", site specific location of reference)
- The emphasis on safety in all areas of the guide.
- Three things.
  1. Address non-curbed facilities and sidepaths.
  2. Address non-curbed facilities and sidepaths.
  3. Address non-curbed facilities and sidepaths.
- Clear understanding of when pedestrian rights of way should be included in a project scope.
- There are standards that are changing in the very near future - ADAAG/PROWAG, MUTCD - please incorporate the newest language from these recognized standards into the AASHTO guide.
- See general questions on content. I'd like to make it much more difficult for folks to ignore proper design practices with impunity (as many continue to do at this time, at all levels of government).
- There should be additional information on pedestrian bridges.
- Tell people to do their homework and make sure they understand what role the facility they are redesigning fulfills. Have them talk to the freight community before they make decisions about major truck streets or streets in manufacturing-industrial centers. We are building and reserving infrastructure for the exclusive use of pedestrians, bicyclists, and transit. We

need to start doing the same for freight. It should be ok to sometimes say, no, not here, let's do it over there.

- include facility costs
- focus on future demographic changes
  more discussion of crosswalks (placement and design) at intersections and mid block
  different cover picture
  better discussion about understanding of signal systems
  update walking speed information
  try to expand on rural and exurban environments
  index
  improve glossary to include acronyms
  update roundabouts safety assumptions/section in general
  in general, update research/factual data
  discuss shared use environments more
  stronger consideration of maintenance (i.e. snow and ice removal)
  better suggestions for how to retrofit within existing environments
  stronger connection to utility issues
  discussion of sawed vs. formed joints (section 3.2.10)
- Don't repeat any language regarding standards that are contained in any other Federal document - simply reference the Federal document (and section of document of appropriate).
- Municipalities are increasingly installing sidewalk directional signs to public restrooms and water fountains. AASHTO should provide guidelines to the size, color, and placement of these signs.
- More emphasis on accessibility.
- Anything that would require or mandate sidewalks at certain levels of demand or along roads of a certain AADT within areas built-up to a given population density.
- Show more about sidewalks from the road to shops, and stores. Have more information about shared driveways and connections between parking lots.
  Have a section on signs.
  Signal loop detection for bikes,
  Canada has signal lights that are just for bike lanes, (red-Yellow-Green) get information about that.
- It is nearly impossible to detour a pedestrian who is blind to the other side of the roadway. Also, a detour that is several miles isn't accessible to many people with disabilities. Rather than putting up unrealistic detours (such as when a bridge is replaced), I recommend sending out press releases with a copy to advocacy agencies (we have a Department of the Blind in our state) so that people can make appropriate travel decisions or contact a project representative for assistance.

- The 2004 edition is groundbreaking, but is just the first small steps in really addressing walkability in a broader transportation context. We should challenge ourselves to push the envelope of creative design tools, the examples are out there. I look forward to seeing the development of this update, now more than ever we need to embrace walking as part of our national transportation solution.
- Expand coverage beyond pedestrian to all vulnerable road users such as: electric wheel chair, in-line skaters, people who skateboard to & from school or college, light very low speed electric vehicle, cyclists. Cover parking needs for these. Consider the design of roads for mixed modes such as these.
- In general, I think it is quite good, though for my tastes could be more assertive.
  I had reviewed it before starting this survey, thinking I would just mention where I would like to see it strengthened and didn't have time to re-review for more precision in your chapter questions. Not lack of interest, lack of time.
- Improving conditions for pedestrians ultimately means reducing convenience or speed of travel for motorists. Designers must recognize this, and not expect that auto travel will be unaffected.
- Roundabouts & ADA issues.
- The overall book presentation/organization of the book is very user friendly. In general is very well illustrated, very easy guide to work with.
- More clarification as to the resulting confusion over the countdown signals. The countdown runs during the flashing don't walk so there is now a mixed message on the part of some engineers, planners, police. It was intended to provide more info (and does, but we are telling people not to start crossing on a flashing hand, but then tell them they may do so if they feel there is adequate time based upon the countdown). Overall I think they are a vast improvement, but the intended message needs to be clear (which is to say that peds may use their discretion as to when to begin crossing).
- Discuss standard method to collect ped data (volume, accident). Most ped counts tend to be inconsistent (direction, time of day, weather conditions). Also accident forms used by police lack detail pertaining to ped accident stats.
  (2) SOME discussion on ped level-of-service. May need to cite Highway Capacity Manual for reference.
  (3) Discuss "compliance rates" pertaining to in-pavement lighted crosswalks and other countermeasures.
  (4) Design practices for ped circulation for off-street parking facilities (lots or garages).
  (5) Successful strategies to educate peds re: rules of road (who has right-of-way), walk facing traffic in areas w/out sidewalks, dress bright colored clothing in winter and/or night, and differences betw. marked + unmarked crosswalks.
  (6) Successful strategies to advise turning motorists at intersections to look right at peds, not only left at on-coming traffic.
  (7) Discuss benefits to peds of nearside vs. farside signals for roads.

- I would like to see before and after surveys conducted much more often to see if the predicted usage matches what actually occurs.

Responses from those who used the Guide rarely or never included:

- guidance on HAWK signals would be fantastic; guidance on street tree conflicts with utilities would be helpful (is this a real or perceived problem?); snow removal guidance
- mid-block crossings are really important
- Documenting design exceptions for allocation of highway sections for bikes and vehicles should be discussed. For instance, using a 10 foot lane with a 5 foot bikes lane may be desired where a 30 foot curb to curb urban section exists. Design criteria may show minimums of 11 to 12 feet.
- Please make the section which deals with handling pedestrians in work zones fairly detailed with numerous good examples.
- Have a summary version that would be useful for advocates and citizen groups and at a reasonable price.
- Build in a quality of service measure incorporating bike and ped user LOS.
  Establish a minimum set of intersection amenities.
  Get signal equipment manufacturers to build truly pedestrian friendly crossing equipment with button activation feed-back, count-down to signal change on button panel, etc. The elevator industry knows how to do this but we get big silver buttons to press that give no feedback anything has happened when pressed except going in and out!
- Include something about partnerships with public health and other interdisciplinary fields that are interested in the pedestrian realm
- Provide guidance for pedestrian access during construction. Provide adequate space for at least two people to walk side by side.
- See above. Also:
  Make it free for download. Advertize it widely to the wider transportation engineering, planning, and design communities. A key national document such as this should be easy for practitioners to access.
- Guide should be available at a modest/free cost. Materials such as AASHTO, APA, and some of the materials/information developed by the APBP - in some cases at taxpayer cost - should be widely disseminated. Many local agencies can't and won't pay $50 for an e-book or what is essentially a brochure. Charging inflated prices for these materials may help organizations to recoup their development costs, but at this stage in the game - when jurisdictions need to be encouraged to plan for pedestrians, bicyclists, the elderly, children, and people with disabilities - it may be worthwhile that organizations distribute this information 'pro bono.'
- ADA requirements should be detailed. Curb ramps, max slopes, DWS, alterations to the crosswalk trigger upgrades.

- Allow for trails in forested areas. Pedestrian connections between areas to accommodate neighborhoods with lots of cul-de-sacs. Short cuts for pedestrians; they should not always have to follow the same routes as cars. Separation between pedestrians and cars. Pedestrian routes should also not have to be on the busiest streets.
- It should be written by walkers, for walkers. And it should be unafraid to challenge the illegitimate rule of cars in American cities.
- I would like to see emphasis on projects strictly for pedestrian accessibility rather than incorporating accessibility into every small project; thereby leaving the corridor with inconsistent access.
- Shouldn't this be in tandem with the Ped Guide Specs maintained by the Subcommittee on Bridges and Structures?
- There shouldn't be a separate guide for pedestrian design. Pedestrians are integral to the travel landscape. Every roadway should accommodate pedestrians. The form of the accommodation is dictated by context. In rural settings a highway shoulder may be all that's needed - or no shoulder at all, if mv traffic volumes are low. In suburban and urban settings no roadway should be built without pedestrians in mind. Roadway design standards should include pedestrian elements and transportation system planning should integrate pedestrian needs. Pedestrian travel is not a separate, specialized, unique or secondary subject, but MUST be fully integrated into all roadway design, in all contexts. Pedestrian accommodation should be a fundamental element of all roadway planning, design and maintenance.
- There are many wonderful models out there for pedestrian planning, design, and operations. Many of them, however, lie outside of the U.S. Please take a look at the German/Dutch/Scandinavian models and include them in the guide.
- In Japan instead of concrete sidewalks they build concrete curbing as edging of the sidewalk and fill between with asphalt which is more flexible and will resist cracking along with less uplifting cracks over which people will stumble.
- Wherever there is wording to "minimize crossing distance" it should be replaced by "provide adequate crossing time". Too often curb extensions are built (expensive) to minimize the crossing distance and then the bicycles lose the clearance they had before in a wide outside lane. Curb extensions are EXPENSIVE and very often HINDER bicycles and other road users. As long as crossing time is adequate, this is enough.
- Could you inform planning agencies that the guide is out. I know this may be difficult but at least let APA know.
- AASHTO needs to do much more work with human factors folks and incorporate the knowledge of human behavior into the design standards at all levels. Refusal to incorporate human behavior factors into urban design has led to ever wider, flatter and faster streets with commensurate increases in accidents, crime, reduced pedestrian and vehicular access and declines in residential, business property values adjacent to these types of streets.

- More discussion on what should be done when cities refuse to put in improvements that do not accommodate non motorized transportation.
- Montgomery county project engineers really need to read this guide, because there are horrific disconnects.
- My statement is based on me being an engineer that supervises highway and bridge construction contracts.
  In my opinion, a determination needs to be made to establish if walking is essential along a highway or the walking is only recreational. For the essential pedestrian accommodations should be made, but if there is no essential need accommodations should not be required. Accommodations can be very expensive.
- Universal design is key. The aging of America needs to be considered now so that our facilities are designed and built for all mobility levels and so we aren't so far behind in accommodating all people in the future.
- Should meet the ADA compliance
- I would need to see the existing copy, but don't have time to secure one for purposes of this survey. AASHTO has been doing great things to embrace good urban design around roadways and this would seem to be another important tool that will be used by those designing our roadways.
  The Willamette Pedestrian Coalition in Portland, Oregon would be happy to provide further comments. Our website is www.wpcwalks.org and we can be reached at info@wpcwalks.org or 503-223-1597. Steph Routh is our Director. Thank you!
  Phil Selinger, Board President
- many options for design around freeways and busy multilane freeway connections management of walkspace through suburban parking lots
- Thanks for offering this survey and improving the AASHTO Ped Guide!
- Hopefully the guide will:
  Be a compilation of US and international best practices.
  Include a discussion of the role pedestrian facilities play in complete streets.
- I must find a copy
- It needs to fully embrace access for pedestrians with disabilities. Also, disabled pedestrians/experts should be consulted.
- Pedestrian facilities benefit the local community and need to be funded and maintained by the local community.
- Education of drivers needed to be emphasized. Often they are completely unaware of pedestrians even when the peds have the right of way. Most often this is when people are making right turns and pedestrians are trying to cross in the crosswalk and the right turning drivers do not yield. More adequate signage should be required to better inform drivers.
- The next edition needs more information for pedestrian treatments for different roadway types (i.e. two-lane, multi-lane roadways) that includes motor vehicle volumes, pedestrian volumes, and low speed versus high speed roadways.

- Haven't seen one yet, so I can't say...
- It is great that the Ped Guide is being updated, but promotion of the Guide, and of the philosophy that pedestrians are not afterthoughts in street design is needed.
- Required reading for every planner, traffic engineer, planning board member and politician in the country. Review other countries' manuals.
- Include a link not just to signal design, but also signal timing. Reference the Signal Timing Manual where appropriate.
- It needs to feature a discussion of how the guide relates to design guidance adopted by each state. While it is a guide, the concepts get operationalized when adopted by a State as part of its own manuals which are prescriptive.
  Also some discussion of how the guide can be used by local jurisdictions and transportation professionals.

CHAPTER 3: PROPOSED CHANGES TO THE GUIDE

This chapter recommends changes that should be incorporated in the update to the 2004 AASHTO Pedestrian Guide. The changes that are proposed were based on: 1) new research; 2) new Federal, State and local guidance and common practices; 3) stakeholder feedback (the survey described in Chapter 2; and 4) professional judgment.

The footnotes in this chapter refer to relevant sources for various proposed changes to the Guide. The source lists are not intended to be comprehensive, rather they point to the most relevant documents that will support revisions to the content of the Guide. The numbers (in parenthesis) after each source correspond with the numbered list of sources in Chapter 1.

3.1 CHANGES APPLICABLE TO ENTIRE GUIDE

Many changes have occurred at the Federal and State level that will impact the next edition of the AASHTO Pedestrian Guide. Some of these changes, such as the imminent adoption of new accessibility standards and the adoption of a new 2009 MUTCD, have rendered the current Guide obsolete. In addition, the field of pedestrian planning and design is advancing at a rapid rate due to widespread concerns among government agencies and citizens that much of our current transportation system does not adequately meet the needs of pedestrians. Much investment has been made in pedestrian research and the development of new technologies to improve pedestrian safety. A comprehensive update of the Guide is therefore necessary.

Additional Exhibits

In general, the exhibits in the 2004 Guide are inconsistent in style and are insufficient to illustrate important concepts throughout the Guide. This chapter recommends numerous locations in the Guide where new exhibits are needed. In general, a consistent style of photographs, drawings, captions and numbering are needed throughout the new Guide. A reasonable goal would be to ensure that every page of the new Guide has either a photograph or drawing that illustrates the concepts described in the text on that page.

ADA

Accessibility standards and guidance in the U.S. have undergone significant changes in the years since the 2004 Guide was published. The 2004 Guide therefore does not provide current and adequate guidance on how to meet ADA design requirements. This problem is systemic throughout the planning and design chapters of the 2004 Guide. In 2005, the United States Access Board published draft *Public Rights-Of-Way Accessibility Guidelines* (PROWAG). While widely used and adopted (in part or in whole) by many State and local agencies, it has not been formally adopted by the U.S. Department of Justice, which is required in order for the PROWAG to become part of the *Americans with Disabilities Act Accessibility Guidelines* (ADAAG).

In the meantime, the 2009 MUTCD includes a number of provisions that are currently in the PROWAG, and therefore provides an interim resource on accessibility guidelines and standards.

It is anticipated that the PROWAG will be published in late 2010. The revised Guide must incorporate the new guidance throughout the document, though timing may be an issue if adoption of the PROWAG guidance is further delayed. Priority should be given to design guidance on sidewalks, intersections and signalization. It will be important that the new AASHTO Pedestrian Guide provide an adequate level of detail on accessibility issues, so that the designer does not have to refer to multiple sources for basic design guidance for pedestrian facilities in the public right-of-way.

The delays in publishing the PROWAG have contributed to some confusion surrounding ADA compliance requirements. Those surveyed about the 2004 Guide identified the need for better ADA guidance as the most important issue to address in the revised Guide. The revised Guide should explain the concept of Universal Design, making the point that good design benefits everyone.

Finally, panel members for this report noted that there is a lack of clarity when it comes to defining what constitutes resurfacing. While this is a policy issue and should not be addressed in a planning and design guide, the revised Guide should highlight the fact that all resurfacing projects are subject to ADA regardless of funding source and that resurfacing projects may result in requirements to retrofit sidewalks and curb ramps.

Manual on Uniform Traffic Control Devices (MUTCD)

On December 16, 2009, FHWA published a revised MUTCD. Similar to the 2003 MUTCD, pedestrian traffic control standards are integrated throughout the update manual. Revisions to the MUTCD are now anticipated for completion on a five year cycle, which is considerably faster than previous MUTCD revisions. This will mean that the new AASHTO Pedestrian Guide will need to closely coordinate with revisions to the MUTCD, as these have a considerable impact on the Guide.

Resources

Additional "Resources" are listed at the end of each chapter of the 2004 Guide. However, it is not clear if these are "Works Cited" or a list of documents that provide additional information.

The revised Guide should provide a list of "Works Cited" at the end of each chapter. A separate list of additional "Resources" could also be provided as an appendix.

Guide Usage

The 2004 Guide has not been as widely used and accepted by transportation professionals as might be expected or desired for an AASHTO Guide. When asked how often they used the Guide, 28.6% said rarely or never; another 42.2% said they used the Guide only a couple of times per year. When asked why they don't use the Guide, 31% didn't know it existed and 27.9% said they did not have access to a copy of the Guide.

Similar to the AASHTO Guide for the Development of Bicycle Facilities (AASHTO Bike Guide), the revised AASHTO Pedestrian Guide needs to take on a more prominent role in directing State and local pedestrian planning and design. Various strategies to accomplish this should be explored including the development of workshops and summary materials that point out the changes between the 2004 and revised Guide.

The Pedestrian Guide should be a more comprehensive resource. At the present time, pedestrian guidance is contained in three major resources – the ADAAG, the MUTCD and this Guide. Comparatively, bicycle guidance is in only two major sources - AASHTO Bike Guide and the MUTCD (ADAAG by inference), making it easier to access. The AASHTO Pedestrian Guide needs to address all pertinent topics that apply to the public right-of-way. This should become easier when the PROWAG is formally adopted and can be incorporated into the next AASHTO Pedestrian Guide.

New Approaches to Public Rights-of-Way

New approaches for defining and organizing public rights-of-way have developed since the 2004 Guide was published. They are reflected in new terminologies that are increasingly being used by Federal, State and local government agencies. Here are some of the more important ones to include in the revised Guide:

Complete Streets

More than 100 States, Counties and Cities have adopted "complete streets" policies in recent years. Complete streets are designed and operated to enable safe access for all users including pedestrians, bicyclists, motorists and public transportation users. Complete streets policies direct transportation professionals to consistently design with all users in mind. The revised Guide should point out opportunities to introduce complete streets policies as a strategy for improving pedestrian safety and accessibility; and how Complete Streets policies complement FHWA policies where a consideration of pedestrian accommodations are likely to be required on all roads and streets.

Green Streets

There is a growing emphasis in the development of environmentally-friendly street design in the transportation field. This includes projects that retain and treat storm water runoff within the right-of-way, reduce the heat island effect, introduce more plant material into the right-of-way and minimize the width of the street. The revised Guide should point out opportunities to introduce “green street” strategies in combination with pedestrian facilities such as median refuges, curb ramp design, curb extensions, and traffic calming devices. Shared Streets

A "shared street" is an urban design concept aimed at integrated use of public rights-of-way. Shared space removes the traditional segregation of motor vehicles, pedestrians, bicyclists and other road users. It is a concept that is being tried on a limited basis in some cities. The revised Guide should provide guidance for where shared streets may be appropriate and refer readers to other sources for further information.

(Note on Parking Lots: Parking lots can be considered as a type of shared street though they are outside the purview of States and most local transportation agencies and therefore may not be appropriate for this Guide. The revised Guide should refer readers to other sources including the AASHTO Green Book which provides guidance on transitions between streets, sidewalks, driveways and parking lots, as well as AASHTO guidance on park and ride facilities, which provides guidance on parking lot design.).

In the United States, a "woonerf" refers to a type of shared street in that it represents a street that removes traditional segregation of motor vehicles, pedestrians, bicyclists and other road users. The term originated in the Netherlands where pedestrians and bicyclists have legal priority over motorists on a street designated as a woonerf. Typically, children are allowed to play in the street and motorists are restricted to a walking speed. The revised Guide should define woonerf as a type of shared street and provide guidance for where woonerfs may be appropriate and refer readers to other sources for further information.

<u>Total Street Capacity</u>

"Total street capacity" is an approach that counts people, not just motor vehicles. For example, a bus carrying thirty people would be counted as thirty; a car carrying two people would be counted as two. Pedestrians and bicyclists are also counted. Total street capacity is often used in before and after studies to measure the impact of lane reduction projects (road diet - e.g. going from four lanes to two lanes with bike lanes and a center turn lane). For example, a study might show that while motor vehicle capacity stayed the same after a reduction in the number of lanes, the overall capacity of the street increased when pedestrians and bicyclists were counted. The revised Guide should introduce the concept of "total street capacity" and point out ways that can be useful in guiding traffic management policies.

3.2. CHAPTER BY CHAPTER CHANGES

The following format was used to organize recommendations for each chapter:

1. New Sections. These are topics that should be added to a chapter.

2. Changes by Section. These are recommended changes to 2004 Guide that are introduced as *Substantive, Update, Revise, Addition, Delete, Wording, Combine, Move and Reorganize.* The intent is to provide direction regarding the action to be taken. In some cases, two or more actions are recommended. 'Substantive' means that the action involves a major change in policy, approach or

design. ‘Update’ and ‘Revise’ are most often used when there is new research or direction in the 2009 MUTCD that requires a change. ‘Addition’ and ‘Delete’ mean just what they say. ‘Wording’ is used when the intent of a sentence or paragraph could be clarified by using a different word or combination of words. ‘Combine’, ‘Move’ and ‘Reorganize’ are used to describe actions that would change the placement of content thereby changing the table of contents in the revised Guide.

Chapter 1: Introduction

NEW TOPICS

Definitions

Update and Move: The *Glossary of Terms* (Definitions) is at the very end of the 2004 Guide. The Glossary is also out of date.

Consideration should be given to moving it into the Introduction. The Glossary should be updated to reflect changes in the field. Terms used in the text of the revised Guide that reflects new technologies, new legislation and new ways to describe policies and programs. Terms to be added to the glossary include: complete streets; green streets; shared streets; modular streets and total street capacity.

CHANGES TO THE INTRODUCTION BY SECTION

1.1 Purpose

Update /Move: The language in the 2004 Guide, in addition to defining the purpose, touches on the MUTCD, the AASHTO Green Book, ADA issues, TEA-21 and FHWA Guidance. The information is out of date, does not directly speak to the purpose of the Guide, and is disconnected from additional information found in 1.3 Design Regulations and Guidelines.

The MUTCD, AASHTO Green Book, ADA, TEA-21 and FHWA information needs to be updated and moved to 1.3 Design Regulations and Guidelines. The 'Purpose' should be concise and to the point. The 2009 Bike AASHTO Guide provides a good model.

1.2 Scope

Wording: The 2004 Guide states that "... in some areas of the guide, design criteria have been provided to indicate suggested minimums. Where deviations from these suggested minimum or from an agency's guidelines are needed, the deviations should be considered on the basis on an engineering study and the rationale for not conforming to this guide or an agency's guidelines should be documented" (pp 2&3). This could be read to mean that a deviation is needed when the minimum is exceeded.

This language should be revised in the new Guide to make it clear that a deviation is only needed when the minimum is not achievable and a design exception or design variation is needed. *Move*: The 2004 Guide has a one-sentence description of the four phases of a project: Concept Definition; Planning and

Alternatives Development; Preliminary Design and Final Design. It is not clear how this information is relevant to the scope and is disconnected from a more detailed discussion found in Section 2.3.*1 Integrating Pedestrian Issues into Transportation Planning Studies.*

This information should be moved and integrated into Section 2.3.*1 Integrating Pedestrian Issues in Transportation Planning Studies.*

1.3 Design Regulations and Guidelines

Addition, Update and Move: This section provides a short description of five manuals and guides that "include pertinent information on pedestrian design and should, therefore, be used in conjunction with this guide." Section 1.2.5 *Accessibility Laws, Regulations, and Standards*, in addition to being out of date, provides a much higher level of context and detail than what is provided for the other manuals and guides.

The revised Guide should have a new introductory paragraph that provides rationale for selecting the manuals and guides for inclusion in this section. Included should be language that explains how the Pedestrian Guide builds on and compliments these other manuals and guides but does not in all cases cover every topic that other guidelines cover. It should also include a description of the next edition of the *Highway Capacity Manual* (expected in 2010), which will include multi-modal quality of service based on user comfort considerations, which is a major change from previous HCM methodology. Section 1.2.5 should be re-written to reflect the latest ADA guidance for the public right-of-way. Specific ADAAG guidance should be incorporated throughout the revised Guide.

Chapter 2: Planning for Pedestrians

NEW TOPICS

Walking Trips

The 2004 Guide does not provide adequate guidance on how to increase the number of walking trips. A community that wants to use the Guide to identify the most effective ways to increase walking will not be able to easily figure out what strategies work best. Recent research is very conclusive – density and proximity (distance) to jobs, shopping and transit are the biggest determinate of walking volumes.[1]

[1] *Built Environment Correlates of Walking: A Review*, 2008 (116); *A Meso-Scale Model of Pedestrian Demand*, 2008 (162); *Travel and the Built Environment and Synthesis*, 2001 (118); *Walkability of Local Communities: Using Geographic Information Systems to Objectively Asses Relevant Environmental Attributes*, 2007 (148); *Low-Traffic Developments: Adjusting Site-Level Vehicle Trip Generation Using URBEMIS*, 2005 (168); *Trip-Generation Rates for Urban Infill Land Uses in California: Phase 2, Data Collection,* 2009 (169)

The revised Guide should provide direction on how to increase the number of walking trips. This guidance should be under a new section on land-use (2004 Guide only addresses site design). It should include a discussion on the relationship between density and proximity (distance) to jobs, shopping and transit, along with specific strategies for achieving changed land-use patterns. Discussion should be limited to key points (land-use is not the central focus of the Guide) and references for further guidance should be provided. The revised Guide should draw on recent (and soon to be published) research and experience of urban and suburban areas to identify successful strategies for increasing the number of walking trips.[2]

Pedestrian Safety

Safety along with achieving interconnectivity and access should be considered when setting priorities and adopting traffic management design and operation guidelines. The 2004 Guide does not provide adequate guidance on how to select infrastructure improvements that will reduce pedestrian crashes. A community which wants to use the Guide to identify the most effective ways to reduce crash rates will not be able easily select those measures that will be most effective.

The revised Guide should serve as an easy reference for identifying policies, design practices and countermeasures that will be most effective in reducing pedestrian crashes. Pedestrian research that identifies crash reduction factors (CRFs) factors for various countermeasures should be summarized in a new section. This discussion should include prioritized lists of proven policies and design practices.[3]

Pedestrian Facility Integration in Transportation Projects

The 2004 Guide does not provide adequate guidance on how to integrate pedestrian facilities into all transportation projects. While it provides guidance on how to integrate pedestrian considerations into various types of transportation planning documents, including some direction on context sensitive design, it does not go to the next step and provide specific policies and strategies to insure that pedestrian considerations are included at the project level. In the survey regarding the 2004 Guide, respondents voiced high levels of frustration concerning projects in their communities that failed to include adequate provisions for pedestrians.

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[2] *A Meso-Scale Model of Pedestrian Demand*, 2008 (162); *Critical Assessment of the Literature on the Relationships Among Transportation, Land Use, and Physical Activity*, 2005 (139)

[3] *Pedestrian and Bicyclist Intersection Safety Indices: Final Report*, 2006 (155); *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, 2004 (159); *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*, 2008 (187); *A Review of Pedestrian Safety Research in the United States and Abroad*, 2004 (188); *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. Volume 10: A Guide for Reducing Collisions Involving Pedestrians*, 2004 (189); *NCHRP Report 500 Volume 12: A Guide for Addressing Crashes at Signalized Intersections*, 2004 (196)

The revised Guide should provide clear guidance on how to develop policies and procedures that will ensure pedestrian facilities are included and safety issues addressed in all projects. Various strategies should be presented including a full discussion of complete streets and green streets, two strategies that have been successfully implemented by many States and local jurisdictions. Additionally, the revised Guide should include an example checklist or similar tool for assessing project compliance in addressing existing safety deficiencies, and should point out opportunities to use the checklist, including road reconstruction as well as road resurfacing projects when fresh pavement markings are being applied. Included in this discussion should be model policy language along with references for further information. The tone of this discussion should be factual rather than imploring.[4]

Data Collection and Analysis

The 2004 Guide does not provide adequate guidance on data collection and analysis. This includes a complete absence of information on pedestrian count and crash data.

The revised Guide should have a new section on data collection and analysis. Included should be a discussion of when and why data should be collected and how it can be used to develop policy and establish priorities. Special attention should be given to collecting and analyzing pedestrian count and crash data.[5] Findings from new research should be used to provide information on the causes of intersection and midblock crashes along with a discussion of crash variables - speed, volume and number of lanes.[6] New research findings should also be used to discuss the relationship between pedestrian volumes and crash rates (safety in numbers).[7]

Technical Analysis Tools

The 2004 Guide does not provide adequate guidance on technical analysis tools that support pedestrian planning. New research along with Federal/State/local guidance provides a variety of models for

[4] *Complete Streets: We Can Get There from Here*, 2008 (177); *Model Policy: Model Policy Outline for State Complete Streets Legislation,* 2010 (95); *Seattle Right-of-Way Improvements Manual*, 2005 (86)

[5] *How to Develop a Pedestrian Safety Action Plan*, 2009 (93); *Traffic Safety Facts: 2007 Traffic Safety Annual Assessment – Highlights*, 2008 (105)

[6] *Pedestrian and Bicyclist Intersection Safety Indices: Final Report*, 2006 (155); *Traffic Safety Facts: 2007 Traffic Safety Annual Assessment – Highlights*, 2008 (105); *Pedestrian and Bicyclist Intersection Safety Indices: User Guide*, 2007 (207); *Characteristics Related to Midblock Pedestrian–Vehicle Crashes and Potential Treatments*, 2006 (214); *Turning at Intersections and Pedestrian Injuries*, 2006 (234); *Advanced Yield Markings and Pedestrian Safety: Analyses of Use With Danish Offsets and Median Refuge Islands*, 2008 (278)

[7] *Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling*, 2003 (170); Safety *in Numbers: Data from Oakland, California*, 2006 (171); *Pedestrian Mid-block Crossing Difficulty, National Center for Transit Research,* 2001 (156); *A Methodology for Counting Pedestrians at Intersections: Using Automated Counters to Extrapolate Weekly Volumes from Short Manual Counts*, 2009 (186)

predicting demand, analyzing level of service and quality of service, and completing safety analyses (audits). Competing models along with a lack of consistency with regard to terminology has resulted in a certain amount of confusion for State and local transportation agencies. Fortunately, new methodologies are emerging and have become incorporated into other appropriate guidance manuals, such as the new Highway Capacity Manual (which includes a qualitative pedestrian level of service model), and the Highway Safety Manual. Technical analysis tools from these manuals should be discussed in the revised Guide.

In addition, more guidance is needed on integrating pedestrian analysis into more comprehensive transportation analyses, traffic impact studies, and regional travel demand models.[8] This section should explain both the opportunities and limitations of current strategies.

The revised Guide should have a new section on technical analysis tools that support pedestrian planning. Included should be definitions and discussion of pedestrian travel demand, level of service (LOS), quality of service (QOS), and safety analysis (audits).

The revised Guide should also include a discussion of Geographic Information Systems (GIS) as a tool for mapping, organizing detailed pedestrian data, measuring pedestrian demand and prioritizing projects[9].

Typical Pedestrian Plan Contents

The 2004 Guide provides some good guidance on integrating pedestrian issues into transportation planning studies, but does not provide guidance on what should be included in a comprehensive pedestrian plan (something many local jurisdictions have done successfully). In general, this section should be given a new title and should be updated. New information should be provided on how to conduct comprehensive pedestrian master plans that are independent of other transportation planning studies. The new text should cover the data needs of a modern pedestrian master plan, and should address how to balance need (demand) with physical deficits – each should be discussed separately, as these are separate analyses that should be included in the planning process.

Exhibit 2-3 should be reconsidered – it is too simplistic to be of much use and it is not supported with any text in this section (regional and statewide pedestrian plans are not mentioned). A chart that is

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[8] *Forthcoming Highway Capacity Manual* due in late 2010, early 2011 (157); *Multimodal Level of Service Analysis for Urban Streets,* 2008 (158); *Forecasting Pedestrian and Bicycle Travel Demands Using Travel Demand Model and Mode Share/Trip Length Data* (167); *Arlington County VA Master Transportation Plan: Pedestrian Element*, 2008 (87)

[9] *Method of Improving Pedestrian Safety Proactively with Geographic Information Systems: Example from a College Campus*, 2001 (145); *Walkability of Local Communities: Using Geographic Information Systems to Objectively Assess Relevant Environmental Attributes*, 2007 (148); *Georgia Department of Transportation: Pedestrian and Streetscape Guide*, 2003 (33);

somewhat similar to this could be helpful; however in general, exhibits should support a more thorough discussion in the text.

There are a number of local Pedestrian Master Plans that can be used as models for this section, including plans completed in Seattle, WA, Charlotte, NC, Sacramento, CA and Washington, DC. [10] Statewide Pedestrian Master Plans should also be consulted, such as those done for Washington State, Vermont, and Louisiana.

Pedestrian Operation and Safety

The 2004 Guide does not provide adequate guidance on pedestrian operation and safety. While there is a section on the Characteristics of Pedestrians (Section 2.2), there is no information on basic traffic principles for pedestrians and there is no information on the causes of pedestrian crashes.

The revised Guide should have a new section on pedestrian operation and safety at the beginning of 2.1. This section should explain that pedestrians have “operating characteristics” that vary broadly and continuously over ranges in different contexts, with no conveniently obvious boundaries or behaviors that can be used to classify them; even children and senior pedestrians, often considered as distinct populations, have very substantially varying abilities, skills, and behaviors. Some pedestrians in their 70s are faster and more nimble than some pedestrians in their 40s. This section should craft an appropriate explanation of this and some general information on differences between various pedestrian populations, stressing that these are generalizations. The Guide should then focus on incorporating discussions regarding pedestrians with special operating characteristics *directly into the sections* dealing with the design element that may be impacted by those operating characteristics.

It would be helpful in this section to include a summary of traffic principles for pedestrians that are applicable in multiple contexts. An example would be the principles for crossing a street at an uncontrolled intersection. Finally, there should be a summary of the causes of pedestrian crashes. Included should be a discussion of different patterns of crashes, depending upon context. For example, walking along the roadway crashes are over represented in rural areas and driver violation at intersections are over represented in urban environments. This should be followed by a discussion of contributing causes of pedestrian - motor vehicle crashes and recommended countermeasures.[11]

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[10] *City of Denver, CO, Pedestrian Master Plan*, 2004 (92); *City of Oakland, CA, Pedestrian Master Plan,* 2002 (90); *City of Berkeley, Berkeley Master Plan*, 2010 (63); “Put Your Money Where the People Are,” *Planning*, June 2009 (166)

[11] *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, 2004 (159); *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*, 2008 (187); *San Francisco Pedsafe II Project Outcomes and Lessons Learned*, 2009 (233)

2. CHANGES TO CHAPTER 2 BY SECTION

2.1.2 Walk Decision Factors

Update: This section has outdated information on walk decision factors, including guidance on distance and densities. The information should be updated using new research that further refines information on walk decision factors.[12]

2.2.1 Walking Speeds

Update: Figures should be reviewed and updated, as needed, using the revised 2009 MUTCD.

2.2.3 Mobility Issues

Move/Update: This section currently consists of a series of paragraphs, each devoted to educating the reader about pedestrians with different mobility issues. Mixed in is some useful information on user needs, ADA issues and design suggestions. However, this information is easily lost within the context of the narrative and is not likely to be used when designing pedestrian facilities.

In the revised Guide, relevant information impacting design, such as user needs should be updated and moved to the appropriate sections in Chapter 3 - *Pedestrian Facility Design*. For example, the paragraph on pedestrians with hearing impairments references accessible pedestrian signals (APS). In the revised Guide, information on the needs of pedestrians with hearing impairments should be part of the discussion of accessible pedestrian signals in Chapter 3.

2.2.4 Conclusion

Substantive: The language in this section states that "Sometimes it is difficult to balance the needs of pedestrians with those of other modes of travel." While true, there is no mention of the fact that many if not most pedestrian improvements benefit other modes. Left alone, this statement perpetuates the myth that accommodating pedestrians necessarily means trade-offs with motor vehicles (capacity, LOS etc), creating winners and losers.

The revised Guide should move away from the notion of balance which creates winners and losers. Instead, the focus should be on developing common goals built around safety, accessibility and total street capacity – a "complete streets" approach. Examples of pedestrian facilities that improve motor vehicle traffic flow and reduce crashes should be provided o.

2.3 Pedestrian Planning Strategies

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[12] *2008 National Household Travel Survey*, 2009 (98); *National Survey of Pedestrian and Bicyclist Attitudes and Behaviors*, 2002 (101)

Delete: This section provides a random list of "common characteristics of pedestrian-friendly urban communities." Topics range from a sentence on pedestrian oriented land uses to a sentence on street trees. It reads as a catch-all with no unifying theme. Suggest deleting this section in the revised Guide. Relevant information should be moved to a new section on Typical Plan Contents (see previous comment on p. 156).

2.3.2 Prioritizing Pedestrian Improvement Projects

Substantive: This entire section is dated and does not reflect modern pedestrian planning strategies. The recommendations for how to select locations for pedestrian improvement projects should be updated and should include a robust discussion of how to do pedestrian data collection (sidewalk inventories and assessments, curb ramp inventories and assessments, intersection assessments, etc).

Also, the 2004 Guide does not provide adequate guidance on how to use crash data to set priorities. Rather than reciting percentages of pedestrian crashes by categories, this information should be organized to help the reader to identify high crash locations, high crash corridors, high crash neighborhoods and high crash typologies (e.g. protected permissive left terns).

The revised Guide should include a thorough review of crash data, and should provide best practices for organizing pedestrian crash data. This should be followed by a discussion of how this information can be used to identify pedestrian project and program priorities and incorporated into departmental work plans. [13]

2.3.3 Rural Considerations

Substantive: This section includes the statement that "sidewalks may not be needed on local streets with traffic volumes less than 400 vehicles per day." This statement can potentially be misinterpreted to apply to suburban areas as well, as the lines between what is classified as "suburban" versus "rural" are often grey. Sidewalks are, in fact, needed on both sides of all suburban streets as otherwise people are required to walk in the road.

2.3.4 Phased Development of Sidewalks

Substantive: In general, this section of the 2004 Guide is weak and provides the wrong advice on this topic. A practical discussion of sidewalk retrofit projects is needed, with instructions on how to deal with neighborhood opposition to sidewalks, and how to minimize disruption that sidewalk construction can cause to existing front yards (examples – reallocate roadway space so that sidewalks are constructed within the original curb lines of the street, creative ways to avoid damaging trees, etc).

[13] *How to Develop a Pedestrian Safety Action Plan*, 2009 (92); *Policy and Planning Strategies to Support Walking: Land Use Policies*, 2010 (96)

The 2004 Guide discusses space for sidewalks, triggers for sidewalks in rural areas and sidewalk funding. No other pedestrian facilities are discussed thereby giving the impression that sidewalks are the most important and possibly the only type of pedestrian facility that needs to be addressed.

In the revised Guide, the content of this section should be expanded to include a discussion of all pedestrian facilities, including sidewalks. Space requirements, triggers for pedestrian facilities and funding are issues that should always be addressed, regardless of facility type.

2.4.1 Development Practices and 2.4.2 Strategies in Pedestrian-Friendly Ordinances

Substantive/Addition/Combine: Section 2.4.1 provides a short list of topics considered important to development practices. However, there is no explanation as to why they are important and there is no guidance regarding best practice. For example, it lists block length with no explanation as to why it is important and how it relates to planning for pedestrians.

Sections 2.4.1 and 2.4.2 fail to distinguish between what would typically be in a street design manual, standard specifications, zoning regulations and subdivision regulations. They only speak to new land development and do not discuss the fact that these guidelines and regulations are also used to guide infill and re-development projects.

Sections 2.4.1 and 2.4.2 should be combined in the revised Guide. The combined section should start with a brief explanation of the different regulatory tools, and how they are used to guide development. This should be followed by a discussion of the basics of good roadway design for pedestrians including a revised, limited list of topics that are most important to pedestrian safety, access, transit and use. Each topic should include a short discussion of best practices with references provided for further guidance.[14]

2.4.3 Pedestrian-Oriented Site Development

Substantive/Addition: This section provides a short list of topics considered important to site development. There is no explanation as to why they are important and the descriptions are so brief that they do not fully convey what is being suggested. Noticeably absent is a discussion on the design of drive-through and corner sites.

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[14] San Diego Association of Governments, *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region,* 2002 (72); *Policy and Planning Strategies to Support Walking,* 2010 (96); *Washington D.C. Pedestrian Master Plan: Appendix C Pedestrian Policy Analysis*, 2008 (30)

The revised Guide should include a revised list of key design elements that are important to pedestrian oriented site development.[15] Each design element should include an 'exhibit' that visually communicates the concept being discussed. It may be possible include multiple concepts on a single 'exhibit'.

2.4.6 Pedestrian-Only Site Design

Addition: The revised Guide should be expanded to include "green streets", "shared streets", “woonerfs" and other new terms to describe car- free (or almost free) areas.

2.5 School Site Planning and Design

Reorganize/Revise: The 2004 Guide devotes almost eight pages to school site planning and design. This is understandable and reflects the growing interest in this important topic. The section as currently written, however, presents some unique challenges. The narrative is long and tedious, and the organization is confusing and hard to follow. In some cases, information on facility design is duplicative or should be in another section. In other cases, the information is simply out of date.

This entire section needs to be revised to reflect new research along with Federal and State programs that have flourished in recent years. The title of this section should be changed to reflect the content which is much broader than just school site planning and design. Where appropriate, 'exhibits' should be added to illustrate planning principles and discussions on design should be referred to the next chapter on pedestrian facility design. More detailed recommendations for subsections of 2.5 are provided below.

2.5.1 Special Considerations Related to Children

Addition: This section provides a list of special considerations related to children. However, it does not provide guidance on how to use this information to shape education and enforcement programs or make changes to the transportation infrastructure. There is no language that that links this section to subsequent sections.

In the revised Guide, this section should be updated and expanded to include a discussion on how this information should be used to develop and prioritize policy, program and infrastructure strategies discussed in subsequent sections. Additionally, the needs of children should be incorporated throughout the revised Guide, including the sections on design. For example, sight distance requirements of children should be considered when locating and designing crossings for children.

2.5.2 Community Response to School Safety

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[15] *How to Develop a Pedestrian Safety Action Plan*, 2009 (92); *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation: Lessons 2 and 8*, 2006 (97)

Delete/Move: This section consists of a short paragraph on community response to school safety that partially duplicates information already presented. This section is out of sequence and should be deleted with non-duplicative material moved to the introductory section (2.5).

2.5.3 School-Related Pedestrian Improvements

Reorganize/Update: There is mix of unrelated topics in this section of the 2004 Guide. It starts with a discussion of school based programs followed by sub-sections on school location, site design, access routes to school, school bus stop design and visibility at crossings.

The revised Guide should have a new section that focuses just on school location and site design. New research and guidance should be used to revise and update this material. This section would also benefit from new 'exhibits' that demonstrate the most important (priority) school location and design elements.[16]

In the revised Guide, the first part of this section on school-based pedestrian improvements (school-based programs), and the subsection on pedestrian access routes to school should be moved and integrated into Section 2.5.5 *Safe Routes to School*. The sub-sections on school bus stop design and visibility at crossings and along school walk route should be moved to Section 2.5.4 *Traffic Control and Crossings Near Schools.*

2.5.4 Traffic Control and Crossings Near Schools

Substantive/Reorganize: This section is currently divided into three sections - a shopping list of things to consider when conducting a traffic study at a school, a second list of potential types of crossings and traffic control improvements, and a more detailed discussion of speed zones, traffic calming flashing beacons and crossing guards. It is incomplete and fails to provide guidance on the decision making process for fully analyzing and improving pedestrian crossings.

Revising this section will be challenging since the solutions for creating good crossings require knowledge and understanding of many other planning and design considerations found throughout the Guide. Additionally, the principles of conducting a traffic study and designing a good crossing are fundamentally the same, regardless of whether it is a school crossing. The difference between school and non-school crossings are reflected more on the programmatic side. For example, school crossings may receive priority treatment when deciding where to make crossing improvements. Additionally, school crossings often have crossing guards and student patrols and they may be targeted for enforcement and education activities.

[16] *Children's Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School*, 2008 (104); *School Trips: Effects of Urban Form and Distance on Travel Mode*, 2006 (117); *Travel and Environmental Implications of School Siting,* 2003 (176)

The revised Guide should have a new section on that provides direction on the thought process for evaluating and designing better crossings at uncontrolled locations.   Included should be a list of things to consider and observe when conducting a traffic study along with a discussion of various traffic control options.[17] The discussion needs to reference (but not duplicate) specific design guidance in Chapter 3 - *Pedestrian Facility Design*. This new section should be in Chapter 3 - *Designing for Pedestrians*, possibly as an introduction to the section on marked crosswalks.

This section of the 2004 Guide should be revised to include a short discussion on design and programmatic strategies unique to increasing walking and improving pedestrian safety near schools. Items to consider include school pick-up and drop-off zones, school zone signing, pedestrian (and bicycle) routes to school, cross guard and student patrolled crosswalks, targeted education and enforcement programs. These are solutions that are most often applied near schools though some may be applied elsewhere. Discussion should be limited to a few key points and references (examples) for further guidance should be provided.

Crossing Guards and Student-Patrolled Crosswalks

Update: The revised Guide should be updated to reflect the 2009 MUTCD which changes operating procedures for crossing guards from recommended to required.

2.5.5 Safe Routes to School

Substantive: This section of the 2004 Guide provides a short introduction to Safe Routes to School (SRTS) followed by a bulleted list of steps for developing school walking routes. The information is incomplete and not very useful to anyone starting a SRTS program.

The revised Guide should integrate child pedestrian safety issues throughout, and should address school walk zone issues in the appropriate sections (i.e. signing and marking strategies in school zones). This section should not attempt provide detailed guidance on planning SRTS programs. This topic is too broad to adequately cover in this Guide; also there are other excellent resources on this topic, such as the information available through the National Center for Safe Routes to School. Instead, SRTS should be described and introduced as an important and dynamic planning opportunity that should be addressed by State and local communities. This should include a brief discussion of the reasons for implementing a SRTS program along with references to other materials for further guidance. This section should be fairly generic and should not discuss Federal legislation in specific terms, as the legislation will evolve in future years.

2.6 Neighborhood Traffic Management and Traffic Calming

Substantive/Move/Delete: The 2004 Guide devotes almost nine pages to neighborhood traffic management and traffic calming. The discussion, however, is limited to neighborhood streets and

[17] *How to Develop a Pedestrian Safety Action Plan*, 2009 (93)

almost completely ignores arterial streets. It also fails to discuss traffic calming within the larger context of speed management.

This section should be re-written under the revised title of Speed Management on Arterial and Neighborhood Streets (don't use the term "traffic calming"). It should start with a thorough discussion of why speed is an issue (it is directly related to the severity of pedestrian injuries), and how good planning and design can be used to manage speeds. Included should be a discussion of street and land use elements that affect speed. Specific traffic calming treatments should be presented as tools that are sometimes needed when good design is not enough to manage speed.[18] This section should be cross-referenced with the new section on speed management tools suggested for Chapter 3 - *Pedestrian and Facility Design.*

Consideration should be given to moving or deleting the twelve traffic calming techniques described and illustrated in the 2004 Guide. They are incomplete and don't fit well into Chapter 2 - *Planning for Pedestrians*. If kept in the revised Guide, they should be given more detail and moved into Chapter 3 - *Pedestrian Facility Design*. References for other guides on speed management should be provided.

(Insert section on Pedestrian Malls and Transit Streets here – see page 176)

2.7 Other Programs to Increase Pedestrian Safety

Substantive: The 2004 Guide touches on education and enforcement but does not provide guidance on how they can complement infrastructure improvements to reduce pedestrian crashes. An analysis of crash reports alone can lead to the conclusion that bad behavior on the part of both pedestrians and motorists is the cause of most crashes, thereby reducing the need for making infrastructure improvements and increasing the need for stand-alone education and enforcement programs.

The revised Guide should address misconceptions that infrastructure plays a minor role in pedestrian crash rates. In the revised Guide, this section should be re-written with a short discussion on the effectiveness of developing complementary engineering, education and enforcement strategies. Discussion on education and enforcement should be limited to a few key points and references (examples) for further guidance should be provided.

[18] *Variation in Free Flow speed due to Roadway Type and roadside Environment*, 2007 (180); *Pedestrian Facilities Users Guide*, 2002 (10); *Traffic Calming: State of the Practice* 1999 (22) ; *Relationship of Lane Width to Safety on Urban and Suburban Arterials*, 2007 (178); *Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections: Supplement to NCHRP Report 613*, 2007 (203)

Chapter 3: Pedestrian Facility Design

General issues: Chapter 3 of the 2004 Guide dedicates 18 pages to sidewalk design (3.2) and 16 pages to intersection design (3.3). Together, they make up about 65 percent of this chapter. Intersection design issues are complex and should be covered in more depth. In addition, the revised Guide should add new language that discusses the relationship between sidewalks (moving along the street), and intersection design (crossing the street). The revised Guide should also explain how sidewalk and intersection designs must complement each other to create complete systems. These issues are further discussed in the recommendations below.

NEW TOPICS

Relationships Between Facility Types

The 2004 Guide does not explain the relationships between various facility types and their designs. Currently, they are presented as independent treatments. For example, a tight curb radius and a sidewalk that is set back from the street (i.e. there is a furniture zone) is needed to properly place two directional ramps which in turn allow for proper placement of the marked crosswalk which affects the placement of the stop bar. These elements in combination affect the turning speed, crossing distance and signal timing. If jurisdictions only focus on one or two design elements such as curb ramps and marked crosswalks, they are likely to install a facility that does not fully address pedestrian safety and accessibility.

The revised Guide should provide direction on how to build complete systems that clearly demonstrate the relationships between various types of facilities, while also providing the level of detail that is necessary in order to design each element. Special attention should be focused on intersections and sidewalks, and how the two complement each other when properly designed. At least four new 'exhibits' are needed: 1) an intersection with multiple design elements along with text explaining their relationships; 2) a sidewalk within the context of the curb, furniture and frontage zones (see p. 170 for a full discussion on zones) with text explaining their relationships; 3) a sidewalk approaching an intersection with text explaining how use of the sidewalk zone system leads to better intersection design; and 4) a sidewalk at a driveway that illustrates how the design can reinforce yielding behavior on the part of motorists entering and leaving the driveway.

Traffic Signs and Signals for Pedestrians

The 2004 Guide covers traffic signs and signals in the final chapter entitled Pedestrian Facility Operation and Maintenance. This topic is proposed to be relocated to Chapter 3, and substantially updated, as described in the discussion of Chapter 4.

CHANGES TO 2004 GUIDE BY SECTION

Addition: An introduction should be added that provides an overview of Chapter 3, similar to the introduction to Chapter 2 - *Planning for Pedestrians.*

3.1 Designing Roadways to Accommodate Pedestrians

Substantive/Move/New: The chapter begins with a discussion of seven planning principles that duplicates some of the information found in 2.3 Pedestrian Planning Principles. For example, both sections address connectivity and circulation. Additionally the language once again stresses the need for balance, suggesting that accommodating pedestrians always requires trade-offs with motor vehicles, creating winners and losers rather than a complete streets approach, which achieves benefits for all users.

Material that is duplicative with Chapter 2 should be deleted, and non-duplicative material should be moved to the appropriate location in Chapter 2 - *Planning for Pedestrians.* The discussion on balance should be deleted since it is already addressed under 2.2.4 Conclusion.

The current section should be replaced with a short section titled 'Elements of Design'. The intent is to identify design elements important to pedestrian safety such as surface condition of sidewalks, geometric design of intersections, issues related to controlled versus uncontrolled crossings, and signal operation.

3.1.1 Speed Management

Substantive/Addition: The design chapter of the 2004 Guide does not provide adequate guidance on how to manage speed. Addressing this issue is extremely important since pedestrian research indicates that excessive speed contributes to crash frequency and severity and is one of the most common consumer complaints received by transportation professionals. Conversely, vehicular capacity is always a concern when considering countermeasures to manage speed. Of particular concern are State routes through small towns and arterials adjacent to schools. Both should be directly addressed, as they are critical issues for State DOTs.

While the current Guide starts out by saying that it is important to reduce speeds to improve pedestrian safety, it fails to provide guidance on how to reduce design speed and operating speed. The current Guide is also silent on the relationship between speed and motor vehicle capacity. Instead, the focus of the discussion is on defending use of the 85th percentile speed of motor vehicles as a way to set speed limits. It correctly points out that motorists will typically travel at a speed that feels comfortable and that simply lowering the speed limit will increase the number of violations without changing actual prevailing speeds. However, no remedies are provided for reducing travel speeds. The tone is one of sympathy for reducing speeds combined with a sort of helplessness for being able to change long-standing practices.

The guide should support a "complete streets" approach to roadway design. A community should be able to use the Guide to identify the most effective ways to manage speeds on arterial streets while maintaining capacity for motor vehicles. The revised design chapter should provide an easy reference for identifying proven design practices that will be most effective in managing speed on arterial and non-arterial streets, as this is critical to pedestrian safety. This information should be summarized in a revised section that includes proven design practices such as eliminating protective permissive signal operations. There should also be a discussion of the relationship between speed and motor vehicle capacity. Depending on the type of road and other conditions, increasing speed does not always result in increased motor vehicle capacity. The revised section should be cross referenced to the revised section on speed management suggested for Chapter 2 - *Planning for Pedestrians.*

3.1.2 Roadway Widths

Revise/Substantive: This section addresses three important topics - roadway width (including number of lanes), lane reductions and narrowing lanes. However, the information is dated and contains information that no longer reflects current research and practice. For example, the text suggests that an alternative to wide streets is to use two or more parallel streets as one-way couplets. In practice, this seldom results in narrower streets and is something increasingly opposed by communities trying to revitalize their downtown areas. In fact, many cities are eliminating one-way couplets in favor of traditional two-way streets. When discussing lane widths, the text states that the selection of lane widths involves "balance between competing needs" and that the "considerations in reaching such a balance include safety, traffic operational efficiency and mobility". The text incorrectly implies that reducing lane widths usually compromises safety, efficiency and mobility. [19]

This is a very important section and should be revised and expanded to reflect the latest research and experience of local communities. Included should be a full discussion along with 'exhibits' of roadway widths, lane reductions and narrowing lanes. Research has identified street width/the number of lanes along with ADT and speed as the most important variables to consider when assessing safety at crosswalks.[20] Research has also shown that reducing lane widths (but still within AASHTO Guidelines) does not lead to more crashes.[21] Experience has shown that reducing the number of lanes does not

[19] *The Truth About Lane Widths* (181); *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities* (179)

[20] *A Resident's Guide for Creating Safe and Walkable Communities*, 2008 (94); P*edestrian Mid-block Crossing Difficulty*, 2001 (156); *Improving Pedestrian Safety at Unsignalized Crossings*, 2006 (161); *A Meso-Scale Model of Pedestrian Demand*, 2008 (162); *A Review of Pedestrian Safety Research in the United States and Abroad*, 2004 (188), *Characteristics Related to Midblock Pedestrian–Vehicle Crashes and Potential Treatments*, 2006 (214); *Motorist Yielding To Pedestrians at Unsignalized Intersections: Findings From A National Study on Improving Pedestrian Safety*, 2006 (234)

[21] *Relationship of Lane Width to Safety on Urban and Suburban Arterials*, 2007. (178)

necessarily reduce capacity and often reduces injury related crashes for all users, including motorists.[22] Finally, the term "refuge islands" should be replaced by the term "crossing island" here and elsewhere in the revised Guide, as this term more effectively explains their purpose in unemotional terms.

3.1.3 Curbs

Addition: The current Guide does a good job of discussing vertical curbs and sloping curbs. The revised Guide should include an additional note on how this is also an ADA issue. Sidewalks built immediately adjacent to sloping curbs enable motor vehicles to park on the sidewalk thereby blocking access for all pedestrians including those with disabilities.

3.1.4 Sight Distance and Sight Lines

Addition: The current Guide does a good job of discussing the importance of sight distance and sight lines. The revised Guide, however, should include additional information on the placement of curb extensions. They are more important at crosswalks located at uncontrolled locations and crossings near schools. Nearside is more important than far side when addressing sight lines. Curb ramps should not extend more than six feet from the curb to avoid creating a problem for bicyclists.

3.1.5 Lighting Overview

Revise/Addition: The 2004 Guide does not provide adequate guidance on lighting. While it correctly notes that two-thirds of all pedestrian fatalities occur during low-light conditions, it does not provide adequate guidance on how to locate and direct lighting at crosswalks. The short discussion, results in a failure to communicate the importance of addressing this issue.

The importance of providing adequate lighting as a way to address crash issues should be given more prominence in the revised Guide. Revised language should be based on recent research that identifies optimum placement and luminary levels of lighting. This should be demonstrated with new plan view 'exhibits' of properly placed lighting at crosswalks. Included should be information on proper procedures for measuring luminary lighting levels in the field.[23] Finally, the title of this section should be changed from "Lighting Overview" to "Lighting".

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[22] *A Resident's Guide for Creating Safe and Walkable Communities*, 2008 (94); *Relationship of Lane Width to Safety on Urban and Suburban Arterials* , 2007 (178); *Road Diet Handbook*, 2007 (183); *A Guide for Achieving Flexibility in Highway Design*, 2004 (2);

[23] *A Resident's Guide for Creating Safe and Walkable Communities*, 2008 (94); *Informational Report on Lighting Design for Midblock Crosswalks*, 2008 (281); *Influence of Vertical Illuminance on Pedestrian Visibility in Crosswalks*, 2006 (283); *Relationship of Vertical Illuminance To Pedestrian Visibility in Crosswalks*, 2008 (285); *The Role of Ambient Light Level in Fatal Crashes: Inferences from Daylight Saving Time Transitions*, 2002 (287)

3.2 Sidewalk Design

Addition: The section should begin by reinforcing statements made in the beginning of the chapter regarding the importance of coordinating sidewalk design with intersection design to create complete systems.

Revise: Section 3.2 of the 2004 Guide includes a list of 'attributes' of well-designed sidewalks. However, they read like planning principles and duplicate some of the information found in 2.3 *Pedestrian Planning Principles* and 3.1 *Designing Roadways to Accommodate Pedestrians*. Suggest that the principles be re-written to directly address design considerations that are covered in more detail later in the Guide. For example, the paragraph on "Adequate Width" should state that five feet is needed for pedestrians to walk side-by-side; the paragraph on "Continuity" should state that all four legs of a signalized intersection should usually be marked so that there is no need for "pedestrians to travel out of their way unnecessarily"; and the paragraph on "Safety" should state that sidewalks should not be built immediately adjacent to the curb so that will not "feel they are at risk due to the presence of adjacent traffic." The examples should be limited to the most important design considerations. Non-duplicative material in the 2004 Guide that does not lend itself to discussing specific design considerations (e.g. Social Space), should be moved to 2.3 Pedestrian Planning Principles.

Wording: The first sentence of Section 3.2 currently states that "All roadways along which pedestrians are not prohibited should include an area where occasional pedestrians can safely walk...." Using the word "occasional" in the very first sentence in the discussion of sidewalks reinforces the notion that sidewalks are rarely used and are therefore not a good expenditure of public funds. The word "occasional" should be deleted in the revised Guide.

3.2.1 Types of Pedestrian Facilities

Revise: The 2004 Guide has a paragraph on "Shared Streets" and a mention of "woonerfs". The revised Guide should also mention "green streets" and then refer readers to the definition of these terms (see page 149 of this report).

3.2.2 Sidewalk Installation

Wording: The language in the first paragraph of this section refers to "new construction" and "reconstruction" of sidewalks. It could be read to indicate that sidewalks are only built as part of larger construction or reconstruction projects. This language should be revised to make it clear that sidewalks can be built as stand-alone projects or as a part of larger land development or roadway projects.

Substantive: The 2004 Guide states that "A useful rule-of-thumb for existing roadways is that sidewalk installation should be considered when the roadway drainage is changed from shoulders and open ditches to a curb-and-gutter section with drainage grates and sewers. This usually occurs when the level of roadside development increases to the point where open drainage ditches are no longer considered appropriate, except in those areas where natural drainage is retained for ecological and/or aesthetic reasons. The needs and desires of local communities should be considered in deciding where sidewalks should be provided."

As previously mentioned, there is a growing emphasis in the development of environmentally-friendly street design in the transportation field. As natural drainage becomes more popular, it is no longer a useful "rule-of-thumb" to equate sidewalk construction with the installation of curbs and gutters. Increasingly, sidewalks are being constructed in conjunction with natural drainage projects. Additionally, the concept of tying roadside development to sidewalk development is problematic in that it often results in arterial streets in built-out areas that lack sidewalks. It is a classic chicken and egg situation. First, there is not enough development to warrant a sidewalk and then when the area is fully built-out, there is neither space nor money to construct the sidewalk. Finally, the last sentence referring to local "needs and desires" is easily interpreted to mean that sidewalks are optional, even when there are significant access and safety issues that need to be addressed (e.g. sidewalk to a school bus stop).

The revised Guide should recommend that sidewalks should be built on both sides of the street whenever a roadway is widened or improved due to growth. This should be followed by a discussion regarding exceptions to this "rule-of-thumb". For example, there may be physical and financial constraints that prohibit installation of a sidewalk on both sides. However, the assumption should always be that sidewalks will be installed unless there are compelling arguments to the contrary. This change in approach should also be applied to the discussion of “Rural Roadways", "Local Urban and Suburban Streets" and "Urban Collectors and Arterials". References to local "needs and desires" should be deleted. Finally, Exhibit 3-4 on "Effective Walkway Width" is misplaced and should be moved to Section 3.2.3 Sidewalk Widths.

New Section on the Zone System

Addition: Prior to Section 3.2.3 *Sidewalks Widths*, recommend the revised Guide include a new section on the streetscape zone system as articulated in the FHWA sponsored course titled *Designing for Pedestrian Safety* (Module 2). The streetscape consists of four parts: the Curb Zone, the Landscape/Furniture Zone, the Pedestrian Zone and the Frontage Zone. Dividing the streetscape into four distinct parts ensures that each will be given the detailed design attention required to make them work together as an integrated system. The text below defines important concepts that should be communicated in this new section.

The Curb Zone is defined as the area between the edge of the roadway and the front edge of the landscaping/furniture zone area. This zone provides the transition from the streetscape area to the adjacent roadway. Curbs are typically six to eight inches and ‘Rolled’ curbs should never be used since they enable motorists to park on sidewalks. Where there are street crossings, the curb is removed and curb ramps are installed. These transition areas should be designed and maintained to accommodate persons with disabilities.

The Landscape/Furniture Zone is defined as the area between the top of the curb and the front edge of the walkway. Objects in the landscape/furniture zones should be set back a minimum distance from the face of the street curb (the new Guide should explore whether this distance should be defined). This zone buffers pedestrians from the adjacent roadway and is the appropriate location for street furniture, art and landscaping. It is also the preferred location for street trees, and other elements such as pedestrian lighting, hydrants, bike racks and below grade utility hatch covers. Transit zones are also located in the landscape/furniture zone and are designated for transit customer waiting and loading and may include signage, shelters, benches and litter receptacles.

The Pedestrian Zone is the area of the sidewalk corridor that is specifically reserved for pedestrian travel. In general, widths should be comfortable for the anticipated variety of uses, well lit and work in all seasons including winter. Street furniture, plantings, outdoor seating and other fixed items should not protrude into the pedestrian zone. The surface material should be smooth, stable and slip resistant and should minimize gaps, rough surfaces and vibration causing features.

The Frontage Zone is defined as the area between the sidewalk and the property line. Frontage zones can accommodate sidewalk cafes, store entrances, retail display or landscaping. A frontage zone is not needed if the sidewalk corridor is adjacent to a landscaped space.[24]

Included in the revised Guide should be an 'exhibit' demonstrating each of the four streetscape zones.

3.2.3 Sidewalk Widths

Substantive: The 2004 Guide states the minimum clear width for a sidewalk should be four feet. However, this contradicts the statement in 3.2 Sidewalk Design that states that two people should be able to walk side-by-side and pass a third person. It also suggests that the ITE Highway Capacity Manual be used to assess the sidewalk width needed to accommodate particular volumes at a desired level of service (LOS).

The revised Guide should recommend a five foot minimum for sidewalks, which is the minimum width needed to walk side-by-side and pass another pedestrian, and is also the minimum width needed for two wheelchairs to pass. Whereas the draft PROWAG allows four-foot sidewalks with five-foot passing areas every 200 feet, this does not prevent AASHTO from establishing a five-foot minimum sidewalk width to adequately accommodate pedestrians. This is an issue that is central to a “complete streets” approach. This discussion should include options for narrowing other elements of the roadway to allow for increased sidewalk width in new construction or major reconstruction projects, in order to reduce the cost of right-of-way acquisition, such as providing travel lanes that are narrower than 12 feet in width.

[24] *A Resident's Guide for Creating Safe and Walkable Communities*, 2008 (94); *Federal Highway Administration*: *Designing Sidewalks and Trails for Access – Part 1 of 2, Review of Existing Guidelines and Practices: Chapter 4 Sidewalk Design Guidelines and Existing Practices,* 1999 (6); *Federal Highway Administration, Designing Sidewalks and Trails for Access—Part 2, Best Practices Guide*, 2001 (7)

Additionally, LOS as found in the 2000 Highway Capacity Manual is often not a good guide for determining sidewalk width. Using a motor vehicle measure that suggests less traffic is good for traffic flow does not translate to pedestrian facilities in most situations. While LOS can be a good tool for determining space needs in some situations, such as at bus stop with heavy boardings and alightings, or a crowded urban street in a downtown core, it does not work for sidewalks in many situations where the goal is to increase the number of pedestrians by improving their sense of comfort and safety in the road environment.

This discontent with traditional level of service methodologies is reflected in new approaches that have been developed since the publication of the 2004 Guide. The new Highway Capacity Manual which is scheduled to be published in late 2010 or early 2011 will introduce quality of service to the LOS determination. This section should refer back to Chapter 2 – Planning for Pedestrians for a full discussion of pedestrian quality of service measures and other ways of incorporating pedestrians in comprehensive transportation analyses.

The revised Guide should consider inclusion of a table with recommended sidewalk widths. Another option would be to refer to other guides. For example, the pending NCHRP Project 07-17, *Methods to Improve Physical Condition for Pedestrians and Bicyclists along Existing Roads*, may be a good reference if completed when this Guide is revised.

3.2.4 Buffer Widths

Addition/Revise: The 2004 Guide does not adequately explain the relationship between the provision of buffers, curb ramp design, driveway design and intersection geometry. Additionally, it states that that the desirable width for a landscape buffer for local or collector streets is 2 to 4 feet which is not enough space to plant street trees.

As previously discussed (p. 164), the revised Guide should use new 'exhibits' to clearly demonstrate the relationships between various facilities including buffers, curb ramps, sidewalks and intersections geometry. Additionally, the recommended minimum width for buffers should never be below five feet (six preferred) to allow for planting of street trees.

3.2.5 Transit Connections

Move/Substantive/Addition: The 2004 Guide does not provide guidance on how to integrate pedestrian facilities with transit. There is almost no discussion of the relationship between transit ridership and the provision of sidewalks and safe crossings to access transit stops. As transit systems expand and ridership grows, issues related to transit safety and accessibility will become increasingly important. At a minimum, this topic should be given an equal amount of attention in the revised Guide as pedestrian access to schools.

The revised Guide should include a new, separate section on transit that focuses on how to integrate pedestrian facilities with transit. A new section called “Transit Access” should be inserted just before

3.5 Grade Separated Crossings. There should be a thorough discussion along with new exhibits on the placement of transit stops in relation to safe crossing locations and sidewalks. This section should discuss pedestrian-oriented transit station design (including a new exhibit), provide guidance on ensuring pedestrian access and safety on surface transit routes (including bus-only routes, fixed transit ways, etc), and should include information on pedestrian LOS as it relates to transit LOS.[25] An exhibit should show the correct placement of a bus shelter with respect to the clear width of a sidewalk.

In general, this section should describe pedestrian improvements as support strategies for increasing transit ridership, in a factual rather than imperative tone.

Delete: The 2004 Guide states that curb ramps should be placed at bus stops. This guidance should be deleted. Since a ramp indicates a crossing, visually impaired pedestrians may be inadvertently led into the street at a potentially unsafe location.

3.2.6 Driveway Access Management

Addition: The 2004 Guide does not provide guidance on the placement of driveways near intersections and crosswalks. Driveways placed too close to intersections can increase motor vehicle and pedestrian crashes and are not allowed by many transportation agencies. The revised Guide should provide guidance on this topic including a new 'exhibit' with recommended setbacks from the intersection.[26]

Revise: The 2004 Guide includes an 'exhibit' that demonstrates four acceptable and one unacceptable driveway design. The text correctly points out that the preferred driveway design allows the sidewalk to remain level and in a continuous direction and that options with 'dipped' sidewalks are to only be used when necessary. However, the 'exhibit' and text do not adequately demonstrate the safety benefits of good driveway design.

The revised Guide should include additional language that explains the safety benefits of 'level' versus 'dipped' sidewalks. The 'exhibit' should be changed to focus the reader on the preferred driveway design. Additionally, it needs to be stated that the final driveway Exhibit (fifth out of five) does not meet ADA and is therefore not legal.

3.2.7 Grade and Cross Slope

Revise/Addition: The guidance on grade is confusing and incomplete with regard to ADA. Exhibit 3.11 indicates that the maximum allowable grade is five percent for sidewalks "Not adjacent of Public ROW". However, it is not clear what is meant by 'Public ROW'. For example, does it include publicly owned

[25] *Pedestrian Safety Guide for Transit Agencies,* 2008 (184) *Multimodal Level of Service Analysis for Urban Streets*, 2008 (158); *Accessible Pathways to Bus Stops and Transit Facilities: A Process Guide,* 2009 (23); *Comparing Transit-Oriented Development Sites by Walkability Indicators*, 2004 (150)

[26] *Urban Street Geometric Design Handbook*: *Chapter 3 Access Management*, 2008 (16); *City of Portland, Oregon City Code and Charter: Chapter 17.28 Sidewalks, Curbs and Driveways,* (89)

street rights-of-way where the street has not been developed? What about publicly owned utility corridors? Additionally, there is no guidance on how to mitigate excessive grades.

In the revised Guide, requirements on maximum allowable grades along with options to mitigate excessive grades should be in accordance with the draft PROWAG or subsequent guidance that may be adopted and supersede PROWAG in the future. The U.S. Access Board is currently considering the development of guidelines for shared use paths in independent rights-of-way (not adjacent to streets) which could have big impact on what should be included in the next edition of this Guide. The terminology used in the next AASHTO Ped Guide should match with the terminology and new guidance provided by the Access Board.

3.2.8 Stairs

Addition: Additional clarification on how to meet ADA requirements is needed with regard to stairs in rights-of-way too steep to allow for the construction of roadways or sidewalks. This section should acknowledge the challenges inherent in areas of steep terrain and provide examples of creative approaches that have been taken in these areas to accommodate pedestrians with disabilities.

3.2.9 Sidewalks for Highway bridges, Underpasses, and Tunnels

Substantive/Revise: The 2004 Guide states that the minimum clear width for a curb-attached sidewalk on a bridge is four feet. This contradicts the statement in 3.2 Sidewalk Design that states that two people should be able to walk side-by-side and pass a third person. It also fails to mention that four feet is only allowed under ADA if passing spaces of at least five feet in width are provided to allow wheelchair users to pass one another or to turn around.

The revised Guide should recommend a five foot minimum for sidewalks which is the minimum width needed to walk side-by-side and pass another pedestrian.

Delete: The 2004 Guide states that "Normally, pedestrians are not permitted in long tunnels." There is no basis for this statement and it is not clear what is meant by 'long'. There are examples of well-designed pedestrian facilities through tunnels in the U.S. (e.g. I-90 tunnel in Seattle) and throughout the world.

3.2.10 Surface Treatments

Move: The 2004 Guide places this section under the discussion of sidewalks even though it addresses crosswalks which are encountered while crossing the street. Placing the discussion under sidewalks implies that surface treatments are primarily sidewalk issues and are only secondarily crossing issues.

This section should be moved to the end of 3.1 Designing Roadways to Accommodate Pedestrians (just prior to 3.2 Sidewalk Design). This will give this important topic more prominence and make the point that addressing surface treatments is a pedestrian facility design issue, not just a sidewalk issue.

Wording: The 2004 Guide states that "Crosswalks that are constructed with bricks or pavers may be outlined with white lines, per MUTCD specifications, to help motorists detect the presence of the crosswalk." The revised Guide should be reconciled with the 2009 MUTCD guidance on the use of color to delineate crosswalks. The revised Guide should make the point that installing brick or other pavement treatments at crossing locations do not necessarily establish legal crosswalks, unless other design measures are taken per the MUTCD (and depending upon the rules of each particular State). The point should also be made that most decorative crosswalks do not improve visibility of crossing markings to approaching drivers.

3.2.11 Pedestrian Facility Lighting

Delete/Move: This section consists of a short discussion on pedestrian lighting that partially duplicates information already presented. This section is out of sequence (lighting is important for all pedestrian facilities - not just sidewalks) and should be moved with non-duplicative material to Section 3.1.5 Lighting.

3.2.12 Obstacles and Protruding Objects

Move: The 2004 Guide places this section under the discussion of sidewalks even though it addresses drainage grates and railroad crossings which are often encountered while crossing the street. Placing the discussion under sidewalks implies that obstacles and protruding objects are primarily sidewalk issues and are only secondarily crossing issues.

This section should be moved to the end of 3.1 Designing Roadways to Accommodate Pedestrians (just prior to 3.2 Sidewalk Design). This will give this important topic more prominence and make the point that addressing obstacles and protruding objects is a pedestrian facility design issue, not just a sidewalk issue.

Wording/Move: The 2004 Guide states that "To ensure that visibility is not compromised along sidewalks and walkways, a local government may establish ordinances that require property owners to maintain their property free of obstacles for the benefit of others." This could be interpreted to suggest that property owners own the sidewalk which is not always the case. Furthermore, the design chapter is not the appropriate location to discuss the need for ordinances. This sentence should be re-worded to more broadly discuss the issue of maintenance as it relates to visibility, rather than defining who should be responsible for it. Further discussion of this topic should be moved to Chapter 4.

Addition: While the 2004 Guide properly addresses drainage grates, it fails to provide visual examples of preferred designs. A new 'exhibit' of preferred drainage grates should be provided in the revised Guide.

Addition: While the 2004 Guide properly addresses railroad crossings, it fails to adequately address crossing angles. The revised Guide should include additional information on the importance of improving the approach if the alignment of if the skew angle is less than 60 degrees.

3.2.13 Ambience, Shade, and Other Sidewalk Enhancements

Move/Delete: The 2004 Guide begins this section with a discussion of comfort and being welcomed by place. It reads more like planning guidance than design guidance. This information should be moved with non-duplicative material into appropriate sections of Chapter 2 - *Planning for Pedestrians.*

Revise: The 2004 Guide's discussion of street trees focuses on the problems that can be caused by street trees - barriers to visibility, interference with overhead utilities, sidewalk heave, sidewalk blockage and grate tripping. This combined with a later discussion on 'clear recovery area policies' for motor vehicles could mislead the reader into thinking that trees are more trouble than they're worth. In fact, many State and local transportation agencies have policies that severely limit or ban the use of trees along arterial streets.

This section should be re-written and expanded in the revised Guide. There should be a more balanced focus on the benefits of trees along with better direction on how to address the challenges they present. There should be more design detail for locating and planting trees and information on how street trees can help manage vehicular speed in areas where lower speeds are desired. This section should provide more information on the appropriate size of tree pits on urban streets. It should describe the merits of individual tree pits versus continuous tree pits, various grate designs for urban street trees, and their relationship to sidewalk clear width.[27]

Revise: The 2004 Guide discusses 'Buffer Zones' only within the context of creating separation from vehicular traffic and providing a place for street trees and other plant materials. It does not explain the relationship between buffer zones and the design of driveways, curb ramps and marked crosswalks (see p. 14 on the relationship between facility types). As worded, its reference to 'clear recovery area policies' could be read to imply that buffer zones pose a safety problem for motorists.

The revised Guide should list all the design benefits of buffer zones and refer the reader to the discussions on the relationships between facility types and the streetscape zone system. The language on 'clear recovery area' should be rewritten and moved to the discussion of street trees.

Addition/Move: The 2004 Guide treats pedestrian malls and transit streets as a single topic. Very little is said about transit streets and organization of the material could be read to suggest that the advantages and disadvantages of pedestrian malls and transit streets are the same. There is no recognition of the fact that transit streets are flourishing in many urban centers.[28]

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[27] *Urban Street Design Guidelines*, Charlotte, 2008 (75); Street Design Manual, New York City, 2009 (78)

[28] *Streets for People and Transit*, 1986 (181)

This section should be moved to Chapter 2 Planning for Pedestrians, just before 2.7 Other Programs to Increase Pedestrian Safety. The revised Guide should separate the discussion of pedestrian malls and transit streets. Examples should be cited and used to provide a complete discussion of transit streets. Included should be a discussion of 'full time' and 'rush hour only' transit streets along with design guidance and references to other materials.[29]

3.2.14 Off-Road and Shared-Use Paths

Substantive: This section of the 2004 Guide provides a short introduction to off-road and shared-use paths followed by a bulleted list of design principles. The information is incomplete, out of date and not very useful to anyone designing an off-road or shared-use path.

The revised Guide should not attempt provide design guidance on off-road and shared-use paths. This topic is too large and is beyond the main scope of this Guide. Instead, off-road and shared-use paths should be described and introduced as an important pedestrian facility that should be considered by State and local communities. Readers should then be referred to the AASHTO Guide for the Development of Bicycle Facilities for detailed design guidance. This section should, however refer to Section 3.2.7 regarding grade requirements for paths that are not located adjacent to roads, per the earlier discussion.

3.3 Intersection Design

Addition: The 2004 Guide starts out by listing six attributes of a good intersection. However, better clarity is needed on how to integrate the six attributes into the design of a single intersection. Suggest adding a new 'exhibit' of an intersection that demonstrates the principles of a good intersection.

Addition: The 2004 Guide's list of six attributes of a good intersection fails to mention pedestrian access. The assumption should be that pedestrians will be able to cross all four legs of an intersection unless there is a compelling safety reason to prohibit a particular crossing movement. 'Access' should be added as an attribute of a good intersection.

Addition: The 2004 Guide also fails to mention the design speed for vehicular turning movements when listing the attributes of a good intersection. Turning movements are a major cause of pedestrian/motor vehicle crashes and speed can contribute to the frequency and severity of pedestrian/motor vehicle

[29] *Walking Wins Out*, Planning Magazine Article, May/June 2010 (135).

crashes.[30] The design speed of turning movements can be managed through geometric design (e.g. curb radius) and other traffic control measures. 'Speed Management' should be added as an attribute of a good intersection.

Addition: The revised Guide should include a new section right-of-way assignment. The 2009 MUTCD provides new guidance on the factors to be considered when establishing intersection right-of-way control. This includes: vehicular, bicycle and pedestrian volumes; number and angle of approaches; approach speeds; sight distance and reported crash performance.

Addition: The revised Guide should relocate the section on signals and signs to this section of the Guide. This reflects the approach taken in the Draft AASHTO Bike Guide. These topics are integrally related to design and should therefore be covered here and substantially expanded per the discussion on p. 190.

3.3.1 Curb Radii

Addition: The 2004 Guide correctly addresses curb radii as the first topic under intersection design. The geometrics of an intersection tend to be fixed (not easily changed) and they form the framework for all other intersection design elements (e.g. location of curb ramps, marked crosswalks, stops bars, signal timing etc.). The revised Guide should have a new introductory paragraph that highlights the importance of intersection geometry, including curb radii, and how they affect other intersection design elements. For example, tight curb radii are needed in order to provide two curb ramps at each corner, which is recommended in PROWAG. Included should be a new 'exhibit' that demonstrates these relationships.

Substantive: The second sentence of this section states that "Curb radii should be based on an appropriate balance of the needs of pedestrians and the needs of heavy vehicles, such as trucks and buses." This statement should be followed by practical guidance on how to balance the needs of multiple users in the design of curb radii (with examples), and a more nuanced discussion on how tight curb radii can often benefit all road users (e.g. shorter crossing for pedestrians reduces walk time which increases signal efficiency).

Addition: The 2004 Guide states that "Curb radii should be appropriate for the largest design vehicle which makes a specific turning maneuver with sufficient frequency to serve as an appropriate basis for design." The revised Guide should provide additional language on what is meant by 'sufficient frequency' and how this along with other information should be used to determine the 'design vehicle'.

Addition: The 2004 Guide states that on "major arterials", the radius should be designed to allow turning vehicles to use all of the available roadway width in the direction of travel." This needs to be illustrated with an 'exhibit', similar the current 'exhibit' on effective curb radius.

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[30] *Guidelines for the Installation of Marked Crosswalks*, 2005 (41); *Pedestrian and Bicyclist Intersection Safety Indices: User Guide*, 2007 (155); *Turning at Intersections and Pedestrian Injuries*, 2006 (236); *Urban Street Geometric Design Handbook: Chapter 4 Intersections*¸2008 (16)

Addition: The revised, 2009 MUTCD includes a graphic demonstrating staggered stop bars as way to accommodate tighter curb radii. This should be included in the revised Guide.

Addition: The 2004 Guide fails to discuss design speed as a factor when determining curb radii. The revised Guide should include a new 'exhibit' that demonstrates the curb radii required for different design speeds in addition to different sized motor vehicles.

Substantive/Addition: The 2004 Guide ends the discussion of curb radii by stating that "Where there are heavy truck volumes, the maximum street corner radius may be increased…." While true in some situations, it is not the first course of action that should be considered.

The revised Guide should recommend that curb returns on arterial and residential streets should be as small as possible – typically 20 to 25 feet on arterial streets and 15 feet on residential streets. When there are high volumes of large vehicles, the first step should be to look at effective turning movements, allowable receiving lanes, staggered stop bars and design speed. This should be followed by a discussion regarding exceptions to this "rule-of-thumb". However, the assumption should always be that curb radii will be as small as possible unless there are compelling arguments to the contrary.

3.3 Intersection Design and 3.4 Midblock Crossings

Move/Reorganize/Substantive: These sections present some unique organizational and substantive challenges. Both sections have sub-sections with the same names that cover some but not all of the same topics. This includes 3.3.2 Crossing Distance Considerations and 3.4.1 Crossing Distance Considerations; and *Design Dimensions of Crossing Islands* (p.75) and *Design Dimensions of Crossing Islands (p.91)*. The organizational challenge is how to cover design elements applicable to both intersection and midblock crossings without causing duplication, and at the same time addressing some of the design issues unique to each crossing type. This is further complicated by the fact that the 2004 Guide sometimes fails to differentiate between design issues that apply to intersection and midblock crossings and those that don't. For example, 3.3.2 Crossing Distance Considerations correctly states that "Short crosswalks help pedestrians cross streets". However, the 2004 Guide fails to mention that this is also true for midblock crossings. The discussion of curb bulbs at intersections fails to mention that they provide most of the same advantages at midblock locations. Many other examples could be provided regarding these organizational challenges.

The revised guide should have a new section titled "Design of Intersections and Midblock Crossings". Design elements common to intersections and midblock crossings should be combined in this section. This should be followed by two sub-sections, one on design issues unique to intersection crossings and the other on design issues unique to midblock crossings. This approach will highlight the similarities of intersection and midblock crossings while avoiding duplication. Pointing out the similarities between intersection and midblock crossings has the secondary benefit of "normalizing" midblock crossings. Midblock crossings are categorically rejected in some jurisdictions as "unsafe". The revised Guide should make it clear when and where midblock crossings are appropriate.

3.3.2 Crossing Considerations

Curb Extension Design

Addition: The 2004 Guide discussion of curb extensions fails to address how they should interface with transit stops. The revised Guide should include a full discussion of this topic including the relationship between near/far side curb extensions and near/far side transit stops; and the use of curb extensions to create in-lane transit stops.

Addition: The revised Guide should include an 'exhibit' that demonstrates the design of a half and full curb extension – one graphic with an extension on just one street; another graphic with an extension that wraps around the corner onto both streets.

Addition: The revised Guide should include a discussion regarding the relationship between curb extensions, curb radii and design speed. Curb extensions and curb radii are two different though related design issues. Curb extensions, for example, can actually increase motor vehicle turning speeds (thereby decreasing pedestrian safety) if the curb radius is increased.

Crossing Islands and Medians

Substantive: The 2004 Guide incorrectly implies that painted medians, though not preferred, are crossing islands. Research clearly shows that painted medians do not improve pedestrian safety.[31] The revised Guide should clearly state that while crossing islands are a known crash reduction factor, painted medians are not crossing islands and do not convey safety benefits to pedestrians.

Move: The first sentence of the second paragraph states that "At signalized intersections, median islands provide a storage area for pedestrians to wait for the next available cycle if they are unable to cross the street entirely during a provided cycle phase." Three sentences later in the same paragraph the text states that "Median Islands should not be used to justify a signal timing that does not allow for pedestrians to complete their crossing in one cycle." These two sentences should be reversed within the paragraph to emphasize the point that signals should be timed to get pedestrians across the street in one cycle. The text should also explain the problem of having two pedestrian signal heads, one in the median and one on the far side. Pedestrians may see conflicting signals and may focus on the wrong signal when stepping into the street. The revised Guide should discuss the problems with two pedestrian signal heads and point out that this is another reason not to install signals with partial crossings.

Once a clear preference has been established for getting pedestrians across the street in one cycle, then follow up statements should be made explaining the requirements for median-mounted pedestrian

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[31] *Improving Pedestrian Safety at Unsignalized Crossings*, 2006 (161); *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines*, 2005 (275)

crossing devices if a full crossing cannot be achieved (including median-mounted pedestrian signals, pedestrian detectors if actuated operation is used, and signs) per the 2009 MUTCD.

Revise: Bullet three states that one of the attributes associated with good crossing island locations include "Two-collector and local access streets where they function as traffic calming devices and street calming aids." Crossing islands and medians may or may not reduce the speed of motor vehicle traffic. Medians may reduce speeds if they narrow traffic lanes and provide space to plant canopy trees. However, in some situations, medians can increase speed by eliminating left turns and improving traffic flow. This statement should be deleted in the revised Guide.

Design Dimensions of Crossing Islands

Revise: This section has a good discussion of crossing island widths and the use of angled median cut-through. However, the text fails to say whether the guidance refers to controlled or uncontrolled intersections. The revised Guide should clarify whether the guidance applies to controlled, uncontrolled or both types of intersections.

Addition: The revised Guide should include an 'exhibit' that demonstrates the best way to design a median cut-through that is ADA compliant and minimizes the maintenance required. Many cities have employed innovative designs that ensure positive water flow while minimizing the slope for wheelchair users.[32]

Skewed Intersections

Addition: The revised Guide should include an 'exhibit' that demonstrates how to rebuild an intersection to reduce or eliminate a skew. A second exhibit should demonstrate how to locate a marked crosswalk at a skewed intersection.[33]

Move: The third sentence of the first paragraph of the 2004 Guide states that "Several jurisdictions are experimenting with linear raised guide strips in the center of a crosswalk to aid pedestrians with vision impairments." While true, this is not directly relevant to skewed intersections and in general, discussions of experimentation should not be included in the Guide. In the revised Guide, this sentence should be moved to 3.3.4 Crosswalks – Marked Crosswalks.

Delete/Addition: This section consists of a bulleted list of generally good points related to topics that are covered elsewhere – curb radii, sight distance, signal timing, crossing distance, crossing islands illumination etc. While it duplicates information found elsewhere, it does a fairly good job of identifying some of the elements that go into designing safe, low speed intersections. Suggest that the narrative in

[32] *Federal Highway Administration*, *Designing Pedestrian Facilities For Accessibility Course: Module 5 Pedestrian Crossings*, 2008 (26)

[33] *AASHTO Guide for the Development of Bicycle Facilities: Chapter 2 Design, Path-Roadway Intersections*, 1999 (24)

this section be replaced with an exhibit that focuses on the relationships between these design elements (see previous comments on the 'Relationship Between Facility Types'; page 164).

Channelized Right-Turn Slip Lanes

Addition: The revised Guide should include an exhibit that demonstrates the proper and improper way to design a right-turn slip lane (triangular crossing island).[34]

Expressway Ramps

Addition: The revised Guide should provide crash data that demonstrates the higher than average pedestrian crash rates at intersections connected to expressway ramps.[35]

Addition: The revised Guide should include new language that stresses the importance of designing intersections connected to expressway ramps the same as any other well designed intersection. They should not be designed with wider lanes and larger curb radii which lead to higher turning speeds. Exceptions should be discussed, along with ways to address those situations, such as conditions where a conventional four-legged intersection at a freeway off-ramp would result in traffic backing up onto the freeway and thus increases rear-end collisions.

Roundabouts

Revise/Addition: The discussion of roundabouts in the 2004 Guide is out of date and needs to be revised to reflect new research on geometric design and traffic control guidelines, and on ways to accommodate pedestrians with vision impairments at roundabouts. Two important resources for this section will be the Federal Highway Administration's new Roundabout Guide, as well as any guidance on this topic that may be adopted in the ADAAG. Included should be a discussion of single lane versus multi-lane roundabouts and their effects on pedestrian safety. Since this topic is very large and is beyond the main scope of this Guide, discussion should be limited and the reader referred to other sources for further guidance.[36]

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[34] *Maryland State Highway Administration Bicycle & Pedestrian Design Guidelines: Chapter 10*, 2007 (35)

[35] *Balancing ADA Requirements, Alternative Modes, and Interchange Capacity*, 2004 (312) *Bicycle and Pedestrian Friendly Crossings at Freeway Interchanges* (315); *Statewide Safety Study of Bicycles and Pedestrians on Freeways, Expressways, Toll Bridges, and Tunnels*, 2001 (313); *Federal Highway Administration, Selecting Pedestrian Safety Improvements: Crash Types/Countermeasures Matrix* (as updated): 49 Pedestrian Push Button/Pole in Median (25)

[36] *Roundabouts in the United States*, 2007 (300); *Crossing Solutions for Pedestrians with Vision Disabilities at Roundabouts and Channelized Right Turn Lanes*, 2009 (305); *Pedestrian Access to Roundabouts: Assessment of Motorists' Yielding to Visually Impaired Pedestrians and Potential Treatments To Improve Access*, 2006 (309); *A*

Addition: The revised Guide should include an exhibit that shows the design details for a splitter island and pedestrian crossing. This should be accompanied by new language that refers the reader to the next section on marked crosswalks. The point should be made that marked crosswalks at splitter islands should be treated like any other marked crosswalk with number of lanes, ADT and speed being the critical variables.

3.3.4 Crosswalks

Addition/Substantive: The text in the 2004 Guide fails to adequately differentiate between marked crosswalks at controlled and marked crosswalks at uncontrolled intersections. Marked crosswalks at controlled intersections are mentioned but not covered in any detail.

The revised Guide should include a thorough discussion of marked crosswalks at controlled locations. Included should be guidance on stop bar design and the relationship between crosswalk markings, curb returns, signal timing and curb ramps. For example, curb ramps should be fully contained within the marked crosswalk.[37] Suggest adding a new exhibit to demonstrate these relationships.

Addition: The text in the 2004 Guide is silent on subject of school crossings. The revised Guide should define school crossings based on MUTCD definitions and requirements.

Addition: A new section is needed that addresses the relationship between crosswalks and curbside management which specifically discusses the differences between near-side and far-side crosswalks along with the signing and marking conventions as found in the MUTCD. In the 2004 Guide, a rudimentary discussion of this is found in the section on Curb Ramp Placement; however it should be expanded and included as a new section.

Crosswalks Defined

Review of Roundabout Safety Performance in the United States, 1999 (301); *Crash Reduction Following Installation of Roundabouts in the United States*, 2000 (303) *Federal Highway Administration*, *Roundabouts: An Informational Guide*, 2000 (11)

[37] *A Policy on Geometric Design of Highways and Streets*, 2004 (1); *Highway Design Handbook for Older Drivers and Pedestrians*, 2001 (8); *Special Report: Accessible Public Rights-of-Way, Planning and Designing for Alterations*, 2007 (17); *Draft Public Rights-of-Way Accessibility Guidelines*, 2005 (19); *Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers*, 2005 (28); *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, FHWA-SA-04-003, (Advanced Stop Lines) 2004, (159)

Update: The 2004 Guide states that "marked crosswalks serve two purposes: (1) to inform motorists of the location of a pedestrian crossing so that they have time to lawfully yield to a crossing pedestrian; and (2) to assure the pedestrian that a legal crosswalk exists at a particular location." This language is inconsistent with the 2009 MUTCD which provides revised guidance for provision of marked crosswalks. The revised Guide should be updated to reflect the 2009 MUTCD.

Marked Crosswalks

Revision: The 2009 MUTCD provides direction on how to evaluate a particular site to determine if a marked crosswalk is appropriate. Included is direction on number of travel lanes, speed and ADT. This direction should be included in the revised Guide.

Addition: The 2004 Guide correctly notes that pedestrians must be able to cross streets at regular intervals and that pedestrians cannot be expected to go a quarter mile or more out of their way to take advantage of a controlled intersection. However, this guidance is easily missed within the context of the longer narrative.

Also included should be a discussion of fencing as a way to control pedestrian crossings. While appropriate in some situations on a spot basis, systematic and widespread use of fencing usually indicates a lack of adequate crossing opportunities and should be discouraged in the revised Guide.

Crosswalk Design

Substantive/Addition: The 2004 Guide suggests a minimum width of six feet for a marked crosswalk and that 10 feet may be appropriate in some business districts of larger cities. The width of a marked crosswalk should be determined by anticipated pedestrian volume and motor vehicle speed (motorists have a harder time seeing narrow marked crosswalks at higher speeds), not whether it is in the business district of a large city. Wider crosswalks are also appropriate in other locations (for example, in the business district of a small city, or at a high volume pedestrian crossing on a rural road across from a community college, or a multitude of other locations), however the current language of the Guide would suggest that six-foot wide crosswalks should be used in these locations.

The revised Guide should recommend that the standard width for marked crosswalks be 10 feet, with a minimum width of six feet. Ten-foot wide crosswalks allow for easy, bidirectional pedestrian travel and it makes the marked crosswalk more visible if longitudinal or diagonal lines are used. In general, two parallel lines should be discouraged, especially at uncontrolled intersections, including school crosswalks, since they are less visible to motorists. This should be followed by a discussion of when wider or narrower marked crosswalks are appropriate due to unique circumstances such as high pedestrian volumes or physical constraints in the built environment. A new exhibit should be added that demonstrates the visual advantages of wider, longitudinal or diagonal lines. Exhibit 3-25 should be revised to include the 'piano' style marked crosswalk which staggers the diagonal lines to avoid placement of paint directly in the motor vehicle path of travel. This type of crosswalk is used by a number of U.S. jurisdictions to reduce maintenance costs, and is not precluded from use by the MUTCD, which offers other designs for high-visibility markings as options.

Addition: The text in the 2004 Guide correctly notes that colored and textured crosswalk design treatments are sometimes used. However, there is not enough guidance on when and where they should be used.

The revised Guide should point out that colored pavement alone does not meet MUTCD standards for a marked crosswalk. One of the MUTCD white paint line options is always needed regardless of whether other colors are used. The text should also point out that any color other than white will be harder to see at night. Consequently, use of colored materials should be discouraged at uncontrolled crosswalks. Additionally, any surface texture is going to cause unnecessary jarring for babies in strollers and persons in wheelchairs. If textured crosswalk designs are going to be used, then a four foot smooth zone that connects to the curb ramps on each end should be maintained in the center of the crosswalk. An exhibit should be added to demonstrate proper use of color and texture in marked crosswalks.

Stop and Yield Line Setbacks

Addition: The 2009 MUTCD provides for regulatory signs that can be placed at the stop (or yield) bar in advance of a marked crosswalk, and should address the whole issue of "multiple threat" crashes. These signs should be provided as exhibits in the revised Guide.

Revision: The recommended setback distances for stop/yield bars at marked crosswalks at uncontrolled locations should be revised to reflect updated MUTCD guidance.

3.3.5 Sidewalk and Curb Treatments at Pedestrian Crossings

Delete/Addition: The 2004 Guide begins this section with a short list of "attributes of a well designed intersection." They include Clear Space, Visibility, Legibility, Accessibility, Small Turning Radii and Separation from Traffic. While it duplicates information found elsewhere, it does do a good job of identifying some of the elements that go into a well designed intersection. The narrative in this section should be deleted and the reader should be referred back to the exhibit that shows 'Relationships Between Facility Types', as described on p.164.

Curb Ramp Design

Update/Revise: This entire section should be updated and revised to reflect current accessibility guidelines. It will be important that the revised Guide provide an adequate level of detail so the designer does not have to refer to other sources for basic curb ramp design. The introduction should make the point that curb ramps benefit everyone, not just those with disabilities.

Landings

Wording: The 2004 Guide states that "Existing facilities do not always have landing areas because of right-of-way restrictions or the presence of obstructions. However, landing areas that meet the guidelines presented above should be provided in new construction, reconstruction or alterations." While true, this could be misread to imply that nothing needs to be done pro-actively until construction/reconstruction happens to occur at a particular location. Local jurisdictions, however, are required to have a Transition Plan that actively identifies how all streets, including ramps that do not meet current guidelines, will be made compliant.

This section should be re-worded in the revised Guide to clarify that all non-compliant ramps must be made compliant as part of a locally-adopted Transition Plan.

Addition: Exhibit 3.28 in the 2004 Guide properly demonstrates a curb ramp with flares. However, as the text correctly points out, flares are only needed where the ramp abuts the paved portion of the sidewalk. In other cases where the ramp abuts landscaping, a curb can be used thus reducing impervious area. The revised Guide should expand Exhibit 3.28 to include a companion drawing of a curb ramp with a curb adjacent to the ramp.

Revise: Exhibit 3.30, 3.31 and 3.32 in the 2004 Guide demonstrate three acceptable curb ramp designs. The text correctly points out that Exhibit 3.3.0, Perpendicular Ramp, is the preferred curb ramp design. However, the Exhibit alone does not convey that this is the preferred design alternative.

In the revised Guide, the 'exhibit' should be changed to focus the reader on the preferred curb ramp design since not everyone will read the text.

Perpendicular Ramps

Move/Addition: The 2004 Guide discussion of perpendicular ramps correctly identifies four strategies for achieving a four-foot landing area at the top of a ramp. However, these solutions also apply to the other two types of ramps described – parallel ramps and diagonal ramps.

The four strategies for achieving a four-foot landing area should be moved to the section titled 'Landings'. New exhibits should be added to demonstrate each of the four strategies.

Addition: While the 2004 Guide correctly points out that the perpendicular ramp is preferred, it fails to adequately address its safety advantages. New language in revised Guide should explain that while perpendicular ramps direct pedestrians into the marked crosswalk, parallel and diagonal ramps may direct pedestrians, especially those with visual impairments, into the street, outside the marked crosswalk area.

Revise: Exhibit 3.3.1 and 3.3.4 in the 2004 Guide incorrectly show ramps without a landing area on the top of the ramp. The landing area is required and is especially needed to allow a wheelchair user to turn the corner on a flat surface. Failing to accommodate this movement is a common mistake that occurs when designers overly focus on providing for wheelchair users who want to cross the street. These exhibits should be corrected in the revised Guide.

Curb Ramp Placement

Revise: The 2004 Guide (first bullet point) states that the full width of a perpendicular ramp (exclusive of flares) must be within the crosswalk. While true, it is true of all types of curb ramps. This language should be changed to include all types of ramps in the revised Guide.

Move/Addition: The 2004 Guide (fourth bullet point) suggests using signs and parking enforcement to keep cars from blocking a crosswalk or curb ramp. However, no detailed guidance is provided on setback distances and how they might be regulated through adding signs and painting the curb.

This is a larger curbside management issue that should be part of the discussion of crosswalks, not just curb ramps. See the recommendations for a new section on this issue, on p. 183.

Detectable Warnings

Addition: The revised Guide should explain why detectable warnings are not required or desirable at driveway crossings since pedestrians have the right of way at these locations. Some communities have improperly installed them on driveways with dipped sidewalks (see Exhibit 3-10 Option C).

3.3.6 Street and Intersection Lighting

Delete/Move: This section of the 2004 Guide duplicates material covered in Section 3.1.5. This section should be deleted with non-duplicative material moved to Section 3.1.5.

3.4 Midblock Crossings

Addition: The revised Guide should include a new exhibit that demonstrates the total number of possible conflict points of a marked crosswalk at a midblock location versus an intersection. The intent is to demonstrate that one of the advantages of midblock crossings is that there are fewer possible conflict points.

Substantive: The 2004 Guide states that "because midblock crossings are not generally expected by motorists, they generally should be used only where they are truly needed…." This becomes a circular, self fulfilling argument. If they were used more widely, then it is possible that motorists would be more likely to expect them. The treatment of this subject should be more balanced and factual, rather than stating previously-held beliefs that have not been supported by evidence.

The need (demand) for midblock crossings has grown as block sizes have increased (super blocks). The language in the revised Guide should reflect a "complete streets" approach. It should be more encouraging of midblock crossings, as long as they meet the criteria for marked crosswalks.[38]

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[38] *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*, 2001 (160); *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines*, 2005 (275)

Delete/Addition: The 2004 Guide states that "In many jurisdictions, individual pedestrians may cross the roadway illegally at midblock locations, even when no crossing has been established." This statement is incorrect and should be deleted in the revised Guide. Most State laws only prohibit pedestrians from crossing midblock between two signalized intersections. If an intersection is not signalized, including stop controlled side streets, then a pedestrian is legally allowed to cross midblock (they must yield to vehicular traffic) unless specifically prohibited. This is an often misunderstood law and should be explained in the revised Guide along with a new exhibit. Readers should be encouraged to check their own State laws since there are exceptions.

Wording/Move: The 2004 Guide is repetitive in its listing of factors to consider when contemplating the installation of a midblock crossing. The second paragraph under midblock crosswalks lists a number of factors that are then listed again in a bulleted list on the next page. These should be combined with duplicative material deleted.

Delete: The 2004 Guide discussion of midblock crosswalks provides information on appropriate ADTs for installing marked crosswalks at midblock locations. It is incomplete and repeats information in 3.3.4 Crosswalks. This information should be deleted in the revised Guide.

Delete: The 2004 Guide (sixth bullet point) states that "The vehicle capacity of a roadway may not be substantially reduced by the midblock crossing." This is a catch-all phrase that could be used to prohibit most midblock crossings. It also puts motor vehicle capacity above pedestrian safety and is inconsistent with a "complete streets" approach. This bullet point should be deleted in the revised Guide.

3.4.1 Crossing Distance Considerations

Move/Reorganize: This section of the 2004 Guide duplicates some of the material found in 3.3.2 Crossings Considerations. The revised Guide should move and reorganize this section as previously described on p.180).

Update: The walking speeds in the 2004 Guide should be changed in the revised Guide to reflect new requirements in the 2009 MUTCD.

Design Dimensions of Crossing Islands

Move/Reorganize: This section of the 2004 Guide duplicates some of the material found in 3.3 Intersection Design, *Design Dimensions of Crossing Islands* (p. 75). The revised Guide should move and reorganize this section as previously described on p.180).

Substantive: One bullet in this section contains muddled guidance that "The lengths of medians and crossing islands should be as described in Section 3.4.1 Crossing Distance Considerations." Insufficient guidance is given on design dimensions of crossing islands in this section, and it is not appropriate for a section to refer to itself for more information.

Signs and Pavement Markings

Substantive: This sub-section of the 2004 Guide again states that "midblock crossings…are typically not expected by motorists. As noted previously, when crosswalks are used at uncontrolled locations along multilane roads, the potential for vehicle-pedestrian crashes increases." This is not true in all situations– research shows that this issue is more nuanced than this statement implies. More important than whether a crossing is at an intersection or midblock, is the number of lanes, ADT and speed. As previously stated, this becomes a circular, self fulfilling argument.

The language in the revised Guide should be more encouraging of midblock crossings, as long as they meet the criteria for marked crosswalks. Additionally, new tools such as the rapid flashing beacon can make uncontrolled crossing much safer.

Wording: The text suggests using yield signs at uncontrolled, midblock crossings. The wording should be changed to clarify that the text is referring to the new stop or yield signs (yield for yield States, stop for stop States) as found in the 2009 MUTCD.

3.4.2 Traffic Calming at Midblock locations

Move/Delete: It was earlier suggested that Section 2.6 Neighborhood Traffic Management and Traffic Calming should be re-written under the revised title of Speed Management on Arterial and Neighborhood Streets. The information in this section on curb extensions and raised crossings should be moved to this section with duplicative material deleted.

3.4.3 Midblock signals

Wording: The 2004 Guide starts out by stating that "The placement of midblock signals may be appropriate at some locations." The word "may" should be deleted – a signal either should or should not be installed. The tone of the entire section should be changed from one of reluctance to one of support; as long as MUTCD warrants and other conditions are met.

(Insert new section on "Transit" here – see comments on page 172)

3.5 Grade-Separated Crossings

3.5.1 Sidewalk Continuity

Delete: This section is duplicative of other sections on sidewalk continuity and should be deleted. Suggest adding a bullet in 3.5 Grade Separated Crossings, that reminds readers that over and under passes can provided needed continuity.

3.5.3 Planning Considerations

Move/Delete: This section duplicates information found in the introduction – 3.5 Grade-Separated Crossings. This section should be moved and integrated into 3.5 with duplicative information deleted.

3.5.3 Overpasses vs. Underpasses

Overpasses – Pedestrian Overpasses/Bridges

Addition: The discussion on elevators is fairly adequate in the 2004 Guide. However, the revised Guide should include a sentence advising the reader that if elevators are anticipated to also serve the needs of bicyclists along these routes, they should be designed with the sufficient capacity to do so.

Chapter 4: Pedestrian Facility Operation and Maintenance

Move/Reorganize: While 'operations' typically include signals, signs and channelization, the 2004 Guide groups signals and signs together with maintenance. This combination of topics could inadvertently imply that signals and signs are primarily maintenance issues.

The revised Guide should move signs and signals to the end of Chapter 3. This reflects a similar approach taken in the Draft Bike Guide. While the content is proposed to be relocated, the proposed changes to that content are covered below.

NEW TOPICS IN THE 2009 MUTCD

The revised 2009 MUTCD manual contains a significant number of changes related to signal timing, pedestrian indications, accessible pedestrian signals, pedestrian-related signing and new tools such as the pedestrian beacon. Consequently, this entire chapter will need to be reviewed in light of the 2009 Guide.

New Pedestrian Hybrid Beacon (aka "HAWK" – High Intensity Activated Crosswalk)

The revised Guide should include a new section on the pedestrian hybrid beacon. It has been included in the 2009 MUTCD and provides a new tool for getting pedestrians safety across the street. Included should be a new exhibit that demonstrates the signal phase sequence and the new "Crosswalk Stop on Red" sign that is required for use with pedestrian hybrid beacons.

New Rapid Flashing Beacons

The revised Guide should include a new section on Rapid Flashing Beacons, per the FHWA Guidance directive on this issue, or any subsequent changes that may be made in future editions of the MUTCD.

CHANGES TO 2004 GUIDE BY SECTION

4.1.1 Pedestrian Signal Phasing

Update: The 2009 MUTCD requires pedestrian countdown displays to be installed when upgrading or installing new pedestrian indications. The language in this section should be updated as needed to reflect this new requirement.

Substantive: The 2004 Guide correctly points out that a lagging pedestrian signal operation "provides little pedestrian advantage." This is a signal phasing operation that only benefits motor vehicles and can cause safety issues for pedestrians when turning vehicles fail to stop or yield to pedestrians who step out into the street. The revised Guide should recommend against the use of lagging pedestrian signal operations.

Substantive/Addition: The 2004 Guide states that "Research has indicated that there are no significant differences in crash rates for traffic signals with no pedestrian signals and those with concurrent pedestrian signal phasing." This is not entirely true. Pedestrian crashes are higher where there is a protected permissive signal phasing for motor vehicles. In other words, a concurrent signal, right after a protected (arrow) phase can have a significantly higher crash rate.[39]

The revised Guide should have a more complete discussion regarding concurrent signals and when they may result in higher or lower pedestrian crash rates. Included should be a complete discussion of safety concerns associated with protected permissive signal timing for motor vehicles.[40]

Addition: The revised Guide should have a discussion of safety issues associated with concurrent double left/rights and the pedestrian walk phase. A separate pedestrian phase is often needed.

Addition: The revised Guide should have new exhibits demonstrating standard, current timing; leading pedestrian intervals (LPI); exclusive pedestrian timing; scramble pedestrian phasing; protected permissive turns; and the protected permissive with a flashing yellow or flashing red (new in the 2009 MUTCD).

4.1.2 Pedestrian Signal Timing

Update/Addition: The section should be updated in the revised Guide to reflect the 2009 MUTCD which now requires signal timing to assume a pedestrian walking speed at 3.5 ft/sec. as opposed to 4 ft/sec.

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[39]Federal Highway Administration, Signalized Intersections: Informational Guide, *("Protected-Only" Left Turn phasing)*, 2004 (27); *Manual of Uniform Traffic Control Devices*, 2009 (9); *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*, 2008 (187); *A Review of Pedestrian Safety Research in the United States and Abroad*, 2004 (188)

[40] *Signalized Intersections: An Informational Guide* ("Protected-Only" Left Turn phasing), 2004 (18); *Manual of Uniform Traffic Control Devices*, 2009 (8); *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*, 2008 (187); *A Review of Pedestrian Safety Research in the United States and Abroad*, 2004 (188)

The 2009 MUTCD also has new requirements for calculating crossing distance that consider the length of the ramp. This information along with a new exhibit should be included in the revised Guide.

4.1.3 Warrants for Pedestrian Signals

Update: The revised Guide should be updated to reflect new warrant language in the 2009 MUTCD.

Substantive/Delete: The 2004 Guide provides eleven reasons for installing pedestrian signal indications. This suggests that there needs to be a good reason for installing pedestrian signal indications.

The discussion in the revised Guide should start with the assumption that all signals will have pedestrian signal indications. This should be followed a list of exceptions – e.g. pedestrians are not allowed to cross. The eleven reasons for installing pedestrian signal indications should be deleted.

Pedestrian Indications

Update/Re-Write: The 2009 MUTCD requires pedestrian countdown displays to be installed when upgrading or installing new pedestrian indications. This section needs to be completely re-written and the exhibits updated in the revised Guide.

Update: The signs in Exhibit 4.1 in the 2004 Guide need to be updated in the revised Guide to reflect the updated signs in the 2009 MUTCD (changes to pedestrian pushbutton signs).

Delete: Exhibit 4.4 in the 2004 Guide has a picture of a pedestrian with a caption that reads, “Vehicular Signal Heads are Obscured so Pedestrian Signals Are Necessary.” This sends the message that pedestrian indications are not always required and may be optional in some situations. This exhibit should be deleted in the revised Guide.

Delete: Exhibit 4.5 in the 2004 Guide includes a picture of a pedestrian indicator with animated eyes and the upraised hand and walking person in outline as opposed to solid images. The 2009 MUTCD requires that the upraised hand and walking person be solid images and walking eyes are not something that should be promoted in an exhibit as they are very rarely used in the U.S. This exhibit should be deleted in the revised Guide.

Innovative Signal Options

Delete: This section is no longer relevant and should be deleted in the revised Guide.

4.1.4 Pedestrian-Actuated Signals

Addition: The revised Guide should include an exhibit that demonstrates recommended, ADA compliant push buttons. Included should be a LED light that tells pedestrians the button works and the signal has received the call; and a tactile arrow that gives direction to visually impaired and fully sighted pedestrians.

Addition: The revised Guide should include information on signal cycle length. In recent years, the trend has turned back to shorter signal cycle lengths. The benefits to pedestrians and motor vehicles should be enumerated.

Revise/Addition: The 2004 Guide does a good job of stating when pedestrian-actuated signals are appropriate: "Pedestrian pushbuttons are appropriate where occasional pedestrian movements occur and adequate opportunities do not exist for pedestrians to cross." The problem is that pedestrian actuation is often used in locations where it is not appropriate, such as locations with regular pedestrian crossings where each cycle should accommodate pedestrians rather than requiring them to push a button. Pedestrian-actuated signals are routinely installed in central business districts and other areas with high pedestrian use. This is an area where some additional research would greatly benefit the next guide so that guidelines for determining when it is and is not appropriate to use pedestrian actuated signal heads could be provided.[41]

Revise: The 2004 Guide provides a bulleted list of "recommended" practices for pedestrian signal control design. Most of the items listed are required in the 2009 MUTCD. The language should be revised to reflect what is required in the 2009 MUTCD.

Accessible Pedestrian Signals (APS)

Addition/Reorganize: The 2009 MUTCD combines Accessible Pedestrian Signals (APS) and Accessible Detectors and reorganizes them into five new sections: General; Location: Walk Indications: Tactile Arrow and Locator Tones; and Extended Press Button Features. The revised Guide should be re-written and organized along the lines of the MUTCD with information added or deleted as needed. It will be important for the revised Guide to also remain abreast of requirements for APS should the Draft PROWAG be adopted, due to differences between what is contained in the 2009 MUTCD versus what is proposed in the Draft PROWAG:

1) The 2009 MUTCD requires the placement of push buttons in an accessible location (including one button for each ramp in an accessible location adjacent to the ramp). These requirements apply to new signals, and to new pedestrian pushbuttons.
2) The 2009 MUTCD makes it *optional* as to whether audible tones, speech messages, and/or vibrating surfaces are used at pedestrian signals (based on an engineering study).
3) If the Access Board's Draft Public Rights-of-Way Accessibility Guidelines (PROWAG) are adopted, then item 2 above would no longer be optional – all new pedestrian signals would have to be accessible in both location and design (including audible tones etc).

[41] *Manual of Uniform Traffic Control Devices*, 2009 (9); *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, 2004 (159)

Addition: The revised Guide should include a discussion of microwave sensors. This is a relatively new tool that tracks pedestrians as they cross the street at a signalized intersection. The controller adds four (or more) seconds crossing time if the pedestrian hasn't finished crossing. This allows the signal to be set at standard walking speeds while accommodating persons with disabilities.

4.1.5 Wide Crossings

Substantive/Delete: The 2004 Guide suggests that one solution to wide crossings is to "prohibit particular pedestrian movements." While this may be appropriate is rare circumstances, it usually is done to benefit vehicular movement and reduces pedestrian safety since pedestrians must now cross up to three streets instead of just one. This advice should be deleted in the revised Guide.

Revise: The 2004 Guide suggests that one solution to wide crossings is to…"construct a median crossing island to reduce the walking distance. This may require slower pedestrians to cross the approach during two signal cycles." The tone implies that it may be okay to design a signal that does not provide adequate time for pedestrians to cross the street during a single cycle. Additionally, constructing a crossing island may actually increase the crossing distance if the roadway is widened to accommodate the crossing island. The language in the revised Guide should be changed to make it clear that partial crossings are not appropriate. It should also point out that medians may not have the capacity to accommodate multiple pedestrians who are caught in the middle between two signal cycles. It should then refer back to Section 3.3.2 for more guidance on crossing island design and signalization issues.

4.1.6 Pedestrian Signals in a Coordinated Signal System

Wording: The 2004 Guide states that, "The use of pedestrian features in a coordinated signal system requires balancing the vehicular movement phasing with the pedestrian crossing time requirements." This sentence could be misread to imply that there are choices when it comes to most 'pedestrian features' when in fact, most of features such as walk time and pedestrian indications are mandated by the MUTCD. This sentence should be re-worded in the revised Guide.

Addition: The 2004 Guide correctly points out that the sequencing of coordinated signal systems are disrupted when a pedestrian uses a push button and that this can be avoided using fixed-time pedestrian signals. The problem is that this message is not getting across to State and local transportation agencies. Pedestrian-actuated signals are routinely installed in conjunction in conjunction with coordinated signal systems.

The revised Guide should highlight this issue and add an exhibit that demonstrates how coordinated signal systems work better without push button interruptions. Included should be thresholds (percent of time a pedestrian uses a push button) for determining when push buttons should not be used.[42]

4.2 Pedestrian-Related Signing

Reorganize: As previously stated, this section should be moved to the end of Chapter 3 – *Pedestrian Facility Design*.

Revise: The introductory paragraph states that "Pedestrians rely on wayfinding information, just as motorists do." The implication is that the focus of this section is on wayfinding when in fact the focus is on regulatory and warning signs. This wording should be changed in the revised Guide.

Revise: Exhibit 4.9 in the 2004 shows yellow school crossing signs. These should be changed to the fluorescent yellow-green color as required in the 2009 MUTCD.

4.2.1. Regulatory Signs

Revise/Reorganize: The 2004 Guide starts with a discussion of signs related to restricting right-turns on red followed by a bulleted list of other regulatory signs. It implies that right-turn on red regulatory signs are more important than other pedestrian-related regulatory signs. In the revised Guide, the discussion on right-turn on red should be included in the bulleted list with other regulatory signs. The discussion of regulatory signs should be expanded to include Yield Here to/Stop Here for Pedestrian signs (R1-5 series), the In-street Pedestrian Crossing (R1-6), and the Turning Vehicles Yield to Pedestrians sign (R10-15).

Addition: The MUTCD lists five conditions when no-turn-on-red may be considered. These should be listed in the revised Guide.

Revise: The photo in figure 4-10 in the 2004 Guide is easily identifiable as having been taken in Detroit. This should be replaced in the revised Guide with a generic photo that is not location specific.

Revise: The 2004 Guide discusses regulatory pedestrian push button signs and signs explaining the meaning of pedestrian indication signs. The revised Guide should note that these signs have been changed in the 2009 MUTCD to ensure old versions of the signs are not inadvertently used. Suggest adding a new exhibit with the revised signs.

4.2.2 Warning Signs

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[42] *Selecting Pedestrian Safety Improvements: Crash Types/Countermeasures Matrix* (as updated): 49 Pedestrian Push Button/Pole in Median (25);

Update: The 2004 Guide states that warning signs are generally on a yellow background. This should be updated in the revised Guide to reflect the 2009 MUTCD which requires some signs be fluorescent yellow-green and gives the option of fluorescent yellow-green for other signs.

Pedestrian Crossing Sign

Addition: The revised Guide should include a new exhibit that demonstrates the proper sign and location for advanced crossing and crosswalk signs. Text should also include information about when it is appropriate to place warning signs on both sides of a one-way street. The text should also address situations in which it is more appropriate to use the combined bicycle and pedestrian crossing sign (W11-15).

Addition: The 2009 MUTCD provides for overhead pedestrian crossing signs and in-street pedestrian crossing signs. These signs should be provided as exhibits in the revised Guide, along with alternative designs that can be used in school zones (using the school crossing symbol). New language should describe when and where these signs should be used.

Addition: The 2009 MUTCD provides new guidance on the use of in-street pedestrian signs. This guidance should be included in the revised Guide.

School Warning Signs

Update: The revised Guide should be updated to reflect the 2009 MUTCD which requires certain school signs to be fluorescent yellow-green.

Update: The revised Guide should be updated to reflect the 2009 MUTCD which provides new optional plaque designs for school area signing.

Update: The revised Guide should be updated to reflect the 2009 MUTCD which replaces the "School Bus Stop Ahead" sign with a new symbol sign.

4.3.2 Guide Signs

Revise/Update: The 2004 Guide states that "No standards have been developed yet for pedestrian guide signs." The revised Guide should be changed to reflect the 2009 MUTCD which has new guidance for the design and use of community wayfinding guide signs, which primarily address the need to ensure guide signs are not mistaken by motorists as being intended for them. No further guidance is given on the design of these signs in the MUTCD, therefore it would be helpful for the revised Guide to provide some "rules of thumb" such the need for the sign to be legible at the height to which it will be mounted.

4.3 Sidewalk Maintenance

Substantive/Addition: While the 2004 Guide discusses sidewalk maintenance, other pedestrian facilities are discussed only briefly giving the impression that sidewalks are the most important and possibly the only type of pedestrian facility that needs to be maintained.

In the revised Guide, the title of this section should be changed from 'Sidewalk Maintenance' to 'Maintenance Programs and Activities'. The content of this section expanded to include a discussion of all pedestrian facilities, including sidewalks, surface repairs, sweeping, snow removal, curb ramps, signs and markings, signals, drainage and landscaping. For each of these activities, there should be guidance on how to approach routine, annual and major maintenance. For example, annual sidewalk maintenance should include spot repairs, sweeping and landscape maintenance; major maintenance should include sidewalk and replacement and major drainage repair and upgrade. The Guide should describe strategies some communities have used, such as focusing on major maintenance needs in sub-areas of a jurisdiction so that over time the entire jurisdiction is covered.

There should also be guidance on what triggers maintenance (e.g. tripping hazards, smoothness, cross slope changes, etc), how to set priorities for addressing maintenance issues and the role that ADA compliance plays in this process. Additionally, there should be a discussion on the relationship between materials and maintenance (e.g. brick pavers). [43]

4.4 Maintenance of Pedestrian Traffic in Construction Work Zones

Wording: The word 'maintenance' in the title of this section incorrectly implies that traffic control in a work zone is a maintenance issue. In the revised Guide, the title of this section should be changed from 'Maintenance of Pedestrian Traffic in Construction Work Zones' to 'Traffic Control in Construction Work Zones.

Addition: Consideration of pedestrians in work zones should more fully addressed in the revised Guide. This includes accommodating disabled pedestrians in work zones, strategies to keep sidewalks open during construction, pedestrian crossings in work zones, guidance for covered walkways and other temporary pedestrian facilities in work zones. The revised Guide should reference and expand upon (not duplicate) the guidance on maintenance found in the 2009 MUTCD with a focus on 'how' to carry out provisions in the 2009 MUTCD. In all cases, it is important that guidelines be national is scope and sensitive to regional differences. The revised Guide should avoid specifying details that may be location and site specific.[44]

Addition: The 2004 Guide correctly states that "Completely closing a sidewalk for construction and rerouting pedestrians to the other side of the street should only be done as a last resort." However, in practice, many transportation agencies routinely route pedestrians to the other side of the street. The

[43] *Federal Highway Administration*, *Planning Design and Maintenance of Pedestrian Facilities*, 1989 (12); Federal Highway Administration, *Designing Pedestrian Facilities For Accessibility Course*: *Lesson 16 Bicycle Facility Maintenance principles can be applied to pedestrians*, 2006 (26); Wisconsin Department of Transportation, Pedestrian Best Practices Guide, 2011 (69)

[44] District of Columbia, Pedestrian Master Plan (specifically – DDOT's Pedestrian Safety and Work Zone Standards, 2007 (37); Wisconsin Department of Transportation, Pedestrian Best Practices Guide, 2011 (69); CALTRANS, *Pedestrian Considerations for California Temporary Traffic Control Zones*, 2010.

revised Guide should include a new exhibit that demonstrates a how to use signs, barricades and fences to maintain pedestrian access in front of a work site.

Addition: The revised Guide should include guidance on installing advance detour signs at intersections in situations where the sidewalk is completely closed midblock. Without advance warning, pedestrians may be tempted to walk in the street if they are half-way down the block and come upon an expected sidewalk closure.

Update: In general, this section should be updated to reflect the 2009 MUTCD.

3.3 SUGGESTED OUTLINE OF THE GUIDE

The outline below is a general guide for the revision of the AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities. As many of the changes described in the chapter above involve substantial structural differences from the current version of the Guide, this outline is intended to be flexible and is likely to evolve as the new Guide is written.

Chapter 1: Introduction

1.1 Purpose

1.2 Scope

1.3 Design Regulations and Guidelines

1.4 Definitions

Chapter 2: Planning for Pedestrians

2.1 Pedestrian Activity in America

2.1.1 Walking as a Basic Transportation Mode

2.1.2 Walk Decision Factors

2.2 Characteristics of Pedestrians

2.2.1 Basics of Pedestrian Operation

2.2.2 Traffic Principles for Pedestrians

2.2.3 Pedestrian Crash Types and Countermeasures

2.2.4 Conclusion

2.3 Pedestrian Planning Strategies

2.3.1 Preparing Pedestrian Master Plans

2.3.2 Integrating Pedestrians in Transportation Planning Studies

2.3.3 Integrating Pedestrians in Transportation Projects

2.3.4 Technical Analysis Tools

2.3.5 Retrofitting Sidewalks on Existing Streets