# Technical Committee on Non-Motorized Transportation Agenda

**Franklin, TN**  
**June 11-12, 2018**  
*(Dial 1-888-585-9008 Conference # 261-892-381)*

### Monday, June 11, 2018

- **8:00 am** Opening Remarks & Roll Call
- **8:30 am** Council on Active Transportation (Toks Omishakin, TN Deputy Commissioner)
- **9:45 am** Break
- **10:00 am** Bike Guide Review Process
- **12:00 pm** Lunch
- **1:00 pm** FHWA Update (Shari Schaftlein, FHWA)
- **2:45 pm** Break
- **3:30 pm** *Green Book 8th edition* (Brian Ray, Kittelson & Associates)
- **5:00 pm** End of Day

### Tuesday, June 12, 2018

- **8:00 am** Project Updates (Ray Derr, TRB)
- **9:45 am** Break
- **10:00 am** Project Reports
  - 20-05/Topic 49-08, Pedestrian Safety Relative to Traffic Speed Management (Rebecca Sanders, Toole Design)
  - 15-63, Guidance to Improve Pedestrian and Bicycle Safety at Intersections (Rebecca Sanders, Toole Design)
  - 17-73 Conducting Systematic Pedestrian Safety Analysis (Laura Sandt, UNC Highway Safety Research Center)
- **11:00 am** Presentations
  - Pedestrian and Bicycle Information Center (Laura Sandt, UNC Highway Safety Research Center)
  - Collaborative Sciences Center for Road Safety (Laura Sandt, UNC Highway Safety Research Center)
- **12:00 pm** Lunch
- **1:00 pm** Conversation with Bill Schultheiss
- **2:45 pm** Break
- **3:15 pm** NCHRP 15-60 Update of the AASHTO Guide for the Development of Bicycle Facilities, (Bill Schultheiss, Toole Design) (Committee on Design)
- **5:00 pm** Closing remarks and adjournment
AASHTO Council on Active Transportation

Toks Omishakin, Vice Chair

Deputy Commissioner / Chief of Environment and Planning
Tennessee Department of Transportation

Wednesday, June 27, 2018
Council Purpose

• The Council on Active Transportation shall:
  o Address issues related to bicyclist, pedestrian, and other active transportation modes, including access to the multimodal network
  o Provide input on policy and cross-cutting/multimodal issues
  o Provide assignments to appropriate committees, and review and approve applicable technical documents
  o Promote and encourage technology and knowledge transfer by member states
  o Make recommendations regarding needed research
Council Membership

Leadership
- Chair: Secretary Leslie Richards, Pennsylvania DOT
- Vice Chair: Deputy Commissioner Toks Omishakin, Tennessee DOT

Full Council
- 1 voting and 2 non-voting members from each of the 52 member departments

Steering Committee
- 11 Council members meet each month
Strategic Plan

• Support the reduction of pedestrian and bicyclist injuries and fatalities
• Communicate the value of active transportation
• Strive to align federal policies with the goals and strategies of the Council
• Support the inclusion of active transportation safety and mobility considerations across state DOT functions
• Monitor and share information related to new technologies that may impact active transportation
AASHTO Publications

• Council on Active Transportation will ballot:
  o Policy on Geometric Design of Highways and Streets
  o Guide for the Development of Bicycle Facilities
  o Guide to the Planning, Design and Operation of Pedestrian Facilities
  o Guide for Achieving Flexibility in Highway Design
  o Guide for Geometric Design of Transit Facilities
  o Guide to Park and Ride Facilities.

• The Council will coordinate in the development of the Highway Safety Manual and Strategic Highway Safety Plan
Geometric Design of Highways and Streets ("Green Book")

- 7th edition - published early fall
  - Multimodal travel
  - Right sizing designs in urban and rural areas
  - Consider all modes when evaluating LOS
- Green Book 8 Visioning Project:
  - Comprehensive update and restructuring
  - Seeking input from internal/external stakeholders
Other Activities

- Center for Environmental Excellence case studies on expediting the delivery of bicyclist and pedestrian projects.
- Trends/Issues:
  - CAV/CAT impacts on active transportation
  - Including active transportation in the transportation planning process
- Research Handout
AASHTO Staff Liaisons

Shannon Eggleston
Program Director for Environment
202-624-3649
seggleston@aashto.org
Questions?
FHWA Update for the Technical Committee on Non-Motorized Transportation

Shari Schaftlein
June 11, 2018

U.S. Department of Transportation
Federal Highway Administration
The Washington Capitals will celebrate winning the 2018 Stanley Cup Championship with a parade in downtown Washington, D.C., On Tuesday, June 12th, 2018
Key National Roles

• Policy and Guidance
• Planning and Design
• Decision Support Tools and Capacity Building
• Research

National Context

FHWA

• Execute transportation policies and practices and deliver more integrated multimodal solutions.
• Advance policies and practices that support an integrated surface transportation system for all users that is efficient, equitable, and safe.

Background

• Safety for all users
• Connected pedestrian and bicycle networks
• Design flexibility
• Accelerated project delivery
• Data to improve the planning process
USDOT Strategic Plan for FY 2018-2022

GOALS

Safety
• Reduce Transportation-Related Fatalities and Serious Injuries Across the Transportation System.

Infrastructure
• Invest in Infrastructure to Ensure Mobility and Accessibility and to Stimulate Economic Growth, Productivity and Competitiveness for American Workers and Businesses.

Innovation
• Lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation’s Transportation System.

Accountability
• Serve the Nation with Reduced Regulatory Burden and Greater Efficiency, Effectiveness and Accountability.

Pedestrian and Bicycle Funding Opportunities

This table indicates potential eligibility for pedestrian and bicycle projects under U.S. Department of Transportation (DOT) transportation funding programs. Additional restrictions may apply based on state and local program requirements. For more information, contact your local Transportation Planning Board.

<table>
<thead>
<tr>
<th>Pedestrian and Bicycle Funding Opportunities</th>
<th>U.S. Department of Transportation Transit, Highway, and Safety Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity or Project Type</td>
<td>ESGA/TEF/FTA</td>
</tr>
<tr>
<td>Access improvements to public transportation (includes sidewalks, bus stops)</td>
<td>$</td>
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<tr>
<td>ADA-504 Self-Evaluation: Transit Plan</td>
<td>$</td>
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<tr>
<td>Bicycle plans</td>
<td>$</td>
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<tr>
<td>Bicycle helmets (project or financing related)</td>
<td>$</td>
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<td>Bicycle helmets (safety promotion)</td>
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<td>Bicycle lanes on road</td>
<td>$</td>
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<tr>
<td>Bicycle parking</td>
<td>$</td>
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<tr>
<td>Bike-racks on transit</td>
<td>$</td>
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<tr>
<td>Bicycle share capital and equipment (not operations)</td>
<td>$</td>
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<tr>
<td>Bicycle storage or service centers at transit hubs</td>
<td>$</td>
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<tr>
<td>Bicycle / crosswalks for pedestrians and/or bicyclers</td>
<td>$</td>
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<tr>
<td>(Bike shelters and benches)</td>
<td>$</td>
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<tr>
<td>Crosswalks (state or local)</td>
<td>$</td>
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<tr>
<td>Curbing or median</td>
<td>$</td>
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<tr>
<td>Curb cuts and ramps</td>
<td>$</td>
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<tr>
<td>Counting equipment</td>
<td>$</td>
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<tr>
<td>Data collection and monitoring for pedestrians and/or bicyclers</td>
<td>$</td>
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<tr>
<td>Historic preservation (pedestrian and bicycle and transit)</td>
<td>$</td>
</tr>
<tr>
<td>Landscaping, striping (pedestrians and/or bicycle)</td>
<td>$</td>
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<tr>
<td>Lighting (pedestrian and bicycle trail)</td>
<td>$</td>
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<tr>
<td>Paths for pedestrians and/or bicyclers</td>
<td>$</td>
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<tr>
<td>Prioritization for pedestrian and/or bicyclist use</td>
<td>$</td>
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</tbody>
</table>

Key: * Funds may be used for this activity (restrictions apply); ** Program-specific rules for co-financing; –S = Eligible for use with other Federal funds to support larger project.
Recent FHWA Pedestrian and Bicycle Resources
www.fhwa.dot.gov/environment/bicycle_pedestrian
 MEASURING MULTIMODAL NETWORK CONNECTIVITY
POSITIONS A TRANSPORTATION AGENCY TO:

- Enhance access to jobs, training, schools, and economic centers
- Accelerate project delivery by capturing efficiencies in economies of scale, project sequencing, construction phasing, financing, and community involvement
- Increase accountability of efforts to increase mobility options and system efficiency
- Prioritize infrastructure investments that fill gaps and address barriers in the transportation network, and that increase safety for all users
- Partner with the private sector to provide innovative multimodal transportation services and capture opportunities relating to shared-use mobility and automated and connected technology
Connectivity Analysis Process

STEP 1: Identify the planning context
- Clarify the purpose of the analysis, the decisions it will support, and the planning processes it will inform.

STEP 2: Define the analysis method
- Decide which methods and measures are best suited to the purpose of the analysis, and will make productive use of available resources.

STEP 3: Assemble the data
- Define the base network and assemble facility attribute and other relevant data.

STEP 4: Compute metrics
- Run the analysis to calculate connectivity for selected links, routes, and areas.

STEP 5: Package results
- Develop overlays, visualizations, and other presentation materials to support the decision-making process.
Planning Context

- What are the key questions, problems, or decisions to be informed by this analysis?
- What related plans and policies might inform or be informed by this analysis?
- What are the relevant existing and/or planned networks?
- What is the agency’s role in advancing multimodal connectivity?
- What is the appropriate scale for this analysis?
Analysis Methods

- Network Completeness
- Network Density
- Route Directness
- Access to Destinations
- Network Quality
Network Data Sources

<table>
<thead>
<tr>
<th>OSM</th>
<th>TIGER/LINE</th>
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Facility Types

- Nonmotorized facility location and type
- Basic street network centerlines
- Roadway functional classification
- Traffic speeds
- Number of lanes
- Shared Use Paths
- Intersection attributes

(✓) Indicates attributes that are not required or less

Facility Types

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(✓) Indicates attributes that are not required or less
Case Studies
Lessons Learned

• Articulate a clearly defined network vision and analysis goal.
• Select a method appropriate for the intended application.
• Select measures that can be tracked over time and appropriate for the study area context.
• Consider potential implications when modifying existing methods and measures.
• Promote consistent standards for facility data.
• Establish data storage parameters.
• Test connectivity measures before committing to them.
• Overlay the analysis results (e.g. safety, equity, activity)

Accessible Shared Streets

1. Introduction
2. Shared streets
3. Legal Framework Regarding Accessibility
4. Shared Streets and People with Vision Disabilities
5. Tactile Walking Surface Indicators and Detectable Edges
6. Planning Shared Streets
7. Lessons Learned from Shared Street Implementation in the United States
8. Shared Streets Design Toolbox
9. Conclusion
What is a Shared Street?

• A street that includes a shared zone where pedestrians, bicyclists, and motor vehicles mix in the same space (typically no curbs present)
• Although the ROW is shared, some provide focused zones:
  – Frontage Zone
  – Comfort Zone
  – Furniture Zone
  – Shared Zone
• Not all streets without curbs are “shared streets”

Shared Street Components
Key Project Challenges

- Promoting design innovation, while still ensuring accessibility
- Capturing state of practice in a rapidly evolving field
- Regulatory context
- Engaging people with disabilities in the planning and design process

Workshops

Silver Spring, MD  Minneapolis, MN  Seattle, WA
Design Principles

- Context sensitivity and treatment levels
- Layers of information
- Consistency and predictability
- Universal design for all
- Programming
- Operations and maintenance

Shared Zone
Comfort Zone

Crossings and Connections
Defined Gateways

Tactile Walking Surface Indicators and Detectable Edges
Organization and Furniture Zone

Things We Need to Understand Better

- Directional indicators
- Rolled curbs
- Sign and striping options
- Technology
- Tactile maps
• Provide a bridge between existing guidance on bicycle and pedestrian design and rural practice.

• Encourage innovation in development of safe and appealing networks for bicycling and walking in small towns and rural areas.

• Provide examples of peer communities and project implementation that is appropriate for rural communities.
Shared Use Path

A shared use path provides a travel area separate from motorized traffic for bicycles, pedestrians, skaters, school/child users, joggers, and other users. Shared use paths can provide a low-投资 opportunity for a variety of users along the network for transportation or recreation.
Johnson Street (Chattanooga, TN)

- Mitigating Flood Risk
- Public-Private Partnership
- Design Flexibility
Interim Approval for Rectangular Rapid-Flashing Beacons at Crosswalks

• Interim Approval for the optional use of the RRFB as a pedestrian-actuated conspicuity enhancement to supplement standard pedestrian crossing or school crossing signs at uncontrolled marked crosswalks
• Must submit a written request to the Office of Transportation Operations.
Bicycle Facility Design Course Update

- Updating and converting to a web-based course
- Procurement Underway
- Available by Fall 2019

Fostering Innovation in Pedestrian and Bicycle Transportation Pooled Fund Study

- Innovative facility design, planning, and implementation to improve safety and mobility for pedestrians and bicyclists.
- Innovative traffic control devices to accelerate their incorporation into the Manual on Uniform Traffic Control Devices (MUTCD).
- Transportation facility data.
- Rural multimodal transportation needs, regulatory streamlining, opportunities to improve cost effectiveness and efficiencies in the transportation system, and multimodal investment analysis.
Safety Projects

- Pedestrian Countermeasure Crash Modification Factor Study
- Identification and Prioritization of Pedestrian Crash Locations and Areas
- Pedestrian and Bicyclist Scalable Risk Assessment Methodology (ScRAM)
- EDC-5 Safe Transportation for Every Pedestrian (STEP) 2.0
- Lighting for Pedestrians

Infrastructure Projects

- Bike Facility Selection Guide
- EDC-4 Community Connections
- Top Strategies for Accelerating Multimodal Infrastructure Delivery
- AASHTO CEE Case Studies on Streamlining Bicycle and Pedestrian Projects
Technology/Data Projects

- MySidewalk
- Connected Bicycle Technology
- Understanding Traffic Systems with Innovative Pedestrian and Cyclist Detection
- Smartphone Based Mid-Block Pedestrian Crossing Application
- Developing National Bicycle Facility Inventory Data

Recently Released

Coming Soon!
Best Practices

• Exemplary Projects
  — Working through our Divisions, FHWA has been identify exemplary projects that advance multimodal connectivity

• 2019 Environmental Excellence Awards
  — Multimodal Transportation Category

Selected Contacts

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Elizabeth Hilton
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Elizabeth.Hilton@dot.gov

Dave Kirschner
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David.Kirschner@dot.gov

FHWA Division Office Pedestrian and Bicycle Points of Contact
www.fhwa.dot.gov/environment/bicycle_pedestrian/
state_fhwa_contacts

State DOT Pedestrian and Bicycle Coordinators
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/state_contacts

For More Information:
www.fhwa.dot.gov/environment/bicycle_pedestrian
The Green Book 8 Visioning Project (GB8) will conduct visioning and create a roadmap to develop and implement the 8th Edition of the Green Book that supports a data driven, performance-based design process. This project will assess:

- Performance-based evaluation approaches—opportunities, success, and gaps
- Key findings, concepts, possible applications, potential conflicts from the literature review
- NCHRP Report 839—performance-based process and suggested future Green Book framework
- Concepts and ideas for a GB8 Vision and roadmap for implementation

The purpose of the visioning portion of the project is to discuss key questions:

- What is your vision for the GB8? What does it look like?
- What are the considerations that will allow us to develop the plan to achieve that vision? How do we get there?

We’ve developed a list of topics/categories we plan to investigate during the visioning process and would like your feedback as we begin.

Questions for the group discussion:

1. Are there additional categories or topics we should include?
2. What are your initial thoughts on each topic?
   a. What are your priorities?
   b. What are some of the key considerations?
3. Functionally, how do we achieve the desired outcome for GB8?
   a. What are the challenges that you see of achieving the vision?
   b. What partnerships need to be developed to achieve the vision?
During the visioning process, we plan to review the following key topics:

- **Complete Project Development Process**
  - Emphasize early participation and contributions from interdisciplinary team members to create context-sensitive solutions.
  - Design *GB8* as a resource for applying roadway design fundamentals at each development stage allowing smooth transitions as projects move from planning and programming to eventual design and construction.

- **Guiding Principles Focused**
  - Design *GB8* to define guiding principles for roadway design elements and for roadway intersection forms. Understanding principles allows users to adapt to virtually any project needs and context.

- **User Centered**
  - Design *GB8* to consider the user and environment first, and then defining roadway forms that meet those needs.
  - Consider whom the facility or design element is intended to serve in order to inform design decisions.

- **Role of Dimensional Design Criteria**
  - Utilizing dimensional design criteria supported by research-based documentation.
  - Integrating previous traditional design criteria.

- **Highlights & References**
  - Include highlights from select references and resources at the beginning of each section to support guiding principles that meet each user type, beyond the historical focus on motorized vehicle and driver influences.

- **Electronic/Digital Format**
  - The industry is going digital and *GB8* must too.
  - Digital format allows hot links and references to other key documents in addition to allowing searching on key words.

- **Modular in Nature**
  - Make *GB8* a much more dynamic resource by allowing portions to be updated more frequently to address various facility types and design users.
  - This will be useful with the incremental integration of connected/automated vehicles and smart roadway systems.
  - Considerations for how a modular format may impact the local, state and federal adoption process.

- **Separating Work Types or Land Use Context**
  - Considerations for developing and publishing the *GB8* in different parts. Such as work type or land use context.
    - Work Types: Resurfacing, New Construction, Reconstruction
    - Land Use Context: Urban, Urban Core, Suburban, Rural, Rural Town

- **Research-Based Leadership**
- AASHTO is a leader in prioritizing research needs, funding applied research, and publishing results.
- The GB8 efforts could better define and refine guidance by non-AASHTO groups for topics to be integrated into the first GB8 document.

• Collaboratively Assessed & Refined
  - The AASGTO Technical Committee on Geometric Design may benefit by contracting out (and still overseeing) GB8 and future editions to professionals in the publication development industry. This would help identify research and meet the needs of the fullest range of users.
  - How will the GB8 be developed? AASHTO Technical Committees? If so, which ones? Should this work be outsourced?

• Expected Development Timeline
  - When is GB8 expected to be published next? 3 to 4 years? 4 to 6 years? 8 to 10 years?
  - The expected development timeline may impact the scope of the document.

• Rome was Not Built in a Day
  - GB8 is the cornerstone of a new way to approach transportation planning and design. GB8 will be a paradigm shift from previous editions, but it may not get it all.
  - Future editions should continue to build and develop the precedent set by GB8, addressing remaining research gaps and incorporating new infrastructure technology and types of users.

• Other Considerations
  - GB8 should utilize infographics, diagrams, and easy-to-understand information to convey complex ideas and concepts.
  - GB8 should provide design guidance to meet current multimodal planning and design objectives for state and non-state transportation agencies charged with the transportation project development.

*Using this visioning discussion, we will create the framework for potential Roadmap elements and early concepts for a recommended approach.*

**Please provide any input to:**

Brian L. Ray, PE.
Kittelson & Associates, Inc.
bray@kittelson.com
503 535-7437
The Green Book 8 Visioning Project (GB8) begins by considering and conducting a literature review of substantive documents/resources related to or applying performance-based approaches to planning and design. We will focus on the relationship to the project development process and performance metrics.

The purpose of the literature review is to:

- Compile a list of documents that may influence GB8
- Identify a list of key themes from these documents that may help guide the visioning for GB8

We’ve compiled an initial list of documents and would like your feedback as we begin.

Questions for the group discussion:

- Are there any other documents that we should consider including in this list?
- What are the priority documents that you think may have the most influence on GB8?
- In your current experience with the documents, what are some of the key themes that will help direct or influence GB8?

The selected literature is chosen to accomplish the following goals:

- Enhance the utility of GB8 as a resource that supports planning decisions in addition to design needs.
- Make GB8 support project planning and policy by connecting technical and dimensional elements of roadway design to various stages of the project development process.
- Consider geometric design elements early in the planning stage to create smooth and efficient transitions to design and construction.
- Inform the GB8 framework by understanding how new metrics can guide geometrics and associated project decision making.
- Integrate the quality of service to consider design users could inform GB8 framework in ways that prior editions have not explicitly addressed.
- Establish a broader framework that ties design decisions to softer project catalysts beyond safety and operations for topics such as livability, economic vitality, and community heritage. The range of project performance metrics should vary as needed to measure the success of achieving intended project outcomes.
- Look beyond what we measure now and be ready for what we might measure in the future.
Representative key documents form a variety of sources are noted below.

**AASHTO**

- A Policy on Geometric Design of Highways and Streets, 7th Edition
- A Guide for the Development of Bicycle Facilities
- Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT≤400)

**TRB/NCHRP**

- Report 600: Human Factors Guidelines for Road Systems
- Report 616: Multimodal Level of Service Analysis for Urban Streets
- Report 642: Quantifying the Benefits of Context Sensitive Solutions
- Report 687: Guidelines for Ramp and Interchange Spacing
- Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets
- Report 839: A Performance-Based Highway Geometric Design Process
- Report 855: An Expanded Functional Classification System for Highways and Streets
- Report 880: Guidelines for Designing Low- and Intermediate-Speed Roadways that Serve All Users

**FHWA**

- Performance-Based Practical Design (PBPD)
  - Main Website: [https://www.fhwa.dot.gov/design/pbpd](https://www.fhwa.dot.gov/design/pbpd)
- Separated Bike Lane Planning and Design Guide
- Small Town and Rural Multimodal Networks
- Rural and Small Town Bicycle and Pedestrian Facilities
- Guide for Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts
- Guidebook for Developing Pedestrian and Bicycle Performance Measures

**NACTO**

- Urban Street Design Guide
- Global Street Design Guide
- Urban Bikeway Design Guide
- Transit Street Design Guide
- Blueprint for Autonomous Urbanism
- Urban Street Stormwater Guide
ITE

- Urban Street Geometric Design Handbook
- Designing Walkable Urban Thoroughfares: A Context Sensitive Approach

AMPO

- [http://www.ampo.org/resources-publications/publications](http://www.ampo.org/resources-publications/publications)
- Publications, such as “Summary Reports”

CNU

- [https://www.cnu.org/resources/tools](https://www.cnu.org/resources/tools)
- Concepts such as “transect zones” and “form-based code”

Other topics/groups to consider and integrate

- Project for Public Spaces
- National Association of County Engineers
- Americans with Disabilities Act
- Public Rights-of-Way Accessibility Guideline
- Visually Impaired and Special User needs
- Freight Mobility and Goods Movement

Please provide any input to:

Brian L. Ray, PE.
Kittelson & Associates, Inc.
bray@kittelson.com
503 535-7437
NCHRP Projects Update:
20-05/49-08 Synthesis on Pedestrian Safety Relative to Traffic Speed Management and
15-63 Guidance to Improve Pedestrian & Bicycle Safety at Intersections

Rebecca Sanders, PhD – Head of Research, Toole Design Group

AASHTO Technical Committee on Non-Motorized Transportation
June 12, 2018
Agenda

• Overview of NCHRP 20-05/49-08
  – Progress to date
  – Current work
  – Remaining work

• Overview of NCHRP 15-63
  – Progress to date
  – Current work
  – Remaining work

• Discussion
NCHRP 20-05/49-08
Synthesis on Pedestrian Safety Relative to Traffic Speed Management

Image credit: Dan Burden
Work Completed to Date

- Extensive literature review
  - Impact of vehicle speed on pedestrian safety
  - Proven and promising countermeasures for slowing speeds
- Screening survey to identify interview candidates
- Interviews with jurisdictions working to address pedestrian safety via managing traffic speed
- Focus on proven and noteworthy practices
• Clear evidence linking speed to pedestrian injury severity
Preview of Key Findings

• Clear evidence linking speed to pedestrian injury severity
• Fewer studies on countermeasures, speed, and pedestrian safety directly
Clear evidence linking speed to pedestrian injury severity

Fewer studies on countermeasures, speed, and pedestrian safety directly

Many studies on countermeasures to address speed
• Clear evidence linking speed to pedestrian injury severity
• Fewer studies on countermeasures, speed, and pedestrian safety directly
• Many studies on countermeasures to address speed
• Solutions vary depending on context
Clear evidence linking speed to pedestrian injury severity
Fewer studies on countermeasures, speed, and pedestrian safety directly
Many studies on countermeasures to address speed
Solutions vary depending on context
Some clear winners and promising strategies
Next Steps

- Submit first draft
- Panel review & revisions
- Revise draft

Estimated completion date: November 2018
NCHRP 15-63
Guidance to Improve Pedestrian & Bicycle Safety at Intersections

Image credit: Dan Burden
• Goals
  – Go-to, high-level resource for practitioners
• Goals
  – Go-to, high-level resource for practitioners
  – Original research project
Project Overview & Work Completed

• Goals
  – Go-to, high-level resource for practitioners
  – Original research project

• Methods
  – Extensive literature review on proven and best practice countermeasures
• Goals
  – Go-to, high-level resource for practitioners
  – Original research project
• Methods
  – Extensive literature review on proven and best practice countermeasures
  – FARS crash analysis to identify key problems to be addressed
• Goals
  – Go-to, high-level resource for practitioners
  – Original research project
• Methods
  – Extensive literature review on proven and best practice countermeasures
  – FARS crash analysis to identify key problems to be addressed
  – Interviews with a range of jurisdictions to understand priority needs for countermeasure guidance
Current Work: Video Observations

• Filming protected intersections in multiple locations
• Will analyze conflicts, yielding behavior, compliance
• Aim to provide insight into protected intersection effectiveness

Image source: Google
Current Work: Guidebook

- High-level: heavily references existing resources
- Draft in progress
- Aim to have to Panel by end of summer
Guidebook Overview

- Ch. 1 - Factors impacting safety, including principles for operations and design safety for pedestrians and bicyclists at intersections
- Ch. 2 - Data needed to identify and evaluate safety at intersections
- Ch. 3 - Methods for identifying and evaluating safety at intersections
Guidebook Overview

• Ch. 4 - Operational characteristics matching project context
• Ch. 5 - Intersection treatments and combinations of treatments addressing known safety issues and project and community needs
• Ch. 6 - Guidance to inform trade-offs, decision-making, and prioritization of treatments based on local needs
Example Pedestrian Crash Scenarios

Pedestrian Crossing, Motorist Left Turn

Pedestrian Crossing, Motorist Straight
Countermeasure Selection Guidance

- Identify Problem
- Understand Context
  Tier
  Evaluate Options
  Select most appropriate
Raised Median Islands with Pedestrian Refuge Areas

- Description
- Tier
- CMF/Rating
- Applicable Crash Types
- Applicable Contexts
- Complementary CMs
- Example Applications
- Considerations
- Estimated Cost
- Impacts on Other Modes
- Alternative Treatments
- Additional Information

Note: expanded information in **bold**
# Ped Straight, Motorist Left Turn at Multi-lane, Signalized Approach

<table>
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<tr>
<th>Traffic Control</th>
<th>Design</th>
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<tr>
<td><strong>Protected Left Turn Phasing</strong></td>
<td></td>
</tr>
<tr>
<td>Can be used at any speed; particularly appropriate for higher-speed locations</td>
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</tr>
<tr>
<td><strong>Leading Pedestrian Interval</strong></td>
<td></td>
</tr>
<tr>
<td>Can be used at any speed</td>
<td></td>
</tr>
<tr>
<td><strong>Curb Extension/Bulb-outs</strong></td>
<td>CM Option 4</td>
</tr>
<tr>
<td>Can be used at any speed</td>
<td></td>
</tr>
</tbody>
</table>

## Speed Considerations
- Can be used at any speed; particularly appropriate for higher-speed locations
- Can be used at any speed

## Motor Vehicle Volume Considerations
- Particularly appropriate for locations with relatively high left turn volumes
- Less effective for large, multi-lane intersections with high traffic volumes
- Appropriate for all locations

## Effectiveness (CM)
- Highly effective (0.01)
- Effective (0.63)
- Effective (n/a)
# Ped Straight, Motorist Left Turn at Multi-lane, Signalized Approach

<table>
<thead>
<tr>
<th>Traffic Control</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected Left Turn Phasing</td>
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<td>CM Option 4</td>
</tr>
</tbody>
</table>

## Pros
- Effective at all times of day
- Reduces need for other countermeasures
- For smaller intersections, may provide adequate clearance time without much additional delay for other users
- Will also help with right-turning conflicts between motorists and pedestrians
- Particularly impactful for locations with high pedestrian volumes

- Narrows effective street width, thereby reducing crossing time
- Increases pedestrian visibility for motorists
- Prevents motorists parking in the crosswalk
- Provides additional space for curb ramp construction
- May reduce turning speeds, due to tighter curb radii
## Countermeasure Comparison

### Ped Straight, Motorist Left Turn at Multi-lane, Signalized Approach

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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<td><strong>Leading Pedestrian Interval</strong></td>
<td><strong>Curb Extension/ Bulb-outs</strong></td>
</tr>
</tbody>
</table>
| **Cons**       | • May reduce intersection capacity  
• May require longer signal cycle lengths to manage volumes  
• Requires exclusive left turn lanes and signal display  
• More effective for traffic starting from a stopped position, rather than approaching on a stale green  
• Needs to be combined with other treatments to enhance visibility at night  
• Only appropriate where there is on-street parking or wide curb lanes, and where bicyclists still have sufficient space for travel | | | |
## Ped Straight, Motorist Left Turn at Multi-lane, Signalized Approach

<table>
<thead>
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<td>Curb Extension/ Bulb-outs</td>
</tr>
<tr>
<td>Leading Pedestrian Interval</td>
<td>CM Option 4</td>
</tr>
</tbody>
</table>

### Impacts on Other Modes
- May increase delay for all users
- Expected reduction in motor vehicle-motor vehicle turning crashes
- May reduce rear-end crash potential

- Slightly increases delay for bicyclists; municipalities can consider allowing bicyclists to proceed on LPI
- Helpful to reduce conflicts with motorists, trucks, and buses

- Care should be taken to maintain bicycle access post installation
- Minor loss of on-street parking post installation
Next Steps

• Analyze protected intersection video data
• Finalize guidebook
• Write final report

Estimated completion date: early 2019
Questions?

20-05/49-08 PI: Rebecca Sanders, PhD

15-63 PI: Krista Nordback, PhD – UNC
nordback@hsrc.unc.edu
TDG PM: Rebecca Sanders, PhD
rsanders@tooledesign.com
Kittelson PM: Conor Semler
semler@kittelson.com
NCHRP 17-73
Systemic Pedestrian Safety Analysis

AASHTO
Technical Committee on Non-Motorized Transportation

June 12, 2018
Presentation Overview

• Background

• Project Description
  • Objectives
  • Research Tasks

• Guidebook Overview
  • Systemic Analysis Process
  • Highlights of Guidebook Steps

• Conclusions
  • Project Limitations and Considerations
  • Future Research Needs
Tenets of a Systemic Approach*

• Identifies a safety concern based on an evaluation of data at the system (or network) level
• Establishes common characteristics (risk factors) of locations where severe crashes frequently occur
• Emphasizes low-cost safety countermeasures to address the risk factors identified
• Prioritizes locations across the entire roadway network where risk factors are present, regardless of prior crash history

*From FHWA’s Systemic Safety Project Selection Tool (Preston et al. 2013)
Project Objectives

Develop a process (and Guidebook) that includes:

1) Analytical methods to identify roadway features, behaviors, and other contextual risk factors associated with pedestrian crashes
2) Methods to identify appropriate and cost-effective systemic pedestrian safety improvements to address the associated risk factors
3) Information to enable transportation agencies to prioritize candidate locations for selected safety improvements
Key Project Tasks

• **Phase 1: Review State of the Practice**
  • Conduct a literature review and interviews with practitioners
  • Focus on differences and challenges for implementing an analytic systemic process for pedestrian safety
  • Identify data needs and sources for a robust systemic pedestrian process

• **Phase II: Conduct Additional Research**
  • Compile risk factors (associated with pedestrian crash frequency and/or severity) from published analyses
  • Conduct original analysis to identify additional risk factors associated with two types of pedestrian midblock collisions
  • Review and identify a select set of candidate pedestrian crash countermeasures compatible with systemic processes

• **Phase III: Develop Guidance**
  • Develop Guidebook on a systemic pedestrian safety process
  • Develop and incorporate case studies describing real or hypothetical applications
Benefits of a Systemic Approach

• Improved safety with more proactive approach
  • Don’t simply “chase the hot spots”

• Informed decision-making utilizes data on key risk factors

• Optimized investment
  • Cost-effective use of resources
  • Consistency in application
Key Takeaway: Systemic Approach Definition

“A systemic approach is a data-driven, network-wide (or system-level) approach to identifying and treating high-risk roadway features correlated with specific or severe crash types. Systemic approaches seek not only to address locations with prior crash occurrence, but also those locations with similar roadway or environmental crash risk characteristics.”
Why Do We Need a Systemic Safety Process Specific to Pedestrians?

• Pedestrian crashes may be rare or widely dispersed across a network, making a hot spot approach unreliable and cost-ineffective in identifying and addressing pedestrian safety.

• Crash risk factors for pedestrians are different than for motor vehicles, and there is a need for specific guidance and research to augment existing tools and guides.

• The process needs to be tailored to data related to pedestrians, and to provide guidance on how to gather needed data.
Guidebook Elements

• Overview
  • Background on a Systemic Process and key features
  • How to use the Guidebook and intended audience
  • Relation to other agency processes

• Process steps

• Examples

• Glossary of key terms

• Appendices

• Companion: Final Technical Report
Steps in the Guidebook

Systemic Pedestrian Safety Analysis Process

- **Step 1**: Define Study Scope
- **Step 2**: Compile Data
- **Step 3**: Determine Risk Factors
- **Step 4**: Identify Potential Treatment Sites
- **Step 5**: Select Potential Countermeasures
- **Step 6**: Refine and Implement Treatment Plan
- **Step 7**: Evaluate Project and Program Impacts

Background | Project Description | Guidebook Overview | Conclusions
**Systemic Process – Safety Management**

*Table 1. Relation of the pedestrian systemic process to the Highway Safety Manual process.*

<table>
<thead>
<tr>
<th>If you are in the HSM process...</th>
<th>Find guidance for incorporating a systemic approach in...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior analysis (not shown in HSM’s six steps)</td>
<td>Steps 1-3</td>
</tr>
<tr>
<td>Network Screening</td>
<td>Step 4</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Step 1 (Section 1.2), Step 3, Step 6 (Section 6.2)</td>
</tr>
<tr>
<td>Select Countermeasures</td>
<td>Step 5</td>
</tr>
<tr>
<td>Economic Appraisal</td>
<td>Step 6 (Section 6.3)</td>
</tr>
<tr>
<td>Prioritize Projects</td>
<td>Step 6</td>
</tr>
<tr>
<td>Evaluate</td>
<td>Step 7</td>
</tr>
</tbody>
</table>
Step 2: Compile Data

- Guidebook provides information and examples on how and why to make data: current and complete, easily accessible, centralized, digitized, linkable across databases, and spatially-referenced

- Recommended data for systemic analysis include:
  - Pedestrian crash records, including injury severity, crash type, and spatial references
  - Detailed roadway data with key characteristics such as # of lanes
  - Vehicle traffic and pedestrian volumes or secondary data to estimate volumes (e.g., transit ridership, population/employment density, etc.)
  - Other measures of the built and social environment
Examples with Key Takeaways

1. Seattle DOT
2. Oregon DOT
3. Arizona DOT
4. California DOT (Caltrans)
Limitations and Considerations

• Recognition that limited data is a primary obstacle to implementing a robust systemic safety analysis process

• Limited data on behavior-based risk factors or examples in practice

• Limited research or evaluation of Steps 6-7 (prioritization and evaluation) in practice

• CMFs for treatments applied systemically may differ from those applied based on crash history

• The Final Technical Report complements the Guidebook with more information on the process rationale and analysis
Future Research Needs

• Research/guidance on how to better measure and account for individual- or behavior-based risk factors, such as motorist speed or pedestrian behaviors

• Further evaluation of the safety impacts of treatments in systemic applications

• Pooled sources of data or research to help quantify risk factors that are more generally applicable to many jurisdictions

• Studies evaluating the safety impacts of systemic vs. traditional (e.g., hotspot) approaches

Project Team:
Laura Sandt, Libby Thomas, Charlie Zegeer, Wesley Kumfer, Katy Lang, Bo Lan, Krista Nordback
Highway Safety Research Center, University of North Carolina – Chapel Hill, Chapel Hill, NC

Casey Bergh, Andrew Butsick, Zachary Horowitz, Bastian Schroeder, Joseph Toole
Kittelson & Associates, Inc., Portland, OR

Robert J. Schneider
University of Wisconsin-Milwaukee, Consultant

NCHRP Program Officers:
Lori Sundstrom and Ann Hartell
Implementation

• NCHRP Implementation Support Program

• Pre-publication of Guidebook & Technical Report expected this summer
PBIC’s Mission

“To improve the quality of life in communities through the increase of safe walking and bicycling as a viable means of transportation and physical activity.”
Funded Team Members

- UNC Highway Safety Research Center
- Toole Design Group (TDG)
- PeopleForBikes
- Governor’s Highway Safety Association (GHSA)
- Institute of Transportation Engineers (ITE)
- Virginia Tech Transportation Institute (VTTI)
Core Activities and Services

1. Data and Information
2. Research and Guidance
3. Capacity Building
4. Outreach and Communications
Websites
Coverage of Critical Topics
Technical Resources: Design Resource Index

- On-street bike facilities, pedestrian facilities, and shared use paths
Defining Connected Bike Networks

What is a “connected bike network”? A connected bike network provides a safe and comfortable transportation experience, enabling people of all ages and abilities to get where they want to go. Consider the road network as an example: when people get in a car to go somewhere, they don’t give much thought to whether the road can get them to their destination or if they feel secure taking children with them. In other words, the road network for motor vehicles in the U.S. connects to the places people want to go in a generally convenient, reliable, and comfortable way.

Bike networks in the U.S. rarely function the same way. In many places, biking isn’t an option that people can get from one place to another or a bike on a network that feels safe, for example. Figure 1 shows the areas accessible by bike how the highlighted areas become using the existing bike and high-visibility bike network. Notice how they overlap, creating a network around the low-stress areas. Additionally, it is uncommon for a connected bike facility to be a connected bike network. Such a network can include a variety of facilities, from a protected bike lane or a quiet neighborhood street to a shared-use path. High-visibility facilities such as a conventional bike lane on a street or a 40 mph speed limit may not meet the needs of people of all ages and abilities and would therefore not be considered part of the connected bike network. In this conceptualization, a connected bike network gets people where they want to go and offers a comfortable way to get there.
Coming soon: crash animation and webinar series

- Multiple threat
- Right “hook”
- Permissive left turn
- Close passing maneuver
- More TBD
Coming soon: Resource on Highway Removals

**The Emerging Language of Highway Removals**

**Types of Highway Removals**

- **Spur Removal**
  - A spur removal is a highway that extends for a distance and then ends by transforming into city streets.

- **Section Removal**
  - A section removal focuses on what highway runs through a city. The removal removes the highway at both edges of the city to rely more on a network of streets and connections within the city.

**Types of Highway Mitigation**

- **Sound Walls and Screening**
  - Sound walls and screening reduce the noise in the vicinity of the highway and screening hides the view of the highway.

- **Underpasses and Overpasses**
  - Underpasses and overpasses help maintain pedestrian and non-motorized connections across highways. They are expensive, but generally non-obtrusive for people walking or bicycling.
Capacity Building

• On-demand technical assistance
• Monthly webinars
• Training courses / peer exchanges
• State Coordinator support
Outreach and Communications

• Quarterly Newsletters:  
  http://www.pedbikeinfo.org/newsletter/signup.cfm

• Social Media
  – Twitter: @pedbikeinfo
  – Facebook.com/pedbikeinfo

• Conferences

• Stakeholder meetings
Contact Info

Laura Sandt, PhD
Director, Pedestrian and Bicycle Information Center
Senior Research Associate, UNC Highway Safety Research Center
919-962-2358
sandt@hsrc.unc.edu
Introduction to CSCRS
CSCRS Mission

The **Collaborative Sciences Center for Road Safety** will accelerate progress in reducing transport injuries and fatalities by utilizing a systems approach to bring perspectives from planning, engineering, public health, data science, and robotics to the road safety field.

- Multidisciplinary
- Collaborative
- Systems approach
CSCRS Team

Led by University of North Carolina at Chapel Hill:
• Highway Safety Research Center
• Department of City & Regional Planning
• School of Public Health

Consortium members:
• Duke University
• Florida Atlantic University
• University of California, Berkeley
• University of Tennessee, Knoxville

www.roadsafety.unc.edu
Snapshot of Current Research Activities

• Explaining the Rise in Pedestrian Fatalities: A Systems Approach (UNC)
• Creating a Clearinghouse for Bicyclist and Pedestrian Safety-Related Data, Phase I: Inventory & Framework (UNC)
• Identifying the Traffic Safety Information Needs of Major Cities in the U.S. (FAU)
• Linking Crash and Post-Crash Data (UCB)
• Opioids at the Health and Transportation Safety Nexus (UTK)
• Strengthening Existing and Facilitating New Vision Zero Plans (UNC)
• Structures of Stakeholder Relationships in Making Road Safety Decisions (UNC)
• Understanding Crash Risk Exposure of Low Income Neighborhoods and Households (FAU)

Browse more at: www.roadsafety.unc.edu/research/projects/
Every Project will Produce…

- Final report and presentation materials
- All final data sets open source
- All materials in TRB’s TRID database and on the CSCRS website
- Technology transfer plan (if applicable)
Snapshot of Non-Research Activities

- Seminar and discussion series (UNC, FAU, UTK)
- Crash Scene Investigation camp (UTK)
- Student scholarships and courses (all)
- K-12 activities (all)
- Safety Sunday at TRB
Upcoming Event: Safe Systems Summit

Travel scholarships available: https://www.roadsafety.unc.edu/summit/scholarship/
Connect with CSCRS

Visit: www.roadsafety.unc.edu

Subscribe: CSCRS Crossroads newsletter

Follow: Facebook & Twitter: @CSCRSinfo

Share: Research needs and ideas

Review: Proposals or pre-published products

Collaborate: On research, student, and/or professional development efforts

Contact:
Laura Sandt
Director, CSCRS
(UNC HSRC)
sandt@hsrc.unc.edu
Thank you!
Walking and Biking in an Automated Future

Automated vehicles (AVs) have the potential to improve mobility, safety, and accessibility for many road users, including pedestrians and bicyclists. Yet, there remain significant technical and social issues that need to be addressed before the safety potential of AVs can be fully realized.

A PBIC discussion guide, webinar series, and Twitter chat conversation explore challenges and opportunities for AVs and provide resources for further research.

Updated Design Resource Index

An updated PBIC Design Resource Index helps engineers, landscape architects, planners, and other practitioners quickly access the right resources from NACTO, Federal Highway Administration, Institute of Transportation Engineers, and many other key national design manuals. The Index helps reduce the search time for specific information on pedestrian and bicycle design treatments.

Updated Image Library

Find and share photos of scenarios related to walking and biking on the updated PBIC Image Library. The open access collection provides photos to use in presentations, blogs, publications, training courses, and other uses. Users can upload photos of people walking or biking, facilities, safety treatments, and anything else related to existing conditions and behaviors to help build a robust community resource.

Guidebook for Developing Pedestrian and Bicycle Performance Measures

Walking and bicycling investments, activity, and impacts can be measured and tracked to help communities integrate pedestrian and bicycle planning in ongoing performance management activities. A guidebook from FHWA provides resources for developing measures and case studies from communities currently using these measures in their planning process.

Automated Enforcement Systems Info Brief

Reducing the number of traffic crashes caused by running red lights and speeding is vital for the safety of all road users. A discussion brief from PBIC explores the impact of automated enforcement systems, specifically red-light and speed cameras, on pedestrian and bicyclist safety, and how they can be used as tools implemented alongside education and engineering improvements.

National Center for Safe Routes to School

Children, parents, school officials, and community leaders across the country participated in record-breaking numbers in National Walk to School Day and National Bike to School Day.

18 Communities Receive Walk Friendly Designation

The Walk Friendly Communities program recognizes 18 communities with new and renewed designations for their commitment to prioritizing pedestrians and creating safe, comfortable and inviting places to walk. The Walk Friendly designation is based on community efforts to expand opportunities for walking and improve pedestrian safety across a wide range of programs and activities, from planning and design to outreach and law enforcement.

All resources listed can be found at www.pedbikeinfo.org

This material is based upon work supported by the Federal Highway Administration under Cooperative Agreement No. DTFH61-16-H-00029. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the Author(s) and do not necessarily reflect the view of the Federal Highway Administration and the National Highway Traffic Safety Administration.
Work Underway

The UNC Highway Safety Research Center is in the second year of a five-year cooperative agreement with FHWA to continue operations of the PBIC, along with partners Toole Design Group, PeopleForBikes, Virginia Tech Transportation Institute, the Institute of Transportation Engineers, and the Governors Highway Safety Association. Current and ongoing projects include:

- Crash animation video series illustrating and explaining common vehicular crash scenarios with pedestrians and bicyclists. A six-part webinar series will further explore and discuss crash situations.
- Updated website with fresh content and features.
- Free monthly webinar series.
- New case studies, training materials, and online resources.

Collaborate with PBIC! We’re calling all:

Photographers
Upload your photos to PedBikeImages, an open access collection of ped-bike related images. Visit our new site for the perfect visual to enhance your presentation, website, or reports: http://www.pedbikeimages.org

Experts and Practitioners
Share your experience and valuable knowledge with colleagues and other ped-bike professionals in panel discussions on webinars, case study profiles in info and research briefs, and other PBIC resources.

Writers and Contributors
Reach an audience of over 6,000 ped-bike professionals by contributing content to the PBIC Messenger. Industry colleagues want to know about your upcoming events, projects, or recent resources. Here’s the chance to be in spotlight in our newsletter.

Questions, suggestions, or want to collaborate? Contact Laura Sandt at sandt@hsrc.unc.edu.

Popular Resources

- **Info and Research Briefs**
  Summaries of the state of the practice and current research for practitioners.
  www.pedbikeinfo.org/data/whitepapers.cfm

- **PBIC Library**
  Browse or search thousands of relevant reports, guides and case studies.
  www.pedbikeinfo.org/library

- **Popular Topics**
  New and important information about popular and emerging topics highlighted on our homepage.
  www.pedbikeinfo.org

- **Monthly webinar series**
  Free webinar presentations covering a range of topics.
  www.pedbikeinfo.org/webinars

- **Searchable Image Library**
  User-generated photo collection featuring thousands of bicycling and walking images.
  www.pedbikeimages.org

- **Interactive state resources tool**
  Find local contacts, plans and maps for every State.
  www.pedbikeinfo.org/data/state.cfm

All resources listed can be found at www.pedbikeinfo.org

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AASHTO Sub-Committee on Design
Update to the 2012 Guide for the Development of Bicycle Facilities

Bill Schultheiss, PE
June 12, 2018
As the 2012 Guide was developed, new types of bicycle facilities were being installed and new design guidance issued:

- Institute of Transportation Engineers (ITE) *Separated Bikeways* (2013)
- FHWA memorandum *Bicycle and Pedestrian Facility Design Flexibility* (2013)
Panel Members for NCHRP 15-60

Ms. Charlotte Claybrooke, Panel Chair
Safe Routes to School Coordinator
Washington State Department of Transportation

Mrs. Lauren Blackburn
VHB, Senior Project Manager
(Former North Carolina DOT)

Dr. Ralph Buehler
Associate Professor in Urban Affairs & Planning
Virginia Polytechnic Institute & State University

Ms. Catherine Cagle
City of Waltham, Planning Director
(Former Massachusetts DOT)

Michael Janzen
Headquarters, Design
California Department of Transportation

Mr. Jon Kaplan
Bicycle & Pedestrian Engineer
Vermont Agency of Transportation

Mr. Jonathan Marburger
Senior Transportation Engineer
JEO Consulting Group (Former Kansas DOT)

Mr. Larry Sutherland
WSP, Technical Director of Highways
(Former Ohio DOT)

Mr. Roger. Gutierrez
ODOT Traffic-Roadway Section
Oregon Department of Transportation

Ms. Julie Walcoff – AASHTO Monitor
Bicycle/Pedestrian and Safe Routes to School Program Manager
Ohio Department of Transportation

Dr. William C. Rogers
Senior Program Officer
Transportation Research Board

Mr. Bernardo Kleiner – TRB Rep
Senior Program Officer - Transportation Safety Specialist
Transportation Research Board

Mr. Edward Stollof – Liaison
Senior Director, Highway Safety Programs
Institute of Transportation Engineers (ITE)

Ms. Elizabeth Hilton – FHWA Liaison
Area Engineer
Federal Highway Administration (FHWA)
NCHRP 15-60 Objectives
(Update of AASHTO Bike Guide)

• Review research and practice to **address gaps in 2012 Guide**
• Develop a **framework for selecting appropriate facility** and design features based on context
• Consider users of **all ages and abilities**, including children
• Harmonization with applicable standards and guidelines
AASHTO Survey: What bicycle design guides do you rely upon on a regular basis? (Check all that apply)

<table>
<thead>
<tr>
<th>Guide</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO A Policy on Geometric Design of Highways and Streets (Green Book)</td>
<td>78.6%</td>
</tr>
<tr>
<td>FHWA Separated Bike Lane Design Guide</td>
<td>35.7%</td>
</tr>
<tr>
<td>ITE Traffic Control Devices Handbook</td>
<td>25.0%</td>
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<tr>
<td>Manual on Uniform Traffic Control Devices (MUTCD)</td>
<td>89.3%</td>
</tr>
<tr>
<td>NACTO Urban Bikeway Design Guide</td>
<td>39.3%</td>
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<tr>
<td>Dutch Crow Design Manual for Bicycle Traffic</td>
<td>3.6%</td>
</tr>
<tr>
<td>Local Agency Bicycle Design Guide, please state which one(s):</td>
<td>21.4%</td>
</tr>
<tr>
<td>Other, please state which one:</td>
<td>14.3%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>3.6%</td>
</tr>
</tbody>
</table>
STANDING COMMITTEE ON HIGHWAYS (SCOH)

ADMINISTRATIVE RESOLUTION

TITLE: DIRECTION ON FLEXIBILITY IN DESIGN STANDARDS

WHEREAS, The AASHTO A Policy on Geometric Design of Highways and Streets (commonly referred to as the “Green Book”) serves as the preeminent design guidance for streets and roadways in the United States; and

WHEREAS, The Green Book is a research based, peer developed set of design standards, which serves as the basis of design for all roads on the National Highway System, as well as many state and local roads; and

WHEREAS, The next edition of the Green Book is currently under development; and

WHEREAS, Increases in bicycle and pedestrian volumes have been recorded nationwide in large cities, suburbs, and small towns, along with corresponding increases in collisions and fatalities; and

WHEREAS, Funding and right-of-way constraints are a continual challenge for transportation facility owners; and

WHEREAS, Additional, robustly-researched guidance is needed on how best to incorporate other modes of travel when designing safe and efficient roadways that serve all users; and
### AASHTO Survey: Rank the importance of including these issues in the next edition of the AASHTO Bike Guide?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Score</th>
<th>Overall Rank</th>
<th>Included in Draft?</th>
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<tbody>
<tr>
<td>Design of transitions between treatments</td>
<td>200</td>
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<tr>
<td>Bicycle intersection treatments (e.g. bike boxes, two-stage turn boxes)</td>
<td>171</td>
<td>2</td>
<td>yes</td>
</tr>
<tr>
<td>Separated Bike Lanes</td>
<td>167</td>
<td>3</td>
<td>yes</td>
</tr>
<tr>
<td>Buffered bike lanes</td>
<td>164</td>
<td>4</td>
<td>yes</td>
</tr>
<tr>
<td>Application of PROWAG</td>
<td>155</td>
<td>5</td>
<td>yes</td>
</tr>
<tr>
<td>Bicycle signals and detection</td>
<td>151</td>
<td>6</td>
<td>yes</td>
</tr>
<tr>
<td>Other (please describe in next question)</td>
<td>146</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Use of green color in bike lanes</td>
<td>137</td>
<td>8</td>
<td>yes</td>
</tr>
<tr>
<td>Bicycle Boulevards</td>
<td>128</td>
<td>9</td>
<td>yes</td>
</tr>
<tr>
<td>Electric assist bicycle (e-bikes)</td>
<td>121</td>
<td>10</td>
<td>yes</td>
</tr>
</tbody>
</table>
Sources: State DOT Guidance
Sources: Federal Guidance

- FHWA Achieving Multimodal Networks Applying Design Flexibility & Reducing Conflicts
- NCHRP 803 Pedestrian and Bicycle Transportation Along Existing Roads
- FHWA Separated Bike Lane Planning and Design Guide
- FHWA Accessible Shared Streets
Revised AASHTO Chapter Outline

1. Introduction
2. Bicycle Operation & Safety
3. Planning
4. Facility Selection
5. Elements of Design
6. Shared Use Paths
7. Separated Bike Lanes
8. Bicycle Boulevards
9. Bike Lanes & Shared Lanes
10. Traffic Signals and Active Warning Devices
11. Roundabouts, Interchanges, and Other Intersections
12. Rural Area Bikeways
13. Structures
14. Wayfinding
15. Maintenance & Operations
16. Parking & End of Trip Facilities
Chapter 1 – Introduction: Design Values

**Minimum** - the use of minimum values should not be considered a default for bicycle facilities

**Desirable or Preferable** - The use of larger values should be used to maximize the safety and comfort benefits for bicyclists
Chapter 1 – Introduction: Design Values

**Minimum** - the use of minimum values should not be considered a default for bicycle facilities

**Desirable or Preferable** - The use of larger values should be used to maximize the safety and comfort benefits for bicyclists

- 5’ Bike Lane
- 5’ Bike Lane
- 7’ Parking Lane
- 4’ Buffer
- 5’ Bike Lane
Chapter 1 – Introduction
Design Values

**Constrained** - values below recommended minimum values. May be used:
- Interim measure
- Limited distances
- Where bike volumes low
Chapter 1 – Introduction
Definitions

**Bicycle Facilities** – A general term denoting improvements and provisions to accommodate or encourage bicycling, including bikeways, bicycle boulevards, bicycle detection, shared lane markings, wayfinding, in addition to parking and storage facilities.
Chapter 1 – Introduction
Definitions

**Bikeway** – A bicycle boulevard or any other facility intended for bicycle travel which designates space for bicyclists distinct from motor vehicle traffic. A bikeway does not include shared lanes, sidewalks, signed routes, or shared lanes with shared lane markings because these treatments do not materially improve operating conditions for bicyclists.
Chapter 2 - Bicycle Operation & Safety

Crashes and Near Crashes

Both crash and near-crash experiences influence perceived bicycling safety and comfort (Lee et al., 2015; Sanders, 2015; Aldred & Crossweller, 2015)
Number of Bicyclist Fatalities
U.S. 2010-2015

2010 vs. 2015: +197 (+32%)
Top Crash Types: FARS Data

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>U.S. Urban Bicyclist Fatalities 2014 and 2016</th>
<th>Percentage of Total Urban Bicyclist Fatalities</th>
<th>Percentage of Crash Type at Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorist Overtaking Bicyclist</td>
<td>397</td>
<td>24%</td>
<td>10%</td>
</tr>
<tr>
<td>Bicyclist Failed to Yield - Signalized Intersection</td>
<td>155</td>
<td>9%</td>
<td>100%</td>
</tr>
<tr>
<td>Crossing Paths - Other Circumstances</td>
<td>140</td>
<td>8%</td>
<td>82%</td>
</tr>
<tr>
<td>Bicyclist Failed to Yield - Midblock</td>
<td>133</td>
<td>8%</td>
<td>0%</td>
</tr>
<tr>
<td>Parallel Paths - Other Circumstances</td>
<td>128</td>
<td>8%</td>
<td>21%</td>
</tr>
<tr>
<td>Bicyclist Left Turn / Merge</td>
<td>115</td>
<td>7%</td>
<td>25%</td>
</tr>
<tr>
<td>Bicyclist Failed to Yield - Sign-Controlled Intersection</td>
<td>103</td>
<td>6%</td>
<td>100%</td>
</tr>
<tr>
<td>Other / Unknown - Insufficient Details</td>
<td>92</td>
<td>6%</td>
<td>32%</td>
</tr>
<tr>
<td>Loss of Control / Turning Error</td>
<td>71</td>
<td>4%</td>
<td>55%</td>
</tr>
<tr>
<td>Wrong-Way / Wrong-Side</td>
<td>71</td>
<td>4%</td>
<td>17%</td>
</tr>
<tr>
<td>Motorist Left Turn / Merge</td>
<td>61</td>
<td>4%</td>
<td>90%</td>
</tr>
<tr>
<td>Motorist Right Turn / Merge</td>
<td>57</td>
<td>3%</td>
<td>93%</td>
</tr>
<tr>
<td>All Other Crash Types</td>
<td>128</td>
<td>8%</td>
<td>49%</td>
</tr>
</tbody>
</table>

24%  
9%  
9%  
2%
Sources:
- Helmet wearing:

- Cyclist Fatalities:
Findings from the Literature Review

User Characteristics

Until age 14, children tend to have slower response and execution times (Plumert et al., 2004; Kali, 1991)

Children also tend to sacrifice cognitive functions to preserve motor functions, e.g., maintaining balance on bicycle (Wierda & Brookhuis, 1991)

Older adults show slower processing time and task performance (Salthouse, 2009; Verhaeghen & Cerella, 2002)

- Particularly true in the face of multiple stimuli (Verhaeghen & Cerella, 2002)
Sidewalk and Sidepath Research Summary

Historical research bicycle safety:

- same or lower crash risk with motorists compared to streets without bike lanes where cyclists ride with traffic
- 2-6 times higher crash risk with motorists where cyclists ride facing traffic

Sidewalks and sidepaths have higher potential for crashes caused by objects in path, deficiencies in width, or collisions with other users
Chapter 2 – Bicycle Operation

SBL Safety Research Summary

Reduced injury risk compared to standard bike lanes and shared lanes
(Lusk et al., 2013; Lusk et al., 2011; NYCDOT, 2014; Winters et al., 2013)

SBL preferred over striped or shared lanes by both cyclists and motorists
(Monsere et al., 2014; Monsere et al., 2012; Sanders, 2014)

One-way generally safer than two-way
(Schepers et al., 2011; Thomas & DeRobertis, 2013)

Two-way SBLs on one-way roads, preferable on right side
(Schepers et al., 2011; Zangenehpour et al., 2015)
New York City Road Diet Lawsuit
Decided December 22, 2016  Turturro vs. City of New York

State’s Highest Court Holds NYC Liable for Injuries on Streets Without Traffic Calming

“This ruling from New York’s highest court puts an end to the notion that traffic safety improvements should be subject to debate and contingent on unanimous local opinion,” White said.
Chapter 2 - Bicycle Operation & Safety

4 - 7% Experienced and confident
5 - 9% Somewhat confident
51 - 56% Interested but Concerned

lower stress tolerance higher stress tolerance

Chapter 2 - Bicycle Operation & Safety

**BICYCLIST DESIGN USER PROFILES**

**Interested but Concerned**
- **51%-56%** of the total population
- Often not comfortable with bike lanes, may bike on sidewalks even if bike lanes are provided; prefer off-street or separated bicycle facilities or quiet or traffic-calmed residential roads. May not bike at all if bicycle facilities do not meet needs for perceived comfort.

**Somewhat Confident**
- **5-9%** of the total population
- Generally prefer more separated facilities, but are comfortable riding in bicycle lanes or on paved shoulders if need be.

**Highly Confident**
- **4-7%** of the total population
- Comfortable riding with traffic; will use roads without bike lanes.
Chapter 2 - Bicycle Operation & Safety Preferred Design User for AASHTO Guide

4 - 7%

Experienced & Confident Cyclist
AASHTO 2012

51 - 56%

Interested but Concerned Cyclist
AASHTO 2018
Chapter 3: Planning: Connected Networks
Necessary to Create A Safety in Numbers Effect

In 1987 alone, Dutch gov't saved $641 Million on school buses, b'cos children were cycling instead. This map shows partly why @AklTransport

NZTA Akld & Nthind, Committee for Sydney, Bicycle NSW and 6 others

USA City
Case Study
Seville, Spain Safety In Numbers

Source: Marques and Hernandez-Herrador, 2017

**Action**
- Built 36 mile separated bike lane network in 1 year (2006)
- 48 mile connected network

**Results**
- Bicycle trips up 435%
- Cycling risk per million bicycle trips decreased by 64%
- Bike mode share
  - 1% in 2006
  - 5% in 2007
  - 9% in 2013

Note: Chart is adapted from source data
Low-stress Network Principles

**Safety:**
- Minimize conflicts
- Encourage yielding
- Delineate space
- Provide consistency

**Comfort:**
- Separate modes
- Balance delay
- Accommodate passing bicyclists

**Connectivity:**
- Provide direct, seamless transitions
- Integrate into multimodal network
Chapter 3
Network Purpose

Low-Stress Bicycle Network - is designed to be safe and comfortable for all users. These support All Ages and Abilities (~72% of public)

Basic Bikeway Network - consist primarily of bicycle lanes and shoulders may. These networks support Highly Confident Bicyclists and some Somewhat Confident Bicyclists (~16%)

Traffic Tolerant Network - all roads and paths on which bicycling is legally allowed. These networks support Experienced and Highly Confident Bicyclists (~4%)
Chapter 3 - Planning

<table>
<thead>
<tr>
<th>Network Types</th>
<th>Expected Users</th>
<th>Percent of the General Public Accommodated</th>
<th>Potential Bicycle Mode Share</th>
<th>U.S. Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Stress Network</td>
<td>Interested but Concerned, Somewhat Confident, Highly Confident</td>
<td>63% to 69%</td>
<td>5% to 50%</td>
<td>Davis, CA: 16.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boulder, CO: 9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Portland, OR: 6.3%</td>
</tr>
<tr>
<td>Basic Facility Network</td>
<td>Somewhat Confident, Highly Confident</td>
<td>9% to 16%</td>
<td>2% to 3%</td>
<td>Tucson, AZ: 2.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Philadelphia, PA: 2.2%</td>
</tr>
<tr>
<td>Traffic-Tolerant Network</td>
<td>Highly Confident</td>
<td>4% to 7%</td>
<td>1%</td>
<td>Numerous examples</td>
</tr>
</tbody>
</table>

* American Community Survey, 2016, 1 year estimates
Note that neighborhoods within cities often see larger bicycle mode share than city-wide numbers indicate.
Chapter 4 - Guidance for Choosing a Bikeway Type
When to Separate Bikes from Motor Vehicles?

4.2. Project Purpose and Need

The design of road or street improvements should begin with an explicit statement that indicates why the project is being undertaken and what the project is intended to accomplish. For example, bikeway design projects are often initiated in communities that have a stated goal of increasing bicycle mode share and improving safety. If this is the case, the purpose and need statement should identify how the project will help to accomplish these goals.

The purpose and need statement should identify the project limits, the land use context, the types of bicyclists that are expected to use the facility, the intended connections that are being made within the larger bicycle network, the various directions of travel from which bicyclists may access the facility, and key safety issues that should be addressed, including the identification of crash patterns where data is available, or the consideration of near-misses or public concerns where crash data is inadequate.

4.2.1. Project Limits

Project limits should enhance network continuity and user safety. Where transitions are necessary, their design should be logical and intuitive for bicyclists, pedestrians, and motorists. Logical project limits should be established to meet the desired connectivity and safety objectives of the project for bicyclists. The facility design chapters in this Guide (see Chapters 6-9) provide guidance for transitions between different roadway designs.

4.2.2. Land Use Context

The AASHTO Green Book defines five land use context classifications: rural, rural town, suburban, urban, and urban core (which are defined by development density (existence of structures and structure types), land uses (primarily residential, commercial, industrial, and/or agricultural), and building setbacks (distance of structures to adjacent roadways). While a street may have one functional classification, it may pass through multiple context classifications. Possible changes in context classification resulting from future development should be considered in design. The purpose of the context classification is to allow a more thorough assessment of multimodal needs to develop an appropriate balance among
Chapter 4 - Guidance for Choosing a Bikeway Type
When to Separate Bikes from Motor Vehicles?

Separate at >25 mph operating speeds or >6,000 ADT.

Also consider:
• Multi-lane roadways
• Curbside conflicts
• Large vehicles
• Vulnerable populations
• Low-stress network gaps
• Unusual peak hour volume

Use Level of Traffic Stress in lieu of Bicycle Level of Service
Chapter 4 - Guidance for Choosing a Bikeway Type

When to Separate Bikes from Motor Vehicles?

- 4.3. Selecting the Preferred Bikeway Type
  - 4.3.1. Streets in Urban, Suburban and Rural Town Contexts
  - 4.3.2. Rural Roadways
  - 4.3.3. Other Considerations
  - 4.3.4. Choosing Between Separated Bike Lanes or Shared Use Paths

- 4.4. Strategies to Achieve the Preferred (or Next Best) Design
  - 4.4.1. Design Flexibility
  - 4.4.2. Example Strategies for Constrained Rights-of-Way
    - Narrowing Travel Lanes
    - Removing Travel Lanes
    - Reorganizing Street Space
    - Reducing Bicycle Facility Widths
    - Making Changes to On-Street Parking
    - Pilot Projects
  - 4.5. Evaluating Trade-offs
    - 4.5.1. Construction Costs
    - 4.5.2. Maintenance Costs
    - 4.5.3. Estimated Bicycle Ridership
    - 4.5.4. Safety
    - 4.5.5. Impacts on Motor Vehicle Capacity and Travel Time
Chapter 4 - Guidance for Choosing a Bikeway Type

When should we separate bikes and pedestrians?

Evaluate with FHWA Shared-Use Path Level of Service Calculator

- Low Volume Pedestrians
  - Low Conflict
  - < 100 users an hour

- Separate Uses
  - Low Conflict
  - > 200 users an hour

- High Volume Pedestrians
  - High Conflict

- High Volume
  - Pedestrians
  - High Conflict
Chapter 5 – Elements of Design

“How to” chapter for critical design elements

approach clear space
Understanding Widths – Side By Side Riding

Side-by-Side Bicycling

- 42” min operating space
- 30” physical space

- 6” min same direction; 12” des 24” pref opposite direction
- 42” min operating space
- 30” physical space

- 24” des 6” min
- 24” pref 0” min

- Flexpost

Fixed objects greater than 3’ in height (railings, bollards, lamp posts, traffic signs, trees, etc.)

Objects less than 3’ in height (planters, etc.)
Understanding Widths – Occasional Passing

Occasional Passing

30”

physical space

6” min same direction; 12” des 24” pref opposite direction

24” min

flexpost

<36”

>36”

full or reduced height curb

12” des 6” min

24” des 6” min

fixed objects greater than 3’ in height (railings, bollards, lamp posts, traffic signs, trees, etc.)

objects less than 3’ in height (planters, etc.)
Minimum Widths – Occasional Passing
Desirable Widths – Side By Side Riding
Chapter 5 – Elements of Design

Path Sight Triangle Equation

\[
\begin{align*}
\ell_v &= 1.47 \frac{V - V_s}{a_j} \\
\ell_p &= \ell_v + \frac{P + L}{1.47V_s} \\
b &= 1.47 V_{mf} t_s
\end{align*}
\]

Where:
- \(\ell_v\) = travel time to reach and clear the path (s)
- \(\ell_p\) = length of leg sight triangle along the path approach (ft)
- \(b\) = length of leg sight triangle along the path approach (ft)

Length of Path and Roadway Sight Triangle (ft) - Bike Case C3

<table>
<thead>
<tr>
<th>Bike Speed (mph)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>96</td>
<td>58</td>
<td>59</td>
<td>60</td>
<td>63</td>
<td>68</td>
</tr>
<tr>
<td>12</td>
<td>98</td>
<td>70</td>
<td>70</td>
<td>164</td>
<td>75</td>
<td>82</td>
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<td>105</td>
<td>87</td>
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<td>174</td>
<td>94</td>
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<td>112</td>
<td>105</td>
<td>106</td>
<td>187</td>
<td>113</td>
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<td>145</td>
<td>147</td>
<td>222</td>
<td>156</td>
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<tr>
<td>30</td>
<td>149</td>
<td>174</td>
<td>176</td>
<td>249</td>
<td>188</td>
<td>204</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roadway Speed (mph)</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>96</td>
<td>74</td>
<td>81</td>
<td>224</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>98</td>
<td>89</td>
<td>97</td>
<td>230</td>
<td>262</td>
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<td>15</td>
<td>105</td>
<td>94</td>
<td>244</td>
<td>297</td>
<td>122</td>
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</tr>
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<td>18</td>
<td>112</td>
<td>111</td>
<td>262</td>
<td>300</td>
<td>122</td>
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<td>20</td>
<td>118</td>
<td>134</td>
<td>262</td>
<td>300</td>
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<td>149</td>
<td>186</td>
<td>311</td>
<td>355</td>
<td>203</td>
<td></td>
</tr>
</tbody>
</table>

Assumptions: Bicycle reaction time = 1.5 sec

- \(a\) = sight distance (ft) along roadway
- \(b\) = sight distance (ft) along path
Chapter 5 – Elements of Design

Motorist Yielding Behavior at Uncontrolled Approaches to Crossings

- % Yield Rate
- ROADWAY CONDITIONS

- N = number of sites where observations were taken
- Traffic control at all study locations were limited to marked crosswalks and standard crossings signs (W11-1, W11-2, W11-15)

Legend:
- Minimum value
- First quartile
- Median value
- Third quartile
- Maximum value

5.9 Evaluating Bicycle and Pedestrian Roadway Crossings
- 5.9.1 Evaluation of Right of Way Assignment
- 5.9.1.1 Volume Assessment
- 5.9.1.2 Considerations for Crossings with No Control
- 5.9.1.3 Considerations for Yield or Stop Control
- 5.9.2 Evaluations of Uncontrolled Roadway Approaches to Bicycle Crossings
- 5.9.2.1 Factors That Impact Motorist Yielding Rates
- 5.9.2.2 Evaluate Crossing Opportunities
- 5.9.2.2.1 Recommended Crossing Opportunities
- 5.9.2.2.2 Gap Studies and Crossing Delay
- 5.9.2.3 Apply Countermeasures to Improve Yielding
- 5.9.2.3.1 Tier 1 Countermeasures
- 5.9.2.3.2 Tier 2 Countermeasures
- 5.9.2.3.3 Tier 3 Countermeasures
- 5.9.3 Evaluation of a Traffic Control Signal or Pedestrian Hybrid Beacon
- 5.9.3.1 MUTCD Traffic Control Signal Warrants
5.10 Geometric Design Treatments to Improve Intersection Safety

5.10.1 Raised Crossing Islands, Median Islands and Hardened Centerlines

5.10.1.1 Raised Crossing Islands

5.10.1.2 Median Islands and Hardened Centerlines

5.10.2 Curb Extensions

5.10.3 Curb Radius

5.10.4 Mountable Truck Aprons

5.10.5 Raised Crossings

5.10.6 Multiple Threat Crossing Solutions

5.11 Warning and Regulatory Traffic Control Devices

5.11.1 Bike Lane Regulatory Signs

5.11.2 Bicycle and Pedestrian or Bicycle Crossing Warning Signs

5.11.3 Active Warning Beacons

5.11.4 Rectangular Rapid Flashing Beacons

5.11.5 In-Street Crossing Signs (R1-6)

5.11.6 Turning Vehicles Yield to Pedestrians/Bicyclists Signs (Experimental)

5.11.7 Yield Here to Pedestrians/Bicyclists Sign

5.11.8 Wrong Way Bicycling Sign

5.11.9 Blank-Out Signs

**Table: Uncontrolled Crossing Countermeasure Evaluation Table**

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Vehicle ADT ≤ 9,000</th>
<th>Vehicle ADT &lt; 9,000 - 12,000</th>
<th>Vehicle ADT ≤ 12,000 - 15,000</th>
<th>Vehicle ADT &lt; 15,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Number of Travel Lanes and Median Type)</td>
<td>Speed Limit (mph)</td>
<td>≤30</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 Lanes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Lanes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 Lanes with raised median**</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4+ Lanes without raised median</td>
<td>1</td>
</tr>
</tbody>
</table>

* Where the speed limit exceeds 40 mph, Tier 3 should be considered

** Raised medians must be at least 6 feet wide to serve pedestrians. See Figure 2-2 for different bicycle lengths to serve bicyclists. Where median width is less than these values, review category of 4+ lanes without raised median.

**Table Legend**

- Tier 1: 1
- Tier 2: 2
- Tier 3: 3
Chapter 5 – Elements of Design

5.10 Geometric Design Treatments to Improve Intersection Safety
  5.10.1 Raised Crossing Islands, Median Islands and Hardened Centerlines
    5.10.1.1 Raised Crossing Islands
    5.10.1.2 Median Islands and Hardened Centerlines
  5.10.2 Curb Extensions
  5.10.3 Curb Radius
  5.10.4 Mountable Truck Aprons
  5.10.5 Raised Crossings
  5.10.6 Multiple Threat Crossing Solutions

5.11 Warning and Regulatory Traffic Control Devices
  5.11.1 Bike Lane Regulatory Signs
  5.11.2 Bicycle and Pedestrian or Bicycle Crossing Warning Signs
  5.11.3 Active Warning Beacons
  5.11.4 Rectangular Rapid Flashing Beacons
  5.11.5 In-Street Crossing Signs (R1-6)
  5.11.6 Turning Vehicles Yield to Pedestrians/Bicyclists Signs (Experimental)
  5.11.7 Yield Here to Pedestrians/Bicyclists Sign
  5.11.8 Wrong Way Bicycling Sign
  5.11.9 Blank-Out Signs

Legend
- mountable truck apron

15° desirable radius
radius based on design vehicle
optional white edge line
5.11.6 Turning Vehicles Yield to Pedestrians/Bicyclists Signs (Experimental)

Where turning vehicles interface with bicycle facilities at signalized intersections, the TURNING VEHICLES YIELD TO (or STOP FOR) BICYCLISTS (OR PEDESTRIANS) sign (R10-15 series) may be installed to alert motorists of their requirement to yield or stop for pedestrians or bicyclists within a crossing. In cases where motorists need to be alert to a potential conflict with pedestrians and bicyclists, the sign should include both a pedestrian and bicycle symbol. The use of this sign with a bicycle and pedestrian symbol is an experimental design. Experimental approval from FHWA is required to use this traffic control device. An MUTCD compliant version of this sign may instead be used which states in words the following message in black letters on a regulatory sign panel: TURNING VEHICLES YIELD TO (or STOP FOR) BICYCLISTS (OR PEDESTRIANS).

The sign can be located at the near or far side of the intersection. Engineering judgment should be used to determine a location that is conspicuous to the turning motorist.

This sign may be used at controlled or uncontrolled crossing locations. The use of the sign should be limited to the following:

- Crossings where turning motor vehicle volumes exceed 50 vehicles/hour
- Locations where there is a documented problem with motorist failing to yield
- Locations with inadequate sight lines and other mitigations are not feasible
Chapter 6 – Shared Use Path Design

Largely the same content except:

Low Volume Pedestrians may be shared

High Volume Pedestrians separate

Design for socialization – side by side walking and bicycling
Chapter 7 – Separated Bike Lanes

MassDOT 2.0

Improved:

• ADA Guidance
• Transit Stop Design
• Sight Distance Assessment
• Constrained Tradeoff Assessment
• Transition Guidance
Chapter 8 – Bicycle Boulevards

Incorporating NACTO bicycle boulevard design treatments

Emphasizes a bicycle boulevard does not exist unless major street crossings are safe

**Daily Volumes:**
- 1,000 ADT preferred
- 2,000 ADT acceptable
- 3,000 ADT maximum

**Hourly Volumes:**
- 50 vehicles/hour preferred
- 75 vehicles/hour acceptable
- 100 vehicles/hour maximum

**Motor Vehicle Operating Speeds:**
- 15 mph preferred
- 20 mph acceptable
- 25 mph maximum

**Major Street Crossing Opportunities:**
- 120 crossings/hour preferred
- 60 crossings/hour minimum
“Wide curb lanes are therefore not recommended as a strategy to accommodate bicycling”

Recommends SHARE THE ROAD signs not be used, instead:
“Shared lane markings are most advantageous on roadways with traffic volumes below 3,000 vehicles per day, and speeds that are 25 mph or less.”
Chapter 9 – Bicycle Lanes and Shared Lanes

Establishes a standard for marking buffered bike lanes
Chapter 10 – Active Beacons and Traffic Signals

Creates a clear process to evaluate major street crossings
Chapter 10 – Active Beacons and Traffic Signals
Chapter 11 – Roundabouts, Interchanges & Alternative Intersections

Provide Separated Facility

Uncontrolled motorist crossings < 25mph or

- Unless lots of gaps
- Add active warning
- Add control

Separate peds/bikes
Chapter 11 – Roundabouts, Interchanges & Alternative Intersections

Introducing new approach to guiding people with visual disabilities…
Sidewalk Level – Directional Indicators

International Standard 23599 (Assistive products for blind and vision impaired persons – Tactile walking surface indicators)
Directional indicator
Directionality Guidance and Warning
Chapter 11 – Roundabouts, Interchanges & Alternative Intersections
Chapter 12 – Rural Roadways

Design User:
Between Towns & Villages
• Experienced & Confident

In Towns & Villages
• Interested but Concerned

Notes:
1. This chart assumes the project involves reconstruction or retrofit in constrained conditions. For new construction, follow recommended shoulder widths in the AASHTO Green Book.
2. A separated shared use pathway is a suitable alternative to providing paved shoulders.
3. Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.
4. If the percentage of heavy vehicles is greater than 10%, consider providing a wider shoulder or a separated pathway.
Chapter 12 – Rural Roadways

central lane suitable for one vehicle

central lane suitable for two vehicles
Chapter 13 – Structures

Largely the same
Chapter 14 – Wayfinding

Expanded guidance for sign design and placement

Added flexibility for sign design
Chapter 15 – Maintenance & Operations

Photo Credit: DDOT
NCHRP 15-60 Objectives
(Update of AASHTO Bike Guide)

• Review research and practice to **address gaps in 2012 Guide**
• Develop a **framework for selecting appropriate facility** and design features based on context
• Consider users of **all ages and abilities**, including children
• Harmonization with applicable standards and guidelines

**Content approved by NCHRP 15-60 Panel May 2018**
Sources: State DOT Guidance

Caltrans

MassDOT

MnDOT

Sources: Federal Guidance

FHWA Achieving Multimodal Networks Applying Design Flexibility & Reducing Conflicts

NCHRP 803 Pedestrian and Bicycle Transportation Along Existing Roads

FHWA Separated Bike Lane Planning and Design Guide

FHWA Accessible Shared Streets
Revised AASHTO Chapter Outline

1. Introduction
2. Bicycle Operation & Safety
3. Planning
4. Facility Selection
5: Elements of Design
6. Shared Use Paths
7. Separated Bike Lanes
8. Bicycle Boulevards
9. Bike Lanes & Shared Lanes
10. Traffic Signals and Active Warning Devices
11. Roundabouts, Interchanges, and Other Intersections
12. Rural Area Bikeways
13. Structures
14. Wayfinding
15. Maintenance & Operations
16. Parking & End of Trip Facilities

Bikeways – 1970s- 1990s

Wide Outside Lanes

Cycling Rates
1-2%
No Safety Gains

“Vehicular cycling…is faster and more enjoyable, so that the plain joy of cycling overrides the annoyance of even heavy traffic.” - John Forester
1975 Effective Cycling

“Fortunately there is a safer way to bicycle than [in bike lanes]. It is to move with cars, as a vehicle, riding accordance to traffic law. Any other method of riding is dangerous.”
- John Forester

Bikeways – 1990s – 2000s

Bike Lanes

Cycling Rates
2 - 8%
Modest Safety Improvements
Bikeways 2010s

2010: < 100/day
2017: 2,500/day
Chapter 2 - Bicycle Operation & Safety

Crashes and Near Crashes

Both crash and near-crash experiences influence perceived bicycling safety and comfort (Lee et al., 2015; Sanders, 2015; Aldred & Crossweller, 2015)

perceptions

reported crashes
Number of Bicyclist Fatalities
U.S. 2010-2015

2010 vs. 2015: +197 (+32%)

Chapter 2 - Bicycle Operation & Safety

4 - 7% Experienced and confident
5 - 9% Somewhat confident
51 - 56% Interested but Concerned

lower stress tolerance higher stress tolerance

Chapter 2 - Bicycle Operation & Safety
Preferred Design User for AASHTO Guide

Experienced & Confident Cyclist
AASHTO 2012

Interested but Concerned Cyclist
AASHTO 2018

Chapter 3
Network Purpose

Low-Stress Bicycle Network - is designed to be safe and comfortable for all users. These support All Ages and Abilities (~72% of public)

Basic Bikeway Network - consist primarily of bicycle lanes and shoulders may. These networks support Highly Confident Bicyclists and some Somewhat Confident Bicyclists (~16%)

Traffic Tolerant Network - all roads and paths on which bicycling is legally allowed. These networks support Experienced and Highly Confident Bicyclists (~4%)
Sport Cyclists Require Road Access & Wide Paths

Image: Fairfax Times

Case Study
United States Cities
Chapter 4 - Guidance for Choosing a Bikeway Type

When to Separate Bikes from Motor Vehicles?

4.2. Project Purpose and Need

The design of road or street improvements should begin with an explicit statement that indicates why the project is being undertaken and what the project is intended to accomplish. For example, bikeway design projects are often initiated in communities that have a stated goal of increasing bicycle mode share and improving safety. If this is the case, the purpose and need statement should identify how the project will help to accomplish these goals.

The purpose and need statement should identify the project limits, the land use context, the types of bicyclists that are expected to use the facility, the intended connections that are being made within the larger bicycle network, the various directions of travel from which bicyclists may access the facility, and key safety issues that should be addressed, including the identification of crash patterns where data is available, or the consideration of noise issues or public concerns where crash data is inadequate.

4.2.1. Project Limits

Project limits should enhance network connectivity and user safety. Where transitions are necessary, their design should be logical and intuitive for bicyclists, pedestrians, and motorists. Logical project limits should be established to meet the desired connectivity and safety objectives of the project for bicyclists. The facility design chapters in this Guide (see Chapters 6-9) provide guidance for transitions between different roadway designs.

4.2.2. Land Use Context

The AASHTO Green Book defines five land use context classifications: rural, rural town, suburban, urban, and urban core, which are defined by development density (existence of structures and structure types), land uses (primarily residential, commercial, industrial, and/or agricultural), and building setbacks (distance of structures to adjacent roadways). While a street may have one functional classification, it may pass through multiple context classifications. Possible changes in context classification resulting from future development should be considered in design. The purpose of the context classification is to allow a more thorough assessment of multimodal needs to develop an appropriate balance among

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Chapter 4 - Guidance for Choosing a Bikeway Type

When should we separate bikes and pedestrians?

Evaluate with FHWA Shared-Use Path Level of Service Calculator
Build More Sidepaths?

Historical bicycle safety research:

- same or lower crash risk with motorists compared to streets without bike lanes where cyclists ride with traffic
- 2-6 times higher crash risk with motorists where cyclists ride facing traffic

Sidewalks and sidepaths have higher potential for crashes caused by objects in path, deficiencies in width, or collisions with other users.

1967 – 1972 Davis California
America's First Sidepaths

"at least 50% of bicyclists rode in the street. Bicyclists didn't like traveling with the pedestrians and they didn't like riding up and down driveway ramps and meandering around utilities in the lane."

- Davis Engineer Duane Copley
Chapter 4 - Guidance for Choosing a Bikeway Type
When to Separate Bikes from Motor Vehicles?

Chapter 12 – Rural Roadways

**Design User:**
Between Towns & Villages
- Experienced & Confident

In Towns & Villages
- Interested but Concerned
Protected Intersection
Chapter 5 – Elements of Design
Example Mountable Truck Corner Apron

5.10 Geometric Design Treatments to Improve Intersection Safety
5.10.1 Raised Crossing Islands, Median Islands and Hardened Centerline
5.10.2 Curb Extensions
5.10.3 Curb Radii
5.10.4 Mountable Truck Aprons
5.10.5 Raised Crossings
5.10.6 Multiple Threat Crossing Solutions
5.11 Warning and Regulatory Traffic Control Devices
5.11.1 Bike Lane Regulatory Signs
5.11.2 Bicycle and Pedestrian or Bicycle Crossing Warning Signs
5.11.3 Active Warning Beacons
5.11.4 Rectangular Rapid Flashing Beacons
5.11.5 In-Street Crossing Signs (R1-6)
5.11.6 Turning Vehicles Yield to Pedestrians/Bicyclists Signs (Experimental)
5.11.7 Yield Here to Pedestrians/Bicyclists Sign
5.11.8 Wrong Way Bicycling Sign
5.11.9 Blank-Out Signs

AASHTO Bike Guide Update
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