The Basics of Bikeway Selection at Intersections and with Parking

Presented by FHWA Office of Safety, VHB, and UNC HSRC
Housekeeping

→ Submit your questions

→ Webinar archive: www.pedbikeinfo.org/webinars

→ Live transcript: www.streamtext.net/player?event=HSRC

→ Certificates and professional development hours

→ Follow-up email later today
Meet the Panel

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FHWA Office of Safety

Lauren Blackburn  
VHB

Dan Goodman  
Toole Design

Jared Draper  
Toole Design
Pedestrian and Bicyclist Safety Program Overview

Tamara Redmon, Office of Safety, Federal Highway Administration
Resources Available to Help Improve Pedestrian and Bicyclist Safety

» Bikeway Selection Guide.
» Updated Pedestrian and Bicyclist Road Safety Audit Guide and Prompt List.
» Pedestrian and Bicycle Safety Focus States Efforts.
» USDOT Action Plan.
» Safe Transportation for Every Pedestrian (STEP).
Helps transportation practitioners consider and make informed decisions about trade-offs relating to the selection of bikeway types.

Builds upon FHWA’s active support for design flexibility and connected, safe, and comfortable bicycle networks.


NEW! Supplemental Resources on Parking and Intersection Considerations
Pedestrian and Bicyclist Road Safety Audit Guide and Prompt List

» Intended to support agencies that are interested in conducting pedestrian- and bicycle-focused RSAs.

» Includes information on safety risks for both modes, the RSA process, necessary data, and the roles and responsibilities of the RSA Team.

» Includes prompt lists for pedestrians and bicyclists to use in the field.

» This guide helps practitioners understand pedestrian and bicyclist issues in their jurisdiction and potentially achieve other goals in addition to safety.
Pedestrian and Bicycle Safety Focus States Efforts

FHWA's Safety Office has been providing extra resources to cities and states with the highest pedestrian and bicyclist fatalities and/or fatality rates.

» Working with the states/cities to assist them with developing pedestrian and bicycle safety action plans.

» Offering free technical assistance and training on how to design safe facilities and how to develop safety action plans.

» We recently re-evaluated the current list of states and cities and will be rolling out the program to new and continuing states this spring/summer.
Pedestrian and Bicycle Safety Focus States and Cities

» Almost 400 training courses delivered.
» Over 6,000 people trained.
» Crash data analysis and countermeasure selection.
» Webinars and peer exchanges.
» Pedestrian and bike safety action plan development.
» Executive briefings.
Complete in November 2020

The Plan identifies what the USDOT intends to accomplish with respect to pedestrian safety in the next 2 years and beyond.

Took into account the themes identified by stakeholders during the July 2020 Pedestrian Safety Summit webinars.

STEP
Safe Transportation for Every Pedestrian

https://safety.fhwa.dot.gov/ped_bike/step/resources/
The Spectacular Seven STEP Countermeasures

- Rectangular rapid flashing beacons (RRFBs)
- Leading pedestrian intervals (LPIs)
- Crosswalk visibility enhancements
- Raised crosswalks
- Pedestrian crossing/refuge islands
- Pedestrian hybrid beacons (PHBs)
- Road Diets
Technical Assistance

» STEP Action Plans.
» STEP Workshops (1/2 day – Full day).
  » MPOs.
» New partners.
» State DOTs.
» Scan Tours.
» Road Safety Assessments (RSAs).

» STEP UP Resources

https://safety.fhwa.dot.gov/ped_bike/step/step_up_campaign/
THANK YOU!

http://safety.fhwa.dot.gov/ped_bike/

E-mail: tamara.redmon@dot.gov

Order documents:
http://safety.fhwa.dot.gov/ped_bike/ped_bike_order.cfm
FHWA Bikeway Selection Guide

Resources

Bikeway Selection Guide (2019)


https://safety.fhwa.dot.gov/ped_bike/tools_solve/
Response to Workshop Feedback

A desire for additional information based upon workshop feedback included:

• Bikeways and on-street parking tradeoffs
• Space allocation for bikeways at intersections with all other modes
Bikeway Selection
Supplemental Resources

Resources:
https://safety.fhwa.dot.gov/ped_bike/tools_solve/
Bikeway Selection Guide Supplemental Resources

The Basics of Bikeway Selection at Intersections and with Parking

April 7, 2021
Introduction and Background Context

- *Bikeway Selection Guide* published in February 2019
- Bikeway selection workshops held throughout the U.S. in 2019-2020
- At workshops, we heard two clear requests for additional information:
  - Bikeway and on-street parking tradeoffs
  - Space allocation for bikeways at intersections
How to Use Mentimeter

1. Grab your phone or open a new tab on your computer browser
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3. Enter the code

39 97 94 32
In your community, what are the biggest challenges when attempting to balance on-street parking needs and goals for a connected bike network?

- political will
- real parking need
- accommodating deliveries
- reallocating travel lanes
- perceived parking need
- congestion concerns
- accessibility
- limited space
On-Street Parking and Bikeway Types

Parking Types:
• Reverse Angle-In
• Parallel
• Head-In Angled

Bikeway Types:
• Shared Lane
• Bike Lane
• One-way Separated
• Two-way Separated
Parking Types

- Dimensions
- Safety Considerations
- Parking Maneuver Considerations
- Loading, Unloading, and Deliveries

Reverse Angle-In  Parallel  Head-In Angled
### Design Criteria

#### Back in Angle Parking

<table>
<thead>
<tr>
<th>$\theta$ (Degrees)</th>
<th>$W_1$ (feet)</th>
<th>$W_2$ (feet)</th>
<th>$D$ (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0\textdegree</td>
<td>7–10</td>
<td>20</td>
<td>7–10</td>
</tr>
<tr>
<td>30\textdegree</td>
<td>8–9</td>
<td>16–18</td>
<td>16.9–17.8</td>
</tr>
<tr>
<td>45\textdegree</td>
<td>8–9</td>
<td>11.3–12.7</td>
<td>19.8–20.5</td>
</tr>
<tr>
<td>60\textdegree</td>
<td>8–9</td>
<td>9.2–10.4</td>
<td>21.3–21.8</td>
</tr>
</tbody>
</table>

$W_1$ = stall width  
$W_2$ = striping width  
$D$ = depth to face of curb  
$\theta$ = angle  

Source: FHWA
Considerations

• Benefits and costs
• Flexible solutions
• Connecting people with disabilities to the sidewalk
• Options for reallocating space from on-street parking
• Equity and inclusion
Bikeway Types

- Shared lane
- Bike lane
- One-way separated bike lane
- Two-way separated bike lane
**Dimensions and Considerations**

One-Way Separated Bike Lane Widths Based on Existing or Anticipated Volumes

<table>
<thead>
<tr>
<th>Peak Hour Directional Bicyclist Volume</th>
<th>One-Way Separated Bike Lane Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Between Vertical Curbs</td>
</tr>
<tr>
<td>&lt;150</td>
<td>6.5 - 8.5</td>
</tr>
<tr>
<td>150-750</td>
<td>8.5 - 10</td>
</tr>
<tr>
<td>&gt;750</td>
<td>≥10</td>
</tr>
<tr>
<td>Constrained Condition*</td>
<td>4.5</td>
</tr>
</tbody>
</table>

*Peak Hour Directional Bicyclist Volume not applicable

Two-Way Separated Bike Lane Widths Based on Existing or Anticipated Volumes

<table>
<thead>
<tr>
<th>Peak Hour Directional Bicyclist Volume</th>
<th>Preferable Two-Way Bike Lane Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Between Vertical Curbs</td>
</tr>
<tr>
<td>&lt;150</td>
<td>10 - 12</td>
</tr>
<tr>
<td>150-350</td>
<td>12 - 16</td>
</tr>
<tr>
<td>&gt;350</td>
<td>≥16</td>
</tr>
<tr>
<td>Constrained Condition*</td>
<td>8.5</td>
</tr>
</tbody>
</table>

*Peak Hour Directional Bicyclist Volume not applicable
## Options

- Enhancing bicyclist comfort and safety
- Reallocating space from on-street parking
  - Intermittent reductions
  - Converting type
  - Reallocating capacity
  - Parking management strategies
  - Hybrid

<table>
<thead>
<tr>
<th>Bikeway</th>
<th>Spatial Impact</th>
<th>Additional Options to Enhance Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared Lanes</td>
<td>None</td>
<td>• Traffic calming to manage speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Traffic diversion to lower volumes</td>
</tr>
<tr>
<td>Conventional Bike Lanes</td>
<td>10-12 feet</td>
<td>• Shared lane markings</td>
</tr>
<tr>
<td>Buffered Bike Lanes</td>
<td>12 – 16+ feet of space</td>
<td>• Green color in bike lanes</td>
</tr>
<tr>
<td>One-Way Separated Bike Lanes</td>
<td>12 – 16+ feet of space</td>
<td>• Green color in bike lanes</td>
</tr>
<tr>
<td>Two-Way Separated Bike Lane (one side of street)</td>
<td>10 feet (constrained) 12+ feet</td>
<td>• Vertical barriers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Green color in bike lanes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Protected intersections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Phase separation at signals</td>
</tr>
</tbody>
</table>
Bikeway Assessment Strategies

1. Assessing tradeoffs at the cross-section level
2. Adjusting on-street motor vehicle parking to better accomplish complete streets goals
3. Strategically reducing parking to improve safety
**Assessing Tradeoffs at the Cross-section Level**

- **Data driven decisions**
- **Questions to discuss in the planning process**
- **Trade-off considerations**

**Bikeway Assessment Strategies**

The following pages describe strategies for using data and decisions to assess options and trade-offs. The first strategy focuses on decision points and considerations at the cross-section level. The second strategy focuses on ways that on-road parking can be used to provide safe access to businesses and other destinations.

**Strategy 1: Assessing Tradeoffs at the Cross-section Level**

This area, with local road safety and urban development, generates significant pedestrian activity and has high loading, delivery, and parking demand. The corridor bike service interconnects downtown. U.S. 1 provides motor vehicle passage movements occur ocassionally in the corridor junctions. Pedestrian crossing desired in high through areas and mid-block locations due to the traffic light, mid-block traffic signal, and on-street parking. Street standards are concerned about their safety and avoid the 3rd street. Describe the presence of off-street parking facilities in the vicinity the public permits a parking lot. It is believed that the on-street parking is critical to the success of the network. The bike path is controlled by the State Department of Transportation. It is important to involve the local transportation agency. Note that it is a critical condition and in the options presented at right, access and freight might need to be different.

The table below outlines key data-driven decisions and questions to be discussed at the planning process.

**Scenario selection**

- What is the through traffic at daily (5 AM) peak (3 PM) on this street and what does it include? Hourly traffic, and access points (bus stops)
- How do the present areas of on-street parking system and the
- How many riders are to be accommodated to the current system?
- How many riders are in the vehicle profile from 5:00 AM to 7:00 PM? How many riders are in the vehicle profile from 10:00 AM to 12:00 PM? How many riders are in the vehicle profile from 5:00 PM to 7:00 PM?
- What are the riders' economic impact of bus stop locations and stops on this street? Are riders' economic impact of bus stop locations and stops on this street?
Adjusting On-Street Motor Vehicle Parking to Better Accomplish Complete Streets Goals

- Swap parallel parking with bike lane to provide a Separated Bike Lane
- Creating space for bike and micromobility parking
- Organizing street elements
- Parklets and outside seating
Adjusting On-Street Motor Vehicle Parking to Better Accomplish Complete Streets Goals

• Providing accessible parking and improving pick-up and drop-off conditions
• Providing better bus stop accommodations
• Commercial loading and shared mobility pick-up and drop-off
Strategically Reducing Parking to Improve Safety

- Daylighting Mid-Block Pedestrian Crossings
- Increasing Visibility of Bicyclists in Separated Bike Lanes
- Improved Intersection Design

<table>
<thead>
<tr>
<th>Toolbox</th>
<th>Discussion</th>
<th>Example and/or Resource</th>
</tr>
</thead>
</table>
| Daylighting Mid-Block Pedestrian Crossings  | Action: Remove selected motor vehicle parking spaces in advance of a pedestrian crossing to improve visibility at the crossings  
Tradeoff: On-street motor vehicle parking capacity along corridor is reduced  
Benefit: Improved pedestrian safety  
Discussion: Reducing on-street parking in advance of a mid-block crossing is recommended to enhance visibility of pedestrians crossing the street. The no-parking area near an intersection is typically 20 ft. from crosswalks and 30 ft. from stop signs. This parking reduction can be done in combination with curb extensions, delineator posts, signs, and other treatments. In many cases, this strategy simply involves enforcing parking laws that are already in place. Enforcement may mean striping out no-parking areas around crossings and this doesn’t necessarily require police enforcement. | Source: FHWA          |
| Increasing Visibility of Bicyclists in Separated Bike Lanes | Action: Remove selected motor vehicle parking spaces in order to improve visibility of bicyclists in Separated Bike Lanes  
Tradeoff: On-street motor vehicle parking capacity along corridor is reduced  
Benefit: Improved bicyclist safety  
Discussion: Strategic parking reductions at intersections can improve visibility of bicyclists and pedestrians for drivers turning onto and off of perpendicular streets and driveways. Parking should be prohibited 20-30 feet from an intersection depending on factors such as motor vehicle speed and sight distance. | Source: FHWA          |
| Improved Intersection Design                | Action: Remove selected motor vehicle parking spaces in order to improve intersection design and operations  
Tradeoff: On-street motor vehicle parking capacity along corridor is reduced  
Benefit: Improved intersection safety for all users  
Discussion: On-street parking can be used in conjunction with separated bike lanes to provide high quality multi-modal interactions. The lane offset created by on-street parking allows fully protected intersection design treatments. Additionally, as above, parking lanes are pulled away from the intersection to enhance visibility of bicyclists and pedestrians. | Source: MassDOT        |
In your community, what are the biggest challenges when attempting to balance on-street parking needs and goals for a connected bike network?

- political will
- real parking need
- accessibility
- accommodating deliveries
- reallocating travel lanes
- perceived parking need
- congestion concerns
- limited space
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In your community, what makes intersections one of the major barriers to a fully connected bike network?

- exposure to cars
- turn lanes
- motor vehicle speed
- bike facilities
- drop
- signalization problems
- unclear expectations
- motor vehicle volume
- wide crossings
Intersection Resource

TRAFFIC ANALYSIS AND INTERSECTION CONSIDERATIONS TO INFORM BIKEWAY SELECTION
Performance Metrics

- Safety
- Accessibility for pedestrians with disabilities
- Pedestrian and bike quality of service metrics
- Traffic analysis
- Travel time

Functional Area of an Intersection
### Spatial Needs by Bikeway Intersection Type

<table>
<thead>
<tr>
<th>BIKEWAY INTERSECTION TYPE</th>
<th>Protected Intersection</th>
<th>Bike Lane (Right Side of Mixed Lane)</th>
<th>Pocket/Keyhole Bike Lane (Left Side of Right Turn Lane)</th>
<th>Mixing Zone</th>
<th>Shared Lane</th>
</tr>
</thead>
</table>

Source: FHWA
Safety and Equity Focused Design Principles

- Bikeway continuity
- Minimize exposure to conflicts
- Reduce speeds at conflict points
- Clearly communicate right-of-way
- Provide adequate sight distances
### Sustainable Safety Considerations for Bikeway Intersection Types

<table>
<thead>
<tr>
<th>Bikeway Intersection Type</th>
<th>Protected Intersection</th>
<th>Bike Lane (Right Side of Travel Lane)</th>
<th>Pocket/Kayhole Bike Lane (Left Side of Right Turn Lane)</th>
<th>Mixing Zone</th>
<th>Shared Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial Considerations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bikeway Width</td>
<td>One-way separated bike lane: 6’-8’</td>
<td>Bike Lane: 4’-7’</td>
<td>One-way separated bike lane approach: 6’-8’</td>
<td>No designated facility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two-way separated bike lane: 10’-12’</td>
<td>Bike Lane: 4’-7’</td>
<td>Bike Lane approach: 4’-7’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shared Use Path: 10’-14’</td>
<td>Bike Lane: 4’-7’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Buffer Width</td>
<td>6’-16’</td>
<td>2’-4’ (applicable for buffered bike lane)</td>
<td>2’-4’ (applicable for buffered bike lanes)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Length of Approach Exposure</td>
<td>None</td>
<td>None*</td>
<td>Sum of pocket/kayhole bike lane and merge area*</td>
<td>Constrained to merge Area</td>
<td>Unconstrained</td>
</tr>
<tr>
<td><strong>Functionality (Comfort) - Roads can be categorized by their function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived comfort based on separation from traffic and constrained entry/conflict point</td>
<td>High</td>
<td>High to Moderate</td>
<td>Moderate to Low</td>
<td>Moderate to Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Homogeneity - Roads with vehicles of balanced speeds, directions, and masses are the safest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection approach exposure to potential motorist conflict</td>
<td>Eliminated</td>
<td>Moderate to High</td>
<td>Moderate to High</td>
<td>Moderate to High</td>
<td>High</td>
</tr>
<tr>
<td>Conflict exposure (turning and angle) result generally based upon vehicle speed/volume at intersection</td>
<td>Low to Moderate</td>
<td>Moderate to High</td>
<td>Moderate to High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

*Exposure for users in bike lanes and buffered bike lanes—defined by the lack of vertical separation—along intersection approach is dependent upon vehicle encroachment.
Sustainable Safety Considerations for Bikeway Intersection Types

<table>
<thead>
<tr>
<th>BIKEWAY INTERSECTION TYPE</th>
<th>Protected Intersection</th>
<th>Bike Lane (Right Side of Travel Lane)</th>
<th>Pocket/Keyhole Bike Lane (Left Side of Right Turn Lane)</th>
<th>Mixing Zone</th>
<th>Shared Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predictability (Right-of-Way) - Roads should be intuitive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to limit or constrain conflicts along bikeway facility</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate to Low</td>
<td>Moderate to Low</td>
<td>Low</td>
</tr>
<tr>
<td>Right-of-way priority between motorists and bicyclists is clarified through the intersection</td>
<td>High**</td>
<td>High to Moderate</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Forgiveness (Safety) - Infrastructure can be designed to accommodate human error</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relies upon highly aware motorist and bicyclist behavior to avoid crashes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bicyclists operate in separated space from vehicles</td>
<td>Yes</td>
<td>Yes, however vehicles can encroach into the facility at any location</td>
<td>Yes, however vehicles can encroach into the facility at any location</td>
<td>Yes, prior to mixing zone; however, vehicles may encroach into facility if it is not separated</td>
<td>No</td>
</tr>
<tr>
<td><strong>Awareness (Visibility) - Awareness improves safety for all users</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of motorists/bicyclists scanning required to identify bicyclists, and/or motorists approaching from behind or operating beside them</td>
<td>Low to Moderate</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>
Traffic Analysis Assumptions and Tips

- **Volume Projections**
- Future Year
- Growth Rates
- Trip Generation
- Level of Service
- Time Period and Analysis Period
- Network Utilization/Peak Spreading
- Signal Timing Assumptions

- Consider the impacts of “conservative” approach (i.e., higher travel volumes:
Traffic Analysis Assumptions and Tips

- Volume Projections
- **Future Year**
- Growth Rates
- Trip Generation
- Level of Service
- Time Period and Analysis Period
- Network Utilization/Peak Spreading
- Signal Timing Assumptions
- 5-30 year future condition
- Presumes existing travel behavior will remain the same:
  - Self-fulfilling prophecy
  - Increased maintenance
  - Reduce safety performance until future condition is realized
Traffic Analysis Assumptions and Tips

- Volume Projections
- Future Year
- Growth Rates
- Trip Generation
- **Level of Service**
- Time Period and Analysis Period
- Network Utilization/Peak Spreading
- Signal Timing Assumptions
- LOS is part of the bigger picture
- Evaluate levels that are “acceptable”

**ANALYSIS TIPS:**
- For motor vehicle queues, evaluate the 50th-percentile queue in addition to the 95th percentile queue.
- When interpreting results, practitioners should consider whether a LOS F (or other conventional standard) may be acceptable during certain peak hours if other project goals are achieved.
Traffic Analysis Assumptions and Tips

- Volume Projections
- Future Year
- Growth Rates
- Trip Generation
- Level of Service
- **Time Period and Analysis Period**
- Network Utilization/Peak Spreading
- Signal Timing Assumptions

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**Time Period and Analysis Period**

KEY TAKEAWAY: People use streets at all hours of the day and night and the use of streets varies throughout the entire day; streets should be designed for all day use, not just a single peak hour (or even peak 15 minutes).

ANALYSIS TIPS:
- Use a peak hour factor based on the entire intersection, not specific movements.
- Collect data for a 2-3-hour peak period at a minimum or, ideally, a 24-hour period to understand the demands of the street throughout the day. Consider averaging 2-3-hour peak to analyze an average peak hour.
The chapter provides key principles that should be used to develop and evaluate design approaches and treatments that will result in intersections that support all ages and abilities of bicyclists. This chapter illustrates the application of these principles for common intersection configurations which include protected intersections, roundabouts, merging zones and driveway crossings. Intersection design also requires consideration of parking, loading and bus stops (see Chapter 5), and signal operations (see Chapter 6).

Don’t Give Up at the Intersection
Designing All Ages and Abilities Bicycle Crossings
In your community, what makes intersections one of the major barriers to a fully connected bike network?

- exposure to cars
- turn lanes
- motor vehicle speed
- bike facilities drop
- signalization problems
- unclear expectations
- motor vehicle volume
- wide crossings
Can you discuss the extent to which design is addressed as part of these resources?
How does the bikeway selection process (and outcomes) intersect with equity?
Discussion of Key Topics

What kind of responses should be expected when discussing bikeways, parking, and intersections?

How do you discuss tradeoffs?
In what ways does COVID-19 fit into this conversation on bikeway selection?
Discussion

Send us your questions

Follow up with us:

- Tamara Redmon tamara.redmon@dot.gov
- Lauren Blackburn lblackburn@vhb.com
- Dan Goodman dgoodman@tooledesign.com
- Jared Draper jdraper@tooledesign.com
- General Inquiries pbic@pedbikeinfo.org

Archive at www.pedbikeinfo.org/webinars