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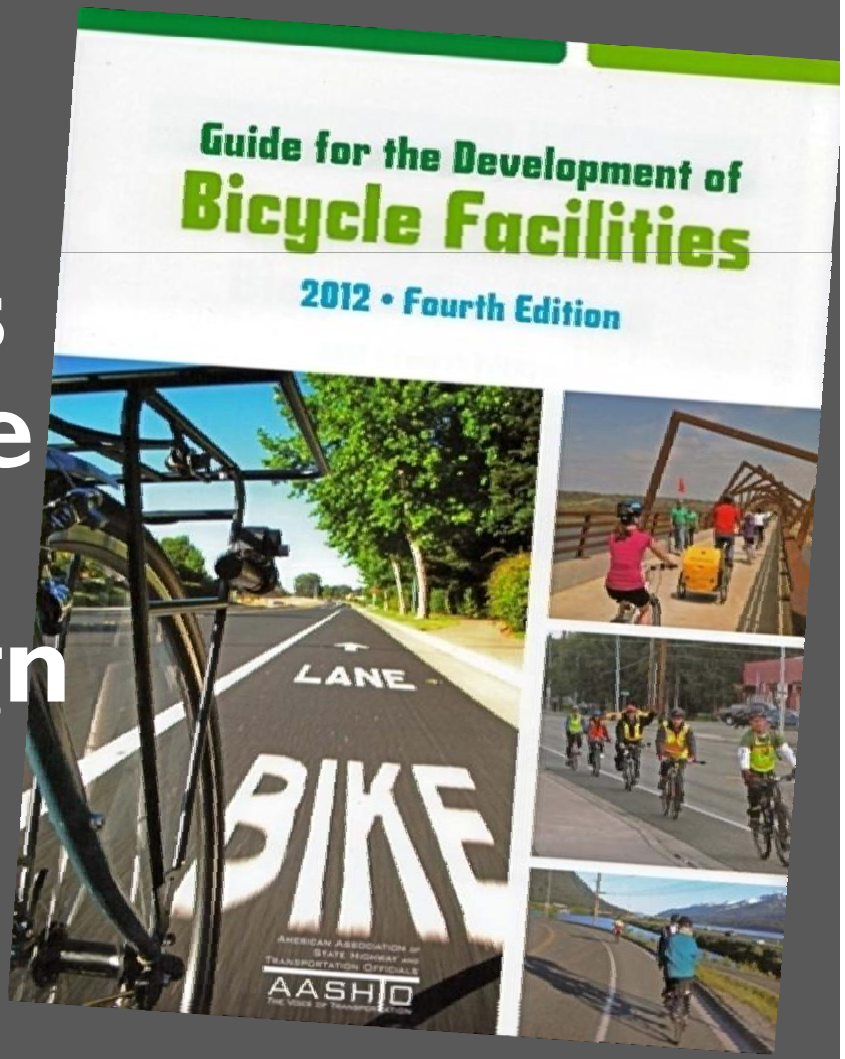
Off-Road Facilities Part II: Shared Use Path – Roadway Intersection Design



Presentation by:
Eric Mongelli, P.E.
Bill Schultheiss, P.E.
October 23, 2012

Toole Design Group

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- Toole Design Group is live tweeting this webinar
  - @tooledesign
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WEBINAR #6: OFF- ROAD FACILITIES
PART 2: SHARED USE PATH DESIGN

- Today's Webinar
- Significant Expansion on Shared Use Path Design
  - Crossing Types
  - Crosswalk Context
  - Determining Control at Mid-block Crossings
  - Crossing Treatments
  - Sidepath Crossings
  - Restricting Motor Vehicle Access

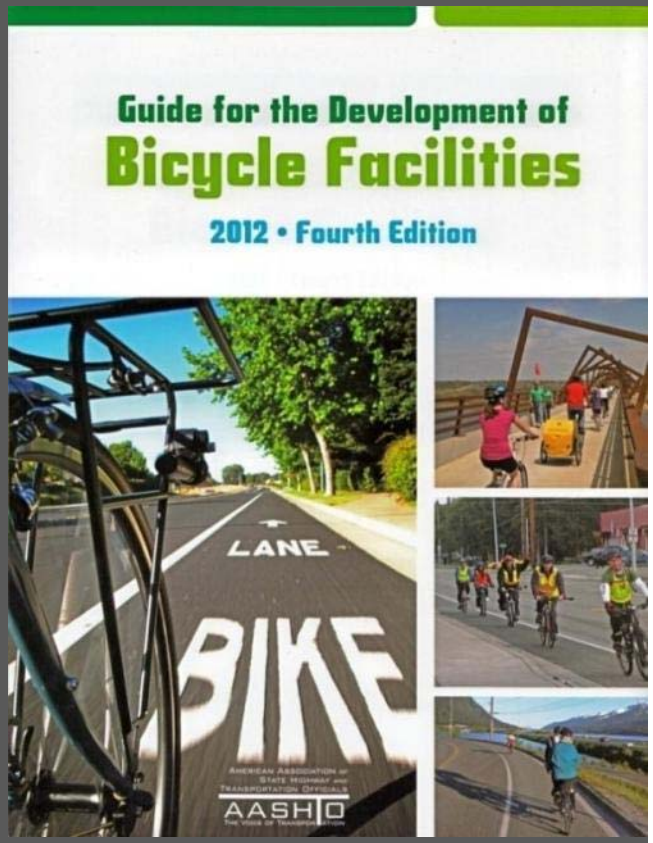
FUTURE WEBINARS

- August 10: Overview
- August 22: Planning Chapter
- September 4: On-Road Bikeways Part I
  - Bike Lanes (including Intersections)
- September 18: On-Road Bikeways Part II
  - Shared lanes
  - Bicycle boulevards & signing
  - Signals
- October 9: Shared Use Paths
  - General design principles
  - Pathway geometry
- **October 23: Shared Use Paths**
  - **Intersection Design**
  - **Mid-block crossings**
- November 6: Bikeway Maintenance and Operation

DISCOUNT FOR WEBINAR PARTICIPANTS

http://www.walkinginfo.org/training/pbic/AASHTO_Promo_Flyer.pdf

Link will be emailed to webinar attendees

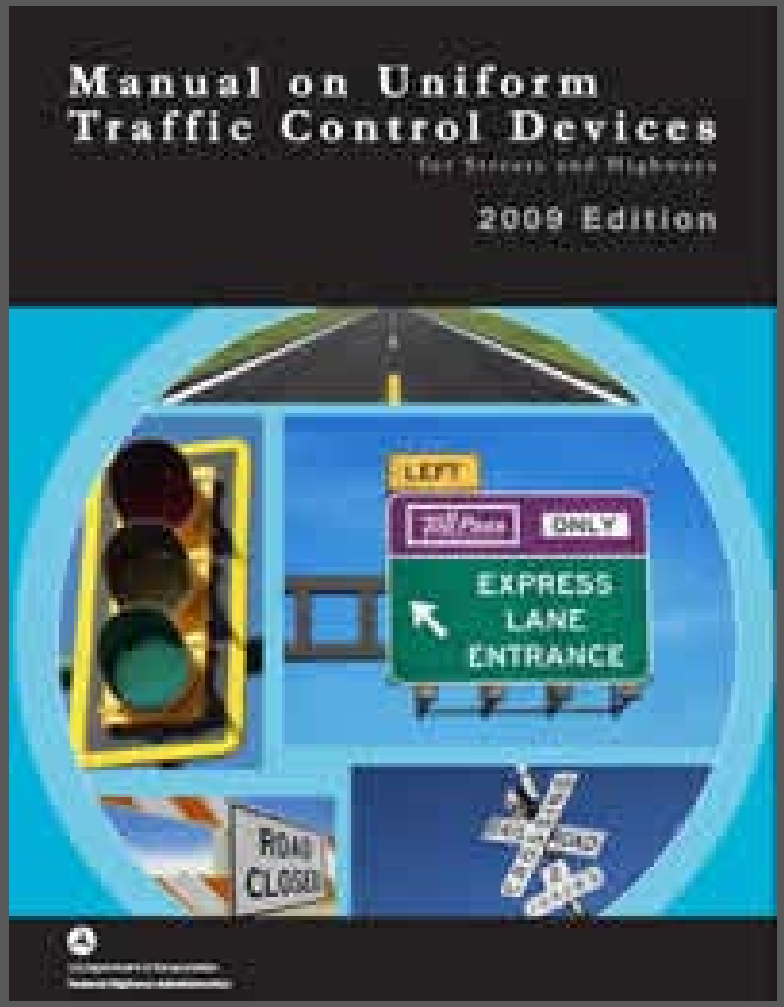


SOME BACKGROUND

- What is AASHTO?
  - Mission: "provides technical services to support states in their efforts to efficiently and safely move people and goods"
- Some history
  - Last Guide – 1999, largely written in 96-98
  - Survey to update Guide - 2004
- Standards vs. guidance (Shall vs. should or may)
- Relationship between AASHTO Guide and the MUTCD
- Innovation vs. accepted practice

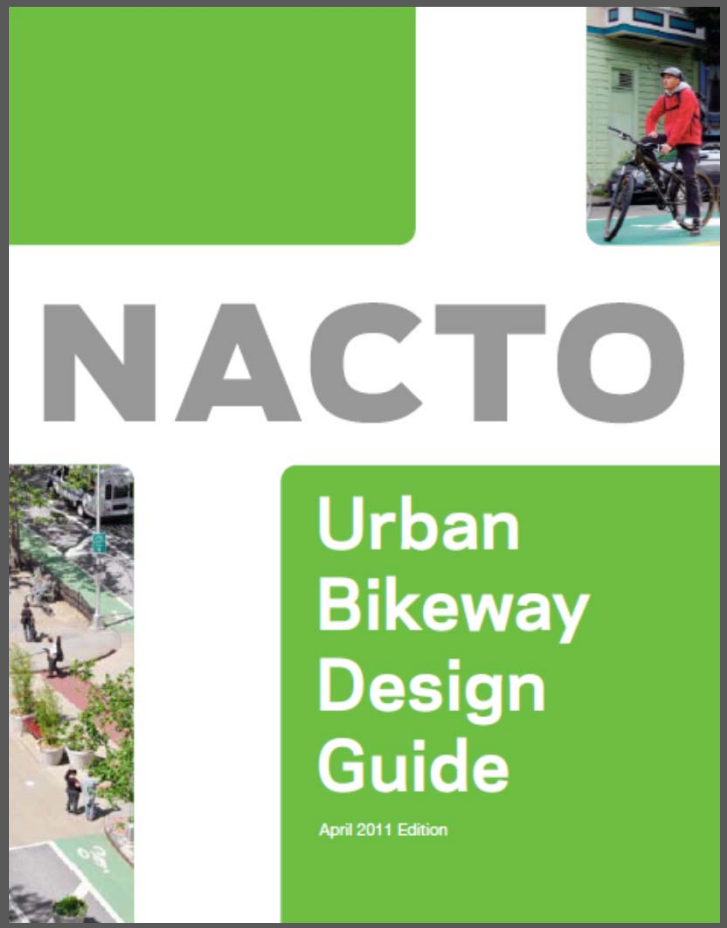
RELATIONSHIP TO OTHER MANUALS

- 2009 MUTCD – FHWA
- 2011 AASHTO Green Book
- Public Right-of-Way Accessibility Guidelines (PROWAG)
- 2010 Highway Capacity Manual



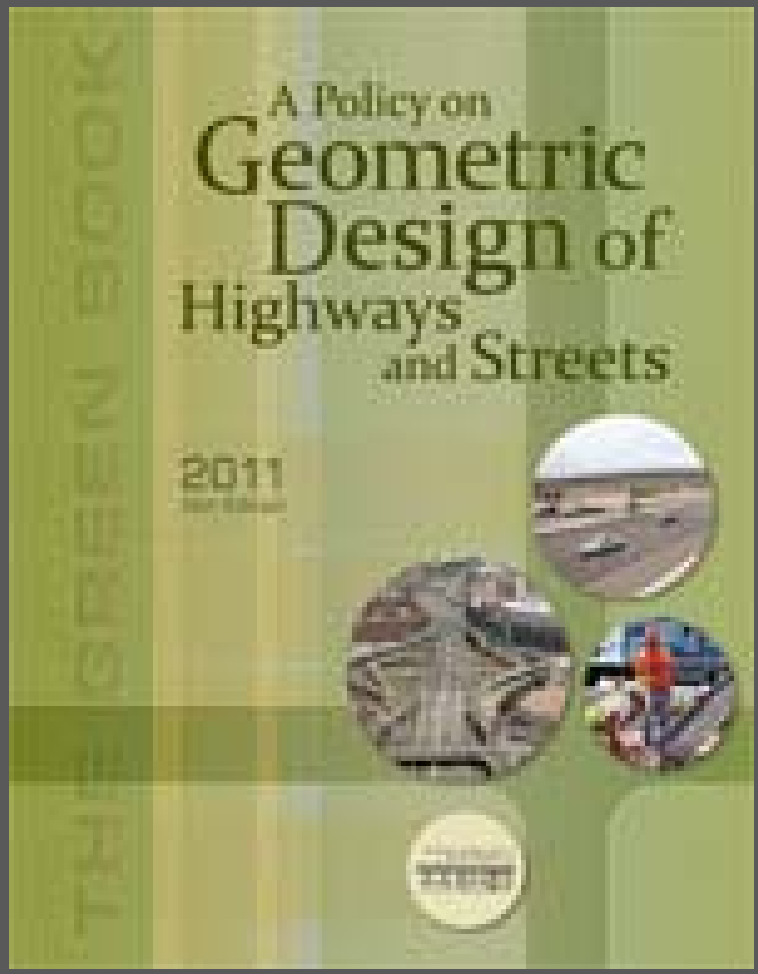
AASHTO VS. NACTO GUIDE: EITHER/OR?

- AASHTO covers paths + on-road bikeways
- AASHTO covers design comprehensively
- AASHTO covers many – but not all innovations
- NACTO is a source of information for solutions that are currently experimental



DESIGN GUIDANCE OF GREEN BOOK

- Share use path design generally follows principles of the "Green Book"
  - Design speeds
  - Geometric Principles
  - Intersection Sight Distance



ENGINEERING JUDGMENT

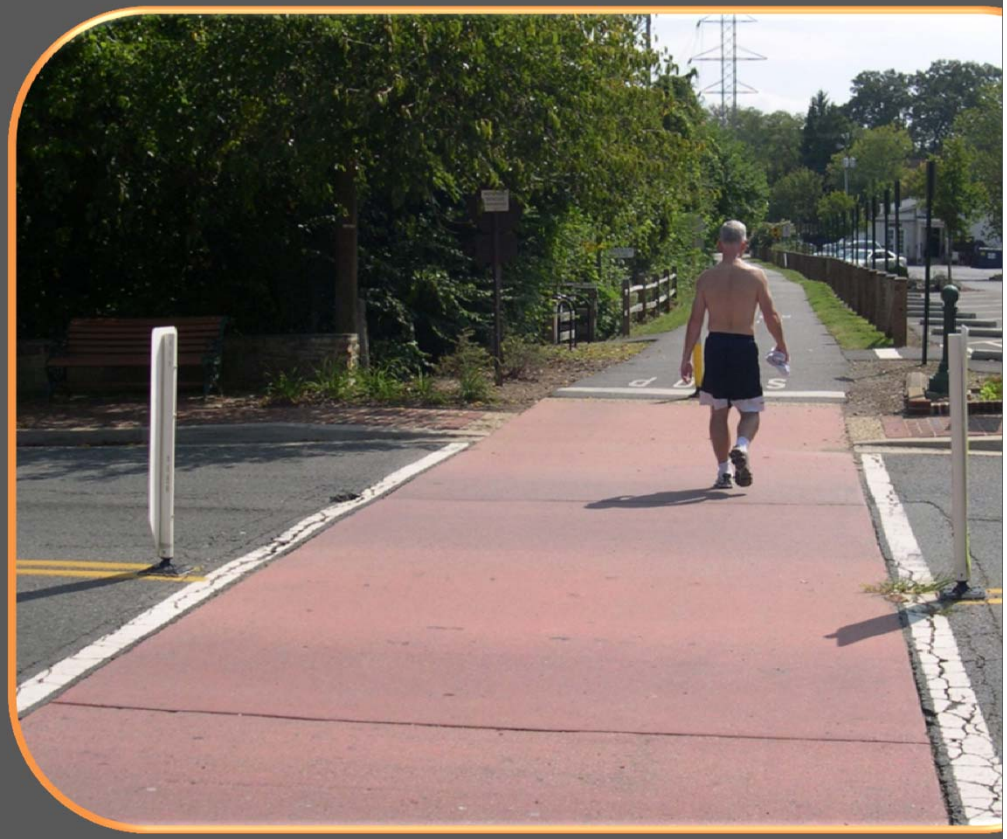
"The treatments described reflect typical situations; local conditions may vary and engineering judgment should be applied."

CHAPTER 5 – DESIGN OF SHARED USE PATHS MAJOR CONTENT CHANGES

- New stand-alone chapter fills missing gaps in the old Guide
- Discusses crossing types:
  - Mid-block
  - Sidepath
  - Grade separated
- Selecting intersection control
- Assessing crossing treatments

INTERSECTION DESIGN PRINCIPLES

- Good Geometric Design
  - Right Angle/Short Crossings
  - Adequate Sight Lines
  - Flat/ Conspicuous Crossings
- Needs of Design Users
  - Pedestrians/Bicyclists
  - Motorists
- Applicability of Good Pedestrian Design
- Appropriate Right-of-Way Assignment



SHARED USE PATH – ROADWAY INTERSECTIONS

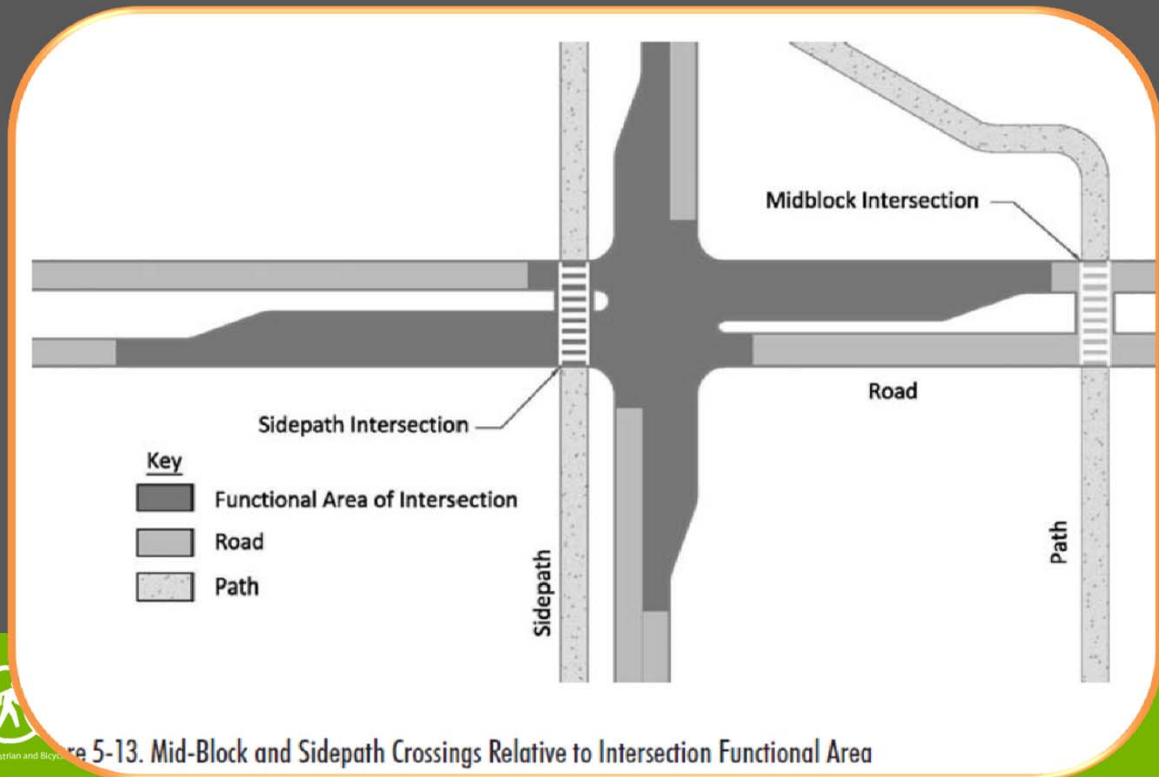
- Should not only address cross-traffic movement

But also address…

- Turning movements of cyclists entering & exiting path

SHARED USE PATH CROSSING TYPES

- Mid-block roadway crossings
  - Outside the functional area of an adjacent intersection
  - Can be considered a four-leg intersection
- Sidepath roadway crossings
  - Within functional area of intersection
- Grade-separated



re 5-13. Mid-Block and Sidepath Crossings Relative to Intersection Functional Area

SHARED USE PATH CROSSING TYPES

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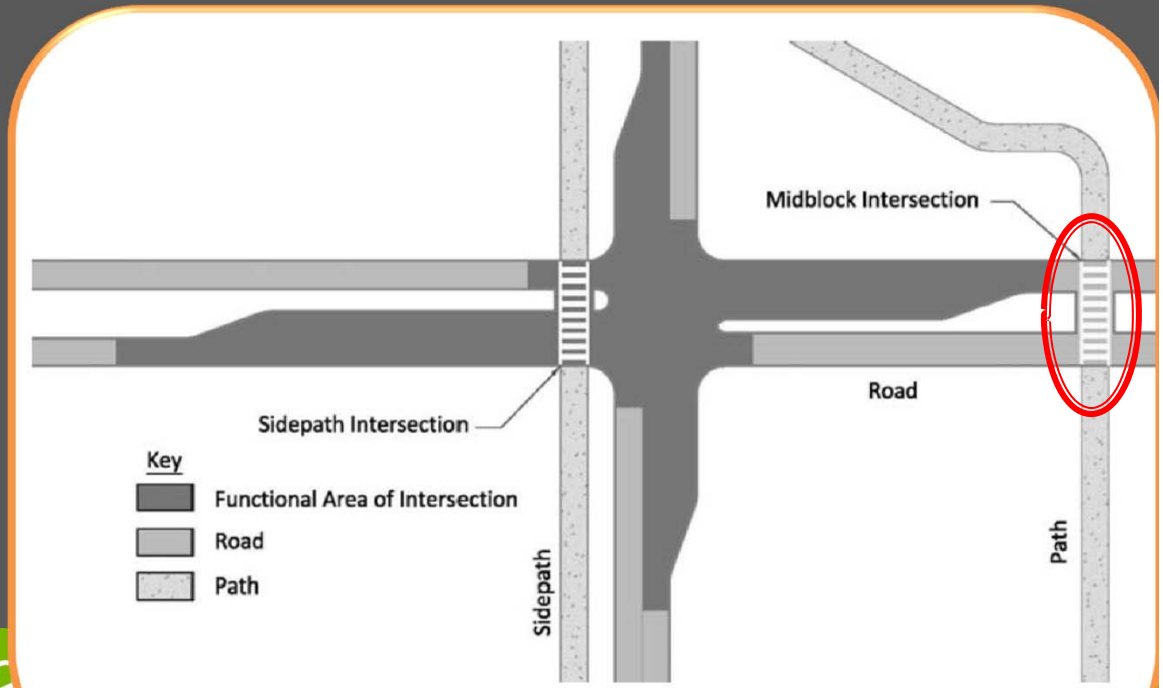

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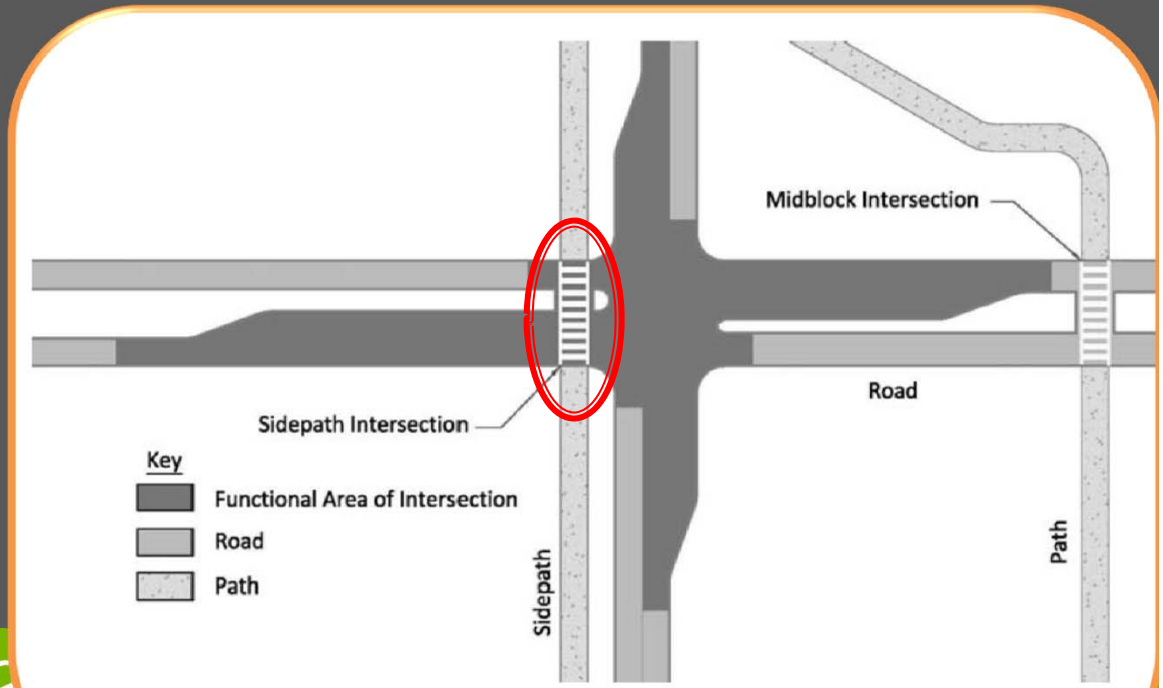

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SHARED USE PATH CROSSING TYPES

Mid-block roadway crossings

Sidepath roadway crossings

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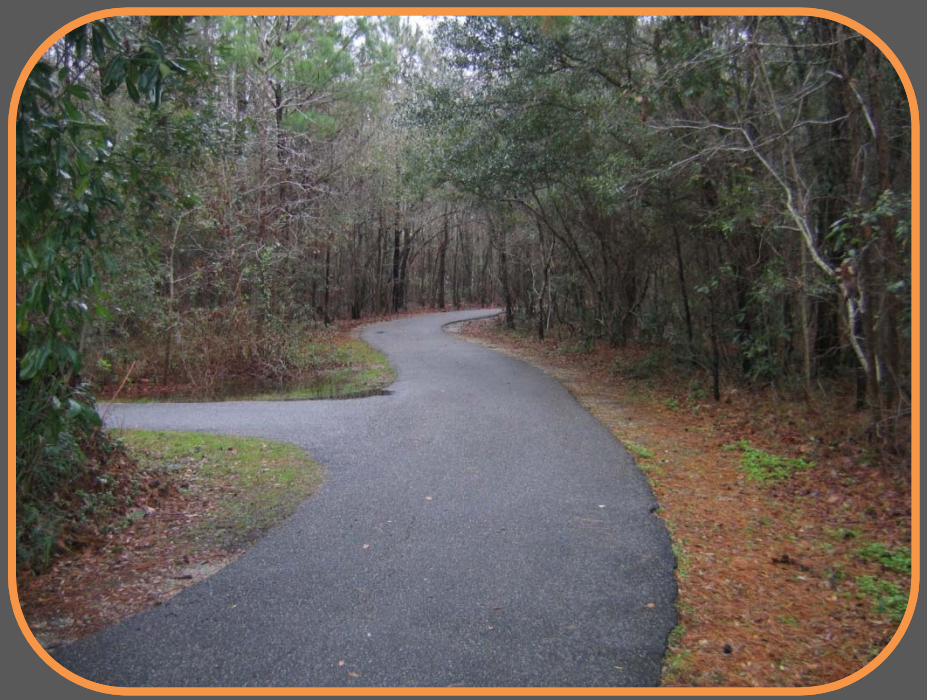
Off-Road Facilities Part II: Shared-Use Path Design

SHARED USE PATH CROSSING TYPES

Paths with Sidewalks

Paths with Paths



CROSSWALK MUTUAL YIELDING CONTEXT

- Mutual yielding
  - Driver must stop/yield to pedestrians in crosswalk
  - Bicyclists/pedestrian must stop/yield to motorists if the motorist can't stop in time (can't disregard traffic)

CROSSWALK MUTUAL YIELDING CONTEXT

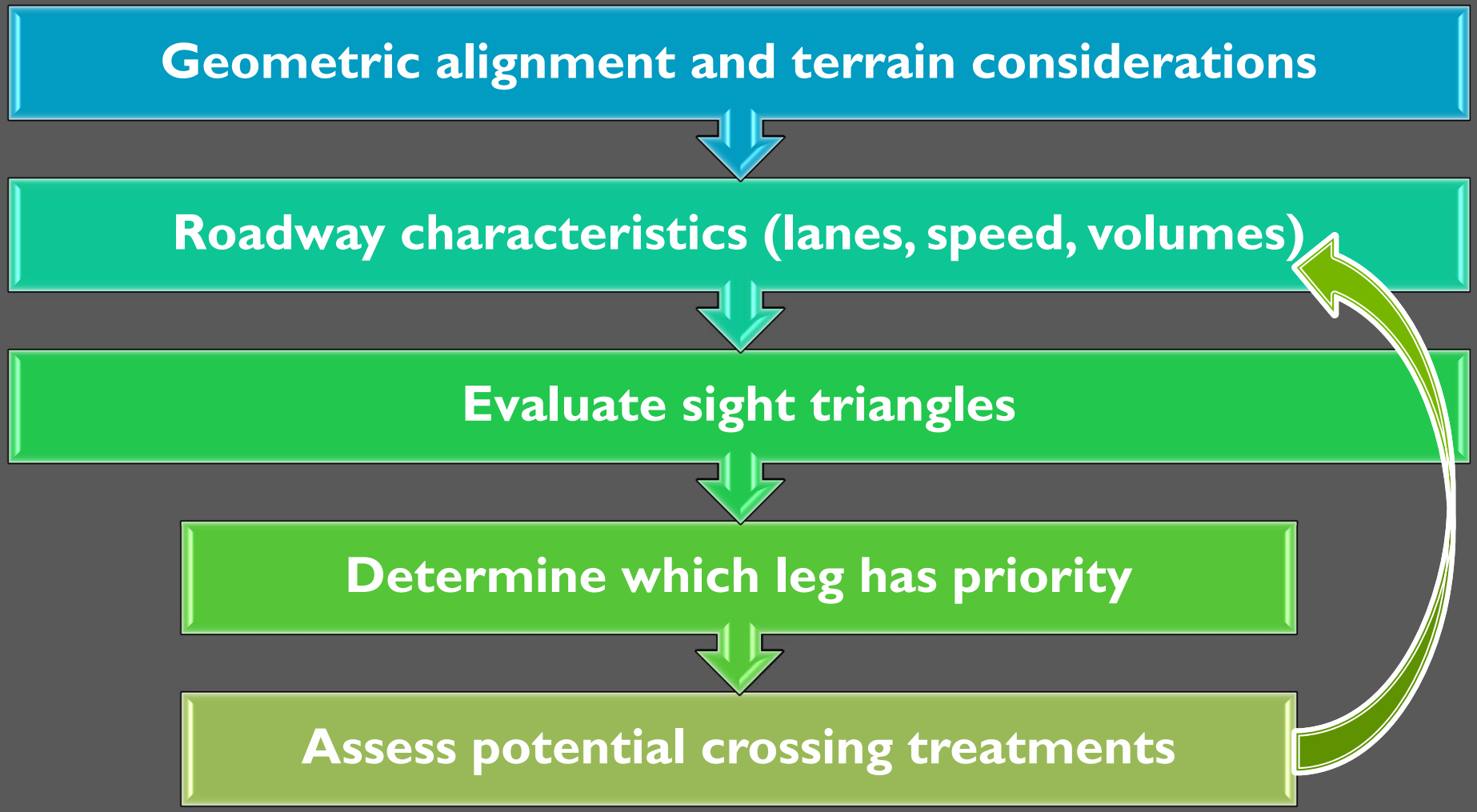
- Legal Crossings
  - Mid-block: marked crosswalks required to create legal ped x-ing
  - Sidepath: crosswalks exists regardless of marking
- Consider state laws
  - How are bicyclists treated? (bicyclist = pedestrian in x-walk?)

MUTUAL YIELDING IMPLICATIONS

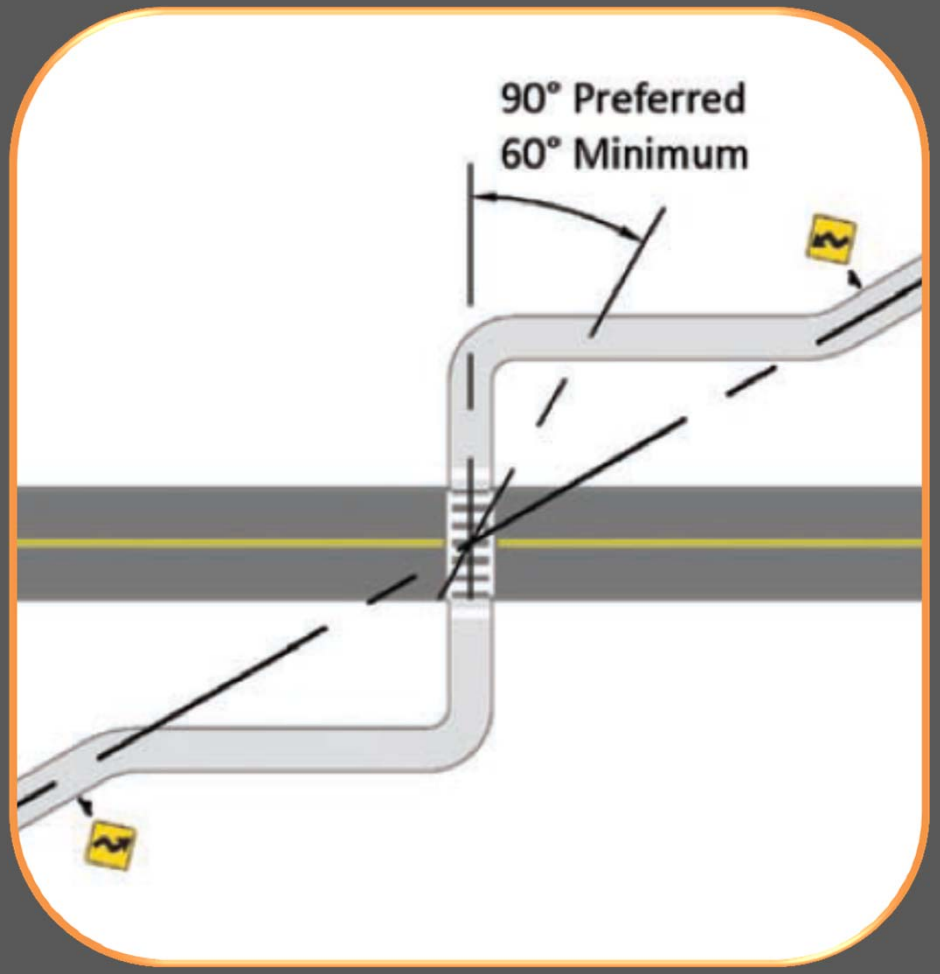
- Bicyclists vs. Pedestrians
  - Cyclists can operate up to 30 mph, desire momentum
  - Pedestrians operate up to 12 mph
- Mutual yielding
  - Works well with pedestrians
  - Doesn't work well where bicyclists approach at higher speeds

MID-BLOCK CROSSINGS

MID-BLOCK INTERSECTION APPROACH



GEOMETRIC ALIGNMENT AND TERRAIN CONSIDERATIONS



ASSESS ROADWAY CHARACTERISTICS (LANES, SPEED, VOLUMES)

Is a Signal Needed?

EVALUATE SIGHT TRIANGLES FOR YIELD CONTROL SCHENARIO

Consideration of Speed Differential of Each User:

- Approach speeds determined by fastest users:
  - Bicyclists (12-30mph)
  - Motorists (15-80mph)
- Departure speed determined by slowest users (typically pedestrian):
  - 3.0 – 3.5 feet/second

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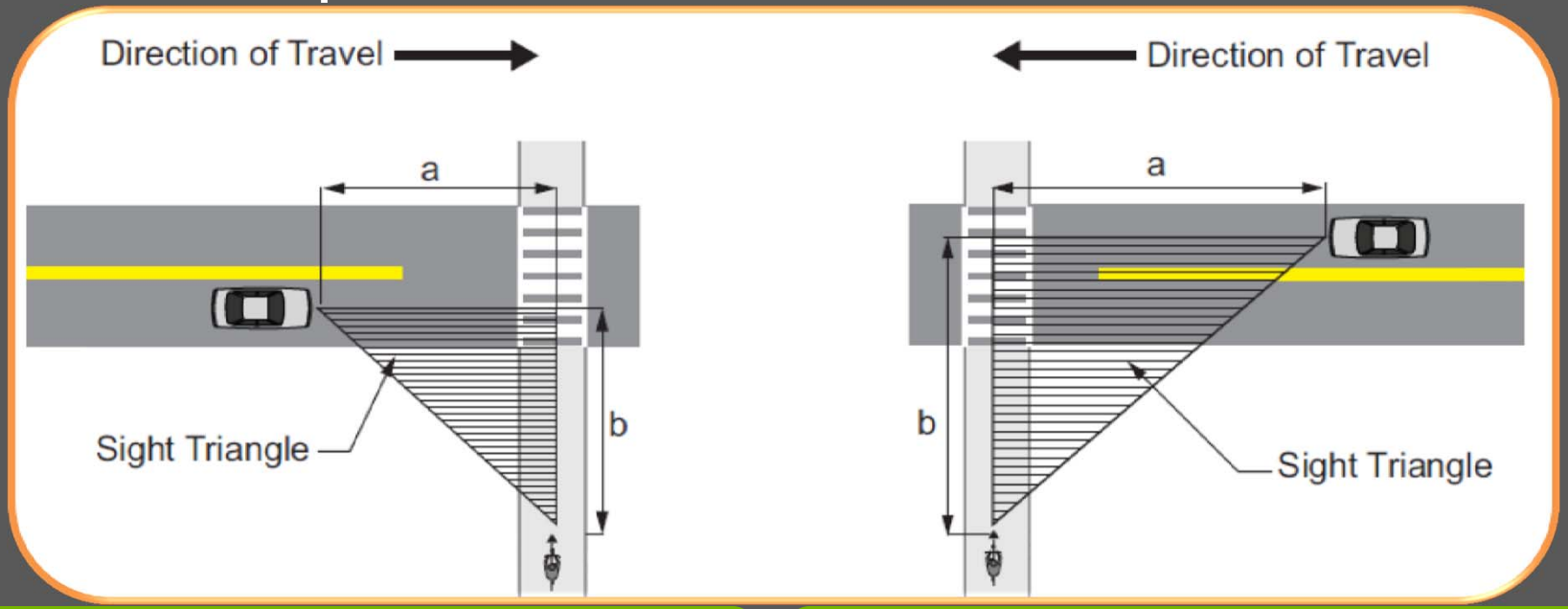
DESIGN SPEED

- Old guide: minimum 20 mph design speed
- New guide: "No single design speed"
  - Consider users, terrain, path surface
  - Typically not lower than 85th percentile (14 mph)
  - 18 mph on flat terrain
  - Higher in hilly terrain, up to 30 mph

EVALUATE SIGHT TRIANGLES FOR YIELD CONTROL SCHENARIO

- Using adult bicyclist (fastest path user)
- Using design speed of road for motorists
- **Objective**: provide unobstructed view to allow user to slow or stop to avoid conflict



EVALUATE SIGHT TRIANGLES FOR YIELD CONTROL SCHENARIO

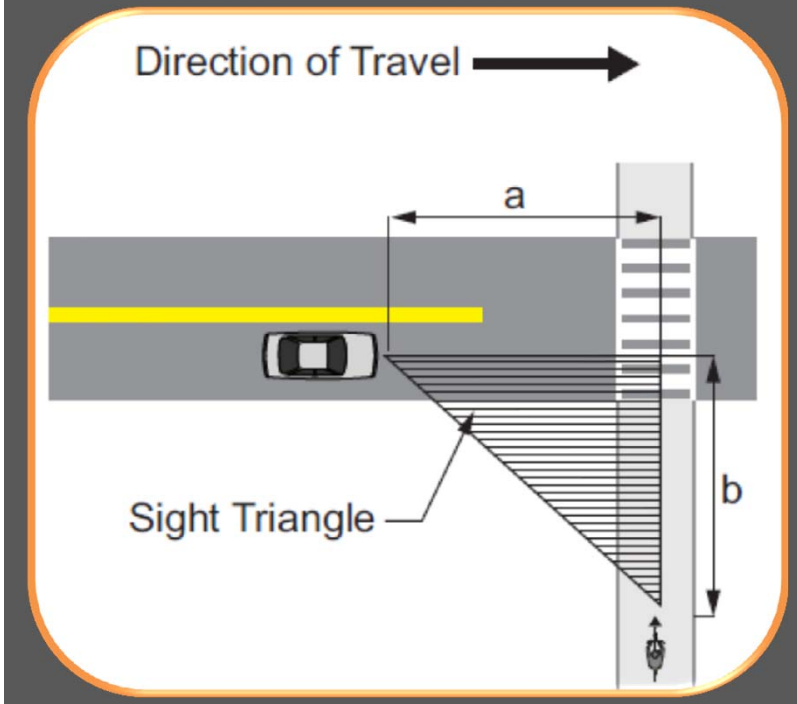


Table 5-7. Length of Roadway Leg of Sight Triangle

U.S. Customary

$$t_a = \frac{S}{1.47V_{path}}$$

$$t_g = t_c + \frac{w + L_a}{1.47V_{path}}$$

$$a = 1.47V_{road}t_g$$

a

where:

t_g	=	travel time to reach and clear the road (s)
a	=	length of leg sight triangle along the roadway approach (ft)
t_c	=	travel time to reach the road from the decision point for a path user that doesn't stop (s)
w	=	width of the intersection to be crossed (ft)
L_a	=	typical bicycle length = 6 ft (see Chapter 3 for other design users)
V_{path}	=	design speed of the path (mph)
V_{road}	=	design speed of the road (mph)
S	=	stopping sight distance for the path user traveling at design speed (ft)

Table 5-8. Length of Path Leg of Sight Triangle

U.S. Customary

$$t_c = \frac{1.47V_e - 1.47V_b}{a_i}$$

$$t_g = t_a + \frac{w + L_a}{0.88V_{road}}$$

$$b = 1.47V_{path}t_g$$

b

where:

t_g	=	travel time to reach and clear the path (s)
b	=	length of leg sight triangle along the path approach (ft)
t_a	=	travel time to reach the path from the decision point for a motorist that doesn't stop (s). For road approach grades that exceed 3 percent, value should be adjusted in accordance with AASHTO's *A Policy on Geometric Design of Highways and Streets* (5)
V_e	=	speed at which the motorist would enter the intersection after decelerating (mph) (assumed 0.60 × road design speed)
V_b	=	speed at which braking by the motorist begins (mph) (same as road design speed)
a_i	=	motorist deceleration rate (ft/s²) in intersection approach when braking to a stop not initiated (assume -5.0 ft/s²)
w	=	width of the intersection to be crossed (ft)
L_a	=	length of the design vehicle (ft)
V_{path}	=	design speed of the path (mph)
V_{road}	=	design speed of the road (mph)

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Off-Road Facilities Part II: Shared-Use Path Design

EVALUATE SIGHT DISTANCE FOR STOP OR SIGNAL CONTROL

- Approach leg determined by Stopping Sight Distance
- Stop leg (departure) determined by stop location
  - Ideal sight lines provide sufficient view of crossing traffic to judge gaps (Highway Capacity Manual Calculation)

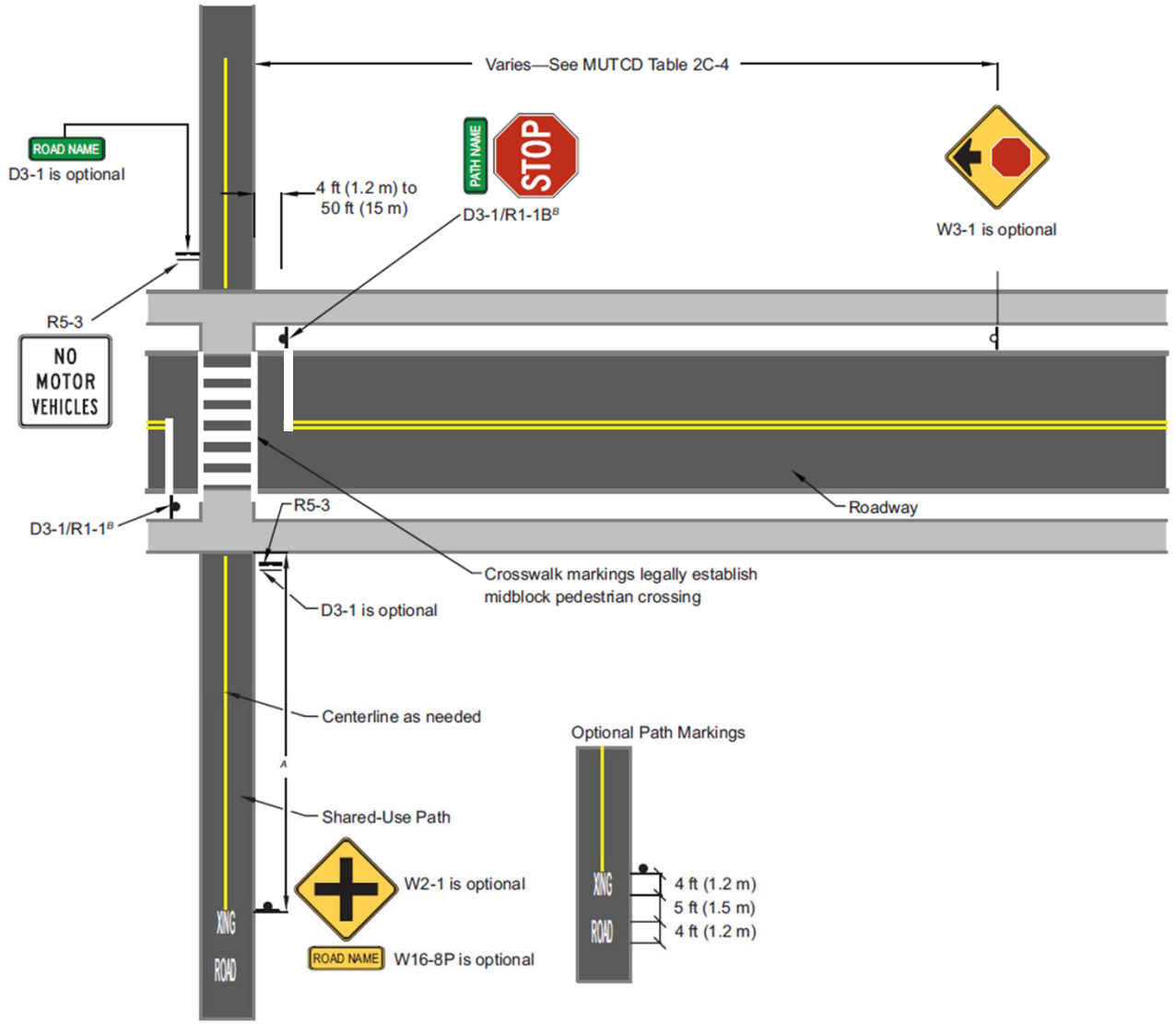
Adequate

Inadequate

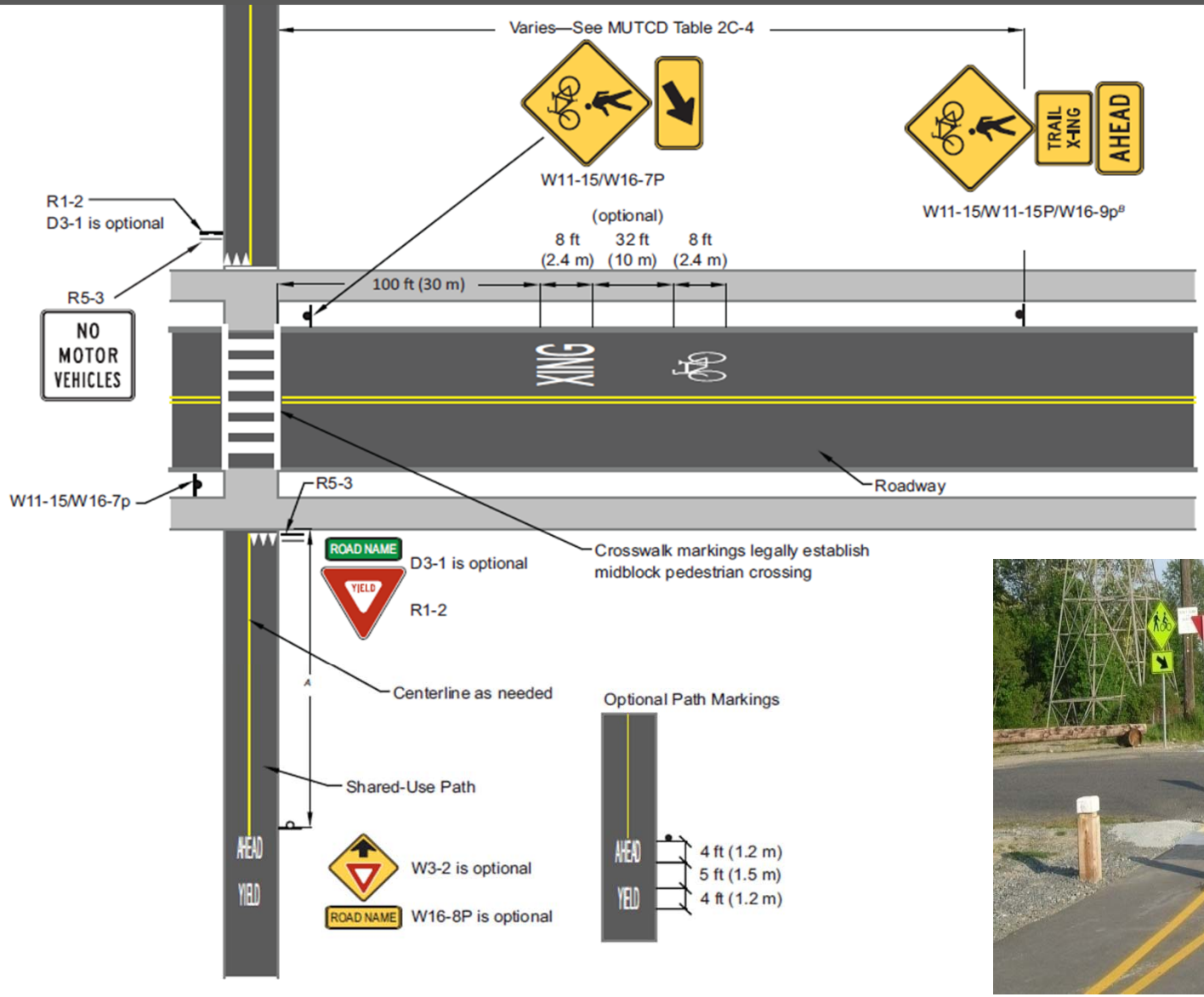
DETERMINE WHICH LEG HAS PRIORITY

- Consider relative volumes, speeds, and system hierarchy
  - Local street vs. regional trail
  - High speed/low volume road vs. high volume trail
- Apply least restriction that is effective

STOP CONTROLLED ROADWAY

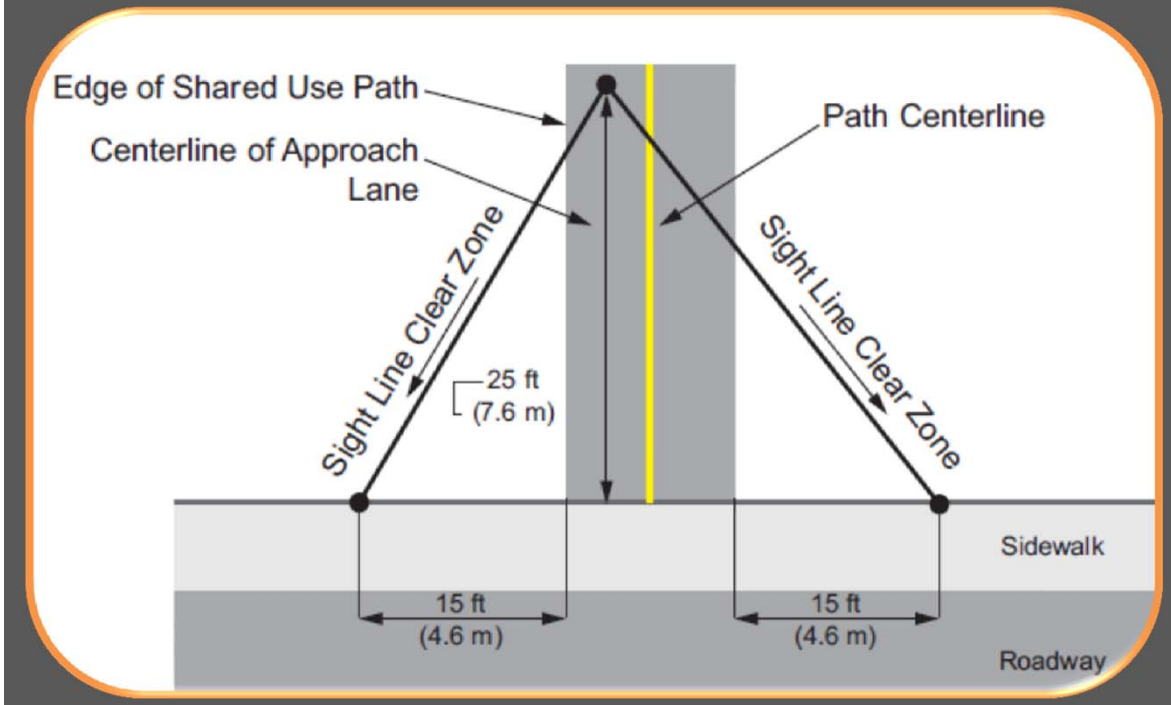


YIELD CONTROLLED PATHWAY



EVALUATE SIGHT TRIANGLES TO PEDESTRIAN SIDEWALKS/CROSSINGS

- Clear sight triangle at least 15 feet along walkway
  - Provides 2.5 second reaction time for a pedestrian moving at up to 6 feet per second (running) to stop



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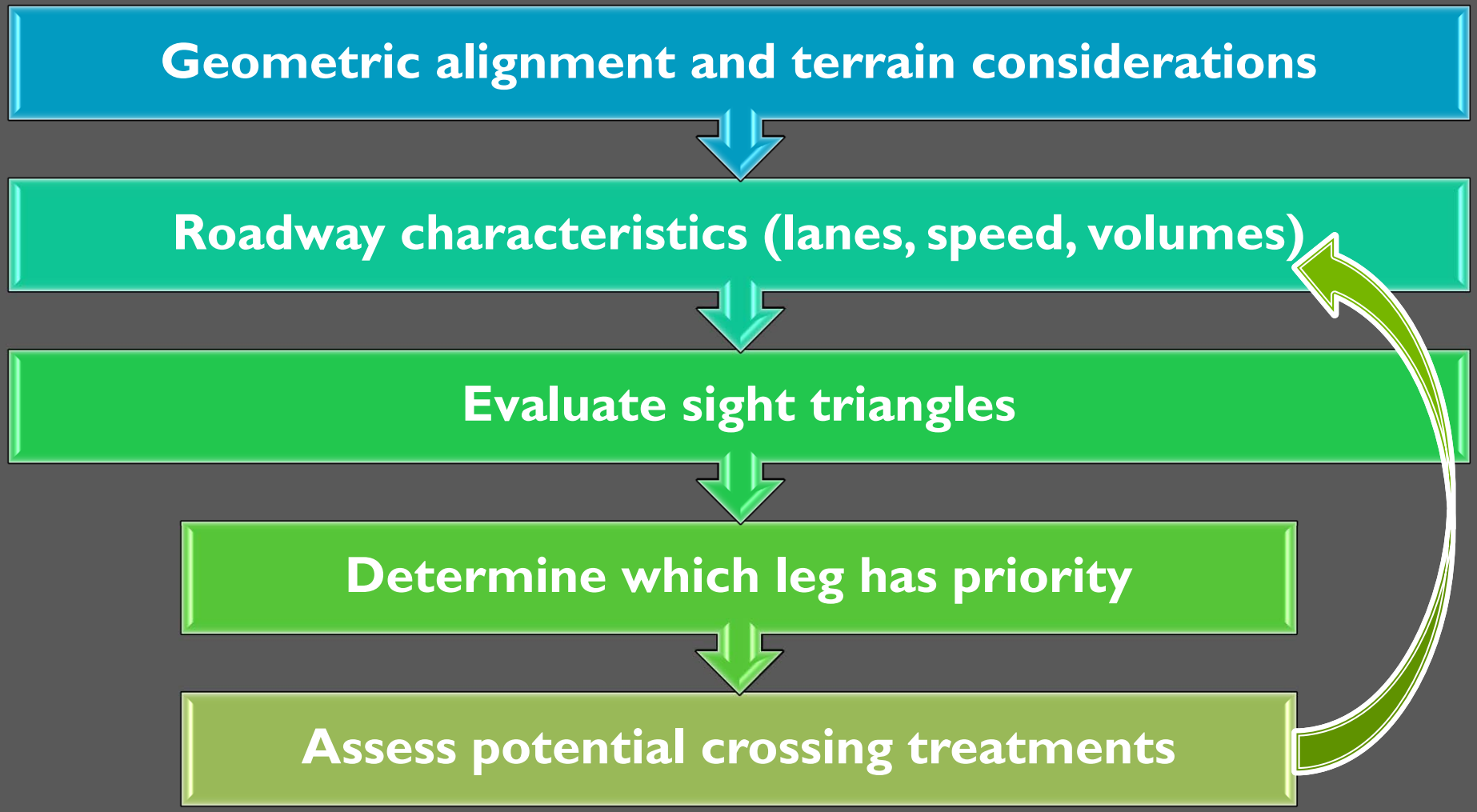
MID-BLOCK INTERSECTION APPROACH



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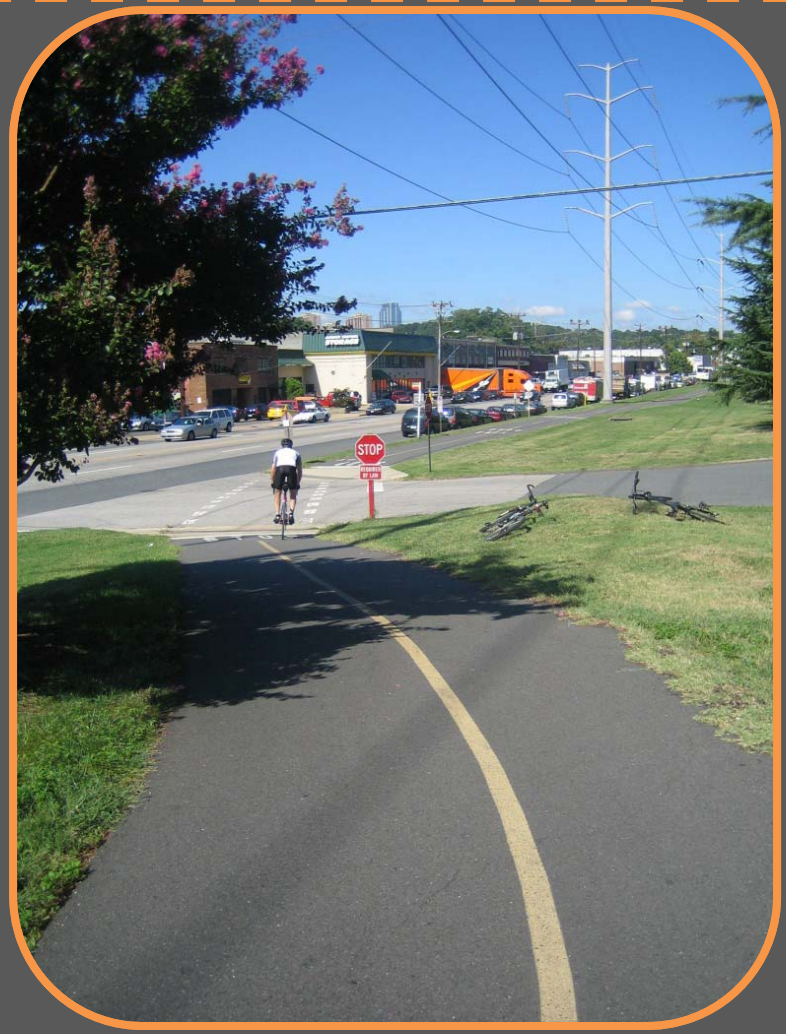


CROSSWALK

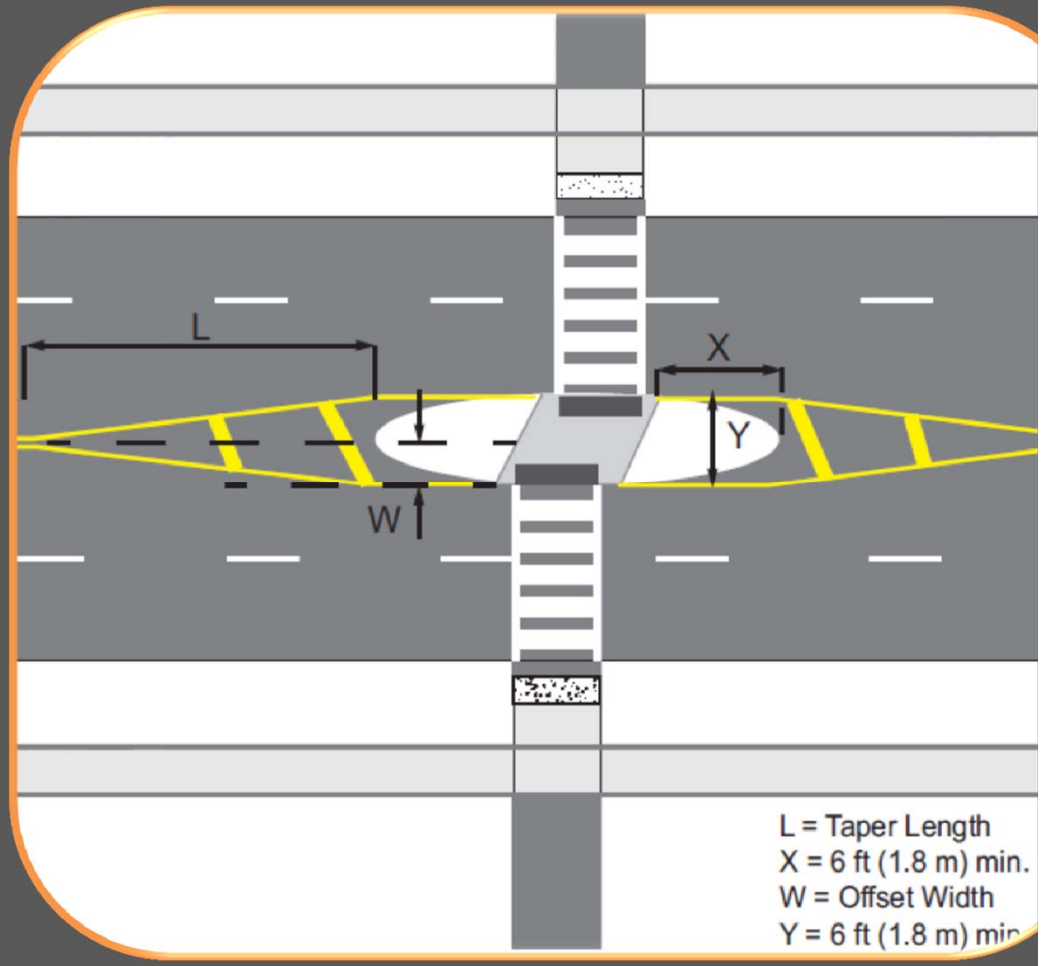
Crosswalks are recommended….

- Further crossing treatments are recommended to complement marked crosswalks if speeds > 40 mph and 4 or more lanes of traffic with either:
  - No raised crossing island & ADT > 12,000
  - A raised crossing island & ADT > 15,000

What are further crossing treatments?

CROSSING ISLANDS

- Lower crash rates
- Beneficial at:
  - High roadway volumes
  - Wide crossings
  - Crossing 3 or more lanes
- Widths
  - Minimum width: 6 feet
  - Preferred width: 10 feet
    - consider platoons



ADVANCE STOP OR YIELD LINES

- Lower crash rates
- Effective on multi-lane crossings

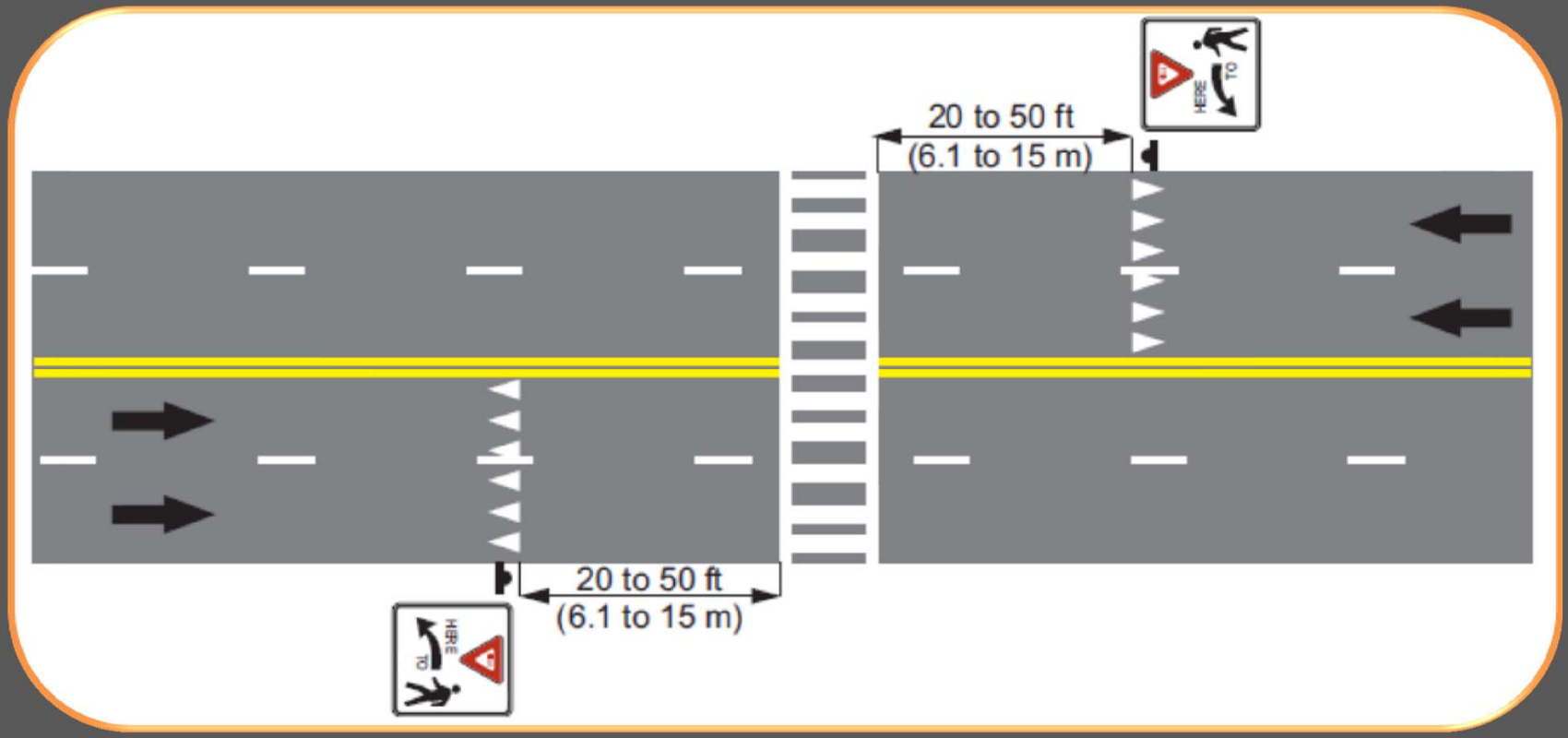
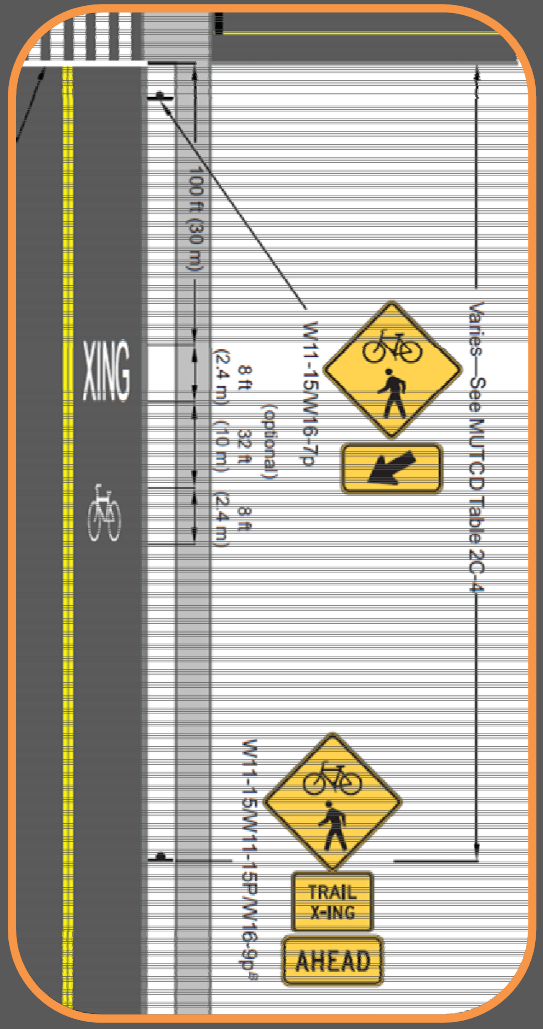


Photo: Bill Cowern

WARNING SIGNS AND MARKINGS

- Should not use where roadway is stop, signal, or yield controlled



CURB RAMPS

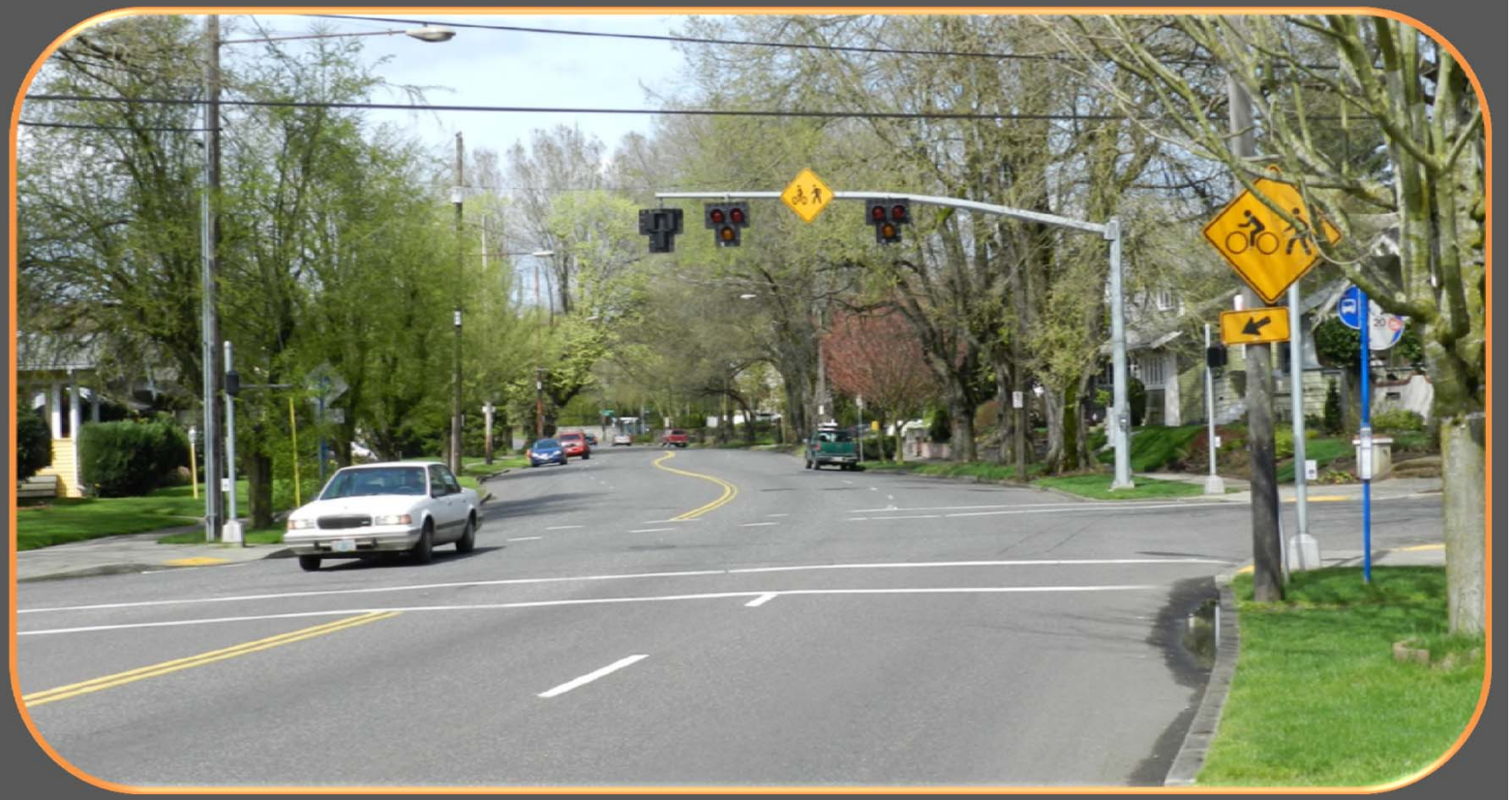
CURB RAMPS

SIGNALIZED AND ACTIVE WARNING CROSSINGS

- Reference MUTCD for guidance
- Signalized shared use path crossings: design for slowest user (pedestrian)
  - Accessible push button
  - Pedestrian signal timing
  - Automated detection

SIGNALIZED AND ACTIVE WARNING CROSSINGS

- Pedestrian hybrid beacon



SIGNALIZED AND ACTIVE WARNING CROSSINGS

- Rapid flashing beacon

SIGNALIZED AND ACTIVE WARNING CROSSINGS

- Standard beacon

SIDEPATH DESIGN

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SIDEPATH GUIDANCE

- Consolidates discussion of SUP's adjacent to roadways – Clearly defines "sidepath"
  - Expands discussion of operational problems
  - Acknowledges reasons for building paths adjacent to roadways
  - Provides guidance on when and where these facilities are appropriate
  - Provides design guidance for those locations

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SIDEPATH PROXIMITY TO PARALLEL ROAD

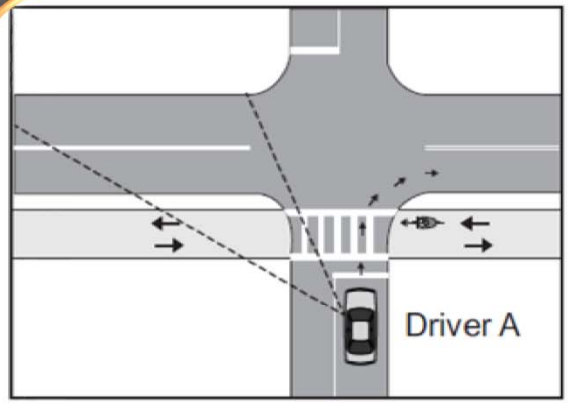
- Based on Florida DOT research for path placement
  - Roads speed limits > 50 mph, increase separation from roadway
- At lower speeds
  - Greater separation from road does not reduce crashes
  - Crossing should be close to the parallel roadway so motorists can better detect sidepath users

SIDEPATHS MAY BE CONSIDERED:

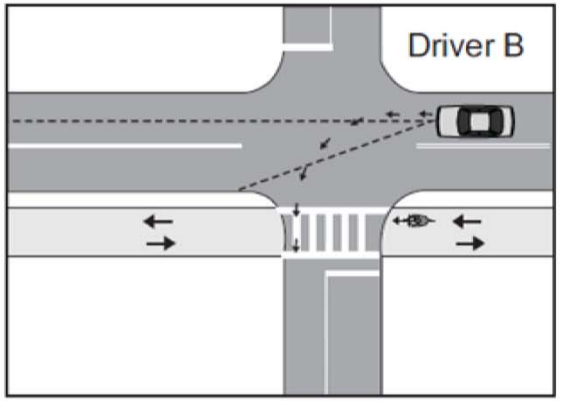
- Adjacent road has high speeds and volumes and no practical alternatives for improving on-road conditions or adjacent routes
- Sidepath is used for a short distance to connect:
  - Pathway segments
  - Local streets used as bicycle routes
- Sidepath can be built with few roadway and driveway crossings
- Sidepath can be terminated in a bicycle compatible location

SIDEPATH CROSSING CONSIDERATIONS

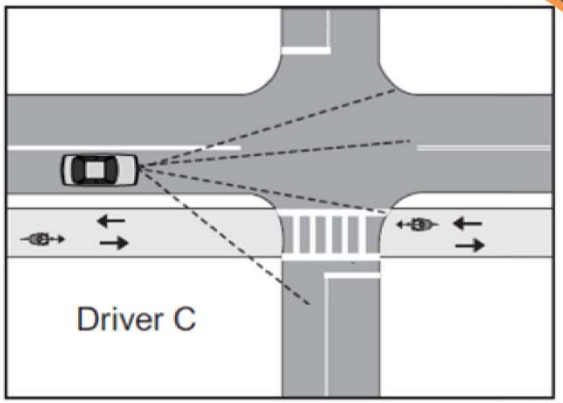
- Must consider driver's attention in the intersection
  - Where do drivers expect conflicting traffic?
  - Where are the virtual "blind spots"?



Right turning Driver A is looking for traffic on the left. A contraflow bicyclist is not in the driver's main field of vision.



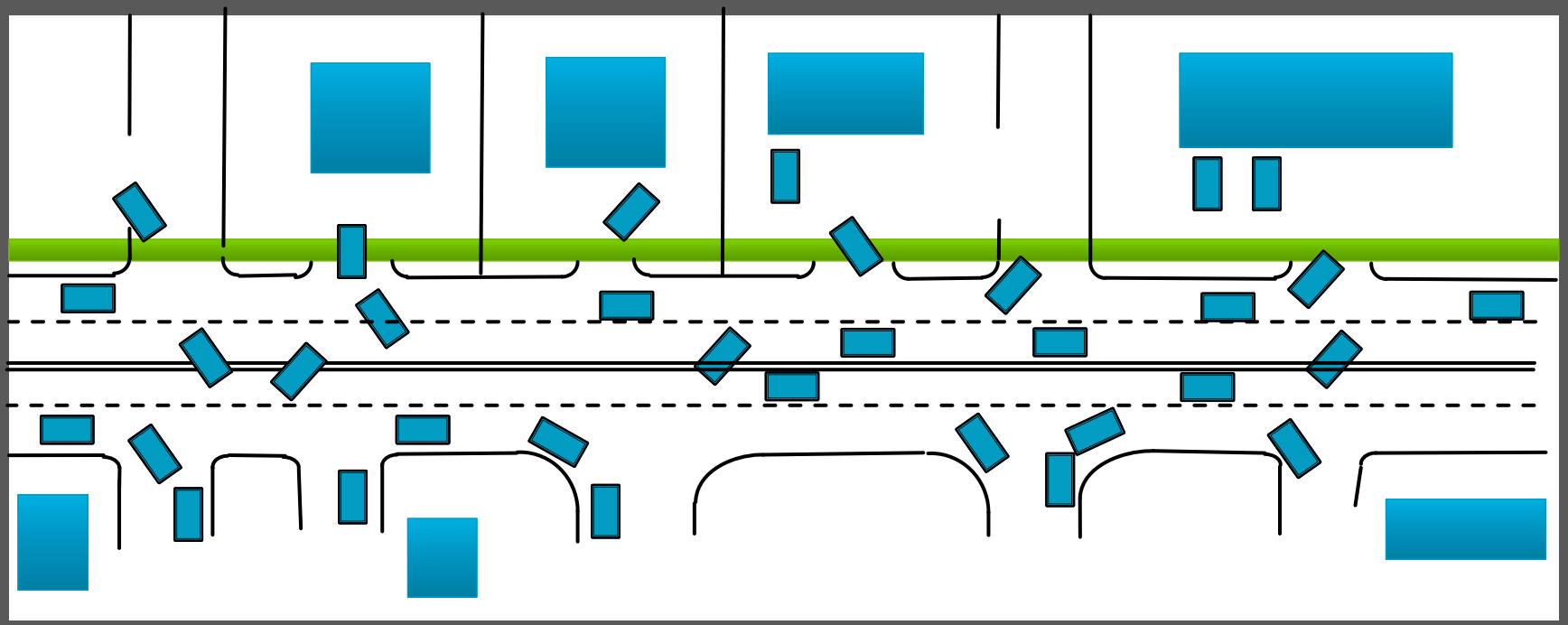
Left turning Driver B is looking for traffic ahead. A contraflow bicyclist is not in the driver's main field of vision.

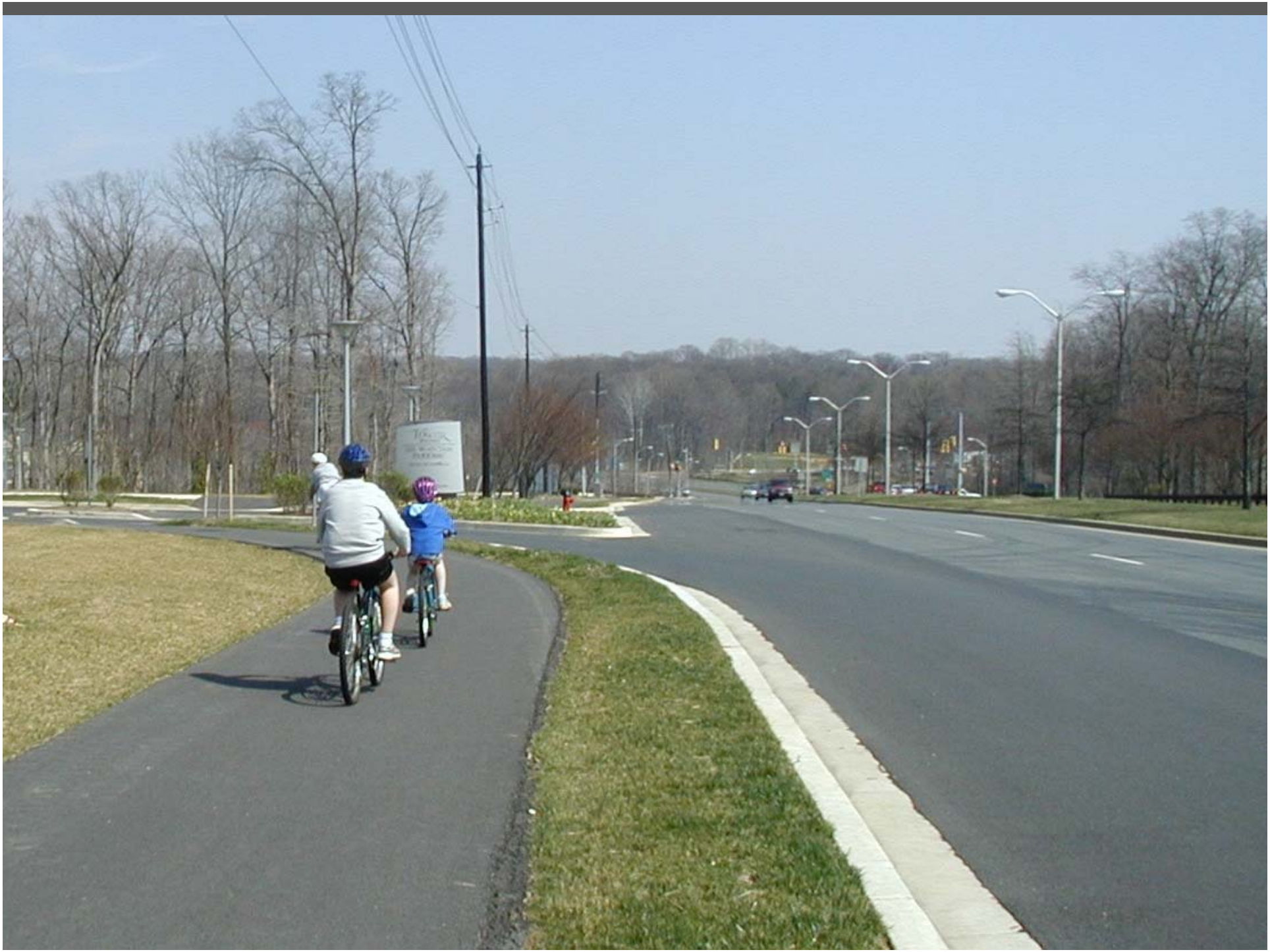


Right turning Driver C is looking for left turning traffic on the main road and traffic on the minor road. A bicyclist riding with traffic is not in the driver's main field of vision.

SIDEPATH CROSSING CONSIDERATIONS

- Utilize access management techniques





SHARED USE PATH CROSSING TYPES

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- Sidepath roadway crossings
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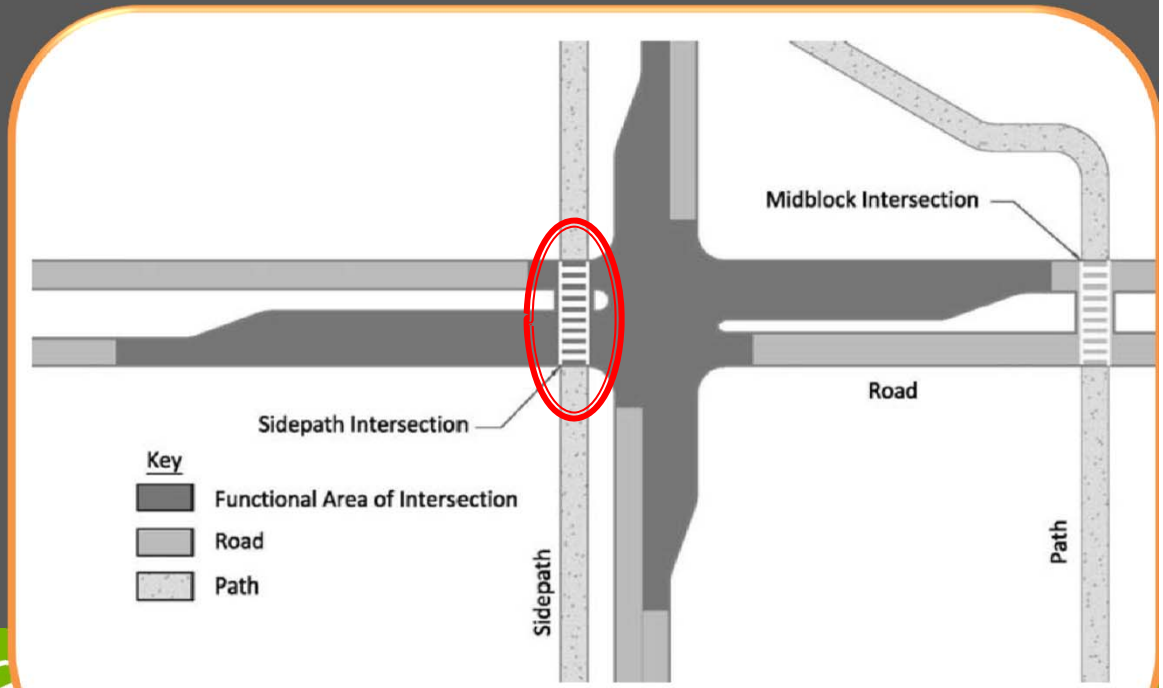
- Grade-separated



re 5-13. Mid-Block and Sidepath Crossings Relative to Intersection Functional Area

SIDEPATH CROSSINGS
SIGNALIZED INTERSECTION CONSIDERATIONS

- Pedestrian vs. Bike Timing
  - Designed for pedestrian walking speed and clearance interval
  - Bicyclists often enter the intersection during the "Don't Walk" interval
- Operations
  - concurrent or exclusive with turning vehicles

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SIDEPATH CROSSINGS AT SIGNALIZED INTERSECTIONS

Pathway should be integrated into the intersection controls following principles of pedestrian crossings

SIDEPATH CROSSING COUNTERMEASURES

Signalized Crossings

- Consider fully protected left and right turns from the parallel street across the sidepath
- Prohibit right turns on red from the crossing roadway
- Consider a leading pedestrian interval or exclusive pedestrian phase

Uncontrolled Crossings

- Reduce speeds of path users & motorists at conflict points
- Consider design to reduce path user speeds
- Employ measures on adjacent road to reduce speeds
- Reduce frequency of driveways

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SPEED CONTROL ON PATHS

- Introduces concept of using geometric design and traffic control to reduce user speeds, such as curvature
- Recommends centerline stripe to reduce speeds and address conflicts
- Depends on site specific context

RESTRICTING MOTOR VEHICLE ACCESS

- "The routine use of bollards…to restrict motor vehicle traffic is not recommended."
- "Barriers such as bollards, fences, or other similar devices create permanent obstacles…and can cause serious injury."

RESTRICTING MOTOR VEHICLE ACCESS

BOLLARD CONSIDERATIONS

- If bollards are justified – design goals:
  - Retroreflectorized
  - Bikes can pass w/o dismounting
  - Provide adequate sight distance
  - Stripe an envelope at approach
  - Use flexible delineators
  - Vehicles should not be able to pass
  - Use an odd number of bollards
  - Set back min, 30 ft from road
  - Flush hardware in ground

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THANK YOU!

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Questions?

TooleDesignGroup

FUTURE WEBINARS

- August 10: Overview
- August 22: Planning Chapter
- September 4: On-Road Bikeways Part I
  - Bike Lanes (including Intersections)
- September 18: On-Road Bikeways Part II
  - Shared lanes
  - Bicycle boulevards & signing
  - Signals
- October 9: Shared Use Paths
  - General design principles
  - Pathway geometry
- October 23: Shared Use Paths
  - Intersection Design
  - Mid-block crossings
- **November 6: Bikeway Maintenance and Operation**