U.S. Department of Transportation
Federal Highway Administration

AASHTO
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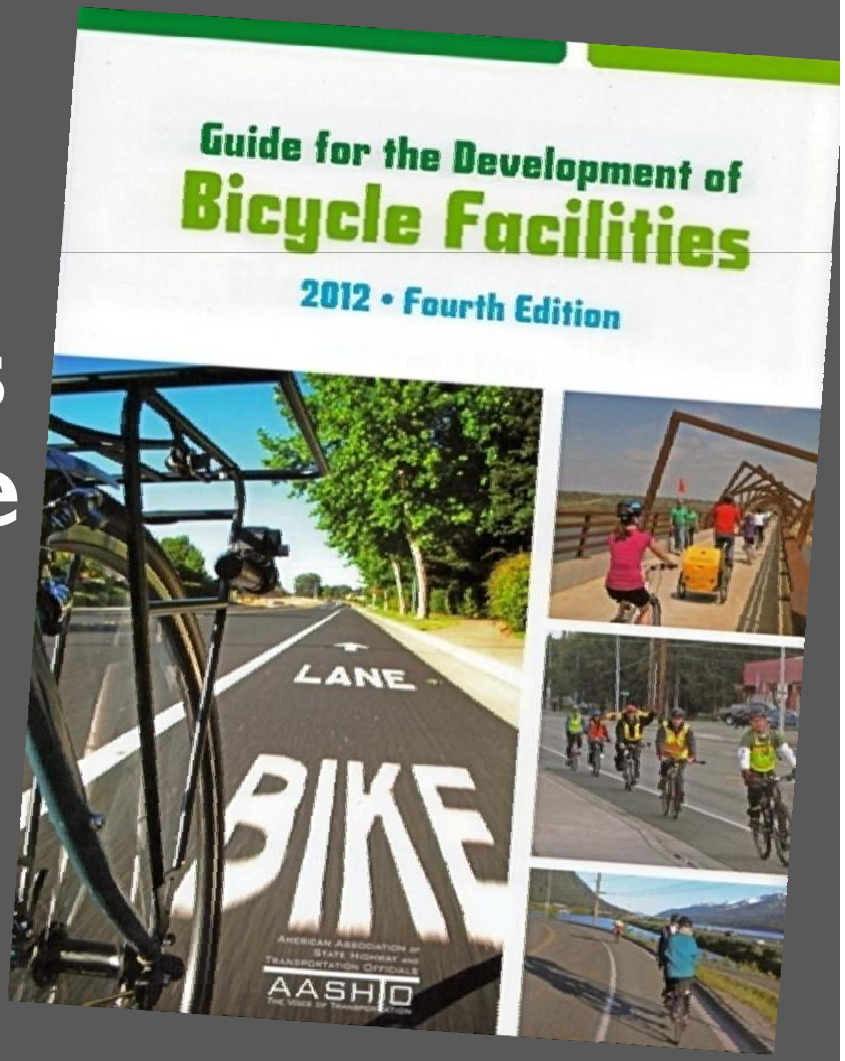
Pedestrian and Bicycle Information Center

Off-Road Facilities Part 1: Shared Use Path Design



Presentation by:
Eric Mongelli, P.E.
Tom Huber
October 9, 2012

Toole Design Group

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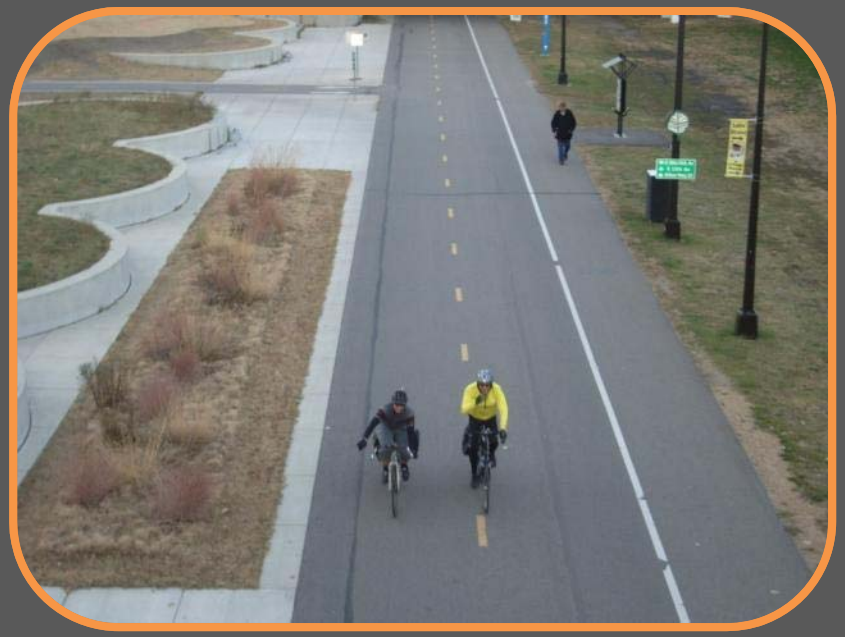
- Toole Design Group is live tweeting this webinar
  - @tooledesign
  - #AASHTO #BikeGuide

WEBINAR #5: OFF- ROAD FACILITIES PART I: SHARED USE PATH DESIGN

Today's Webinar

- Significant Expansion on Shared Use Path Design
  - Basics – Users, Purpose, Location
  - Sidepaths
  - Widths and Clearance
  - Design Speed
  - Alignment
  - Slopes & Gradients
  - Stopping Sight Distance
  - Other Design Considerations



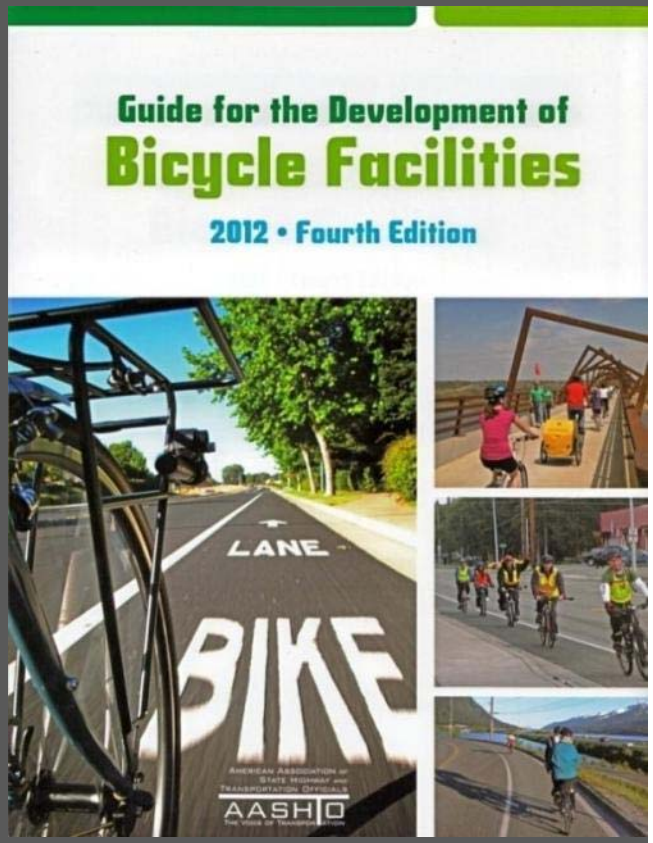
FUTURE WEBINARS

- 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

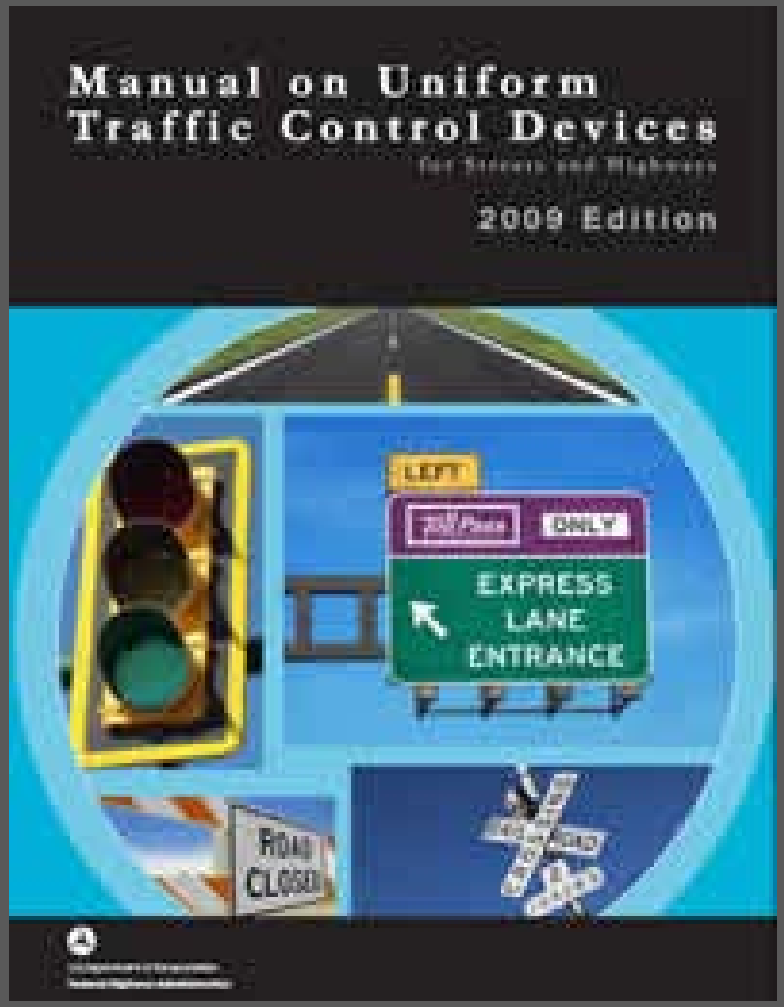


SOME BACKGROUND

- 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

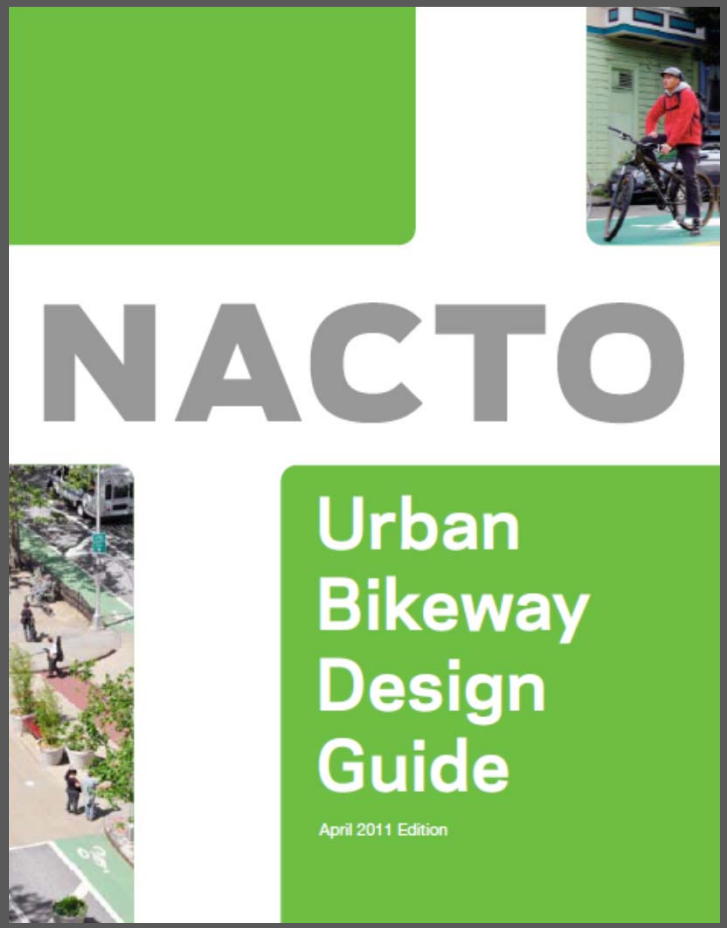
RELATIONSHIP TO OTHER MANUALS

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



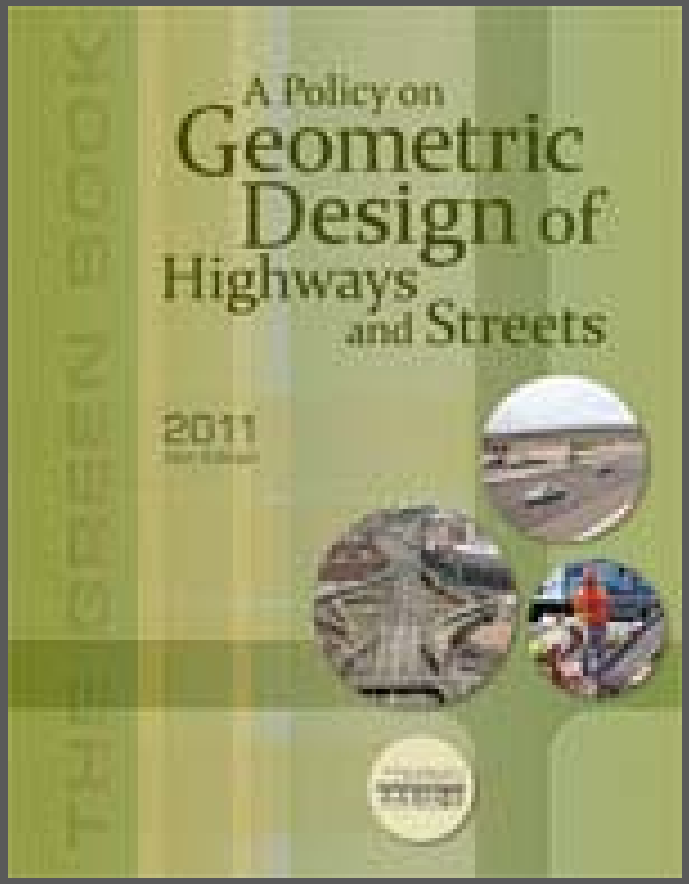
AASHTO VS. NACTO GUIDE: EITHER/OR?

- 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 principals of the "Green Book"
  - Design speeds
  - Horizontal & vertical curves
  - Cross slopes
  - Sight distances



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
- New/Revised/Expanded Guidance on:
  - Accessibility
  - Sidepaths
  - Widths, Shoulders and Safety Rails
  - Design Speed
  - Horizontal Alignment
  - Speed Control
  - Stopping Sight Distance
  - Path/Roadway Intersections
    (discussed in next webinar)

INTRO TO SHARED USE PATHS

- Bikeways physically separated from motorized traffic
- Typically designed for two-way travel
- Supplement a network of on-road bike facilities

SHARED USE PATH USERS

- Bicyclists
  - Upright adults, children
  - Recumbent & tandem users
  - Bicyclists pulling trailers/bikes
- Pedestrians
  - Walkers
  - Runners
  - Wheelchair users
  - People with strollers
  - People walking dogs
- Inline/roller skaters
- Kick scooter users
- All others

USERS

- Motorized vehicles not recommended
- Can accommodate horses with an adjacent bridle trail

SHARED USE PATH LOCATIONS

- Abandoned or active railroad
- Rivers
- Lake and ocean fronts
- Canals
- Utility rights-of-way
- College campuses
- Roadway corridors
  - called "sidepaths"

SHARED USE PATH LOCATIONS

Lakes and Ocean Fronts

Along Canals

SHARED USE PATH LOCATIONS

- Utility rights-of-way
- Rivers

SHARED USE PATH LOCATIONS

- College campuses
- Roadway corridors
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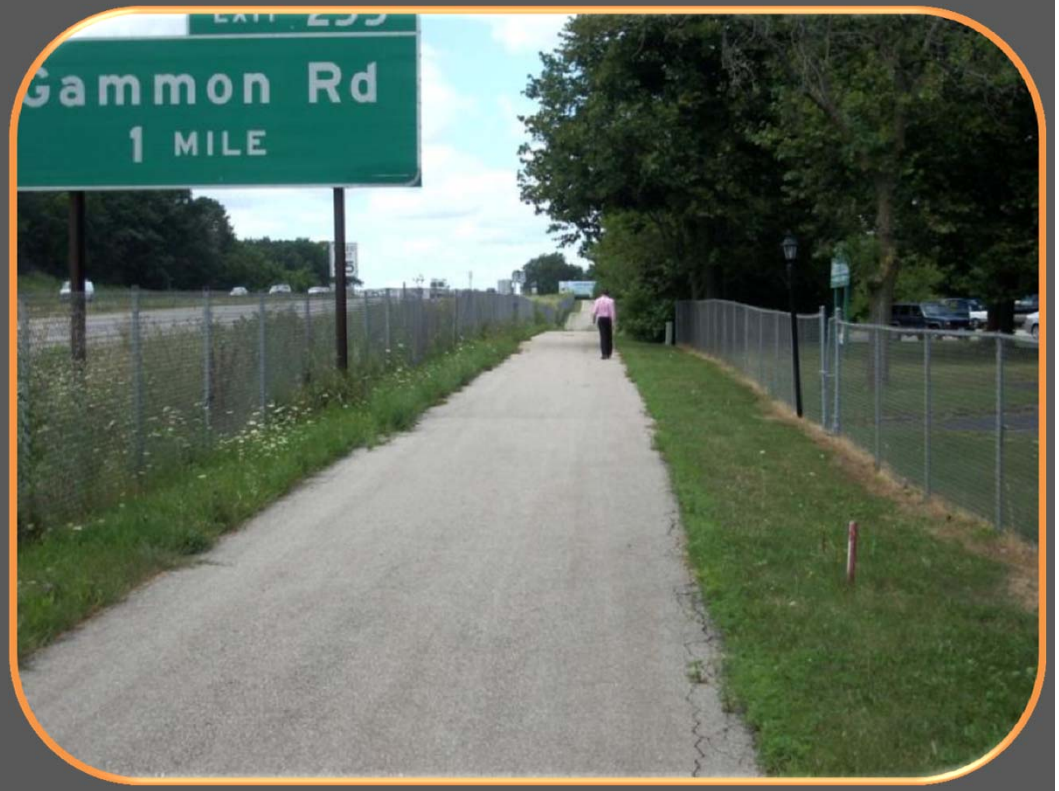


SHARED USE PATH PURPOSES

- Off-street residential connection or school access
- Commuting route
- Recreational route

ACCESSIBILITY REQUIREMENTS

- Must meet accessibility requirements of the Americans with Disabilities Act
- Public right-of-way: Public Rights-of-Way Accessibility Guidelines (PROWAG)
- Independent rights-of-way: Advance Notice of Proposed Rulemaking (ANPRM) on Accessibility Guidelines for Shared Use Paths

SHARED USE PATH BASICS

- Primary design user: adult bicyclist
- Guide instructs for adjustments if another user type is primary
- Paths frequently used by children:
  - Children's design speed are accommodated in the guide
  - Use engineering judgment to modify other values

SEPARATION OF DIRECTIONS

- Provides space for directional travel
- Solid where passing is not permitted
- Broken where passing is permitted
- Along entire length of trail or only where operational challenges exist

SEPARATION OF USERS

- Bi-directional walking lane for pedestrians with directional lanes of travel for cyclists
  - At least 5 feet for pedestrians
  - At least 10 feet for bicyclists

SEPARATION OF USERS

- In areas with "extremely heavy pathway volumes"

SEPARATION OF USERS

- Be aware that if pedestrians outnumber bicyclists, they are less likely to follow the rules.

SEPARATION OF USERS

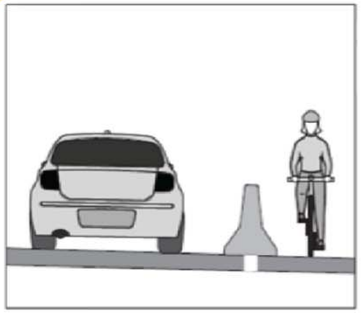
SIDEPATHS

- New term in guide
  - Sidepath = shared-use path that runs along a roadway
- Supplements, does not substitute on-road bicycle facilities
- Provides separation from motor vehicles,
- Guide has extended guidance on potential conflicts

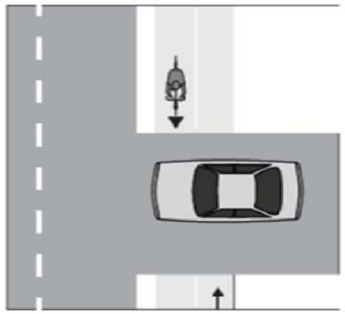
ONE-WAY SIDEPATHS

- "May be possible" to place one-way paths on both sides of a roadway
- Provides planning and design considerations

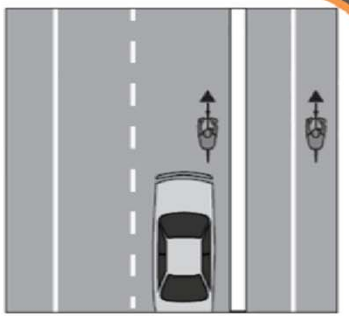
SIDEPATHS



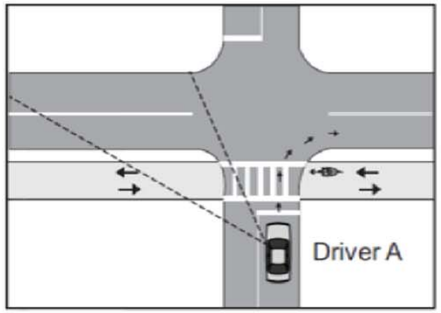
Barriers, while needed in tight spaces, can narrow both roadway and path, and create hazards.



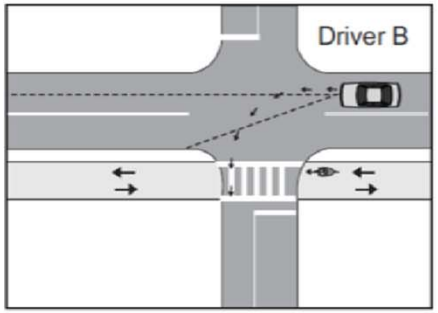
Stopped motor vehicles on side streets or driveways may block the path.



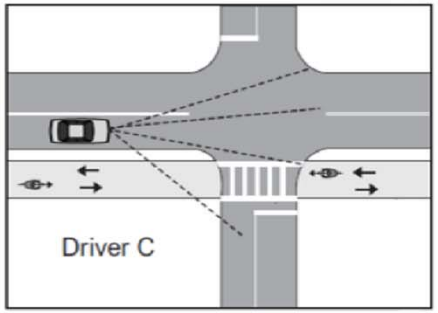
Some bicyclists may find the road cleaner, safer, and more convenient. Motorists may believe bicyclists should use a sidepath.



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.

SIDEPATHS

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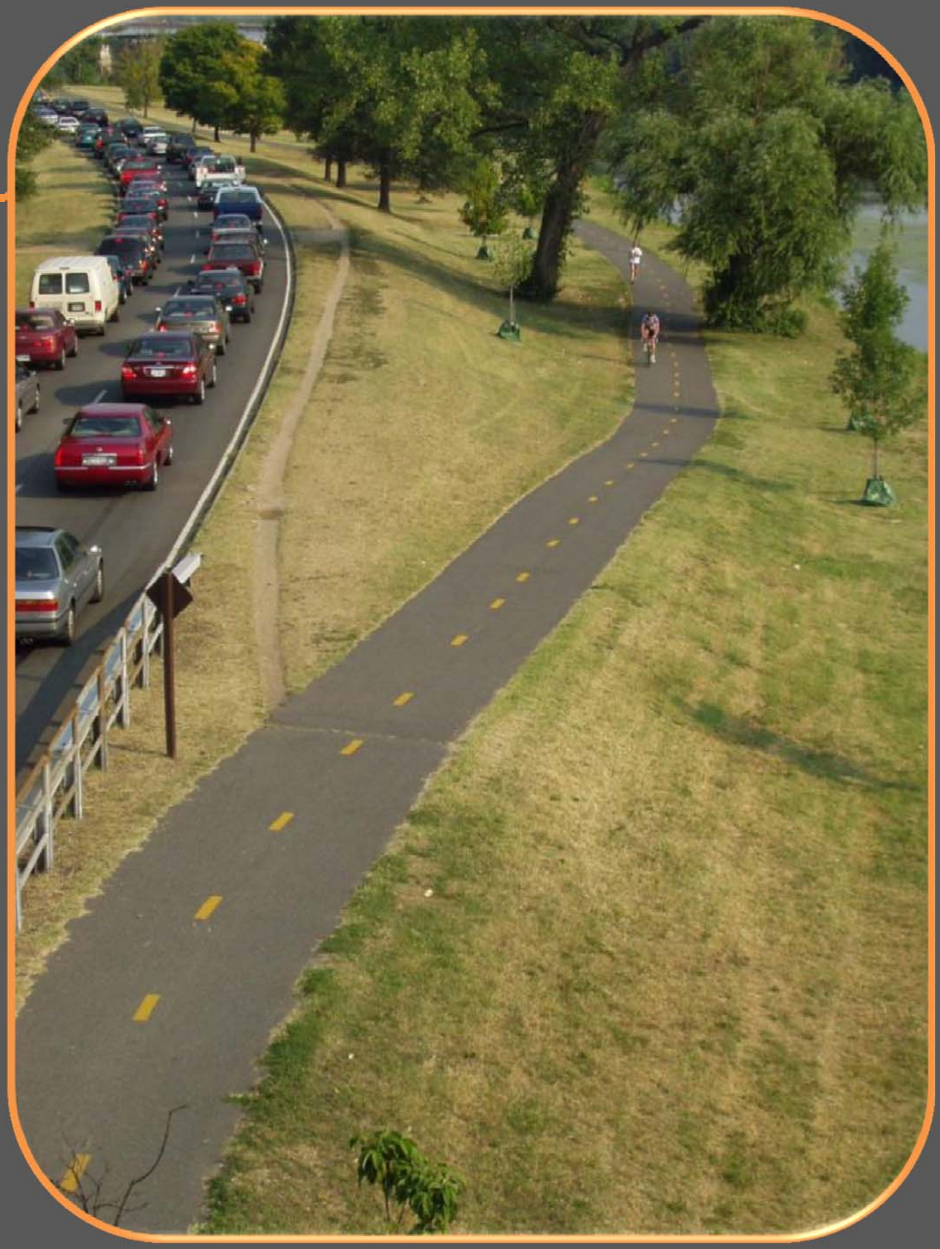
- If along a high-speed highway, a sidepath should have 5 feet or more separation or a barrier



SHARED USE PATH DESIGN BASICS

- Widths and Clearance
- Design Speed
- Horizontal Alignment
- Cross Slope
- Vertical Alignment
- Stopping Sight Distance
- Other Considerations (Surface, Bridges & Underpasses, Drainage, Lighting)

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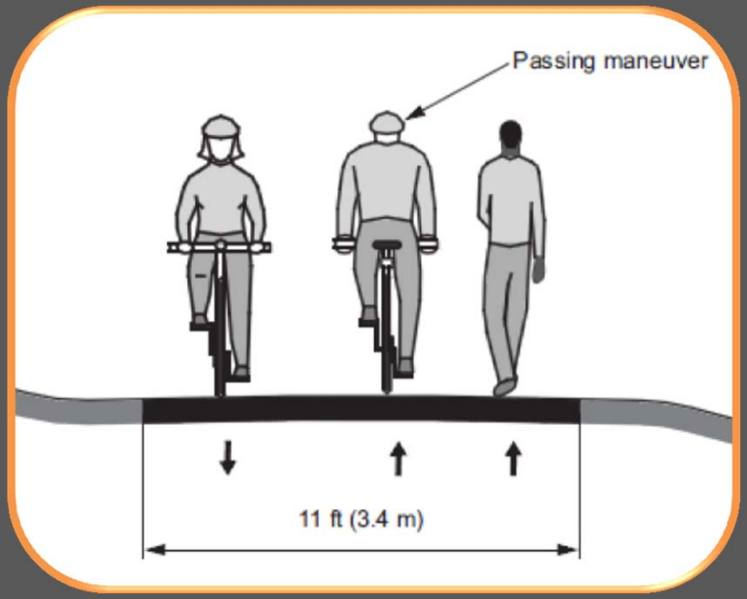
Off-Road Facilities Part 1: Shared-Use Path Design

WIDTH AND CLEARANCE

- 10 feet = minimum width
- 11 feet is needed for passing
- 10- to 14-foot width is typical
  - Wider path accommodates higher volumes or more varied user groups
  - Guide sets forth specific scenarios where a wider path may be warranted
- 8 feet is acceptable in rare circumstances

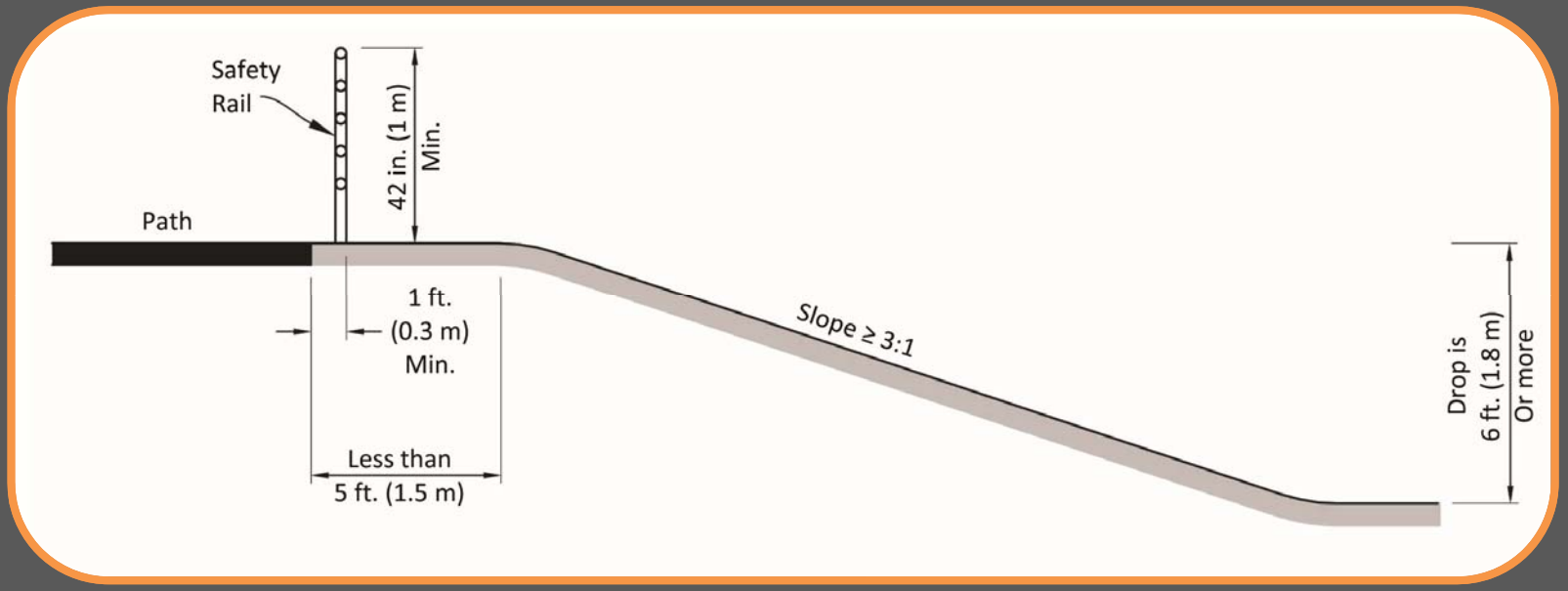


SHOULDERS

- Graded should 3-5 feet recommended with maximum 1:6 cross slope
- Minimum 2-foot clearance or 1-foot clearance to "smooth" features
- Recommended 5-foot separation to roadways, use barrier or rail if less than 5 feet

SHOULDERS

- Provide 5-foot separation to trailside hazards or slopes of 1:3 or steeper
- Provide barrier or safety rail if separation is less than 5 feet



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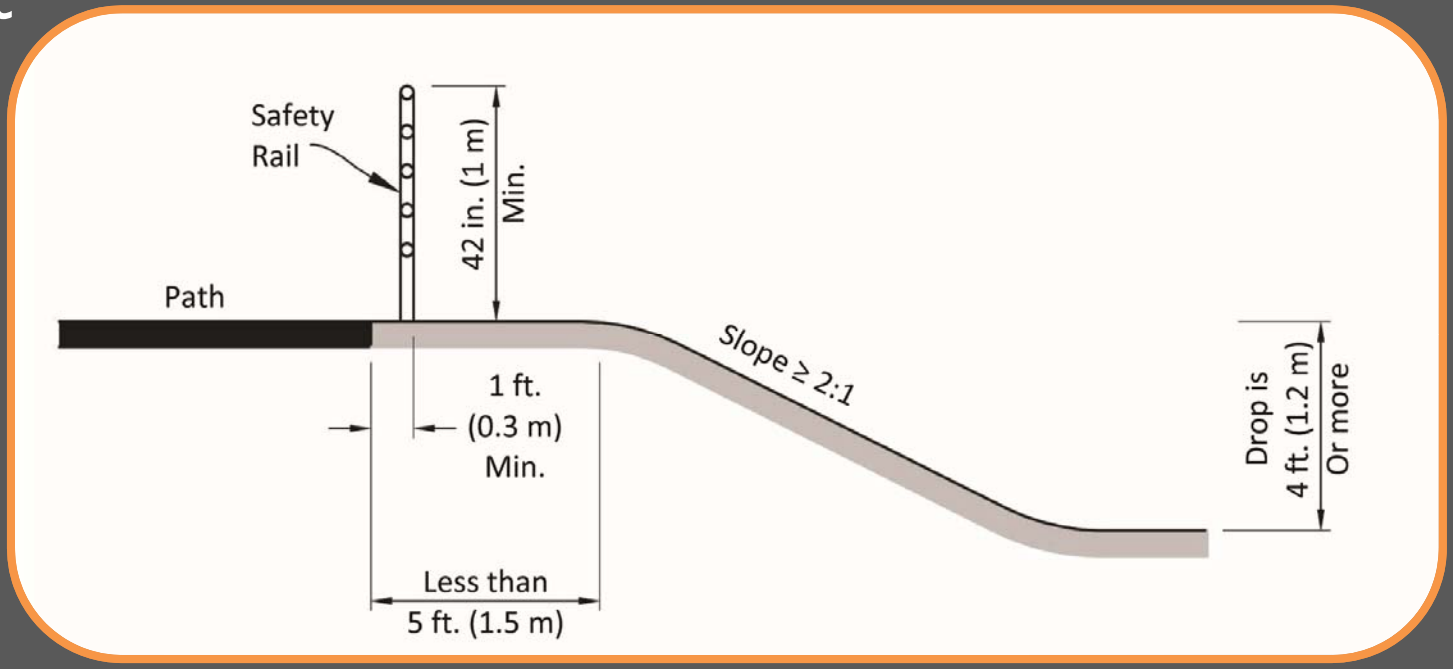

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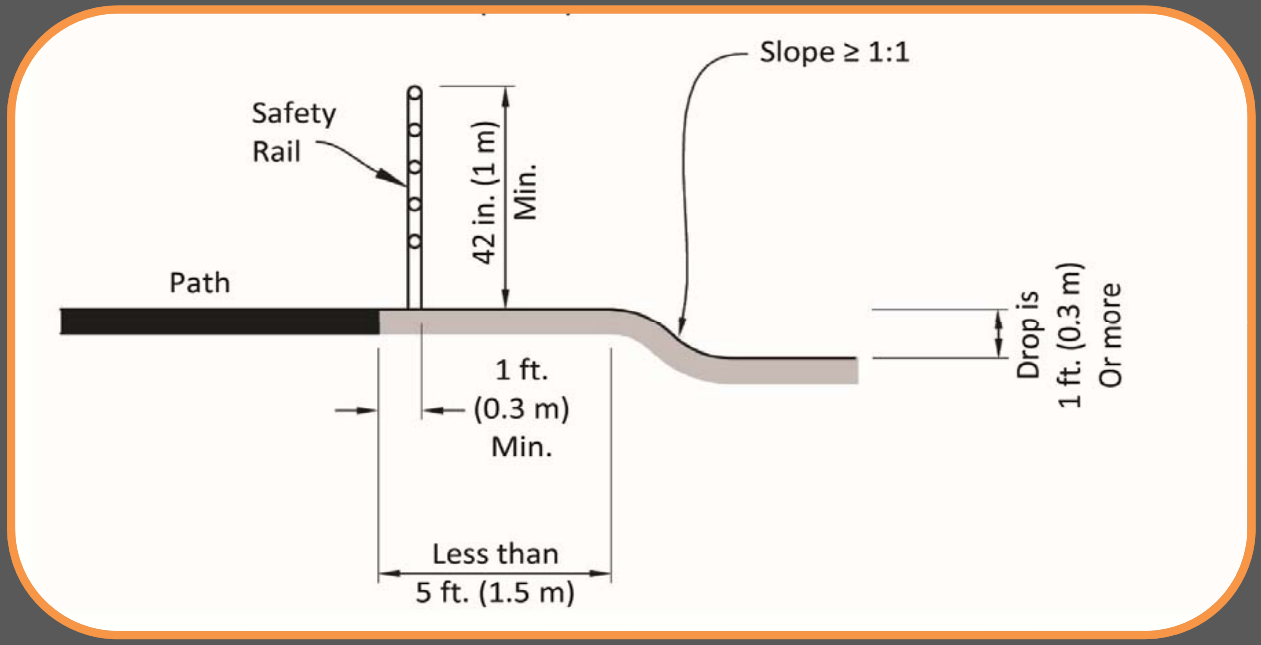


DESIGN SPEED

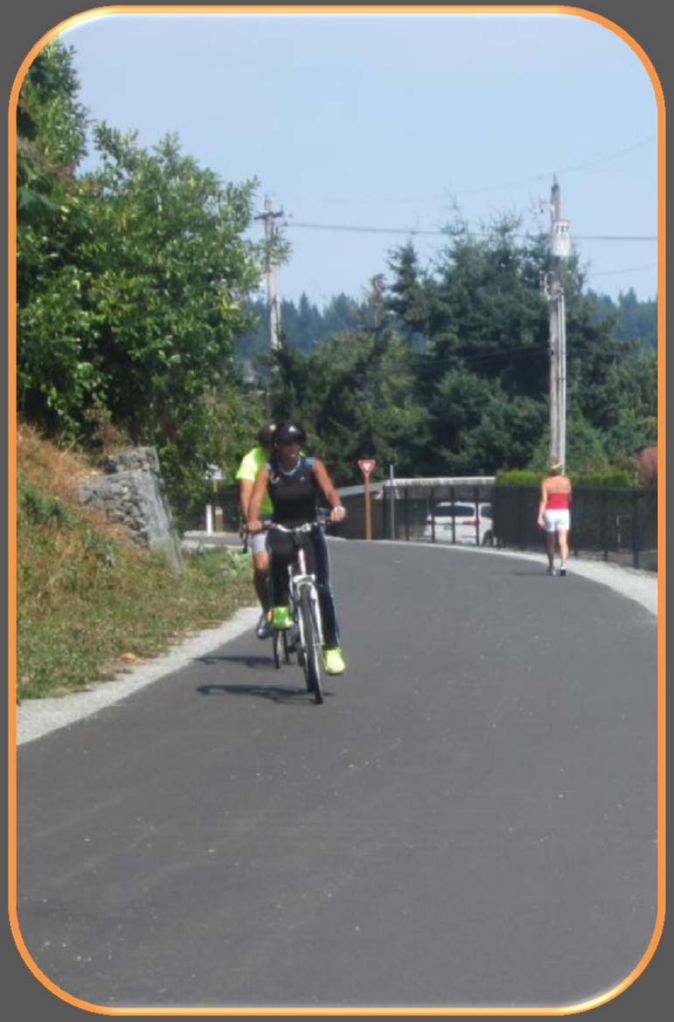
- Old guide: minimum 20 mph design speed
- New guide: 18 mph generally sufficient
- Additional guidance on selecting design speed
- Higher in hilly terrain, up to 30 mph

HORIZONTAL ALIGNMENT: LEAN ANGLE

- Maximum lean angle = 20 degrees
- Min. Curve 60 feet at 18 mph

U.S. Customary		
$R = \frac{0.067V^2}{\tan\theta}$		
where:		
R	=	minimum radius of curvature (ft)
V	=	design speed (mph)
θ	=	lean angle from the vertical (degrees)

Metric		
$R = \frac{0.0079V^2}{\tan\theta}$		
where:		
R	=	minimum radius of curvature (m)
V	=	design speed (km/h)
θ	=	lean angle from the vertical (degrees)



HORIZONTAL ALIGNMENT: SUPERELEVATION

- Recommended for unpaved paths or bike only paths with tighter curves

U.S. Customary

$$R = \frac{V^2}{15\left(\frac{e}{100} + f\right)}$$

where:

R	=	minimum radius of curvature (ft)
V	=	design speed (mph)
e	=	rate of bikeway superelevation (percent)
f	=	coefficient of friction

Metric

$$R = \frac{V^2}{127\left(\frac{e}{100} + f\right)}$$

where:

R	=	minimum radius of curvature (m)
V	=	design speed (km/h)
e	=	rate of bikeway superelevation (percent)
f	=	coefficient of friction

CROSS SLOPE

- PROWAG & ANPRM on Shared Use Paths require maximum cross slopes of 2%
- 1% recommended
- Superelevation typically not needed, so cross slopes can follow terrain
- Transition Rate 1% in 5 feet

SPEED CONTROL ON PATHS

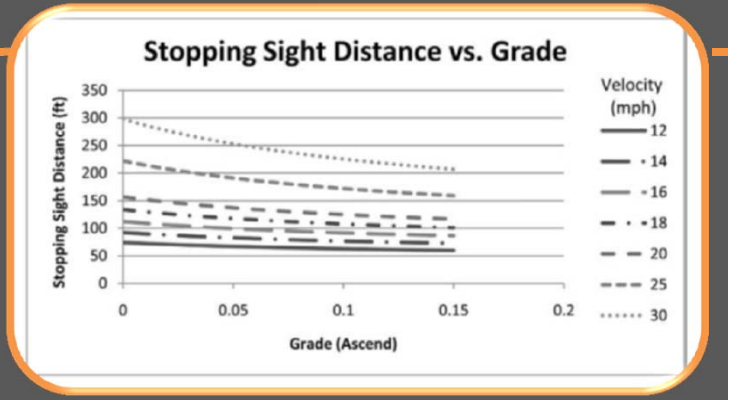
- Introduces concept of using geometry (curvature) and traffic control to reduce user speed
- Depends on site specifics

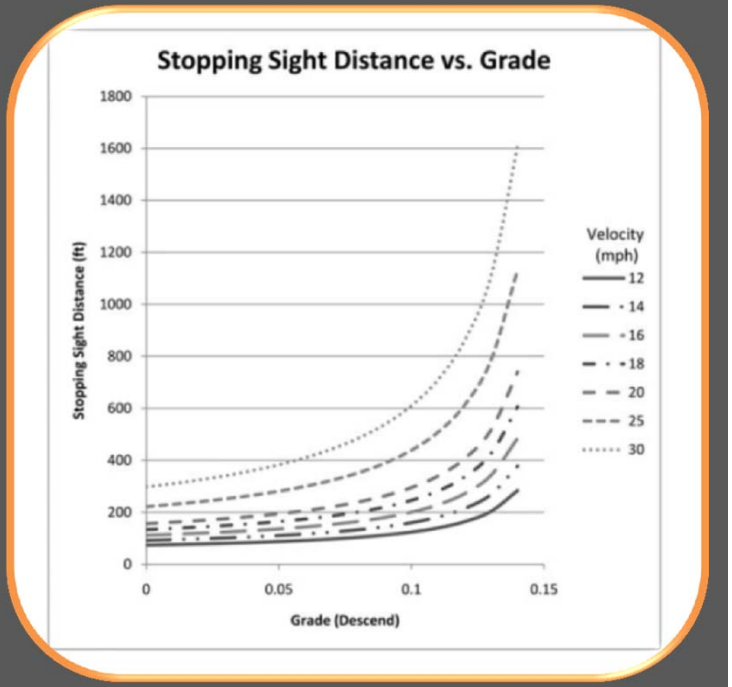
GRADE

- Between 0.5 & 5%, no steeper than adjacent roadway
- New guide removes specific grade restrictions, refers to shared-use path provisions in ANPRM for paths.
- To mitigate excessive grades, consider:
  - Higher design speeds
  - 4 to 6 ft additional width
  - Exceed min clearances, recovery areas, railings
  - Hill warning sign for bikes, other signage
  - Switchbacks with extra width
  - Resting intervals w/ flatter grades

STOPPING SIGHT DISTANCE

- Based on wet conditions
  - New 0.16 braking coefficient of friction
  - 2.5 seconds reaction time





U.S. Customary		
$S = \frac{V^2}{30(f \pm G)} + 3.67V$		
where:		
S	=	stopping sight distance (ft)
V	=	velocity (mph)
f	=	coefficient of friction (use 0.16 for a typical bike)
G	=	grade (ft/ft) (rise/run)

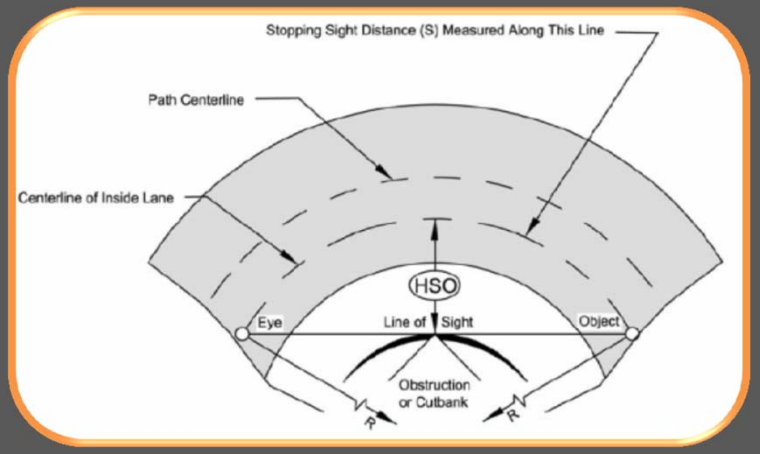
Metric		
$S = \frac{V^2}{254(f \pm G)} + \frac{V}{1.4}$		
where:		
S	=	stopping sight distance (m)
V	=	velocity (km/h)
f	=	coefficient of friction (use 0.16 for a typical bike)
G	=	grade (m/m) (rise/run)

VERTICAL CURVE LENGTH

US Customary	Metric
$S > L$ $\quad L = 2S - \frac{200\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A}$	$S > L$ $\quad L = 2S - \frac{200\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A}$
$S < L$ $\quad L = \frac{AS^2}{100\left(\sqrt{2h_1} + \sqrt{2h_2}\right)^2}$	$S < L$ $\quad L = \frac{AS^2}{100\left(\sqrt{2h_1} + \sqrt{2h_2}\right)^2}$
where:	where:
L = minimum length of vertical curve (ft)	L = minimum length of vertical curve (m)
A = algebraic grade difference (percent)	A = algebraic grade difference (percent)
S = stopping sight distance (ft)	S = stopping sight distance (m)
h_1 = eye height (4.5 ft for a typical bicyclist)	h_1 = eye height (1.4 m for a typical bicyclist)
h_2 = object height (0 ft)	h_2 = object height (0 m)

- Consider other users
- Recumbent cyclists sit lower and travel faster, if many are expected, crests should be longer

HORIZONTAL SIGHT DISTANCE



US Customary	Metric
$HSO = R\left[1-\cos\left(\frac{28.65S}{R}\right)\right]$ $S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-HSO}{R}\right)\right]$	$HSO = R\left[1-\cos\left(\frac{28.65S}{R}\right)\right]$ $S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-HSO}{R}\right)\right]$
where: S = stopping sight distance (ft) R = radius of centerline of lane (ft) HSO = horizontal sightline offset, distance from centerline of lane to obstruction (ft) Note: -angle is expressed in degrees -line of sight is 2.3 ft above centerline of inside lane at point of obstruction	where: S = stopping sight distance (m) R = radius of centerline of lane (m) HSO = horizontal sightline offeset, distance from centerline of lane to obstruction (m) Note: -angle is expressed in degrees -line of sight is 0.7 m above centerline of inside lane at point of obstruction

UNPAVED PATHS

- May be appropriate for rural or recreational paths
- Typically crushed stone, stabilized earth, limestone screenings
- However
  - Some users cannot traverse
  - Drainage issues
  - Difficult to plow

PATH SURFACE

- Asphalt
  - Typically lower construction cost
- Concrete
  - Typically longer service life
- Maintain a smooth surface
- Consider subsurface drainage

BRIDGES AND UNDERPASSES

- Maintain at least minimum path and shoulder widths, typically 14 feet (10-foot path & two 2-foot shoulders)
- Bridge railings 42 inches (48 inches in some cases)
- Vertical clearance 10 feet

DRAINAGE

- Minimum recommended slope of 1%
- Cross slope with terrain if possible
- If needed, ditches and culverts should not present a hazard
- Consider low-impact development techniques

LIGHTING

- Where nighttime use is permitted
- Pedestrian scale fixtures
- Consider 0.5 to 2 foot candles
- Higher illumination at crossings

THANK YOU!

Contact information:

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Questions?

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WEBINAR 6: ROAD/PATHWAY INTERSECTIONS

- Midblock & side path crossings
- Intersection control treatments
- Assignment of right-of-way
- Other crossing considerations
  - Transition zone
  - Traffic calming at intersections
  - Approach markings and signs

Webinar Date: October 23

Presenters: Eric Mongelli, PE & William Schultheiss, PE