Designing for Bicyclist Safety

Module B

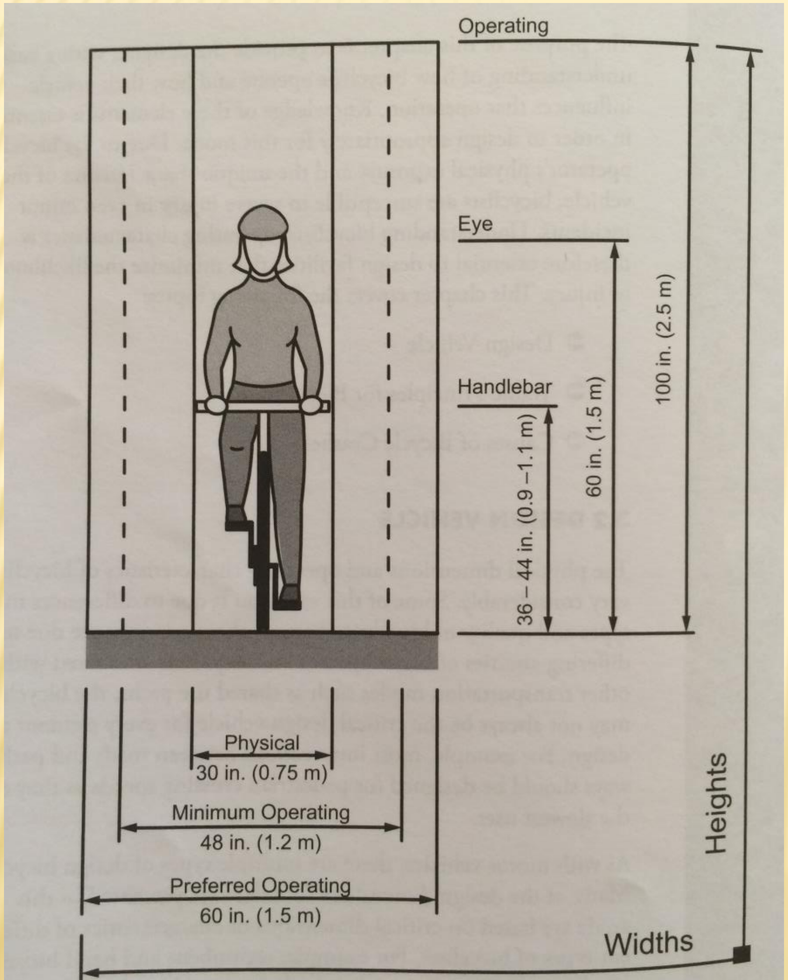
DESIGNING ON-ROAD BIKEWAYS

LEARNING OUTCOMES

- Describe features of on-road bikeways
- Select design criteria for on-road bikeways in various contexts

BICYCLE CHARACTERISTICS

BICYCLE CHARACTERISTICS



- Height
  - Handlebar - 36-44 in
  - Eye - 60 in
  - Operating - 100 in
- Width
  - Physical – 30 in
  - Minimum operating – 48 in
  - Preferred operating – 60 in

BIKEWAY NETWORK

- Just like roads and sidewalks, bikeways need to be part of an connected network
- Combine various types, including on and off-street facilities

TAXONOMY OF BIKEWAYS

- Shared-Use Paths
- Separated Bike Lanes
- Bike Lanes
- Shoulders
- Shared Roadway

What Type of Bikeway Would You Choose?

What Type of Bikeway Would You Choose?

A. Sharrow
B. Bike Lane
C. Buffered Bike Lane
D. Separated Bike Lane
E. Sidepath

Posted Speed = 25 mph
Vehicle Volume = 4,000 AADT

U.S. Department of Transportation
Federal Highway Administration

What Type of Bikeway Would You Choose?

Would You Choose?

A. Sharrow
B. Bike Lane
C. Buffered Bike Lane
D. Separated Bike Lane
E. Sidepath

Posted Speed = 25 mph
Vehicle Volume = 14,000 AADT

U.S. Department of Transportation
Federal Highway Administration

What Type of Bikeway Would You Choose?

What Type of Bikeway Would You Choose?

A. Sharrow
B. Bike Lane
C. Buffered Bike Lane
D. Separated Bike Lane
E. Sidepath

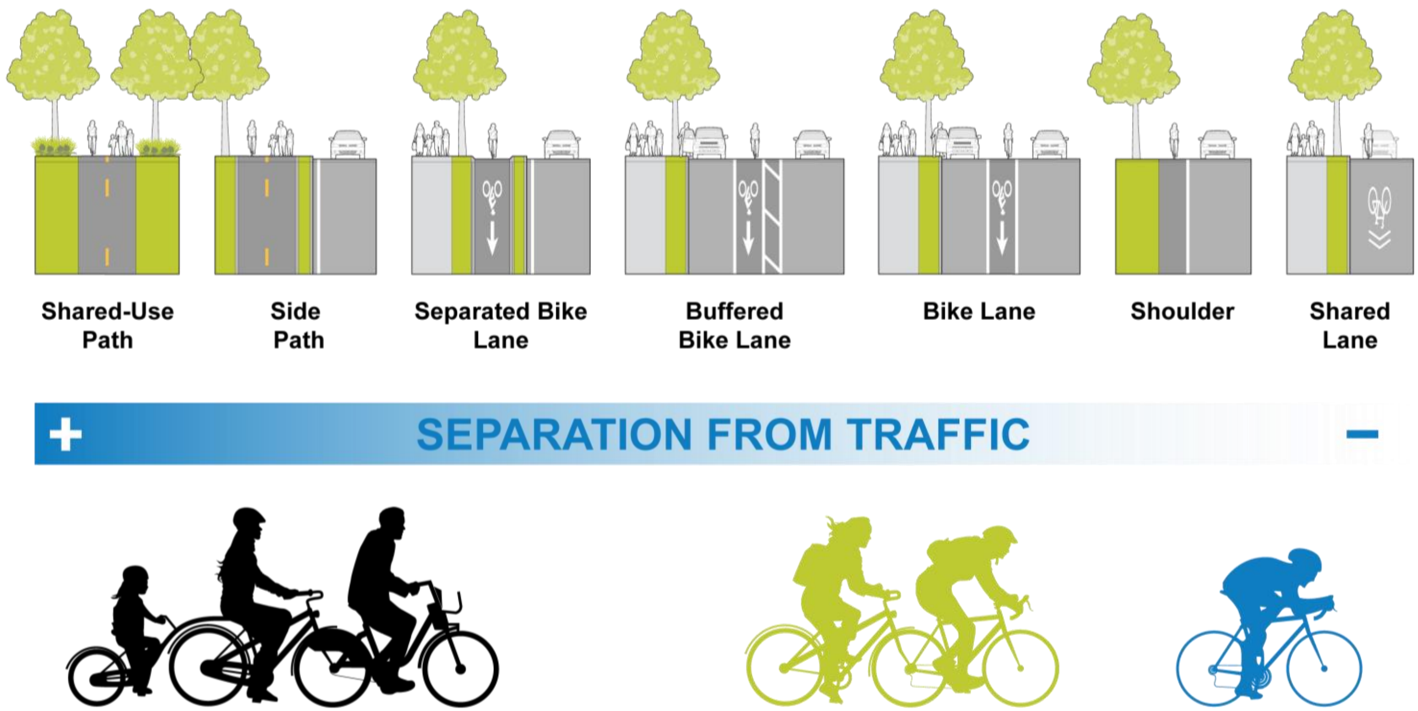
Posted Speed = 30mph
Vehicle Volume = 40,000 AADT

Chapter 3:
Bicycle Network – Design User

Alternate image: LTS Map Example

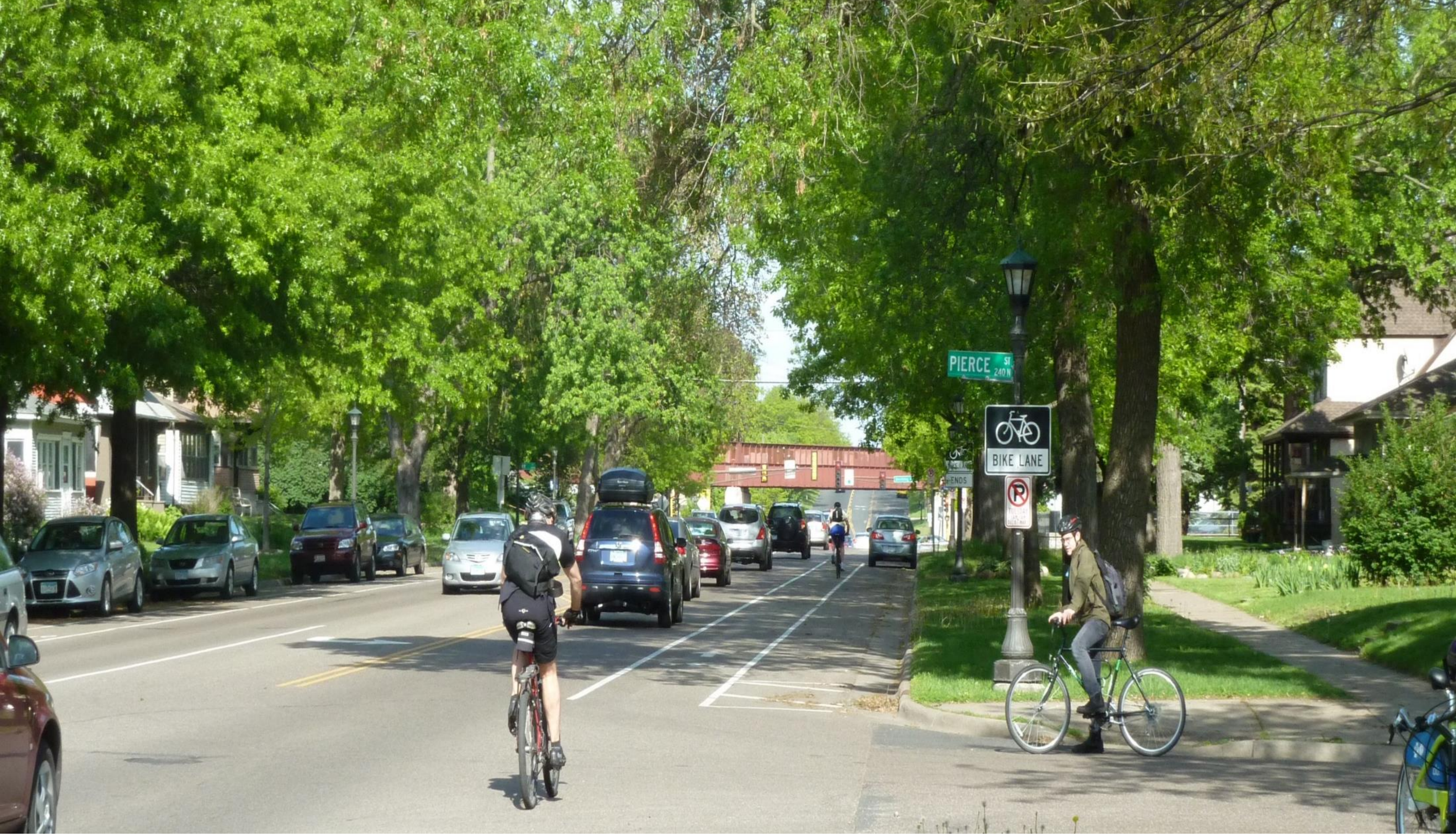
High Traffic Stress

Low Traffic Stress


Shared-Use Path
Side Path
Separated Bike Lane
Buffered Bike Lane
Bike Lane
Shoulder
Shared Lane
+
SEPARATION FROM TRAFFIC
–

Conventional Bike Lanes (High Speed and Volume Environments)

U.S. Department of Transportation
Federal Highway Administration



Conventional Bike Lanes (Low Speed Environments)

Buffered Bike Lanes (High Speed and Volume Environments)

U.S. Department of Transportation
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Separated Bike Lane - Retrofit

Separated Bike Lane - Reconstruction

U.S. Department of Transportation
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Shared Use Paths

U.S. Department of Transportation
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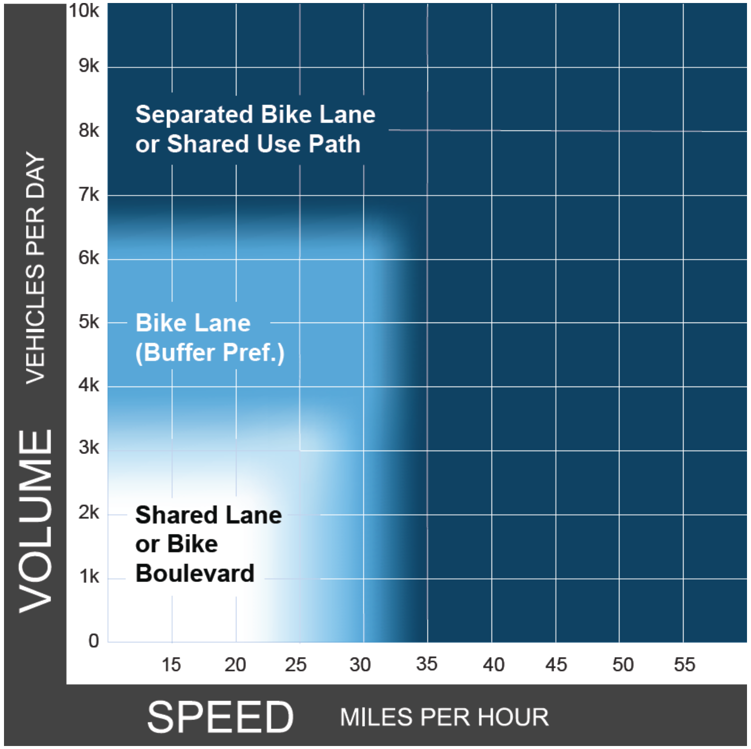
Neighborhood Greenways (aka Bike Boulevards)

U.S. Department of Transportation
Federal Highway Administration

City, Small Town, and Suburban Roadways



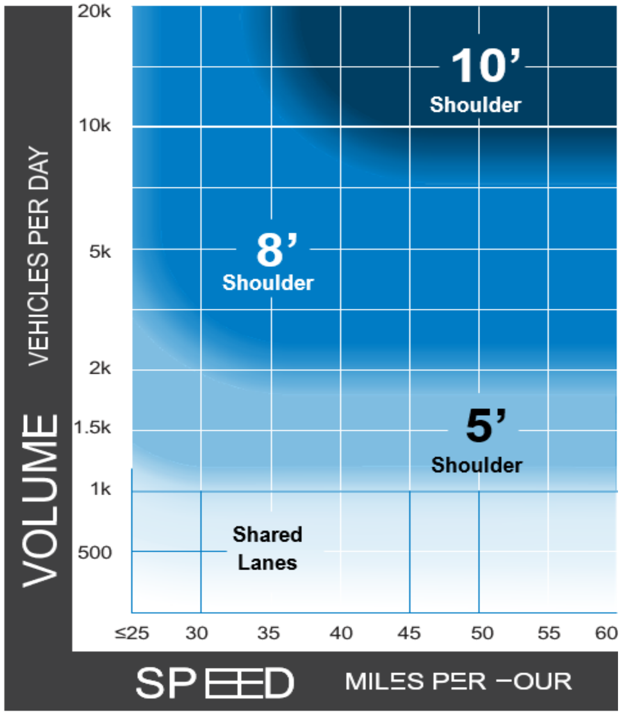
Identifies the **preferred** bikeway type.

Design User Assumption:
Interested but concerned cyclist

Analysis:

Bicycle Level of Traffic Stress

Rural Roadways



Identifies the **preferred** shoulder width.

<u>Design User Assumption</u>:
Confident bicyclist

<u>Analysis</u>:

Bicycle Level of Service

Designing On-Road Bikeways

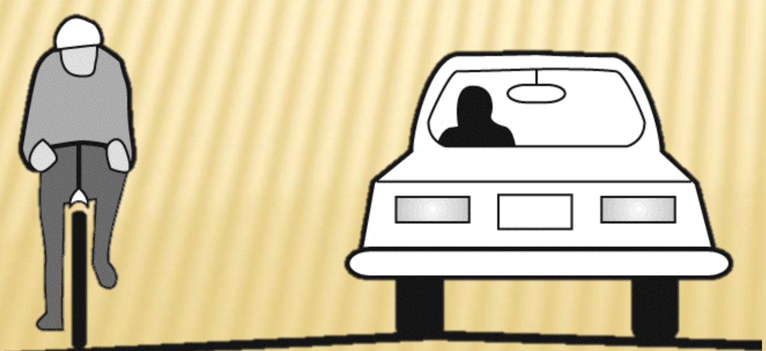
SHARED ROADWAY

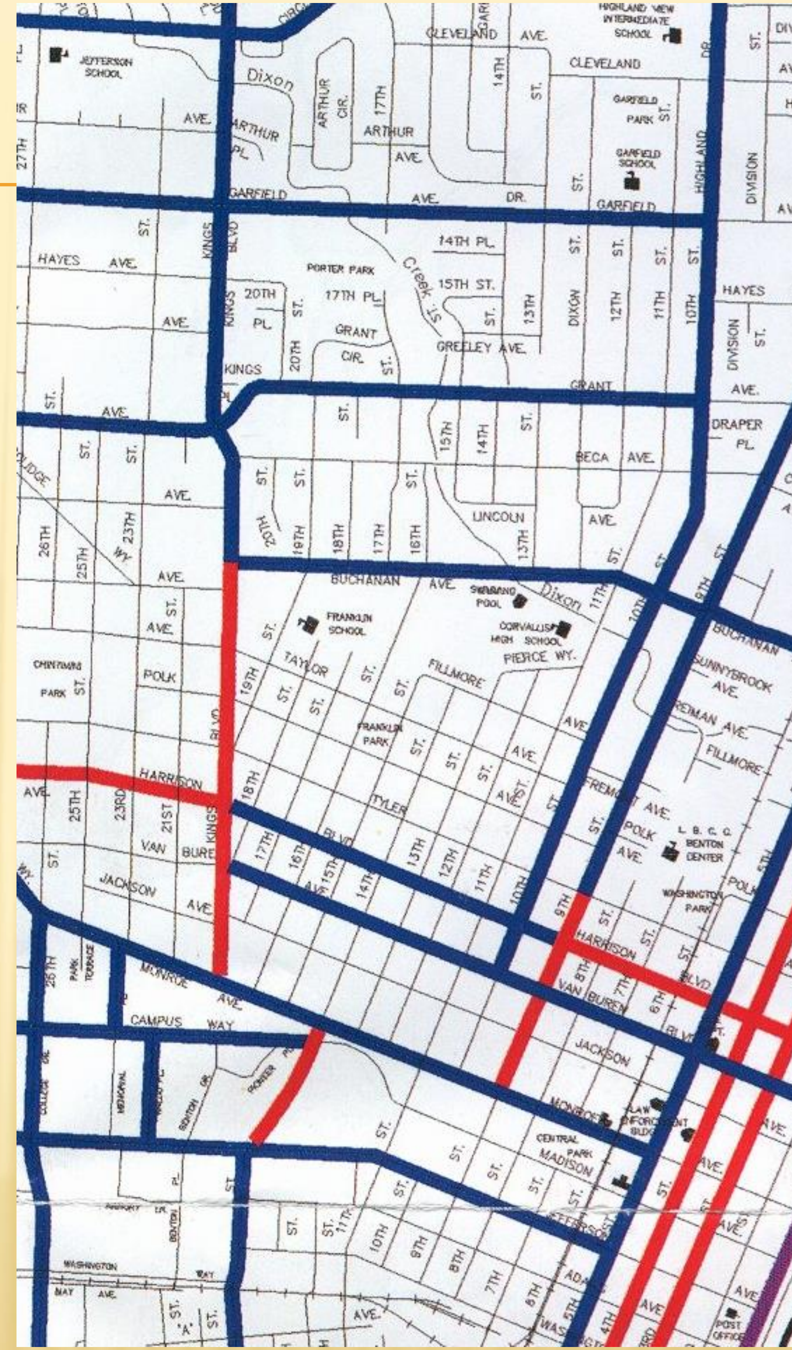
Camp Richardson, California

Coeur d’Alene, Idaho

SHARED ROADWAY

- Most common—roads as they are
- Appropriate on low-volume or low-speed
- 85% or more of a <u>well-connected</u> grid





SHARED LANES

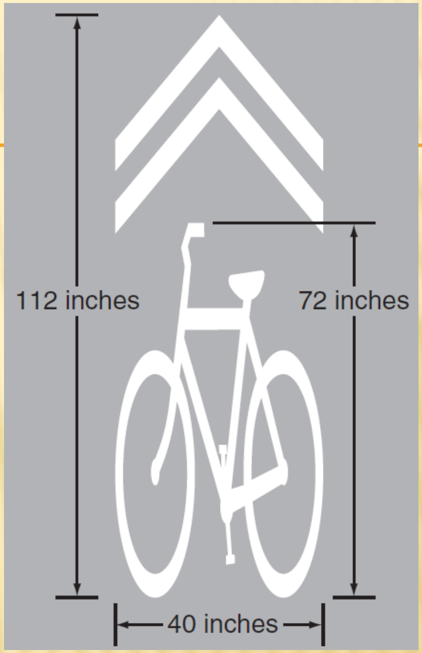
- Unless prohibited, all roads have shared lanes
- No special features for:
  - Minor roads
  - Low volumes (< 1000 vpd)
  - Speeds vary (urban v. rural)

SHARED LANES

- Supplemental features
  - Pavement markings or “sharrows”
  - Detectors & signal timing

SHARED LANE MARKING

- Lateral position
- Connect gaps in bike lanes
- Roadway too narrow for passing
- Position in intersections & transitions



SHARED LANE MARKING

Supporting Characteristics

Nonsupporting Characteristics

- More than 1 lane
  Downhill or level
- Short segment to fill gap in bikeway
- Speed < 30 mph
- High bicycle use

- Single lane
- Uphill
- Parallel route option
- Long segment
- Speed > 40 mph
- Low bicycle use

SHARED ROAD SIGNS

- Reminder for motorists

Corvallis, Oregon

- Low speed/low volume
- Up to 25 mph for LTS 1

Salem, Oregon

- Increased speed or volume, increased LTS
- LTS 4

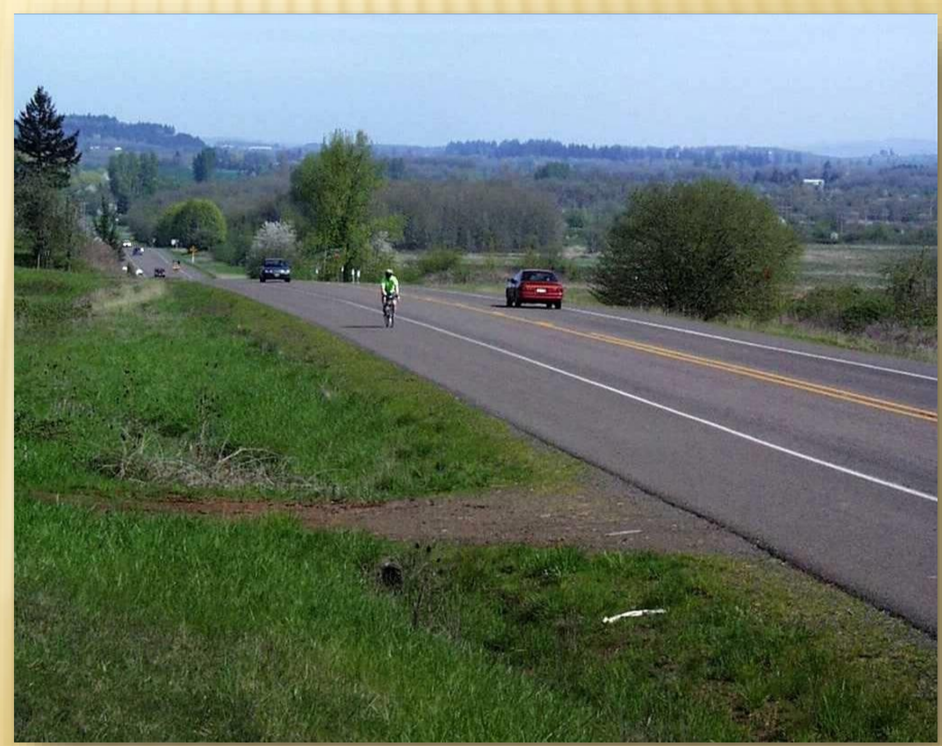
- Rural back roads

Designing On-Road Bikeways

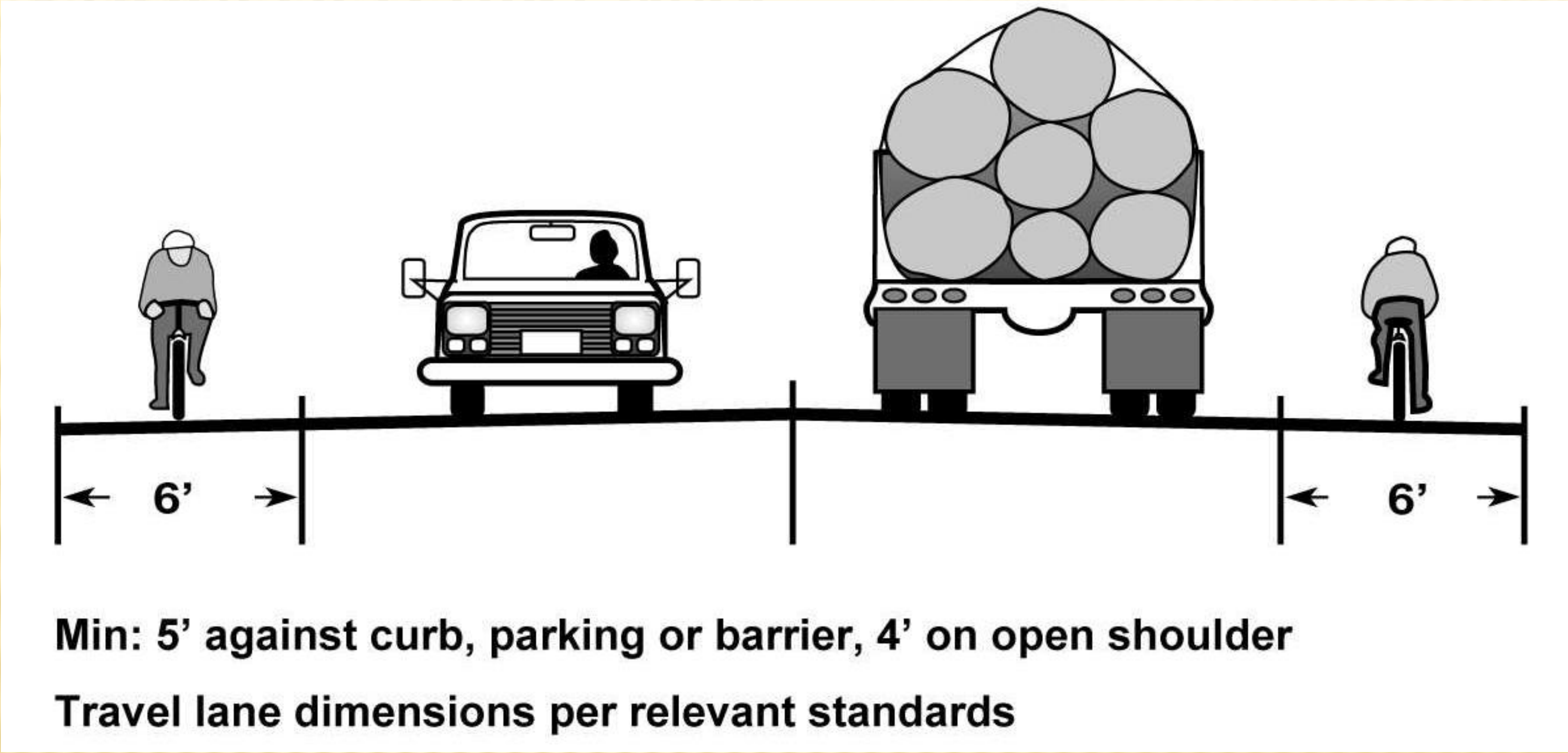
PAVED SHOULDERS

PAVED SHOULDERS

- Useful for higher traffic volume and/or speed
- Frequently used for rural
- Uphill direction
- Not a travel lane – intersection conflicts
- Rumble strips
- Maintenance



SHOULDER BIKEWAY

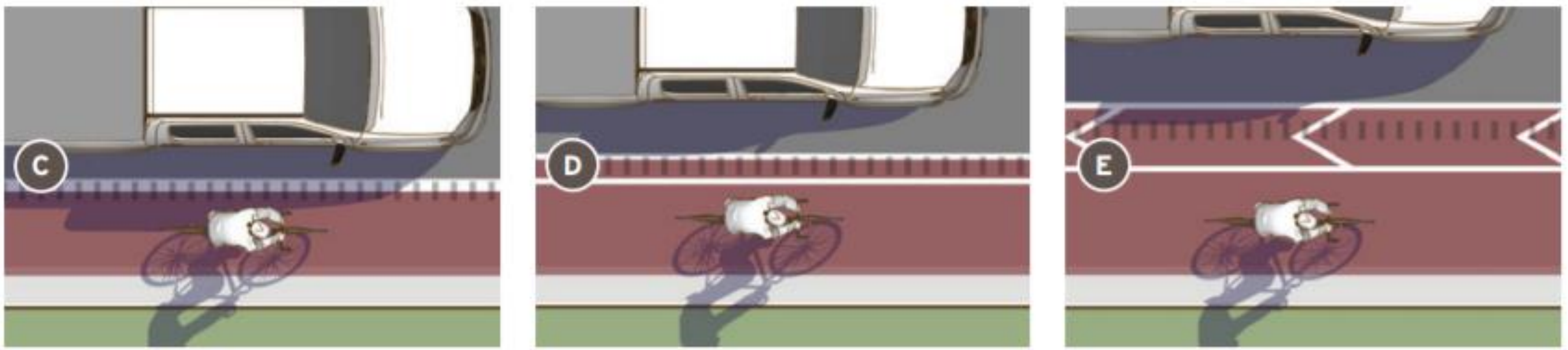


Use AASHTO _shoulder_ standards

For bicycles: 4 ft minimum, 6 ft desirable

No special markings

SHOULDER BIKEWAY



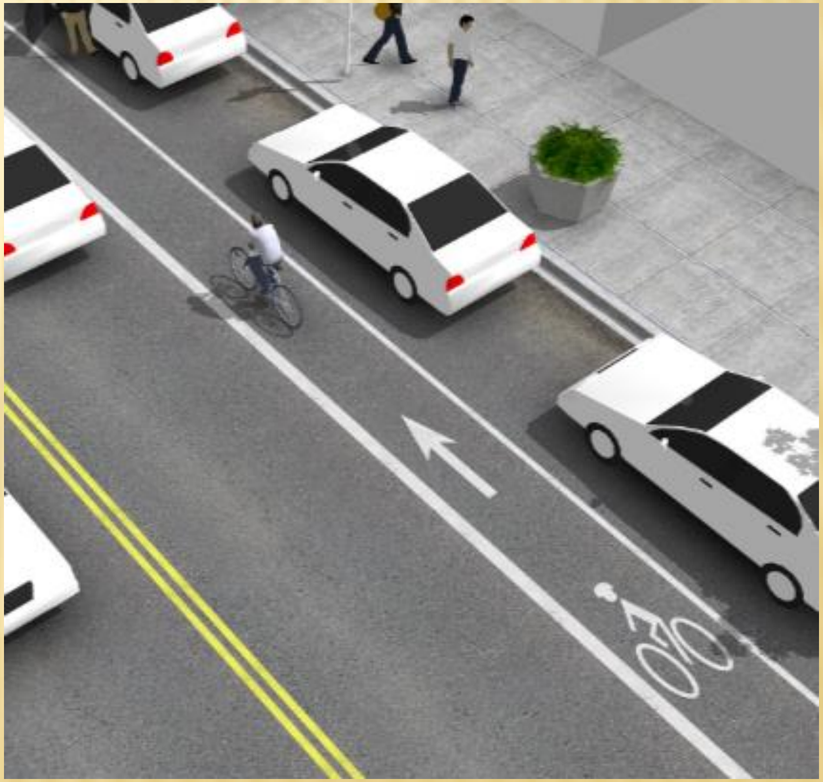
Functional classification	Volume (AADT)	Speed (Mi/h)	Recommended Minimum Paved Shoulder Width
Minor Collector	up to 1,100	35 (55 km/h)	5 ft (1.5 m)
Major Collector	up to 2,600	45 (70 km/h)	6.5 ft (2.0 m)
Minor Arterial	up to 6,000	55 (90 km/h)	7 ft (2.1 m)
Principal Arterial	up to 8,500	65 (100 km/h)	8 ft (2.4 m)

Designing On-Road Bikeways

BIKE LANES

BIKE LANE DEFINED

Portion of the roadway or shoulder designated for exclusive or preferential use by people riding bicycles



ADVANTAGES

- Low stress on wide/low speed streets
- Access to major destinations
- Mobility on arterials
- Guide bicyclist behavior
- Improve visibility

ADVANTAGES

- Travel at bicyclist's pace

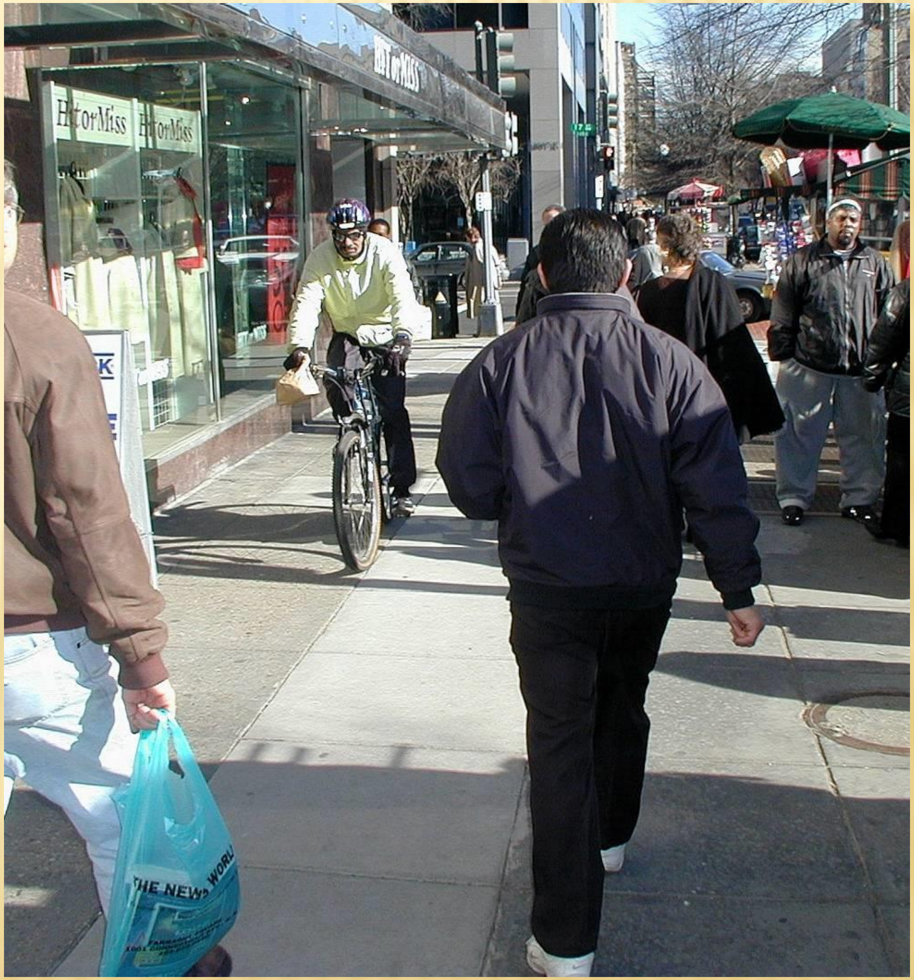
Geneva, Switzerland

ADVANTAGES

- Guide cyclists behavior
  - Visible
  - Predictable

ADVANTAGES

- Reduce pedestrian conflicts
- Improve visibility at driveway conflicts

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News


TIRE
GMC

Proven Safety Countermeasure

- **CMFs (from 2020 ELCSI-PFS)**
  - Up to 49% reduction in total crashes on 4-lane undivided collectors and local roads
  - Up to 30% reduction in total crashes on 2-lane undivided collectors and local roads

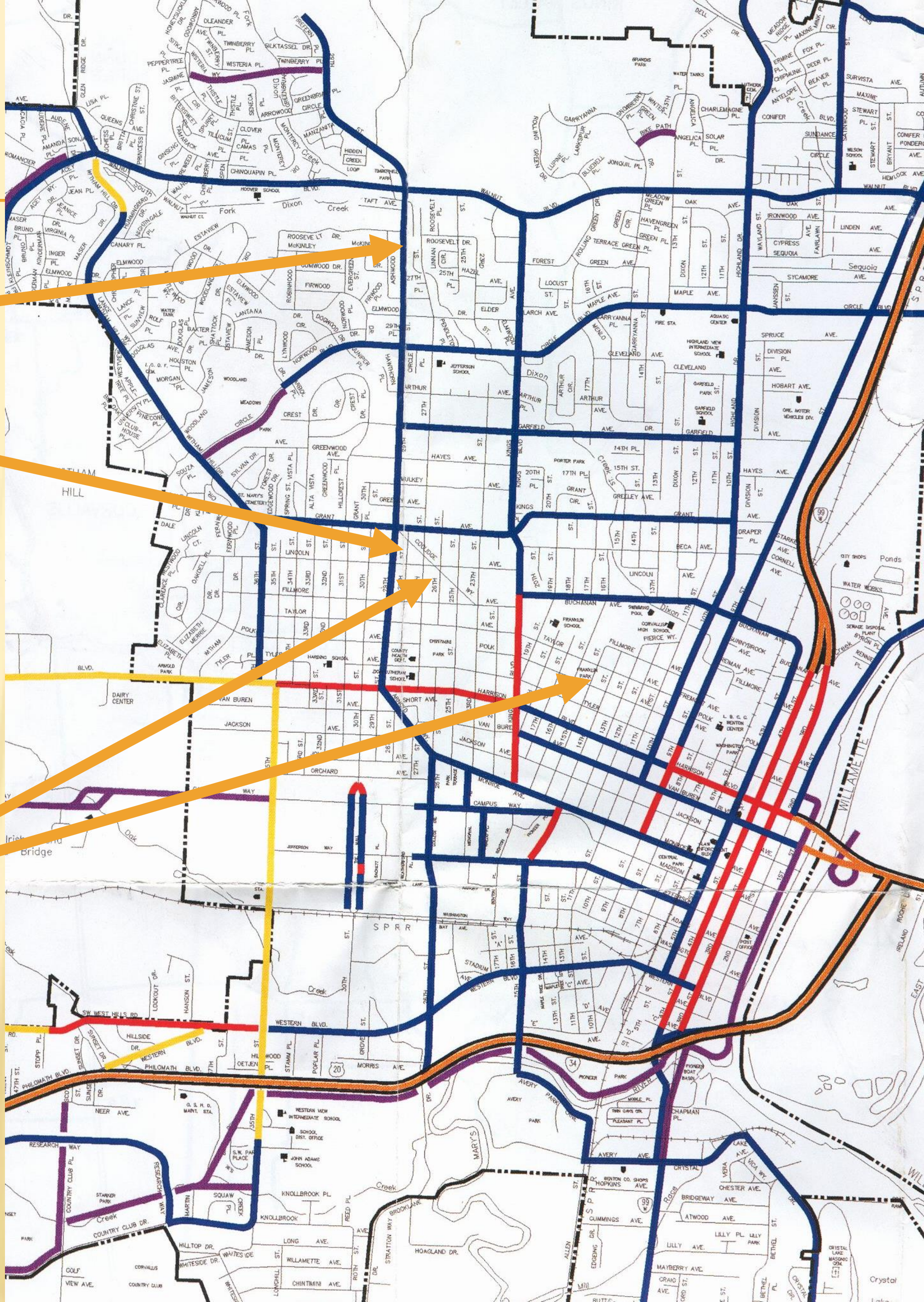
Photo source: FHWA

DISADVANTAGES

- LTS 3 or 4 on arterials
- Often too narrow
- Removal of parking

BIKE LANES

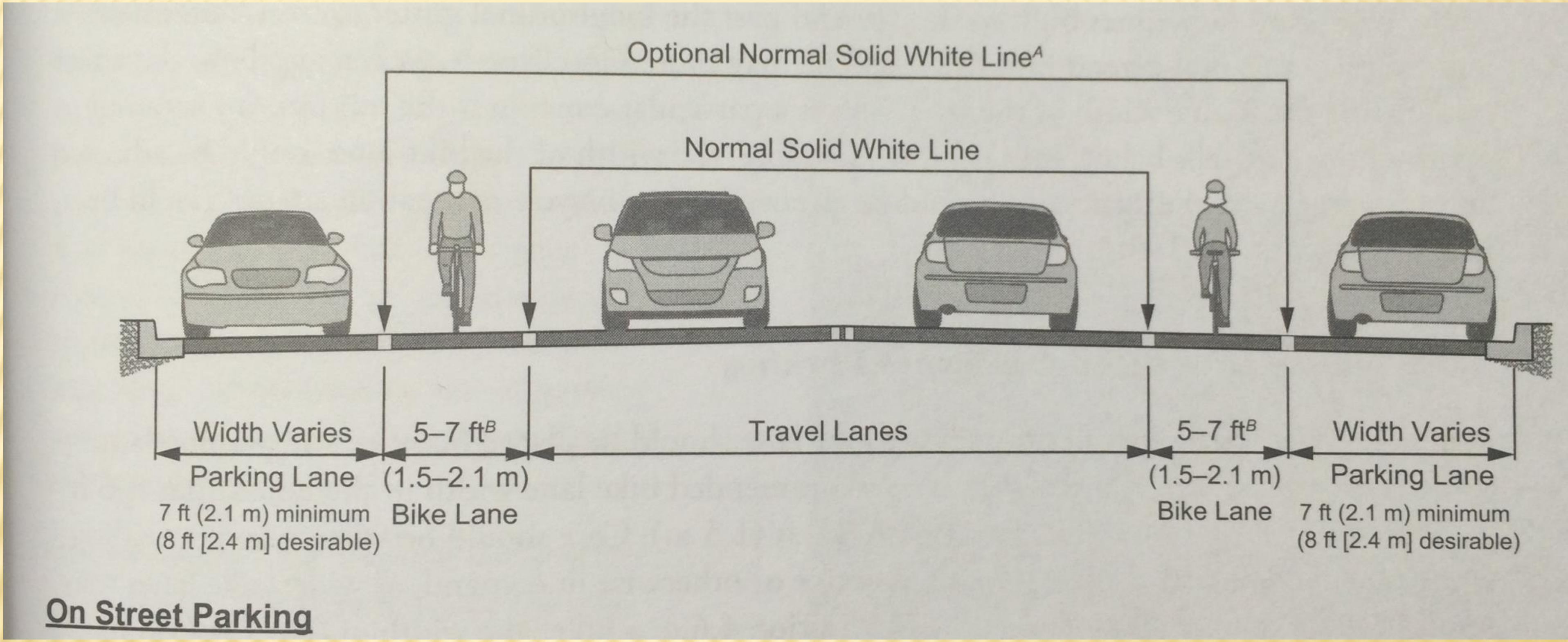
- Urban thoroughfares
- Efficient cross-town travel
- Stop or signal control
- Lower need on low-volume/speed local streets



BIKE LANES

- Preferred in urban/suburban
- Rural for high demand for bicycle travel
- Preferential space for bicyclists delineated
- Bicyclists may leave lane
  - Passing
  - Turning
  - Avoid debris
  - Avoid buses
- Priority for uphill

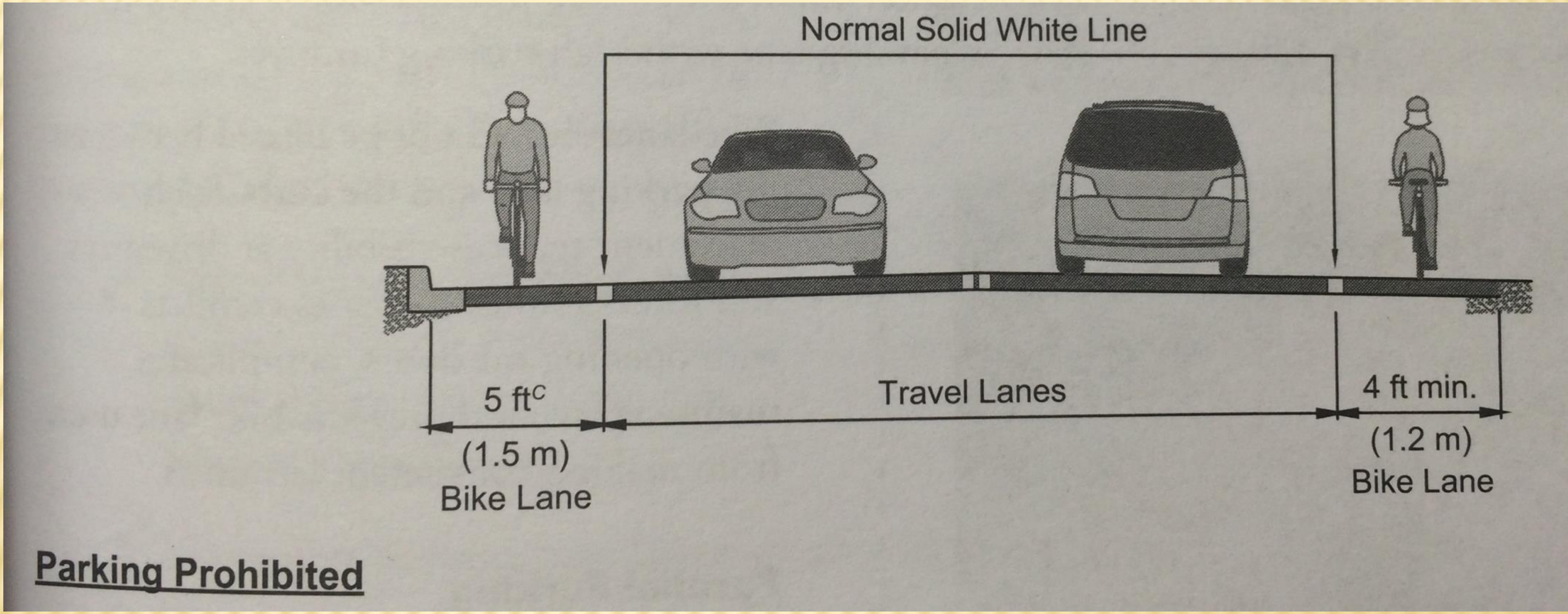
BIKE LANE WIDTH

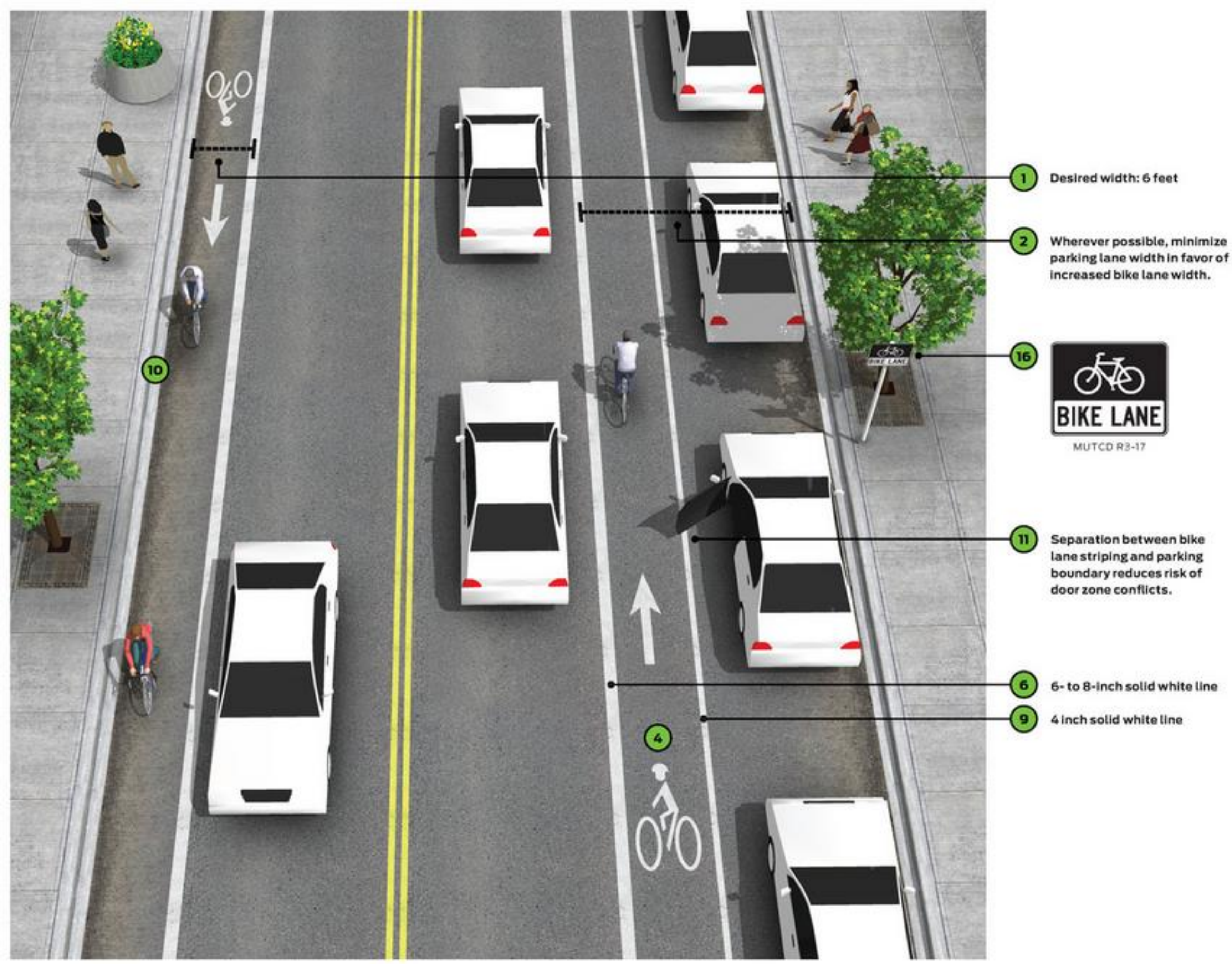


Desirable: 7 feet

AASHTO Guide minimum: 5 Feet

BIKE LANE WIDTH



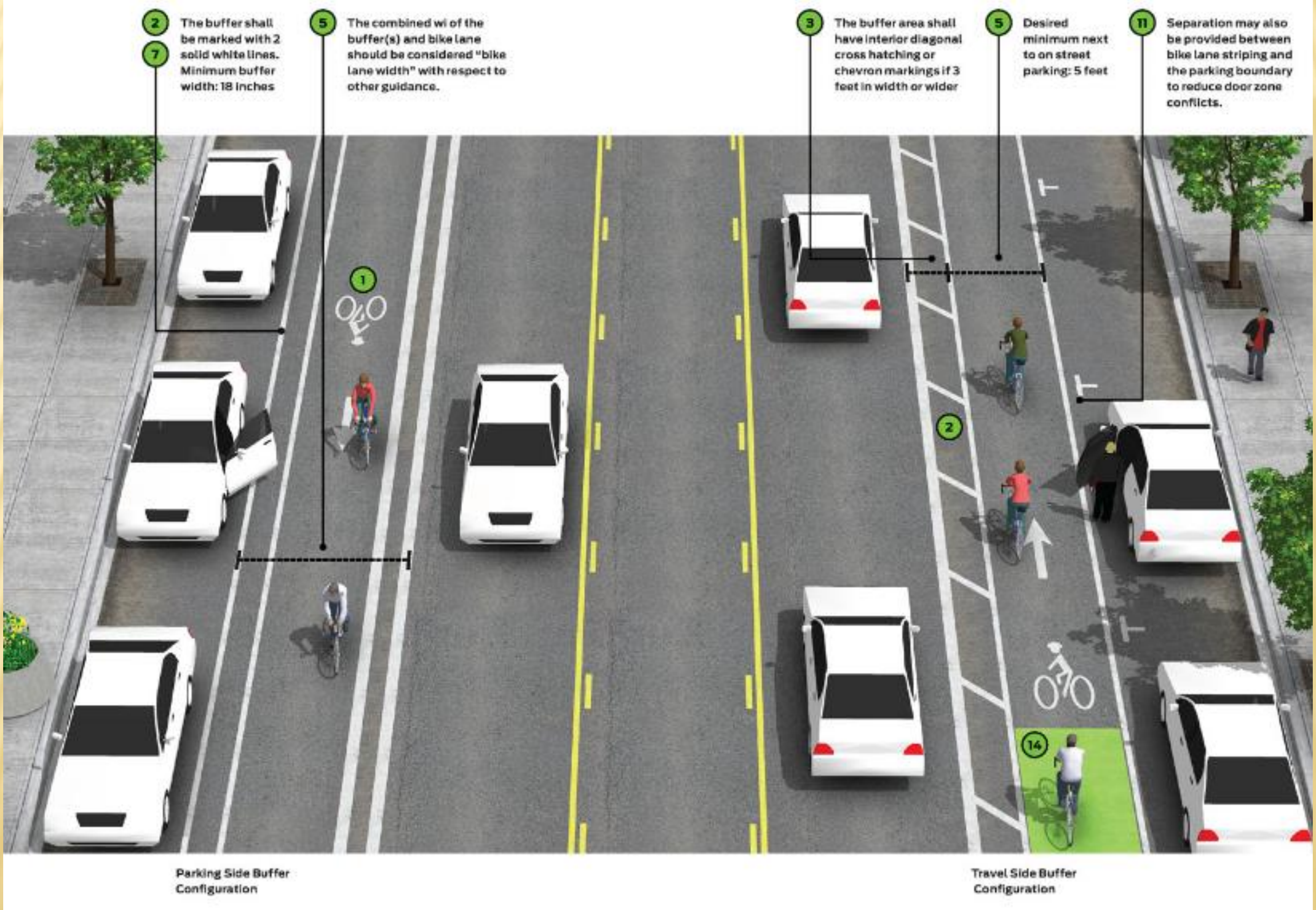


1 Desired width: 6 feet
2 Wherever possible, minimize parking lane width in favor of increased bike lane width.
16
BIKE LANE
MUTCD R3-17
11 Separation between bike lane striping and parking boundary reduces risk of door zone conflicts.
6 6- to 8-inch solid white line
9 4 inch solid white line
10
4

BUFFERED BIKE LANE

- Shy distance
- Bike passing
- Door zone
- Wider w/out confusing motorists
- More comfortable

BUFFERED BIKE LANE



WIDE BIKE LANE/LOW SPEED

LTS 1

BUFFERED BIKE LANE

LTS 1

5 FT BIKE LANE/30 MPH

LTS 2

5 FT BIKE LANE/35 MPH

LTS 3

5 FT BIKE LANE/40 MPH

LTS 4

PAVEMENT MARKING & SIGNING

- Longitudinal marking required
  - Solid white line between bikes & motor vehicles
  - Line recommended between bikes & parking
- Symbols at beginning & interval
- Signs

PAVEMENT MARKINGS

Both sides preferred

SIGNING

- Beginning, end, & interval
- Optional

1988

2000

2009

SIGNING

R3-17aP

R3-17bP

SIGNING

CONTRA-FLOW BIKE LANE

Reasons for:

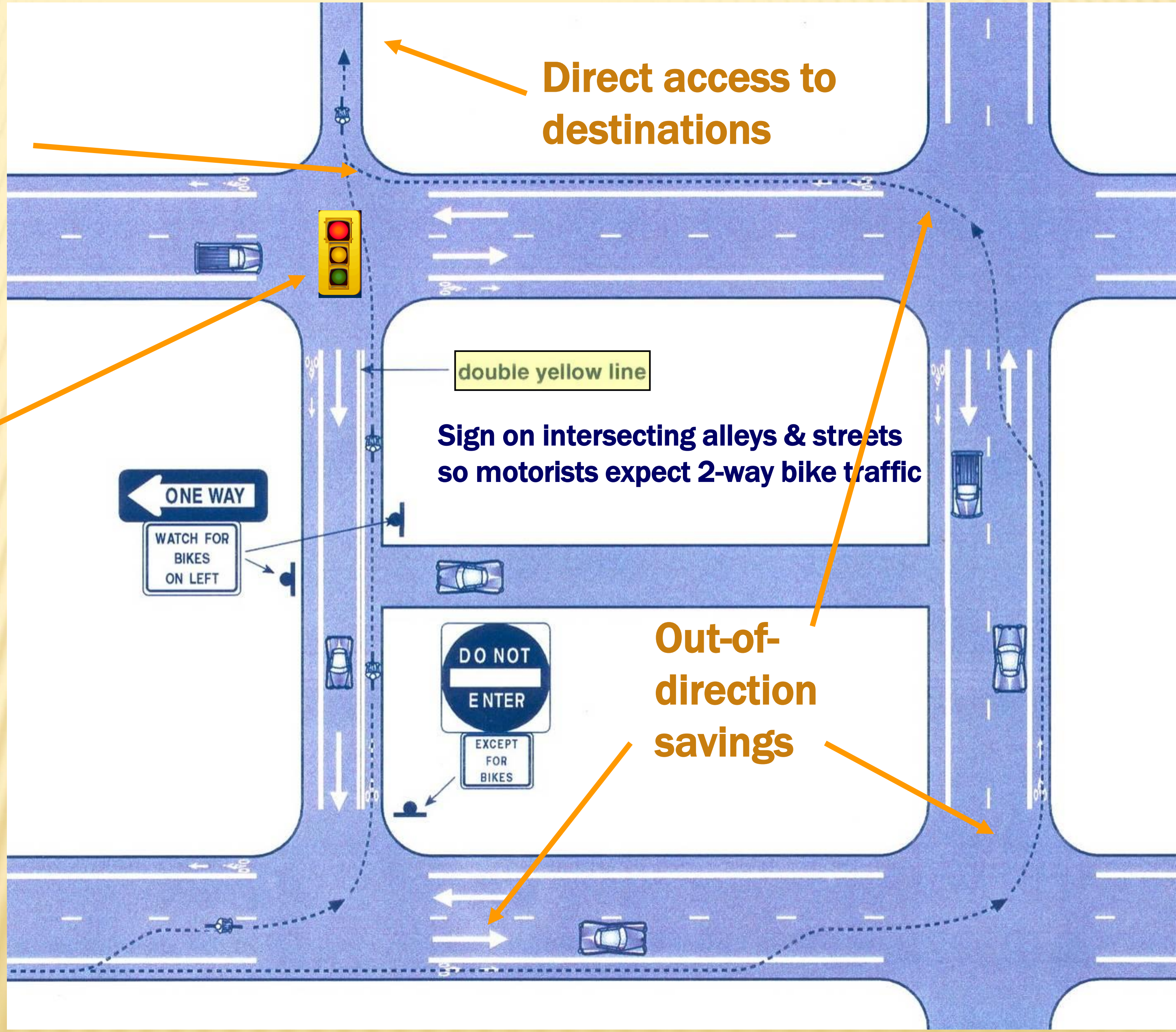
- Continuity on one-way
- Avoid conflicts
- Maximize space

Considerations:

- Markings
- Signing
- Intersections

Cyclists can reenter traffic at each end

Retrofit signals (where applicable)



Double yellow line creates 2-way street
With-flow cyclists ride in "normal" bike lane…

…or in a shared travel lane without bike lane

Madison, Wisconsin

BIKE LANE PLACEMENT

- Both sides of two-way streets

BIKE LANE PLACEMENT

- Exception – may omit on downhill

BIKE LANE PLACEMENT

- Add shared-lane for downhill
  - – discourage wrong-way

BIKE LANE PLACEMENT

- Between parking and travel lane

BIKE LANE PLACEMENT

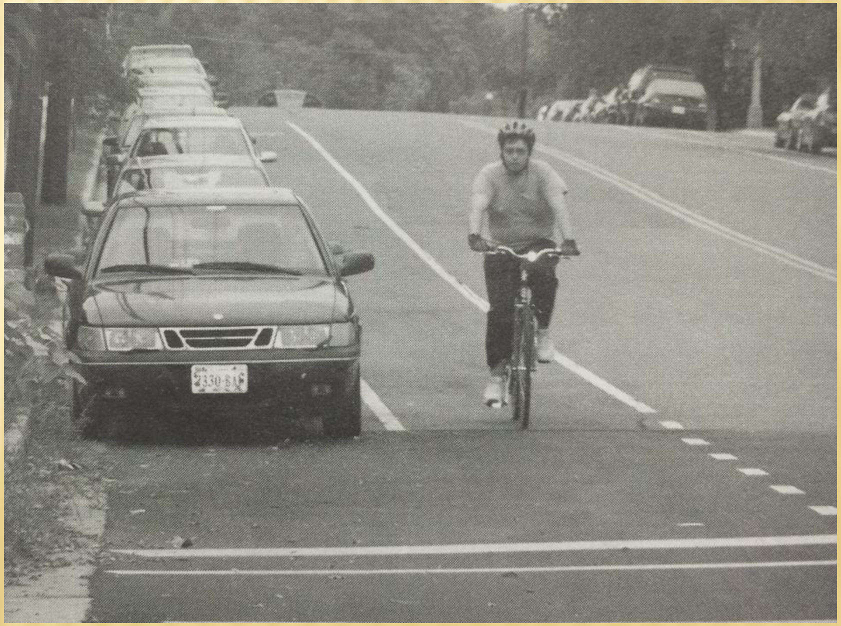
- Right side of one-way

BIKE LANE PLACEMENT

- Exception—left side to avoid conflicts

BIKE LANES & ON-STREET PARKING

- Use wider bike lane with
  - High turnover parking
  - Narrow parking lane



Is diagonal parking compatible with bicycling?

BACK-IN DIAGONAL PARKING

- Back-in diagonal parking
  - Improve sight distance
  - No door conflicts
  - Easier trunk access
  - Passengers channeled to curb

Designing On-Road Bikeways

SEPARATED BIKE LANES

SEPARATED BIKE LANES

- Exclusive bike facility
- Adjacent to or on roadway
- One-way or contra-flow
- Separated from traffic by vertical element

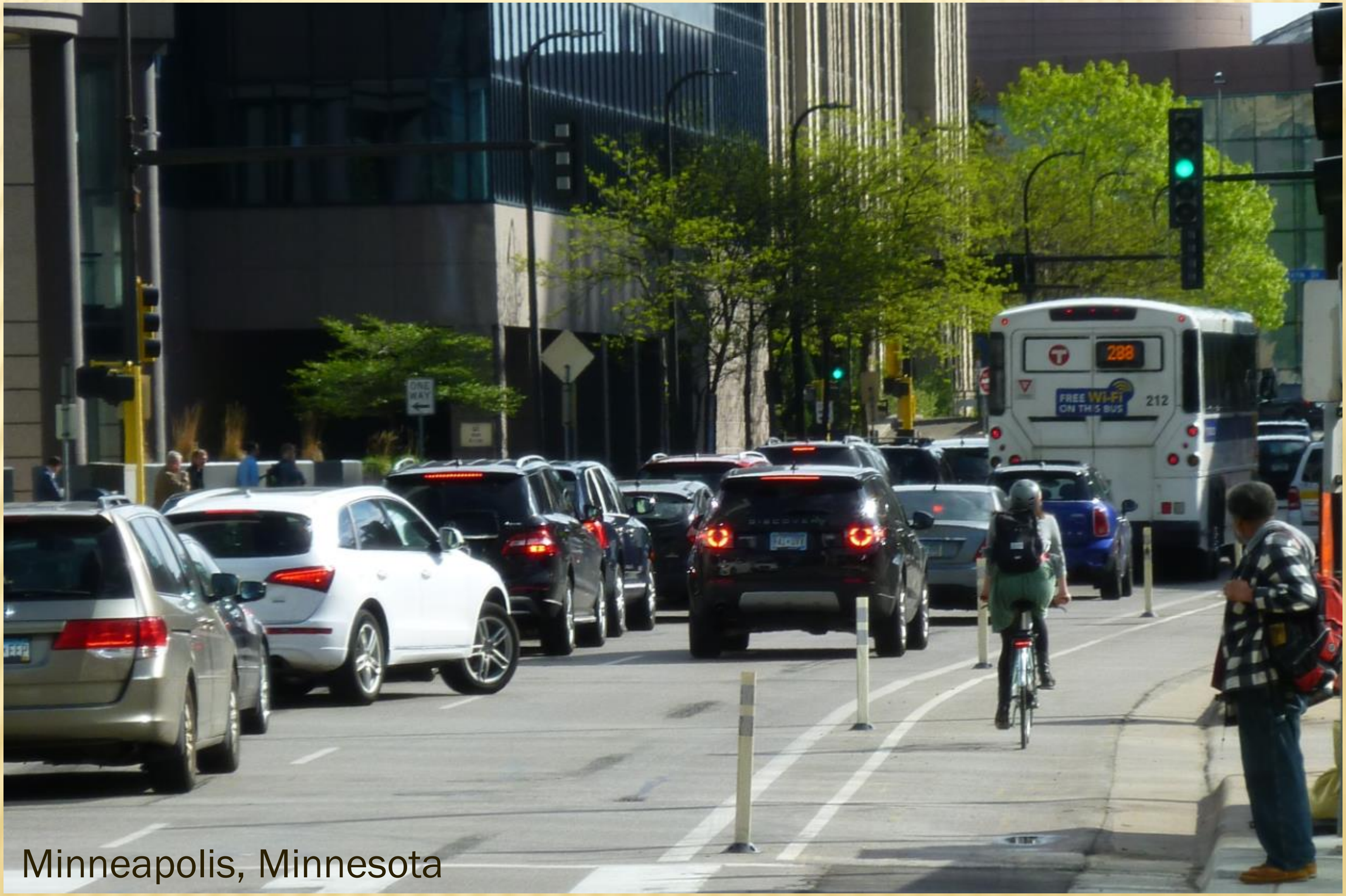
SEPARATED BIKE LANES

Mid-block (LTS 1)

SEPARATED BIKE LANES

Mid-block (LTS 1)

SEPARATED BIKE LANES



Minneapolis, Minnesota

Mid-block (LTS 2)

SEPARATED BIKE LANES

Mid-block (LTS 1 – except at intersection)

SEPARATED BIKE LANES

Mid-block (LTS 1 – except at driveways)

SEPARATED BIKE LANES

Advantages

- Very low stress midblock
- Encourages bike riding
- More conspicuous
- Crash rate reductions

SEPARATED BIKE LANES

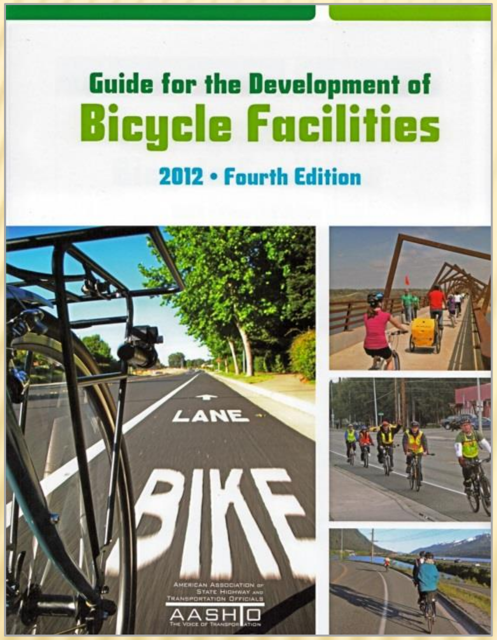
Disadvantages

- Special intersection treatments
- Special driveway treatments
- Additional space needed
- More costly than bike lanes
- More to learn

SEPARATED BIKE LANES

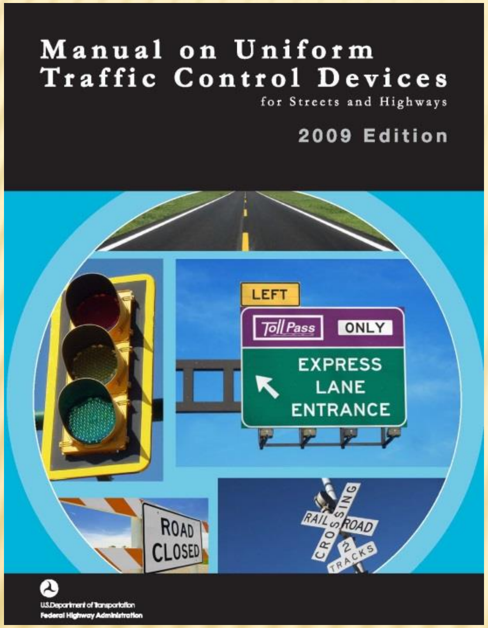
- Exclusive bike facility
- Adjacent to or on roadway
- One-way or contra-flow
- Separated from traffic by vertical element
  - Delineators
  - Bollards
  - Barrier
  - Median
  - Raised bike lane
  - Planters
  - Wheel stops
  - Parked cars

DESIGN GUIDANCE



- Primarily a geometric design feature
- Follow combination of shared use path & bike lane guidance
  - Dimensions
  - Horizontal
  - Signal timing
  - Design controls (speed, braking)

DESIGN GUIDANCE

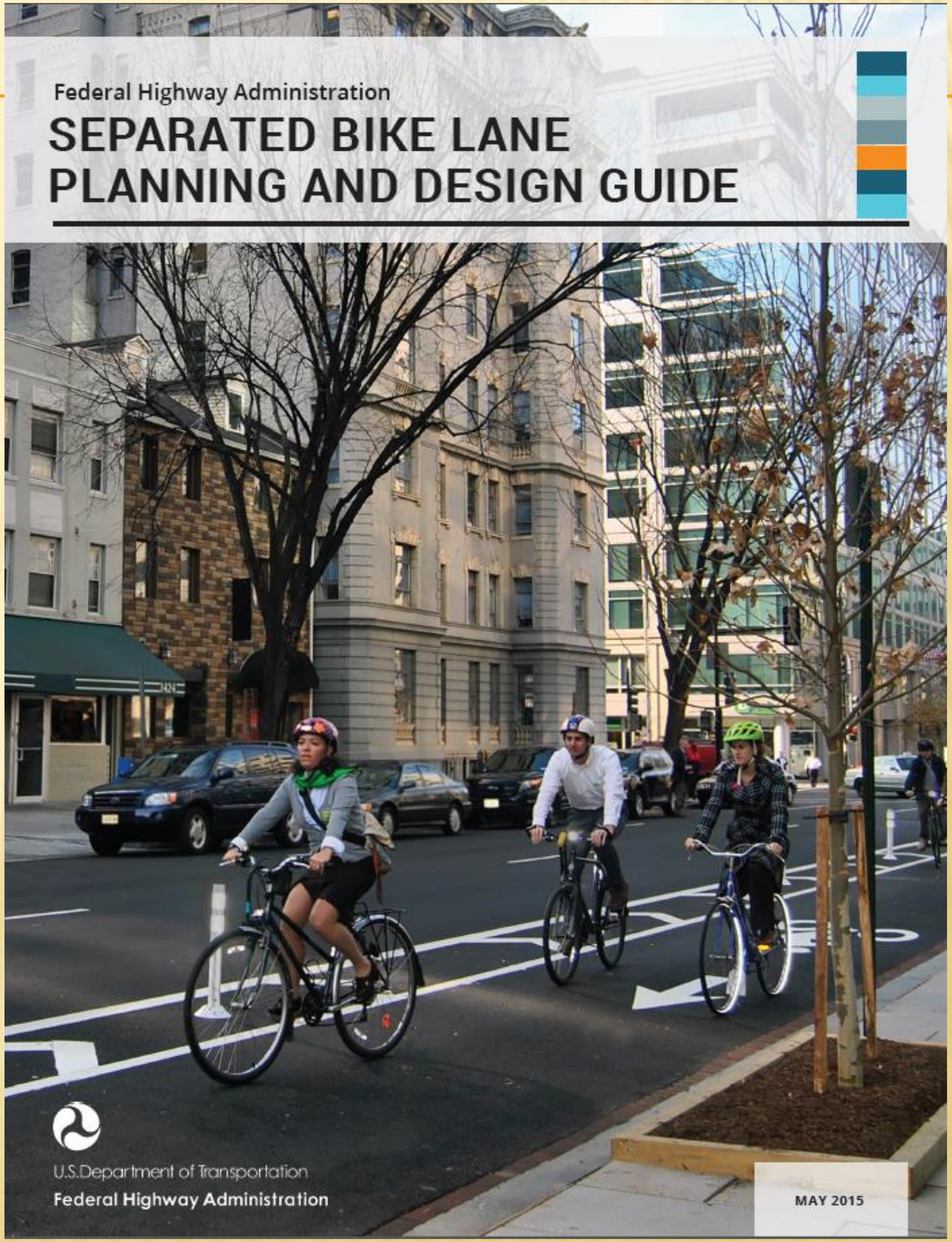


- Follow combination of shared use path & bike lane guidance (chapter 9)
  - Bike lane signs
  - Bike lane and path markings
  - Bike lane extensions
  - Signal placement
  - Contra-flow

Look beyond current MUTCD

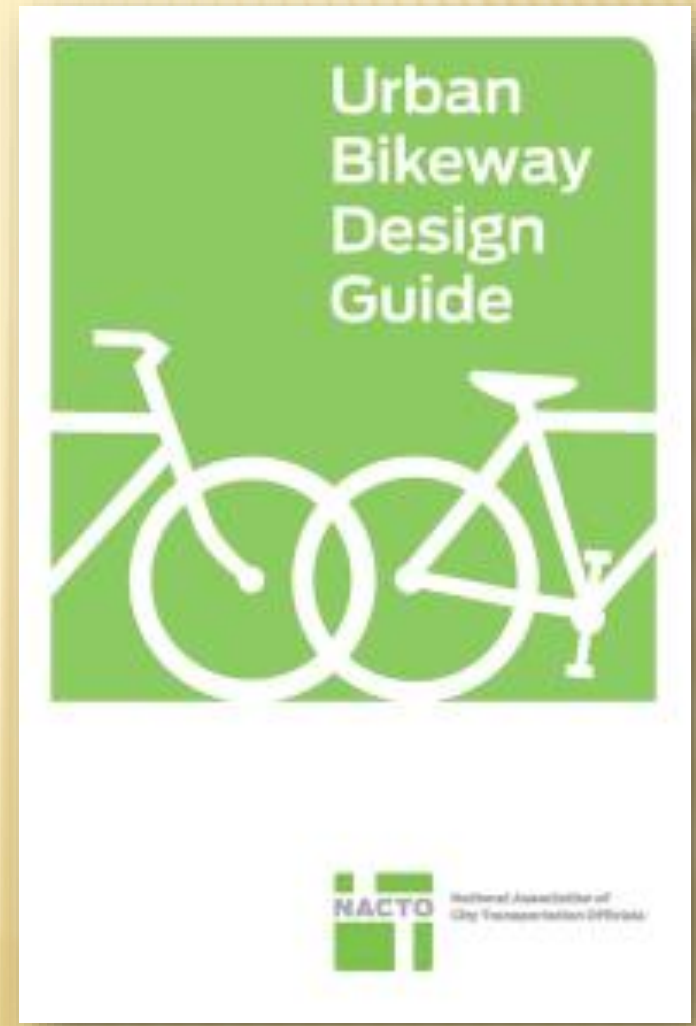
DESIGN GUIDANCE

- Not addressed in AASHTO
- Emerging need for design guidance
- Evolving knowledge with increasing experience



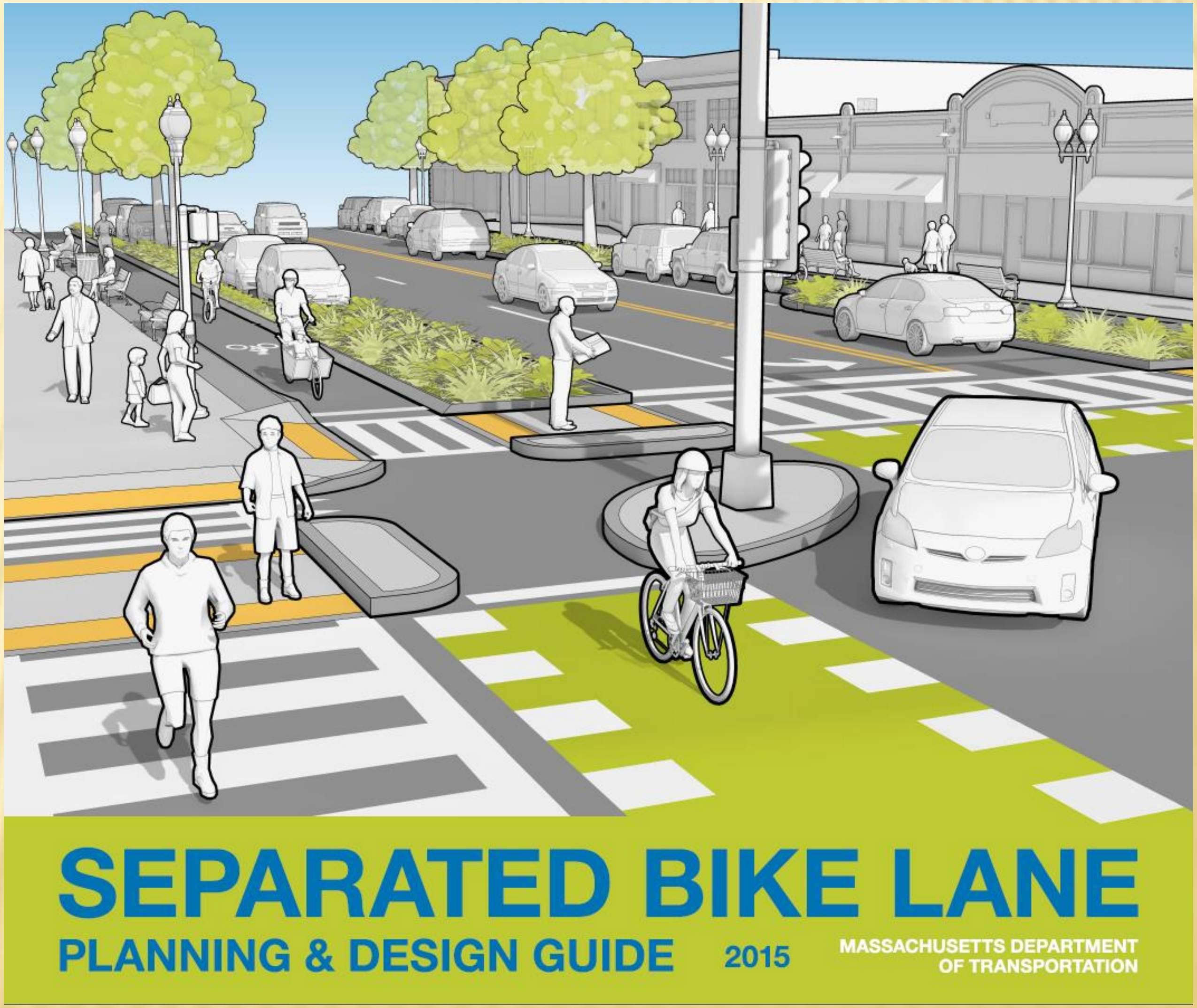
DESIGN GUIDANCE

- Conflicting definitions
- Basic dimensions
- Intersection considerations
- Goes beyond MUTCD
- Some contradictions



DESIGN GUIDANCE

- MassDOT



CONSIDERATIONS

- Are cyclists already using corridor?
- Would potential cyclists use the corridor if a separated facility existed?
- Could a SBL connect origins and destinations?
- How can a SBL help build a low stress bicycle network?
- Could a separated bike lane improve connections for disadvantaged populations?

BIKE LANE ELEVATION

- Considerations
  - Ped/bike encroachment
  - Usable bike lane width
  - Accessibility
  - Frequency of transition ramps
  - Drainage
  - Maintenance

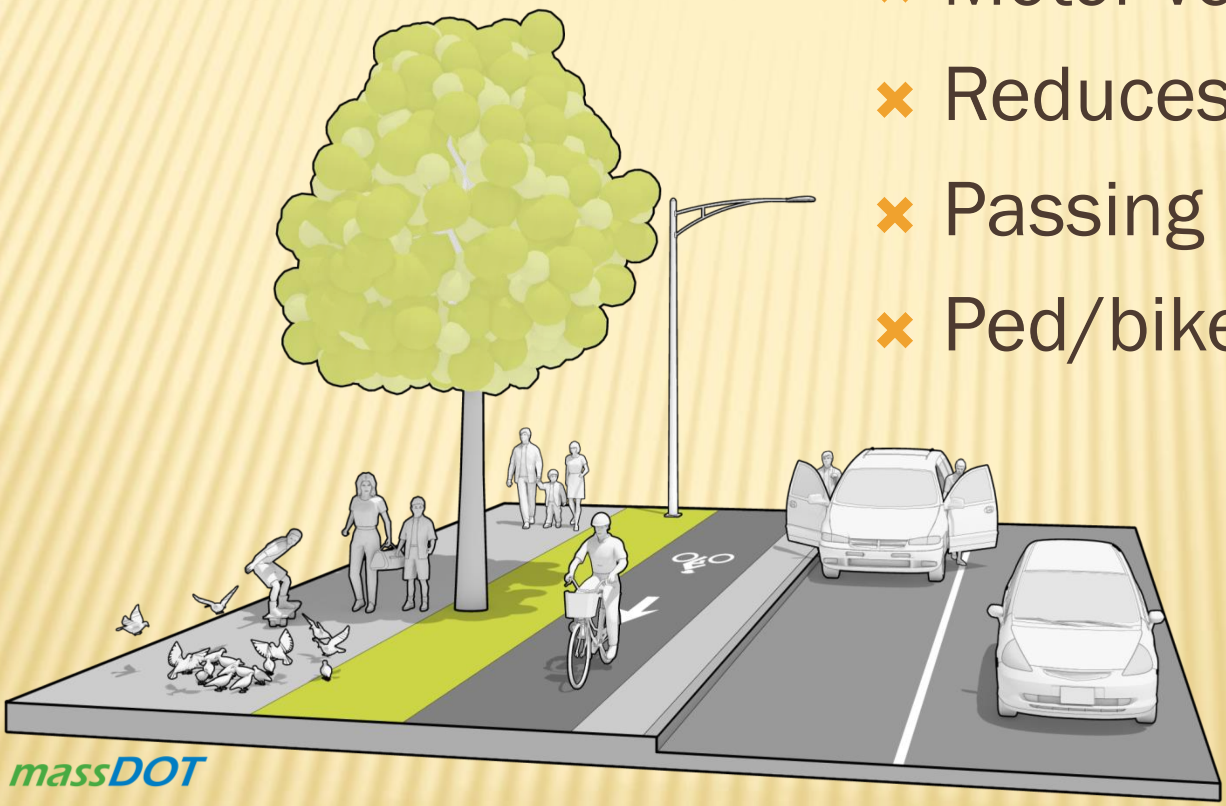
sidewalk level

intermediate level

street level

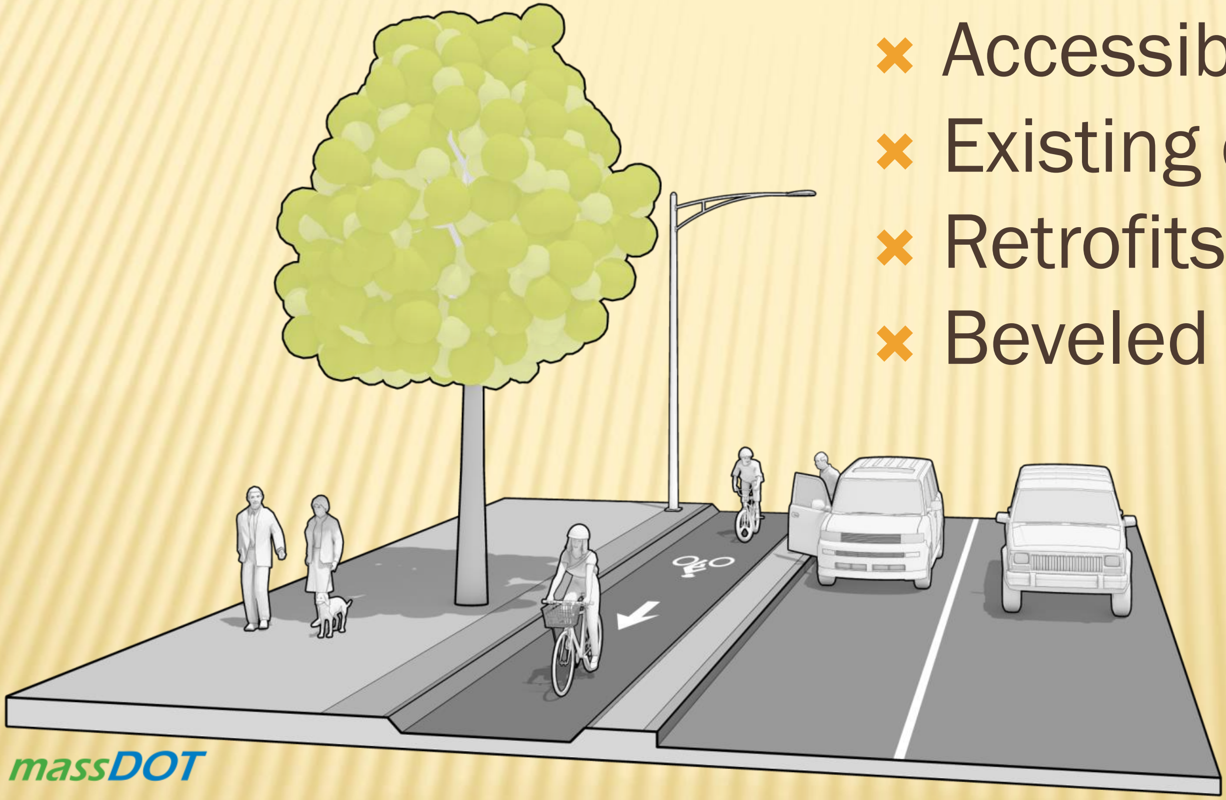
raised bike lane

SIDEWALK LEVEL



- Motor vehicle separation
- Reduces debris
- Passing
- Ped/bike encroachment

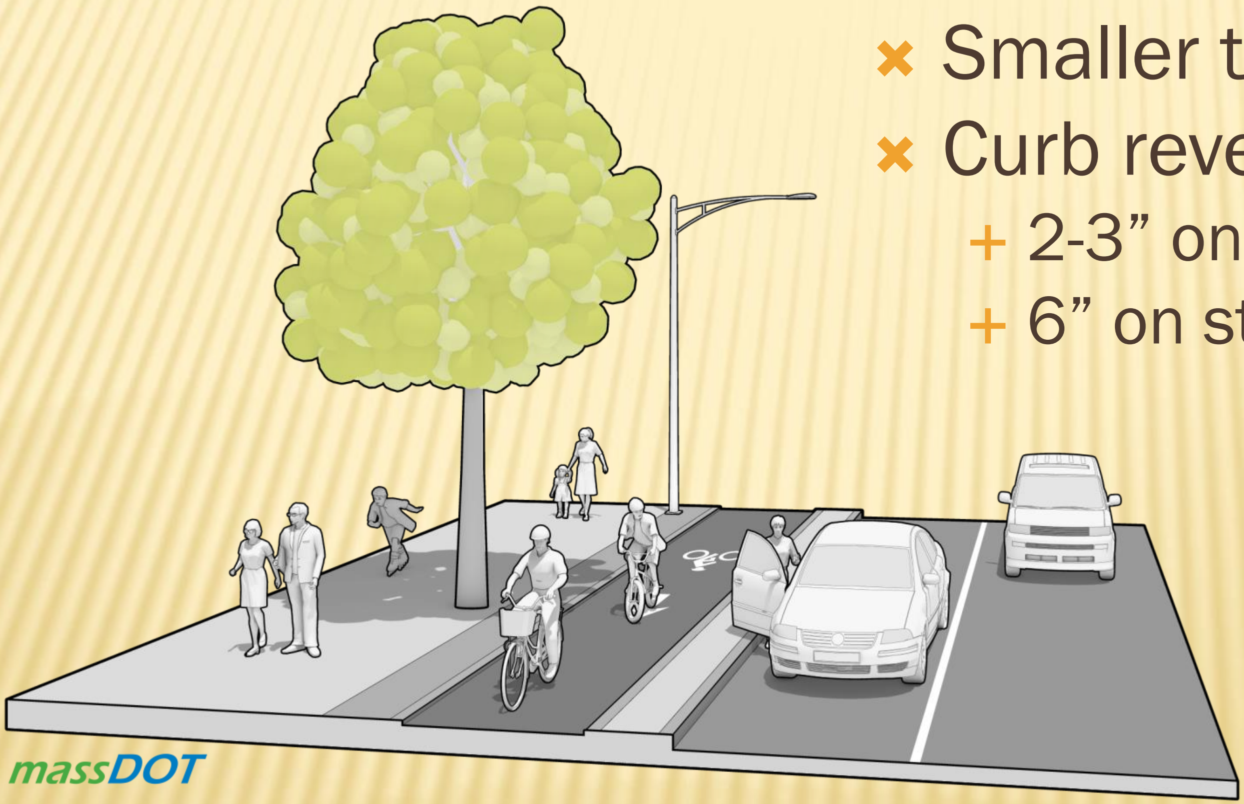
STREET LEVEL



- Sidewalk delineation
- Accessible parking
- Existing drainage
- Retrofits
- Beveled curbs

INTERMEDIATE LEVEL

- Curb & drainage flexibility
- Smaller transitions
- Curb reveal:
  - 2-3" on bike lane
  - 6" on street



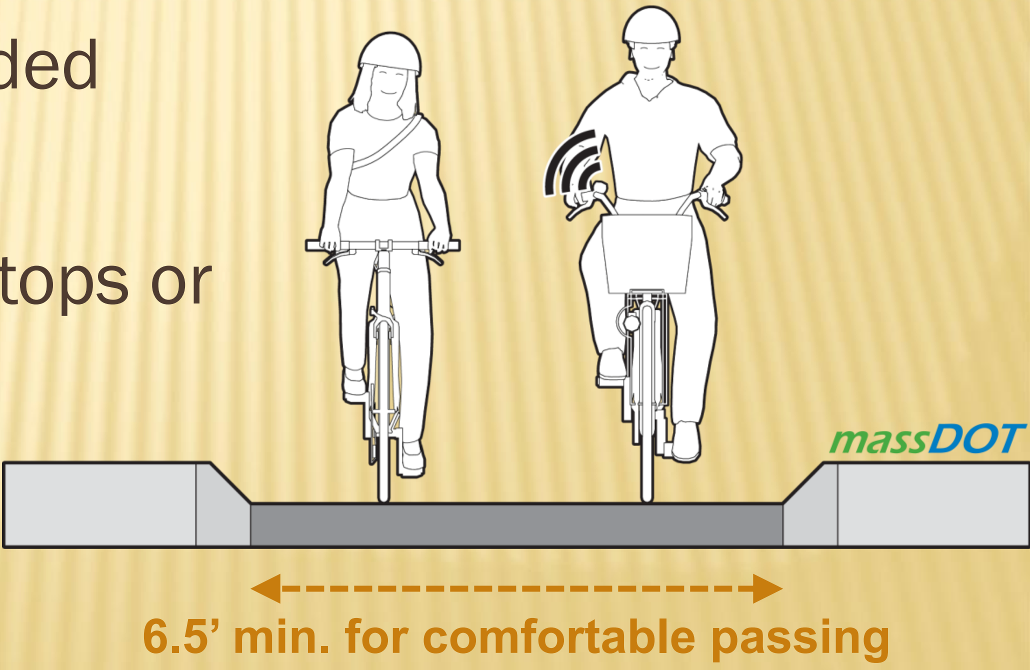
BIKE LANE WIDTH

Same Direction Bicyclists/ Peak Hour	Bike Lane Width (ft.)	
	Rec.	Min.*
<150	6.5	5.0
150-750	8.0	6.5
>750	10.0	8.0

- One-way

Widths vary by peak hour volume

- 6.5-10 ft recommended
- 5-8 ft minimum
- 4’ allowable at bus stops or accessible parking



ONE-WAY BIKEWAY

San Francisco, CA

ONE-WAY BIKEWAY

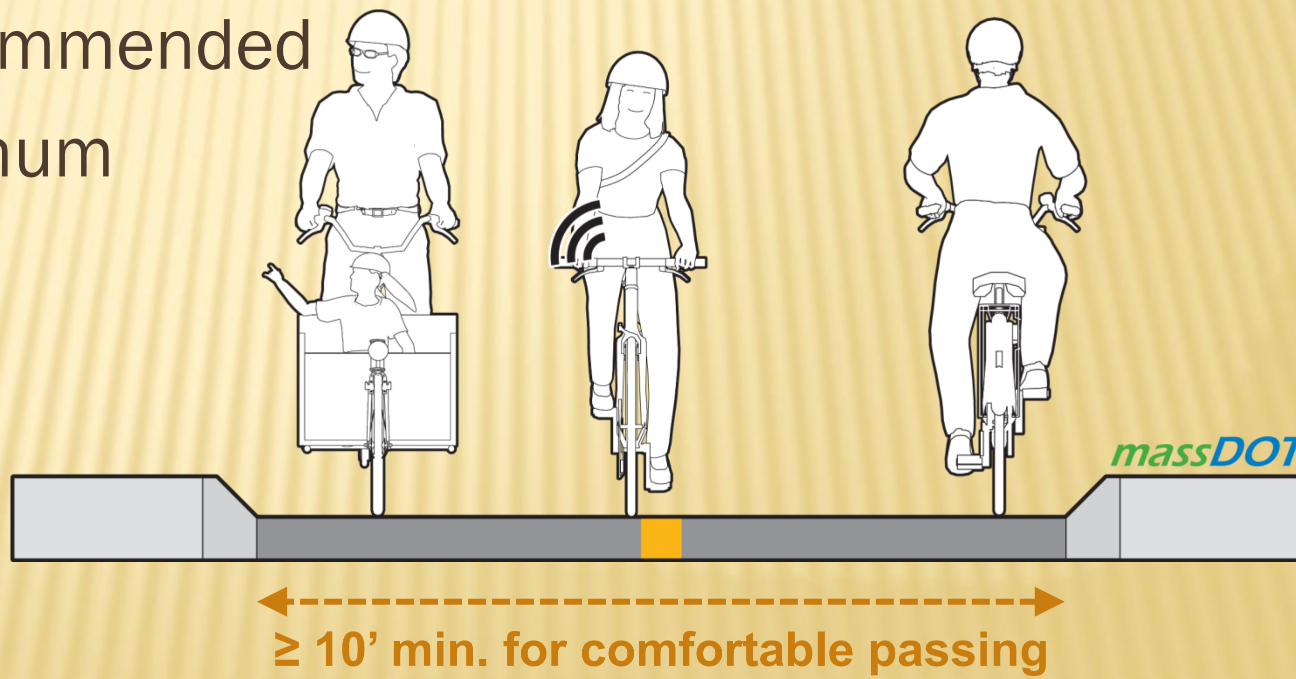
BIKE LANE WIDTH

Bidirectional Bicyclists/ Peak Hour	Bike Lane Width (ft.)	
	Rec.	Min.*
<150	10.0	8.0
150-400	11.0	10.0
>400	14.0	11.0

- Two-way

Widths vary by peak hour volume

- 10-14 ft recommended
- 8-11 ft minimum



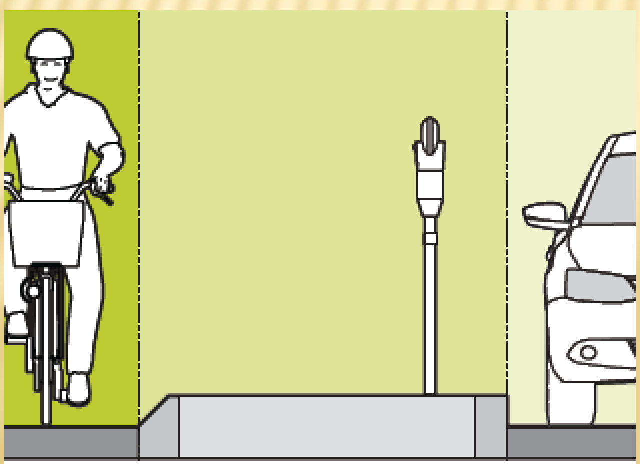
TWO-WAY BIKEWAY

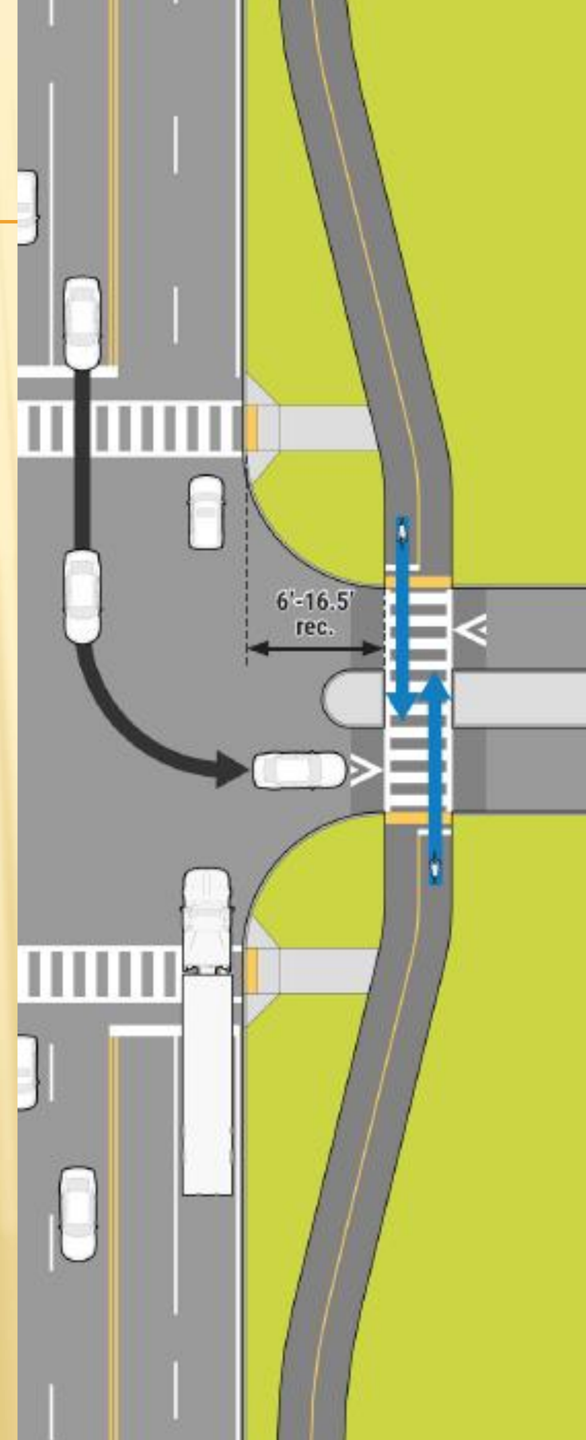
BIKE LANE WIDTH

- Maintenance
  - Sweeping
  - Snow removal

STREET BUFFER WIDTH

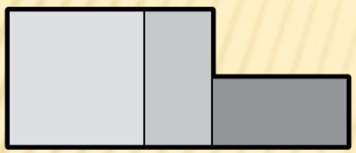
- 6’ preferred
- 2’ when constrained
- 1’ along raised SBL
- 6-16.5’ optimum for intersections





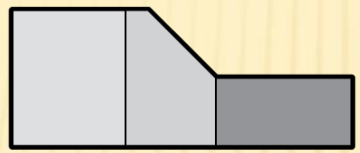
VERTICAL ELEMENTS

Vertical



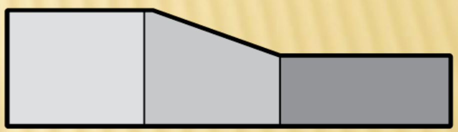
Beveled

1V:1H



Mountable

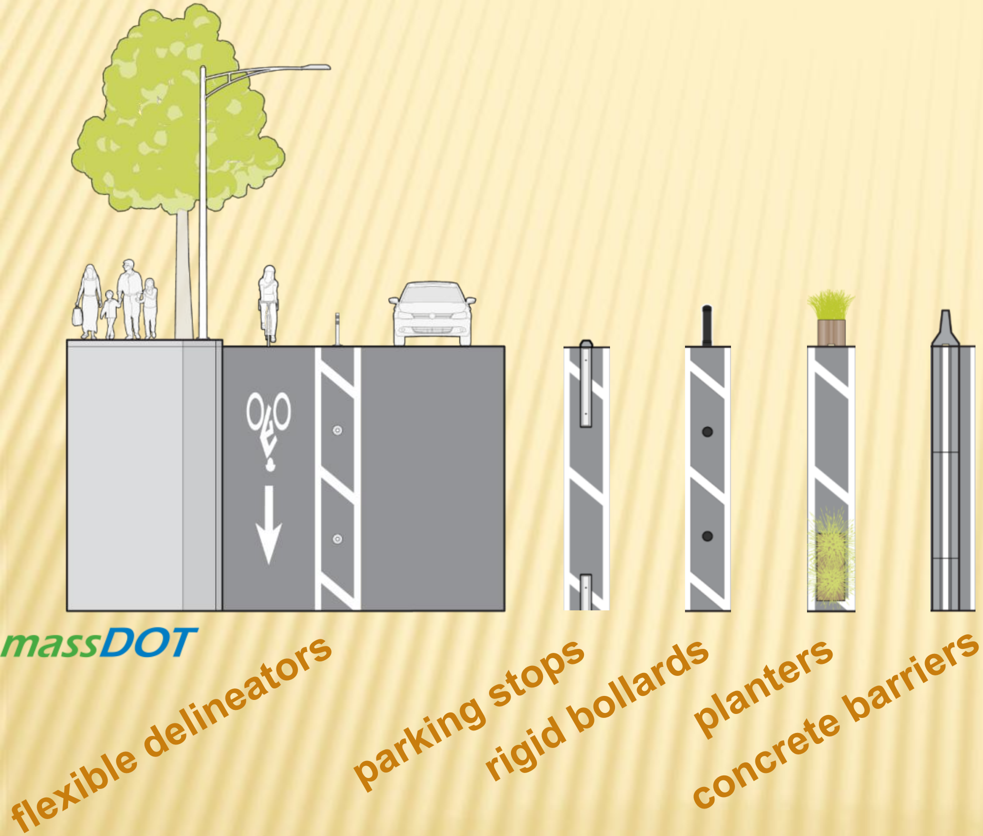
1V:4H



Curb angle & height influence:

+ Wheel & pedal strike hazard
+ Bicycle access to sidewalk
+ Motor vehicle encroachment
+ Cross section width

VERTICAL ELEMENTS



- Painted median
- Parking
- Lower cost
- Considerations
  - Shy distance
  - Spacing
  - Durability
  - Clear zone

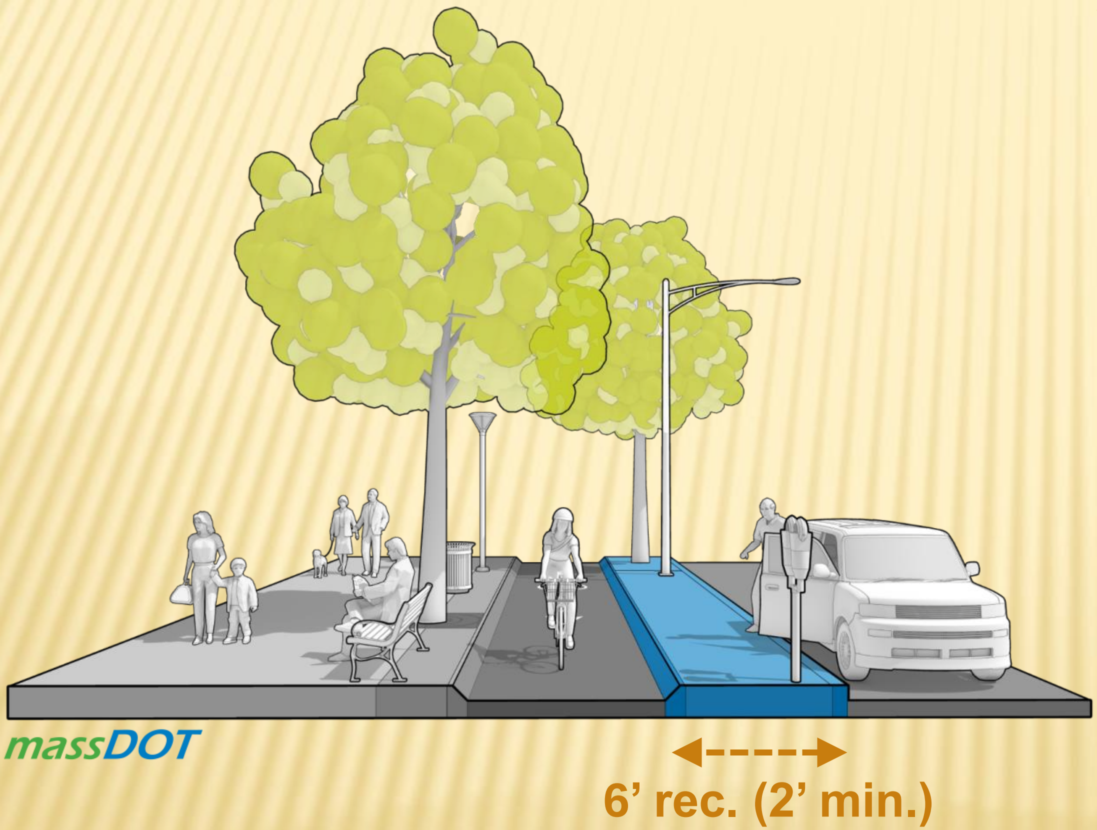
FLEXIBLE DELINEATORS

ARMADILLOS

LOCAL BRANDING

Seattle, WA

VERTICAL ELEMENTS



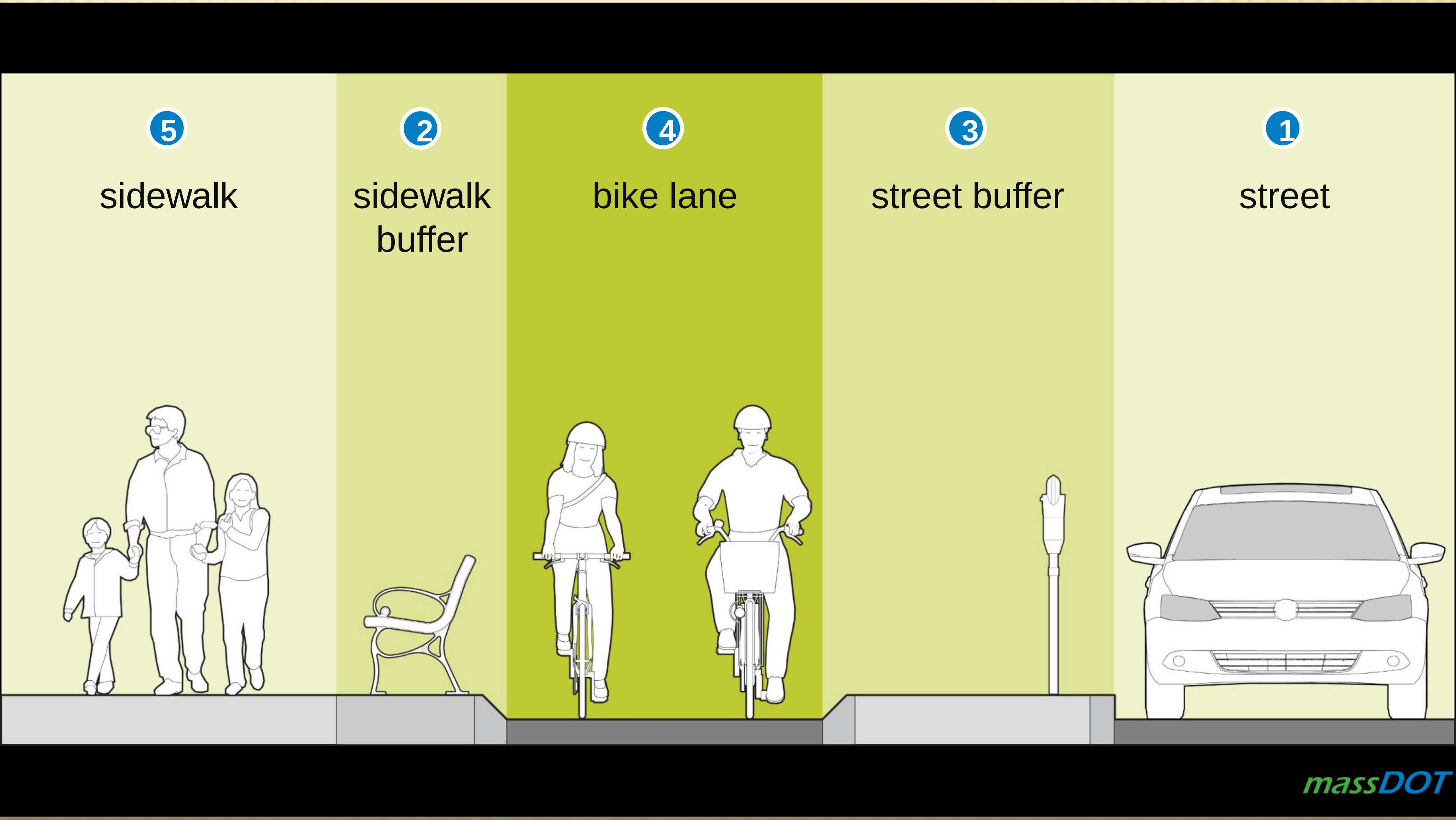
- Raised median
  - Any bike lane elevation
  - Higher cost
  - Considerations
    - Streetscape
    - Landscaping
    - Drainage

SIDEWALK BUFFER

- Width considerations
  - Minimum continuous sidewalk width 4’
  - Minimum sidewalk for passing 5’
  - Wider in commercial centers
  - Shy distance
  - Visual contrast

Philadelphia, PA (concept)

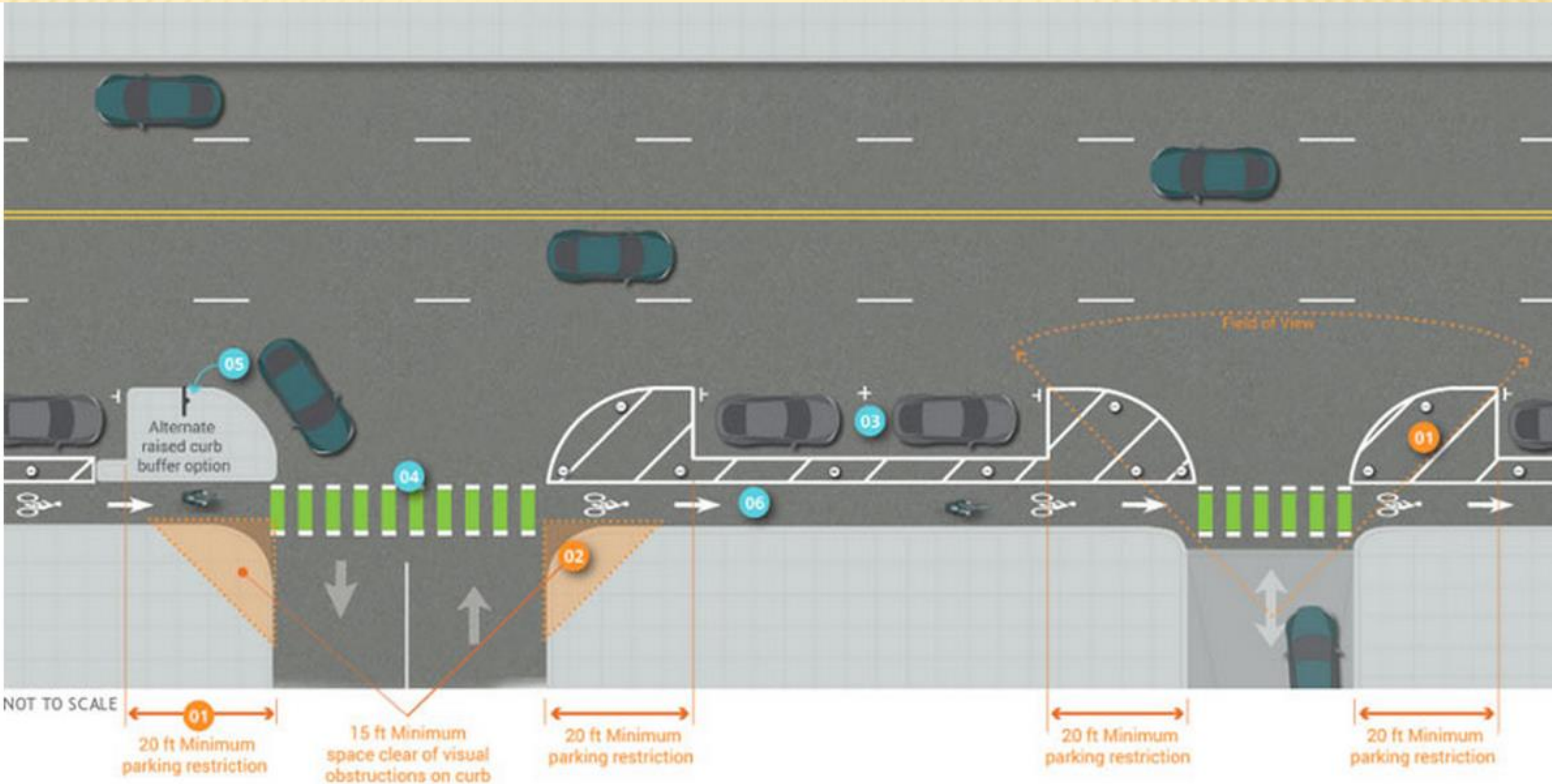
CONSTRAINED CORRIDORS



DRIVEWAYS AND CROSSINGS

Portland, OR
Photo: Alta Planning + Design

DRIVEWAYS

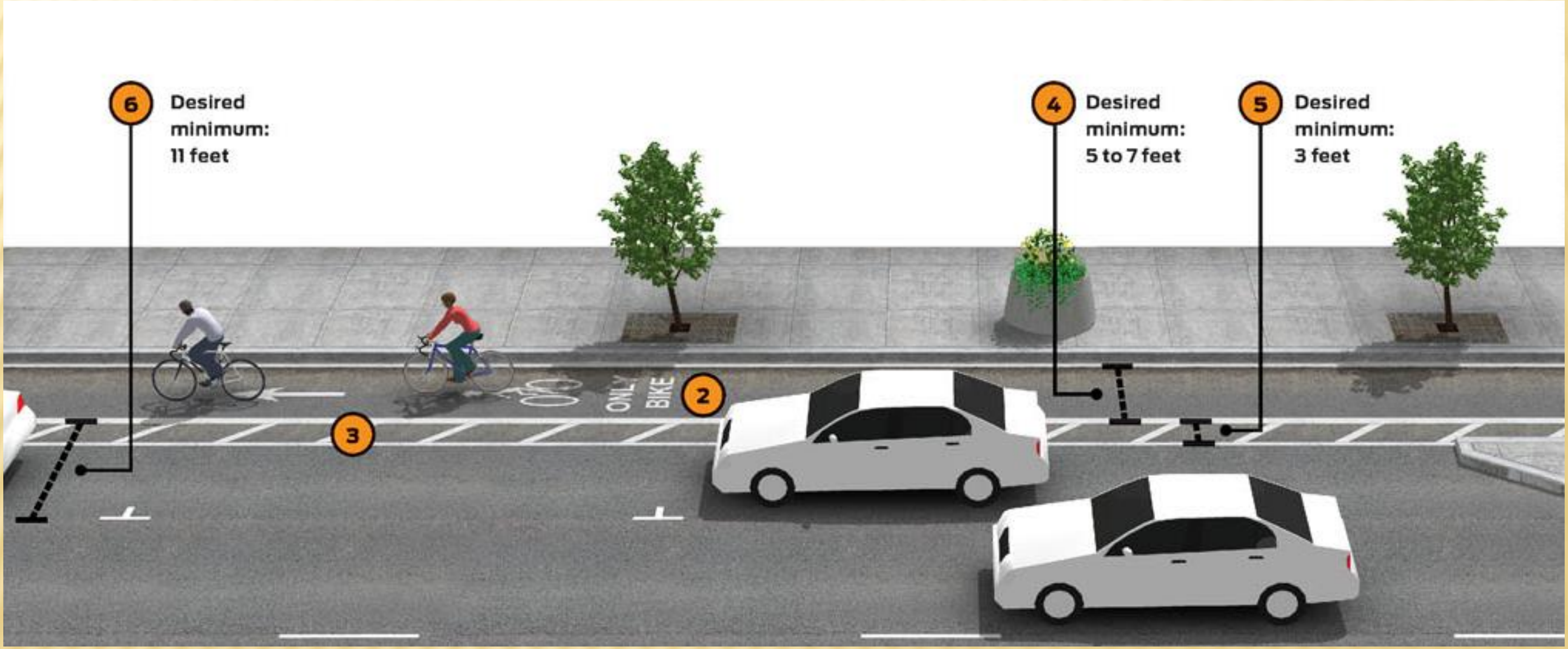


Field of View
05
Alternate raised curb buffer option
03
01
04
06
02
NOT TO SCALE
01
20 ft Minimum parking restriction
15 ft Minimum space clear of visual obstructions on curb
20 ft Minimum parking restriction
20 ft Minimum parking restriction
20 ft Minimum parking restriction

CURBSIDE ACTIVITY

- Motor vehicle parking
- Bike parking
- Loading zones
- Bus stops

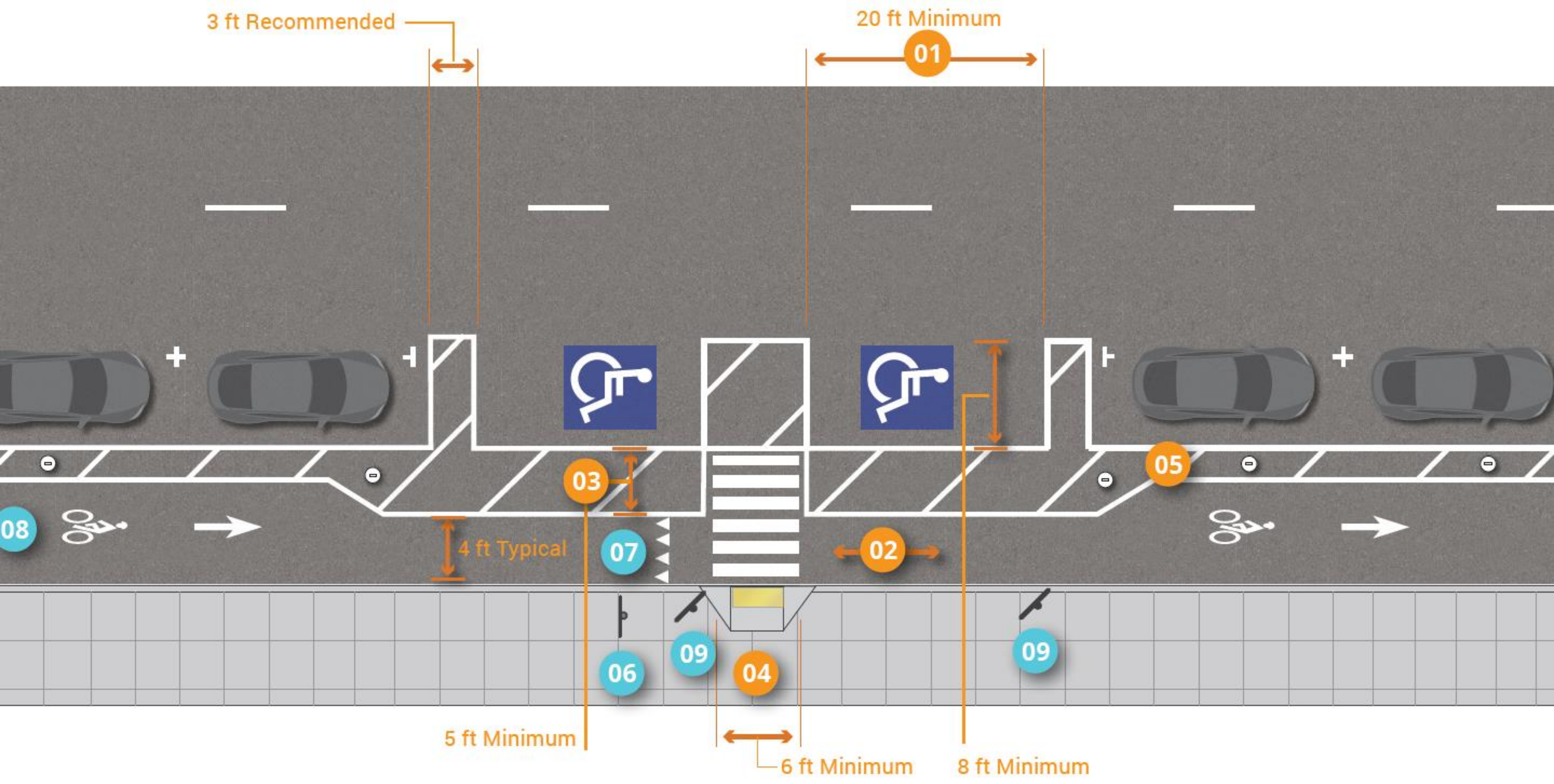
MOTOR VEHICLE PARKING



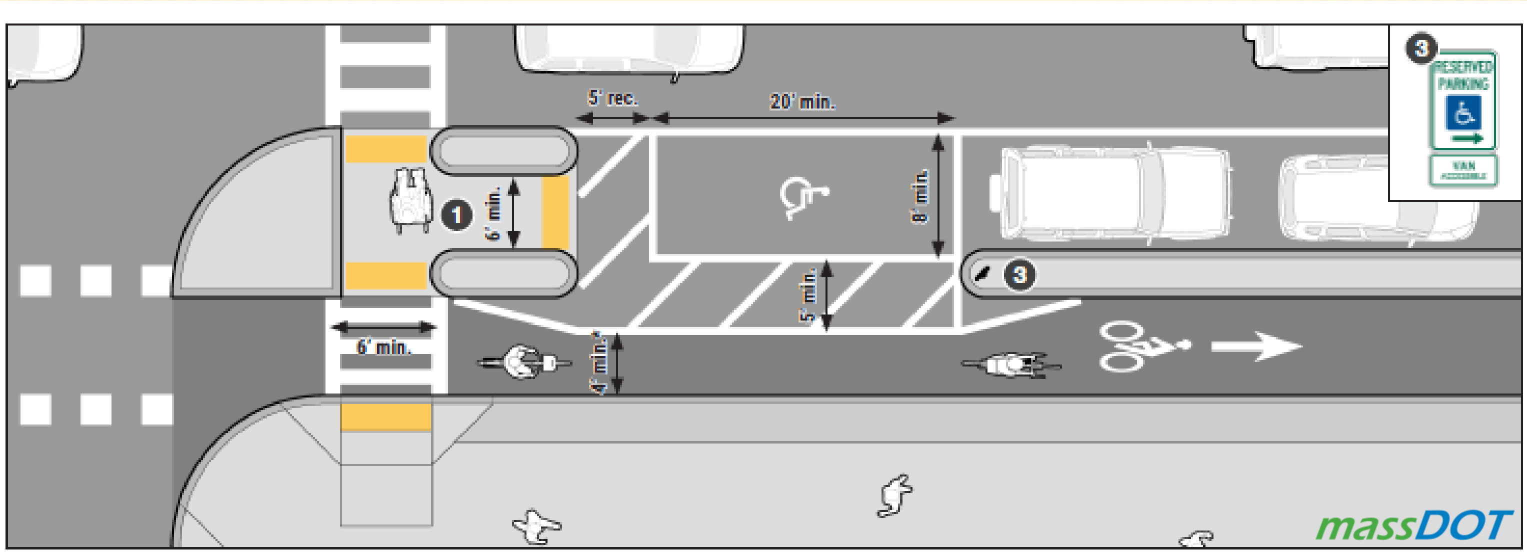
MOTOR VEHICLE PARKING

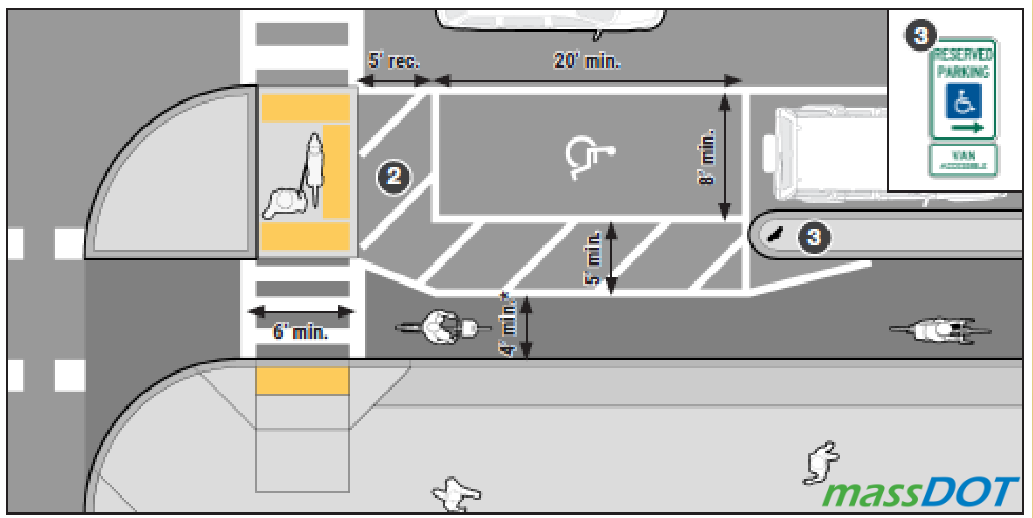
Columbus, OH

ACCESSIBLE PARKING

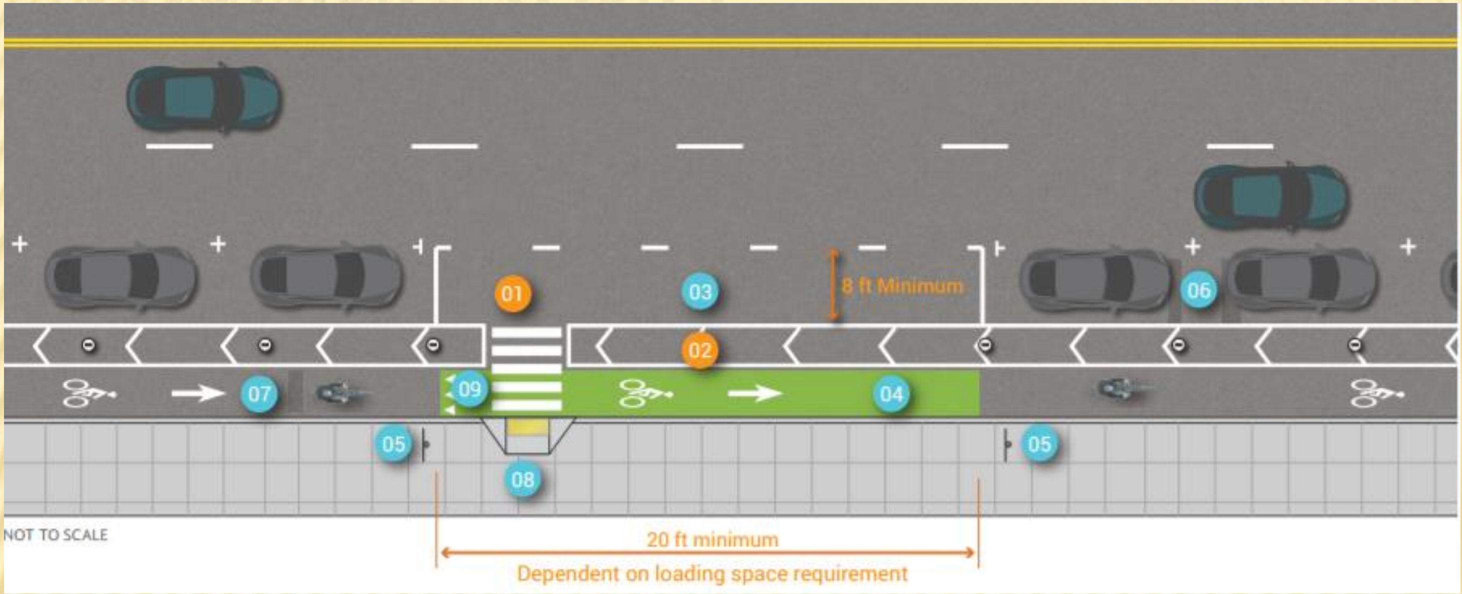


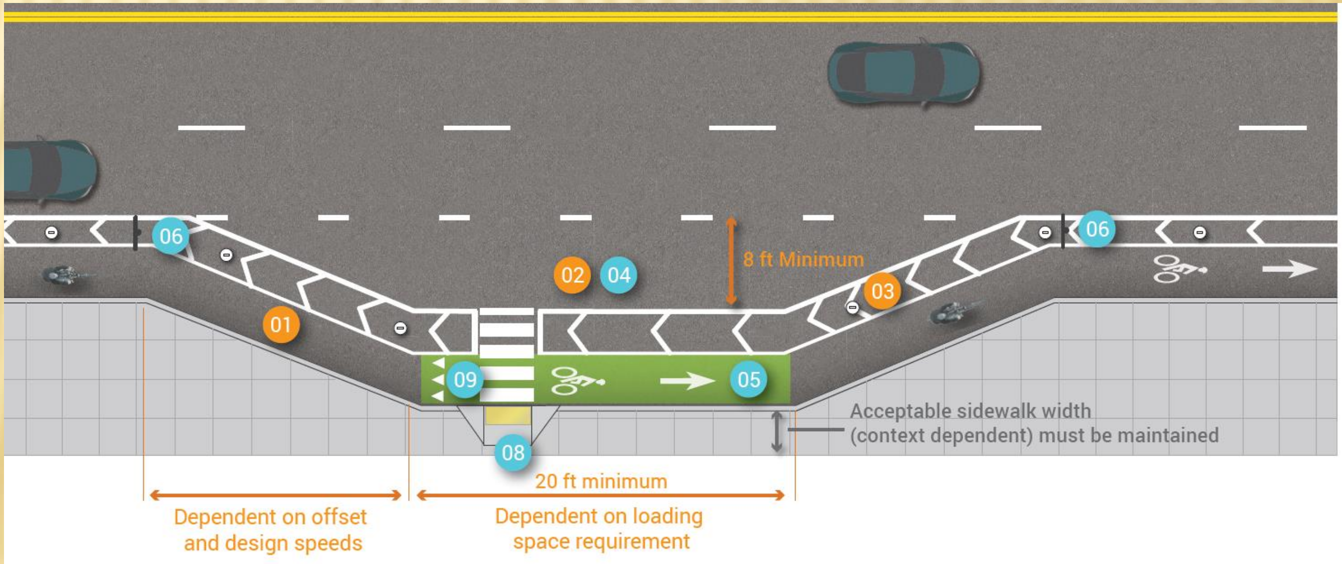
ACCESSIBLE PARKING



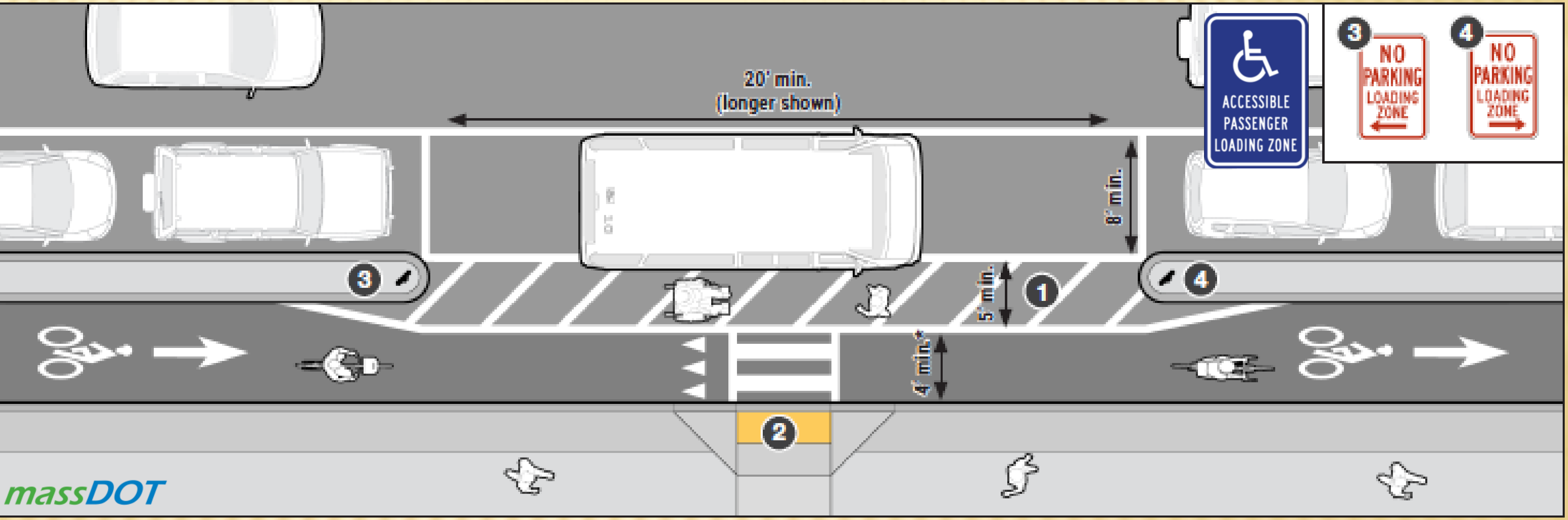


LOADING ZONES

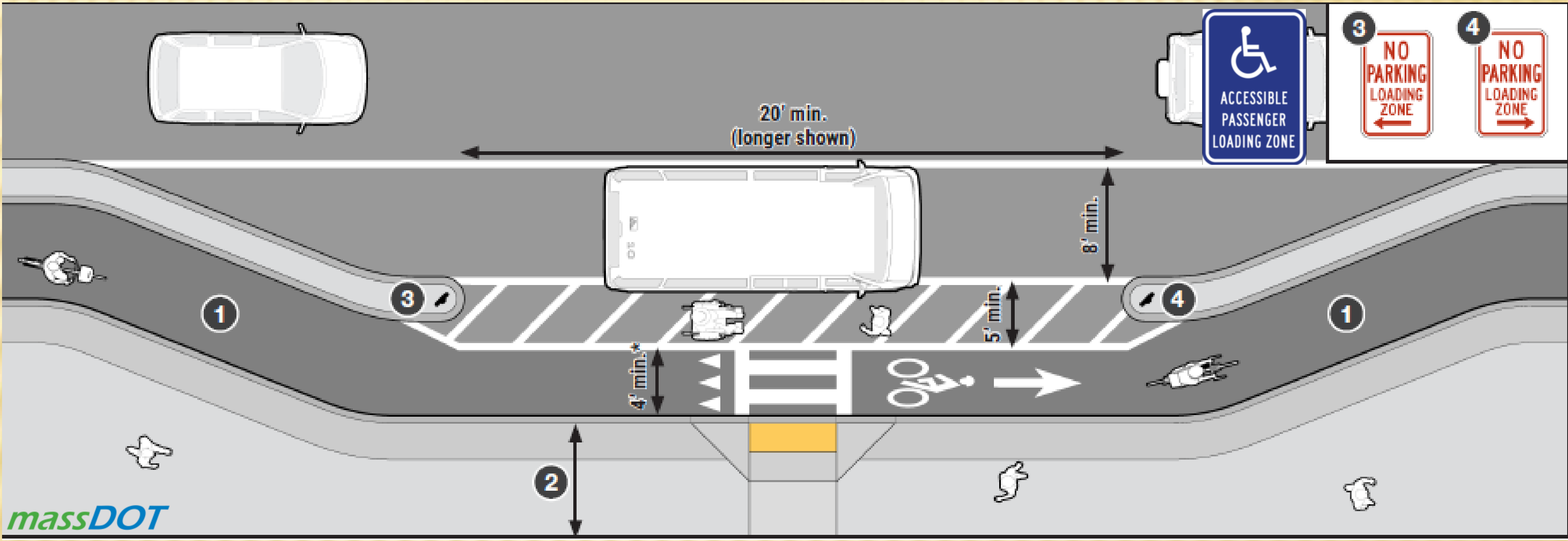




ACCESSIBLE LOADING ZONE



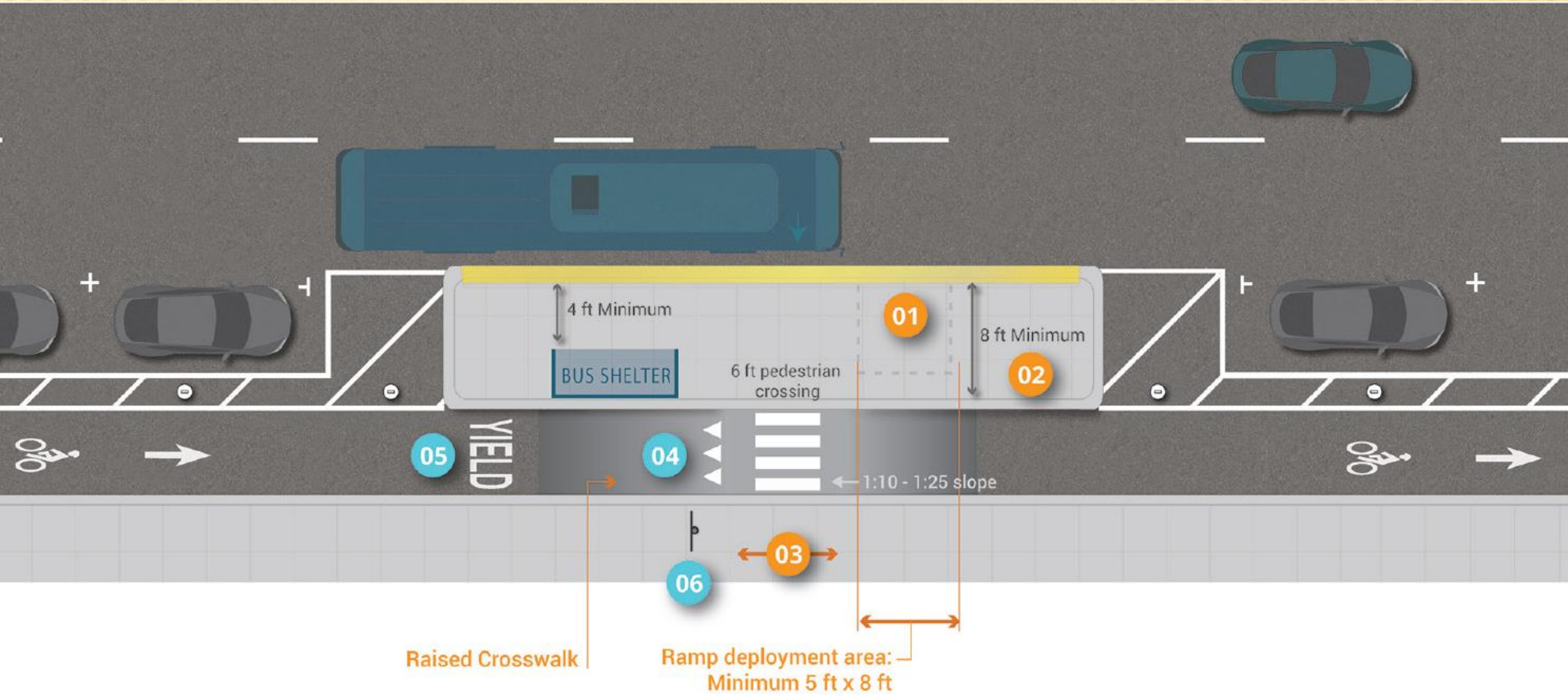
ACCESSIBLE LOADING ZONE



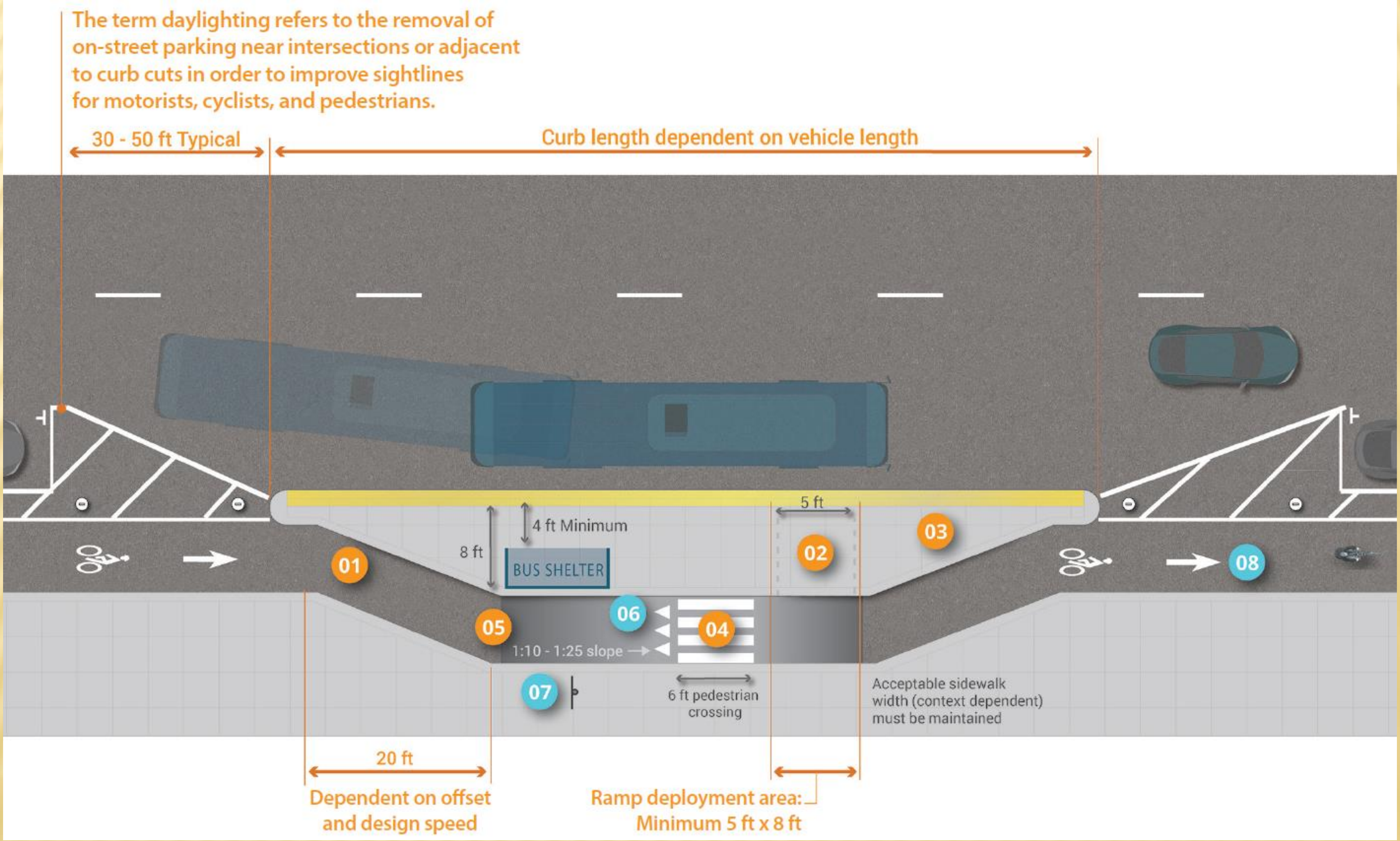
TRANSIT STOPS

- Considerations
  - Opposite side of street
  - Guide passengers
  - Two crossings
  - Communicate to bicyclists
  - Floating bus stop
  - In-lane bus operation

TRANSIT STOPS



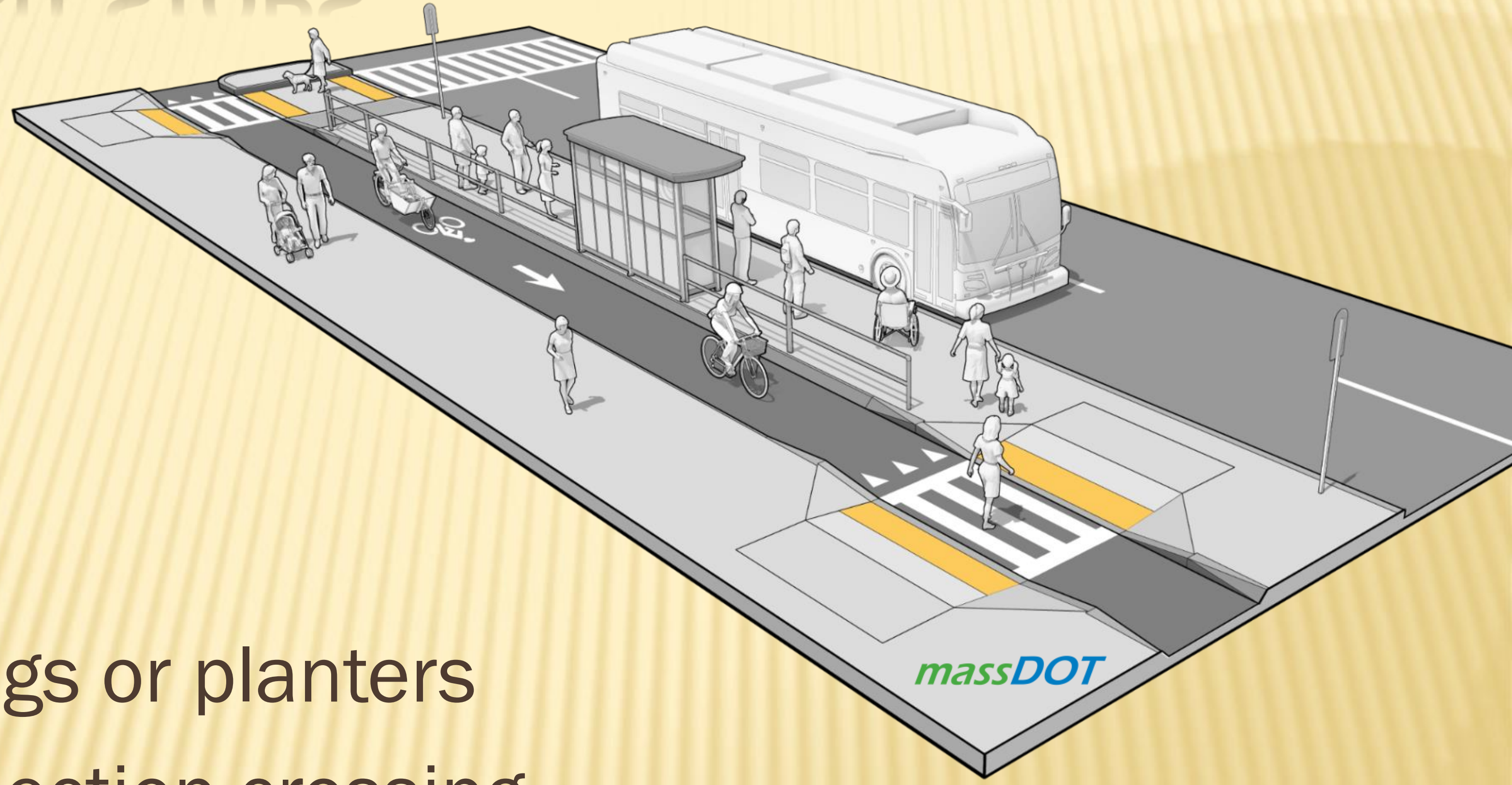
TRANSIT STOPS



TRANSIT STOPS

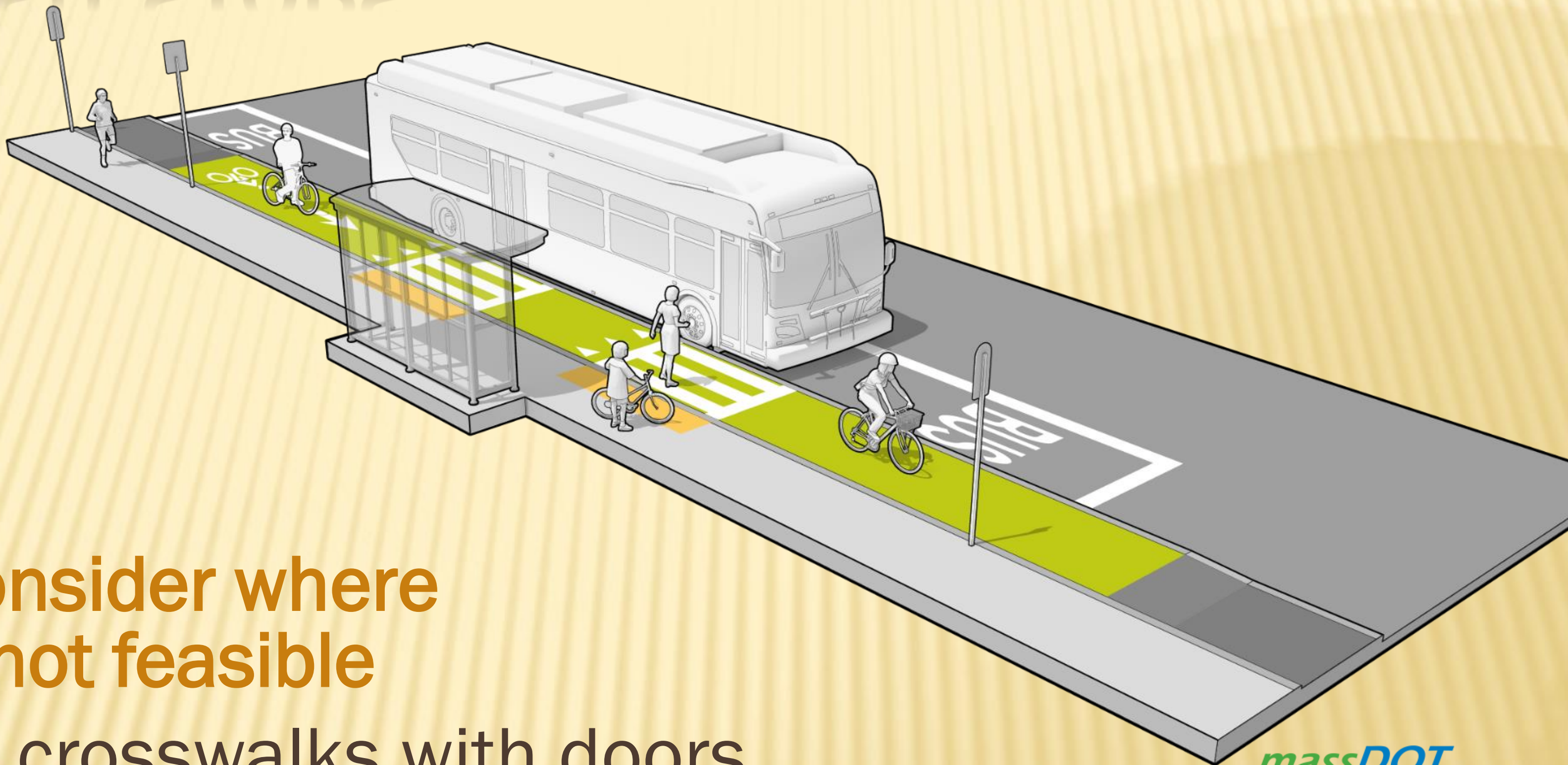
Minneapolis, Minnesota

TRANSIT STOPS



- Railings or planters
- Intersection crossing
- Stop or yield markings

TRANSIT STOPS



Only consider where island not feasible

- Align crosswalks with doors
- Green pavement
- Do not pass when bus is stopped

TRANSIT STOPS

TRANSIT STOP


BEFORE
H. BRICKMAN & SONS
X-ING
SCHOOL


AFTER
X-ING X-ING
SCHOOL SCHOOL

Designing for Bicyclist Safety

SUMMARY THOUGHTS

LEARNING CHECK

- On what type of highway would you consider providing shoulders for bicycle travel?

LEARNING CHECK

- Under which conditions are shared-lane operations with shared-lane markings most appropriate?

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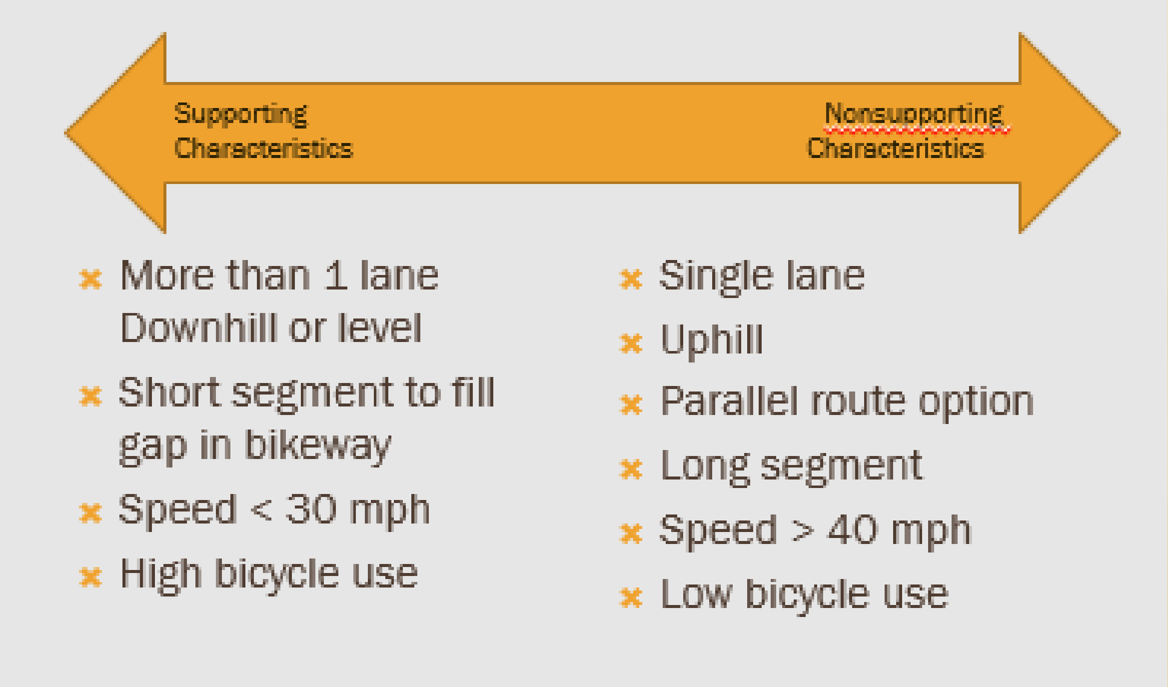

KEY CONCEPTS

- Shared-Use Paths
- Separated Bike Lanes
- Bike Lanes
- Shoulders
- Shared Roadway

Designing for Bicyclist Safety

QUESTIONS

PAVEMENT MARKINGS

- Add green pavement marking – bike lanes & sharrows

PAVEMENT MARKINGS

- Add green pavement marking – bike lanes & sharrows