Designing for Bicyclist Safety

Module B

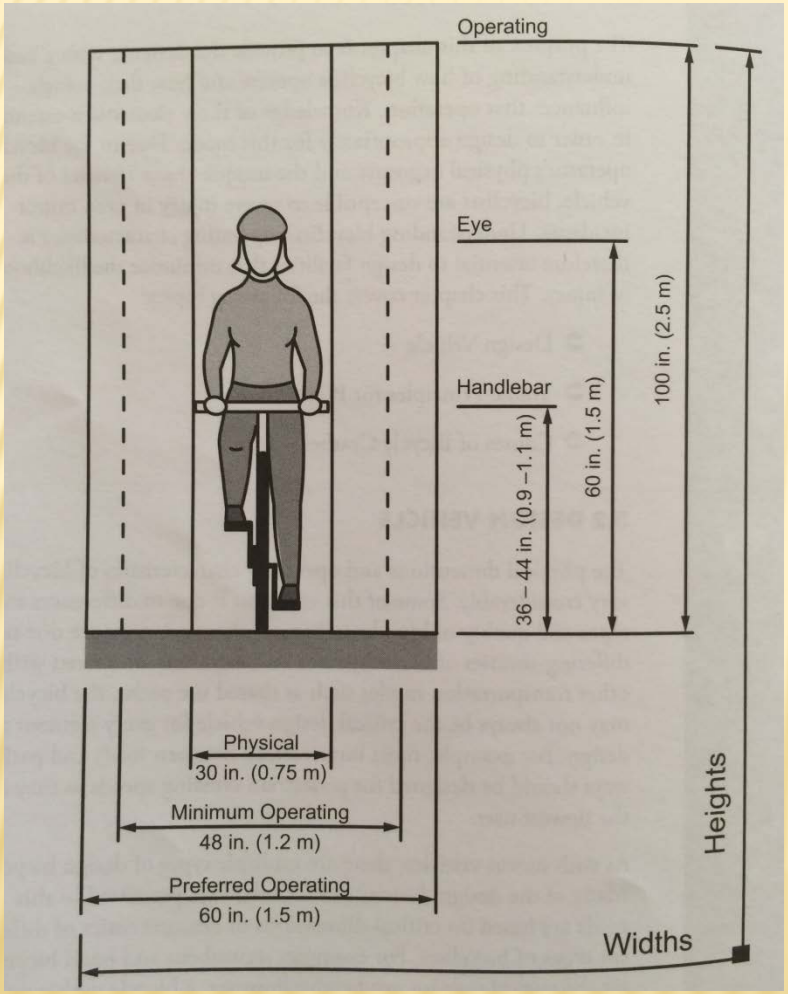
DESIGNING ON-ROAD BIKEWAYS

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

OLDER BIKEWAY TYPES

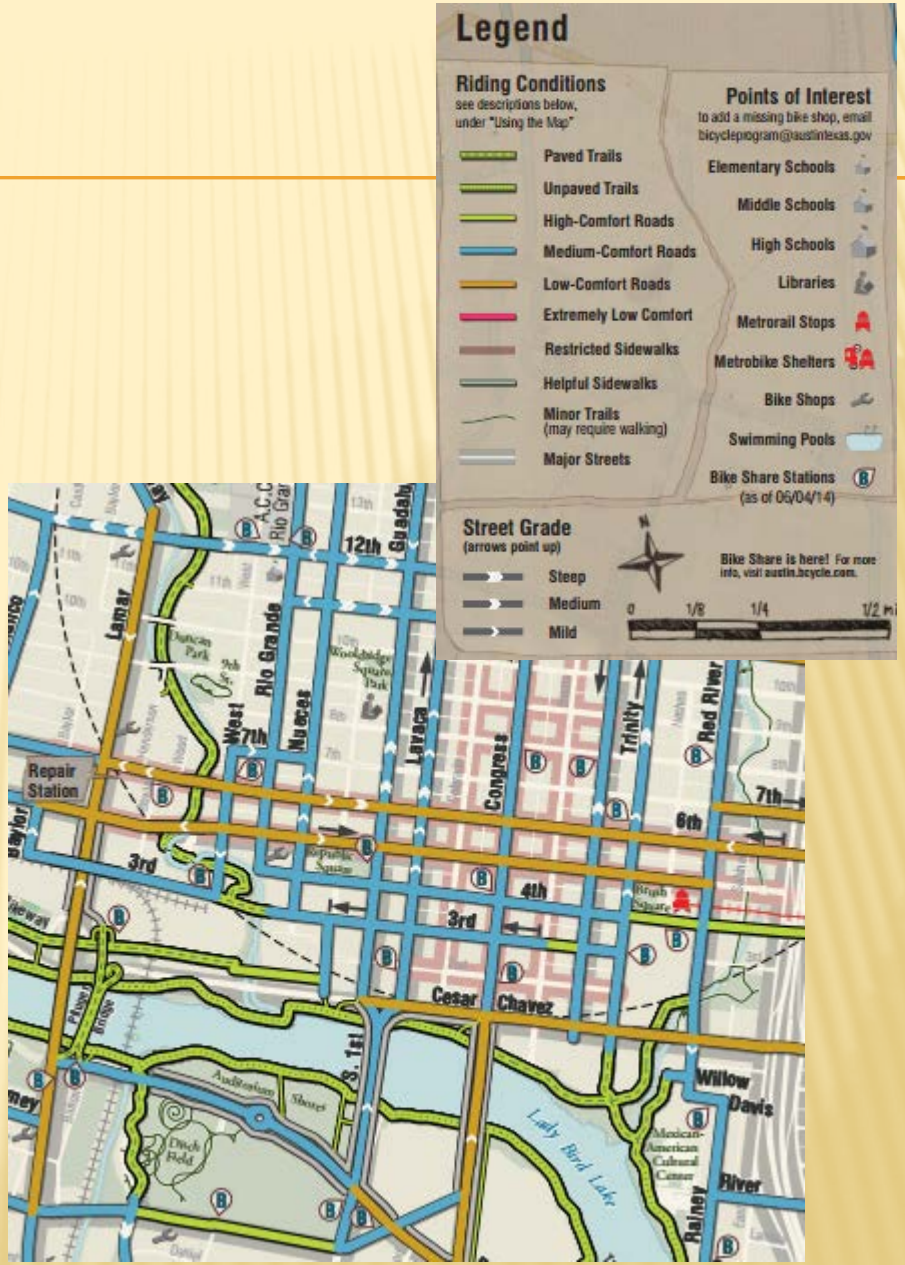
- “Bike Route”
- “Bike Path”

Neither term is clear

They are all *bikeways*

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



HIERARCHY OF BIKEWAYS

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

Photo by Harvey Muller

Photo by SCI

Photo by Harvey Muller


TAXI
D.C.FLYER 63

Photo by SCI

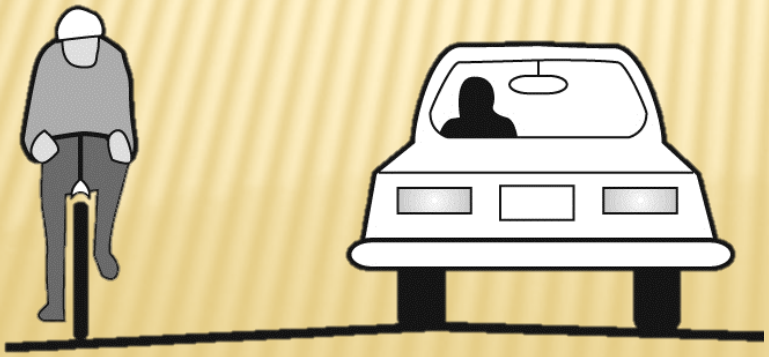
Designing On-Road Bikeways

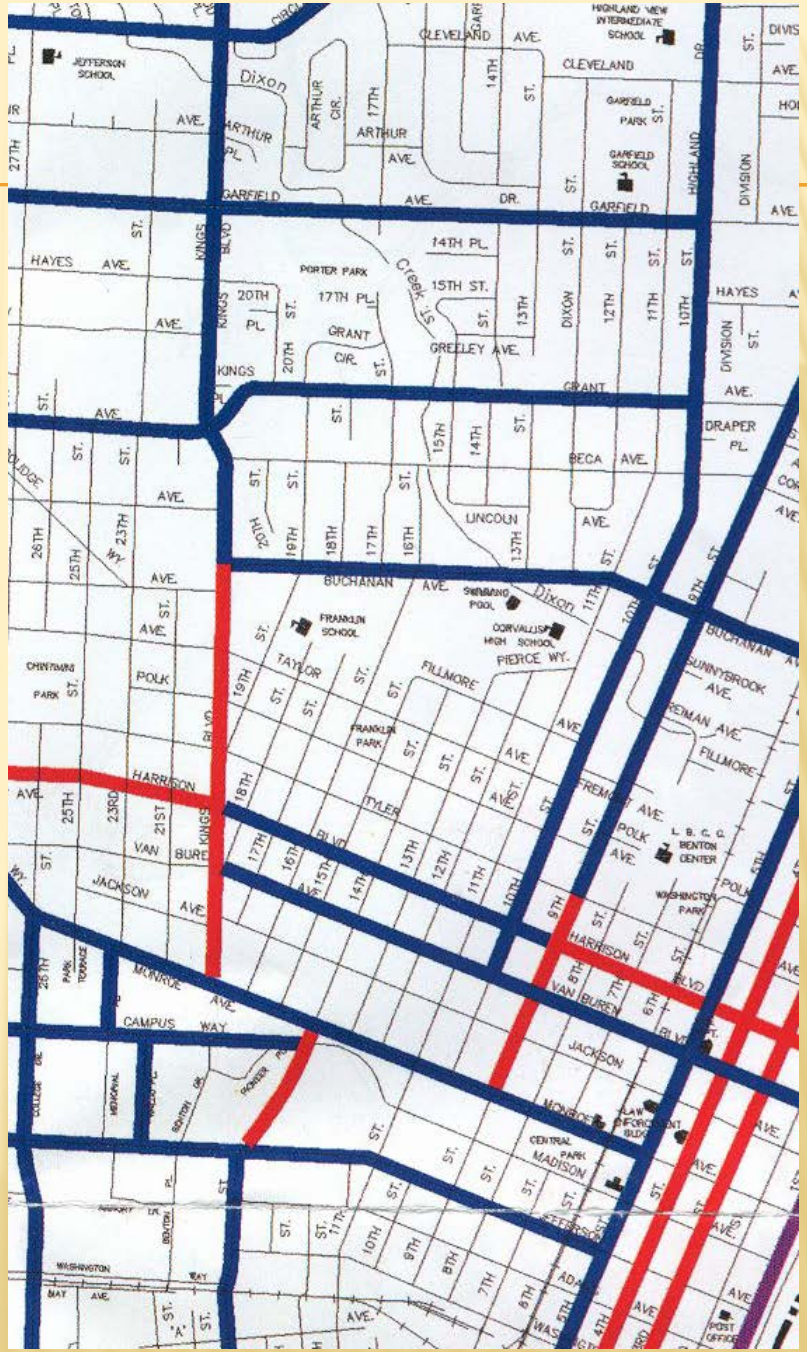
SHARED ROADWAY

Photo by Harvey Muller

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





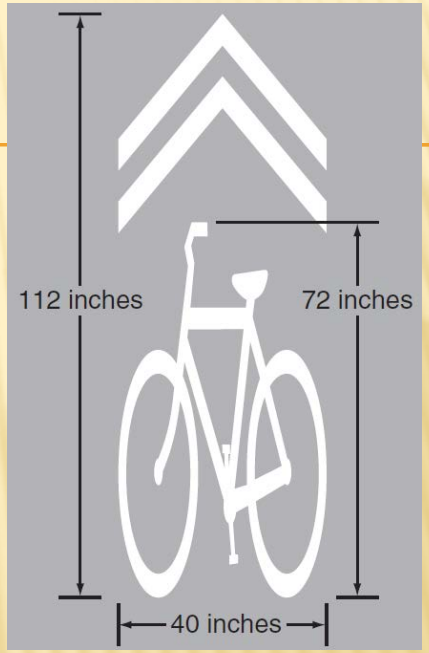
SHARED LANES

- 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 ROAD SIGNS

- Ride side-by-side?
- Chase bicyclist?
- Warning or regulation?
- Opposite forces?

Philadelphia, PA

...and who "shares"?

New Orleans, LA

California

SHARED ROAD SIGNS

- Reminder for motorists

PASSING SIGNS

- TCD's not meant to be educational
- Limit to areas with identified problem

Corvallis, Oregon

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

Salem, Oregon

- Increased speed or volume, increased LTS
- LTS 4

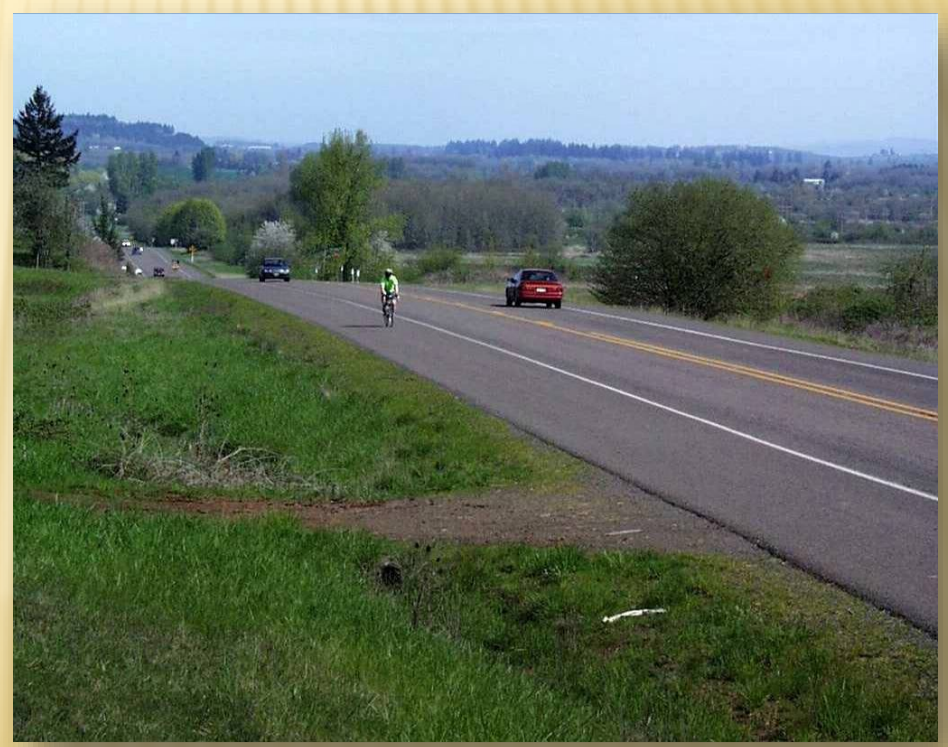
- Rural back roads

Designing On-Road Bikeways

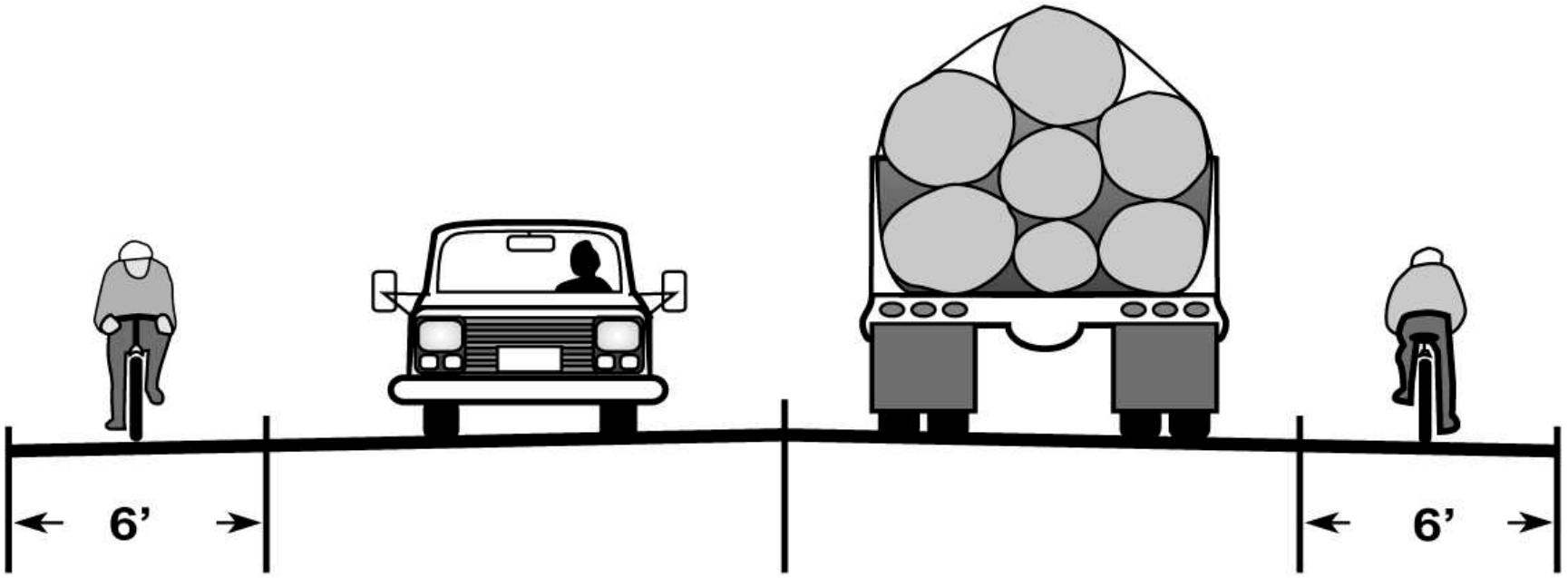
PAVED SHOULDERS

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



Min: 5’ against curb, parking or barrier, 4’ on open shoulder

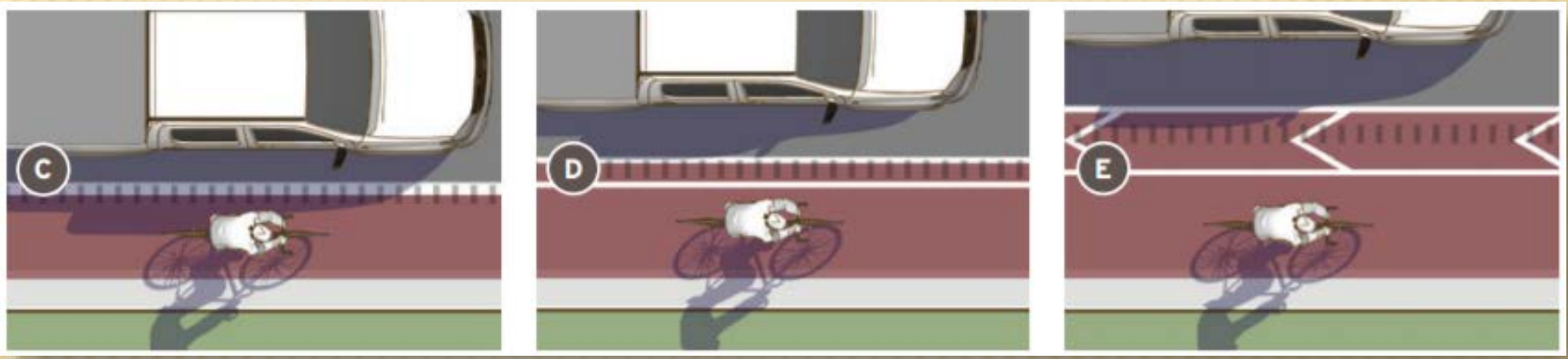
Travel lane dimensions per relevant standards

Use AASHTO *shoulder* standards

For bicycles: 4 ft minimum, 6 ft desirable

No special markings

SHOULDER BIKEWAY



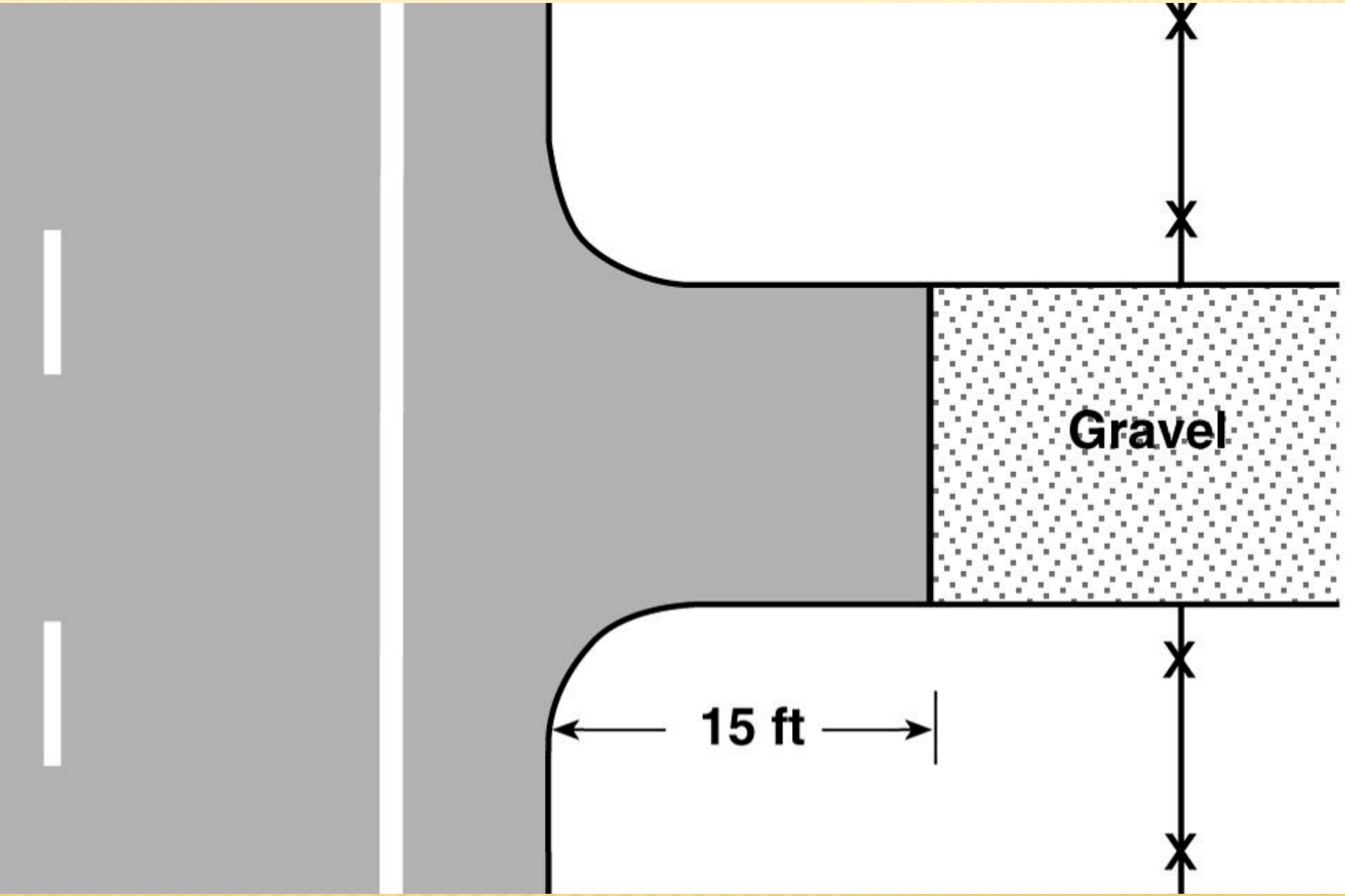
Functional classification	Volume (AADT)	Speed (Mi/h)	Recommended Minimum Paved Shoulder Width
Minor Collector	up to 1,100	35 (55 km/h)	5 ft (1.5 m)
Major Collector	up to 2,600	45 (70 km/h)	6.5 ft (2.0 m)
Minor Arterial	up to 6,000	55 (90 km/h)	7 ft (2.1 m)
Principal Arterial	up to 8,500	65 (100 km/h)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

RUMBLE STRIPS

- Safety countermeasure for motor vehicle ROTR crashes
- Can render shoulder unrideable

RUMBLE STRIPS

- Minimum clear path
  - 4 feet
  - 5 feet adjacent to curb
- Periodic gaps
  - Minimum length 12 feet
  - Interval 40 – 60 feet
- Gaps at intersections
  - 10 – 20 feet prior to cross-street or driveway
- Bicycle tolerable (?) rumble strips


Gravel
15 ft

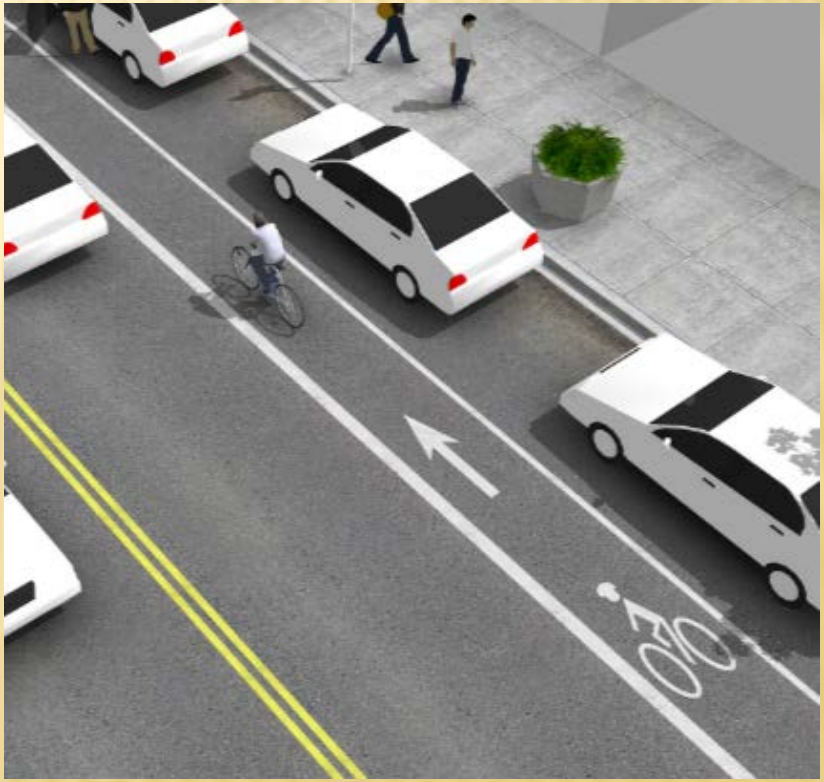
Benton County, Oregon

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

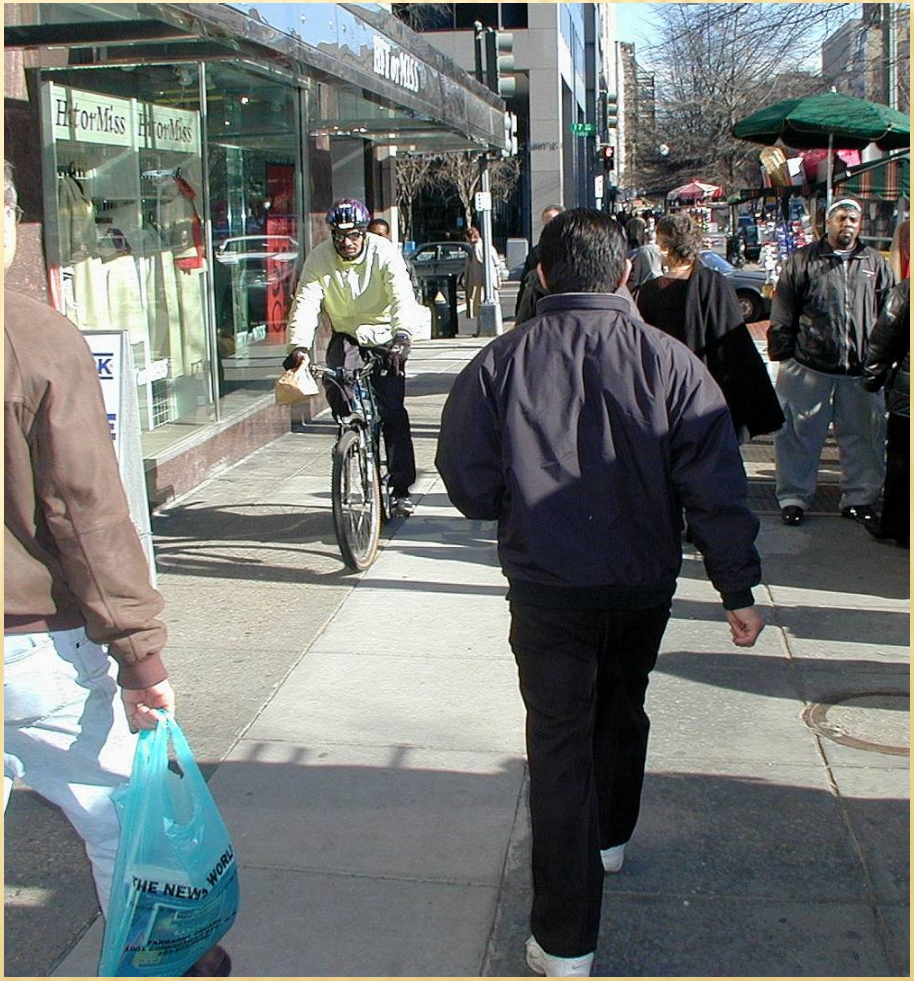
Geneva, Switzerland

ADVANTAGES

- Guide cyclists behavior
  - Visible
  - Predictable

ADVANTAGES

- Reduce pedestrian conflicts
- Improve visibility at driveway conflicts




News


RIDER


SSING

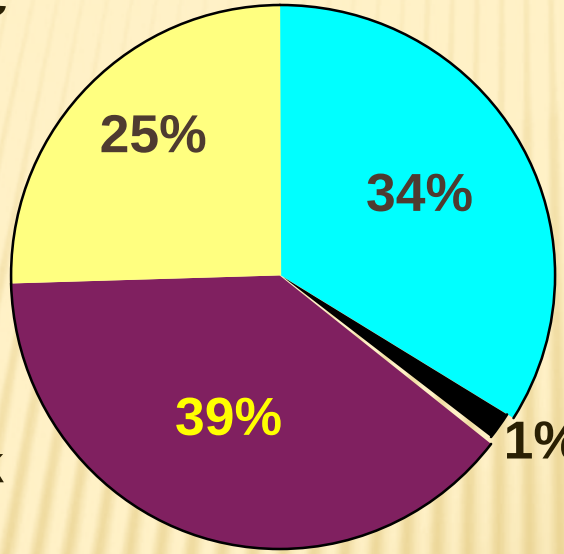

TIRE
GMC

EFFECT ON RIDER CHOICE

Riders on sidewalk against traffic

Riders on road with traffic

Total sw riders: 64%



Riders on sidewalk with traffic

Riders on road against traffic

Riders at sites with sidewalks & no bike lanes

RELATIVE DANGER INDEX

Facility	Relative Danger Index
Major Streets w/out bike lanes	1.28
Minor Streets w/out bike lanes	1.04
Streets with bike lanes	0.5
Mixed-use paths	0.67
Sidewalks	5.32

1.00 = median

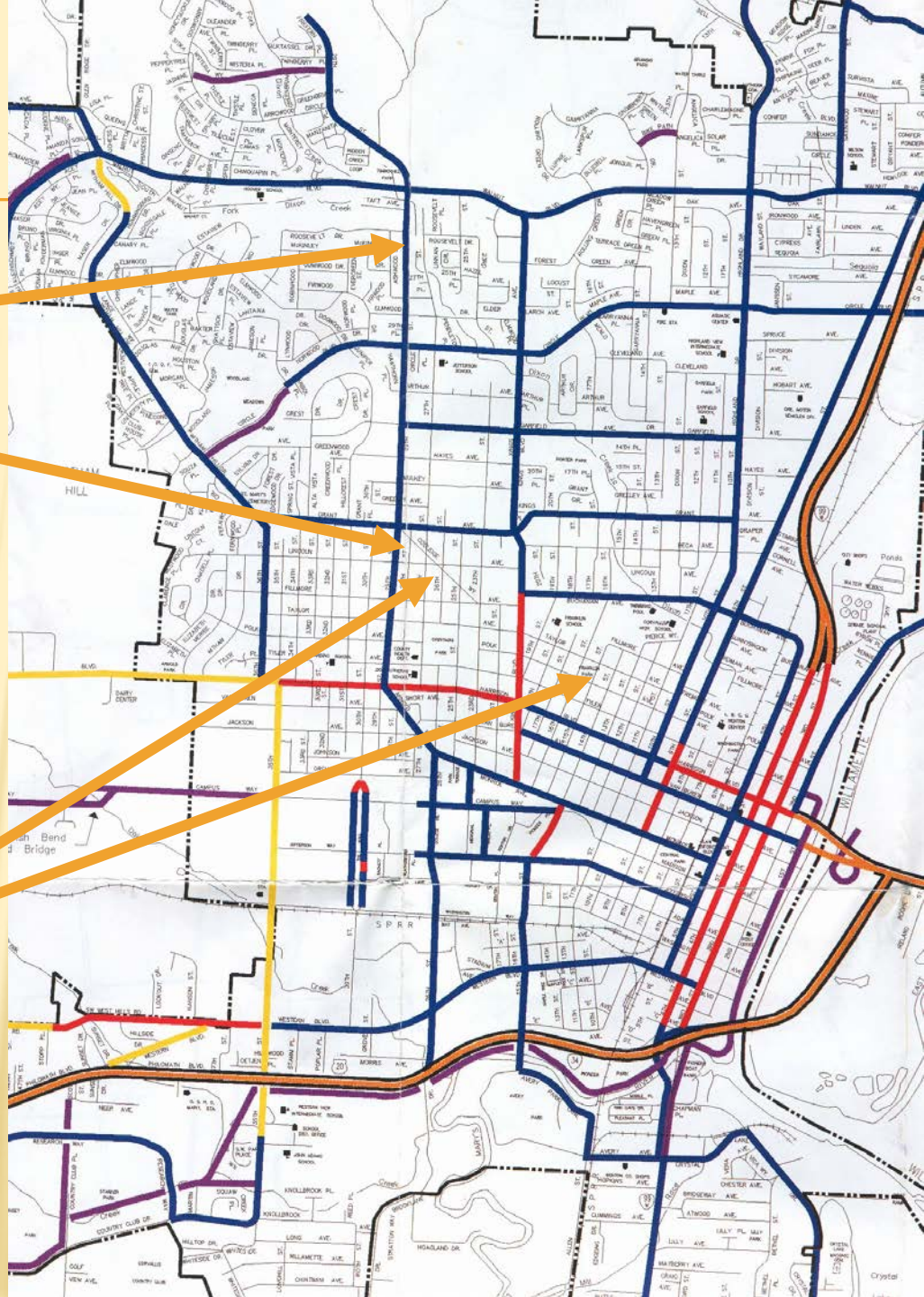
* Typical shared roadway

DISADVANTAGES

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

BIKE LANES

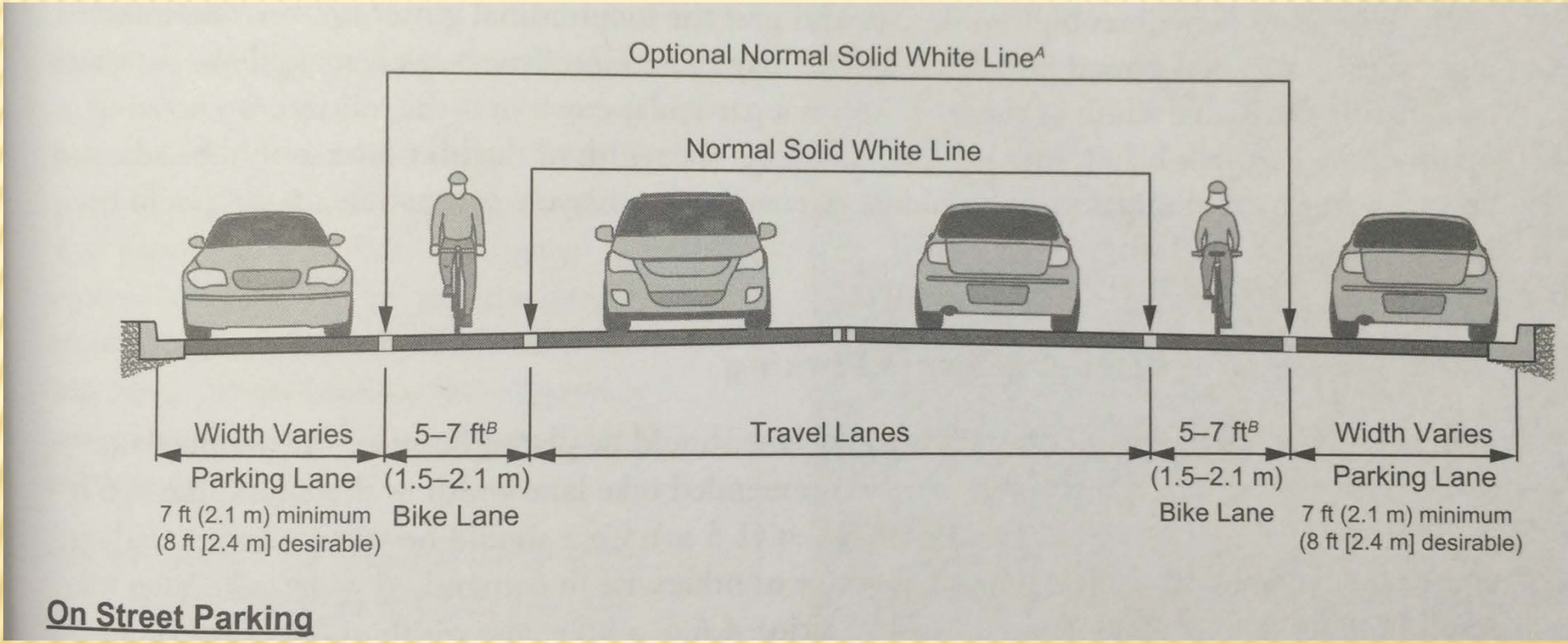
- Urban thoroughfares
- Efficient cross-town travel
- Stop or signal control
- Little point on local streets



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

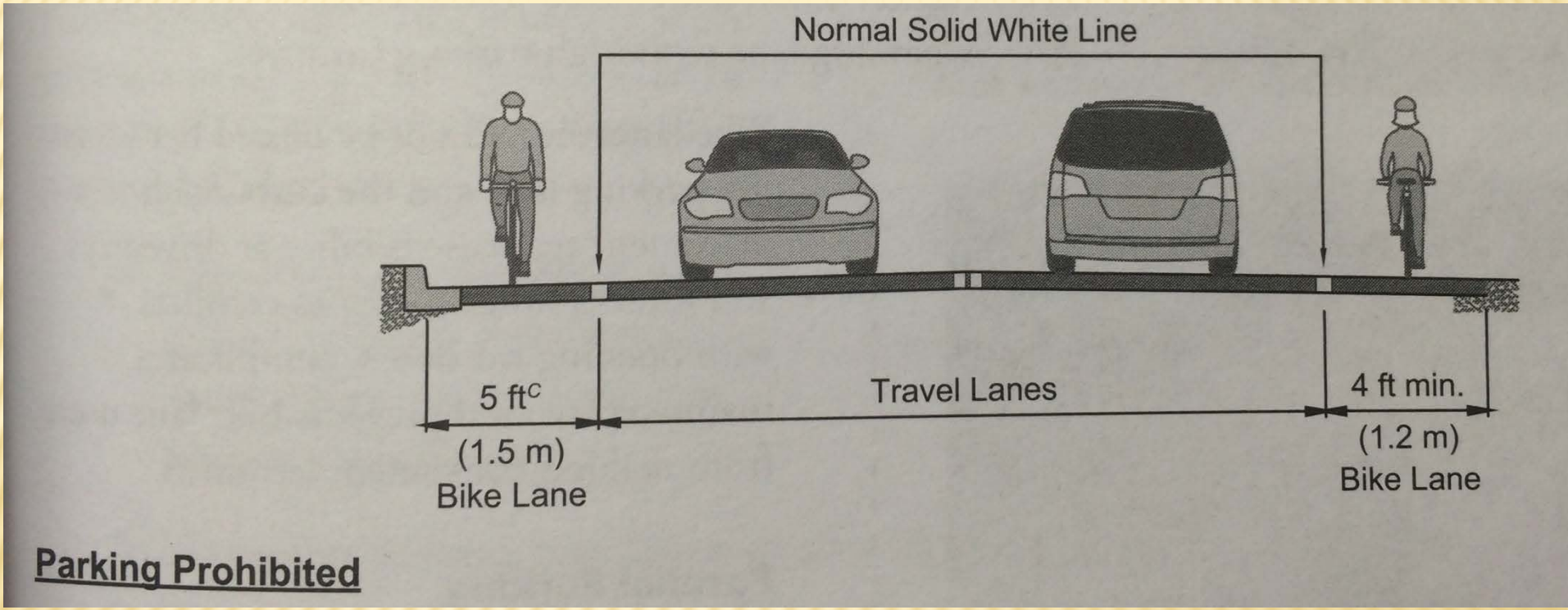
BIKE LANE WIDTH

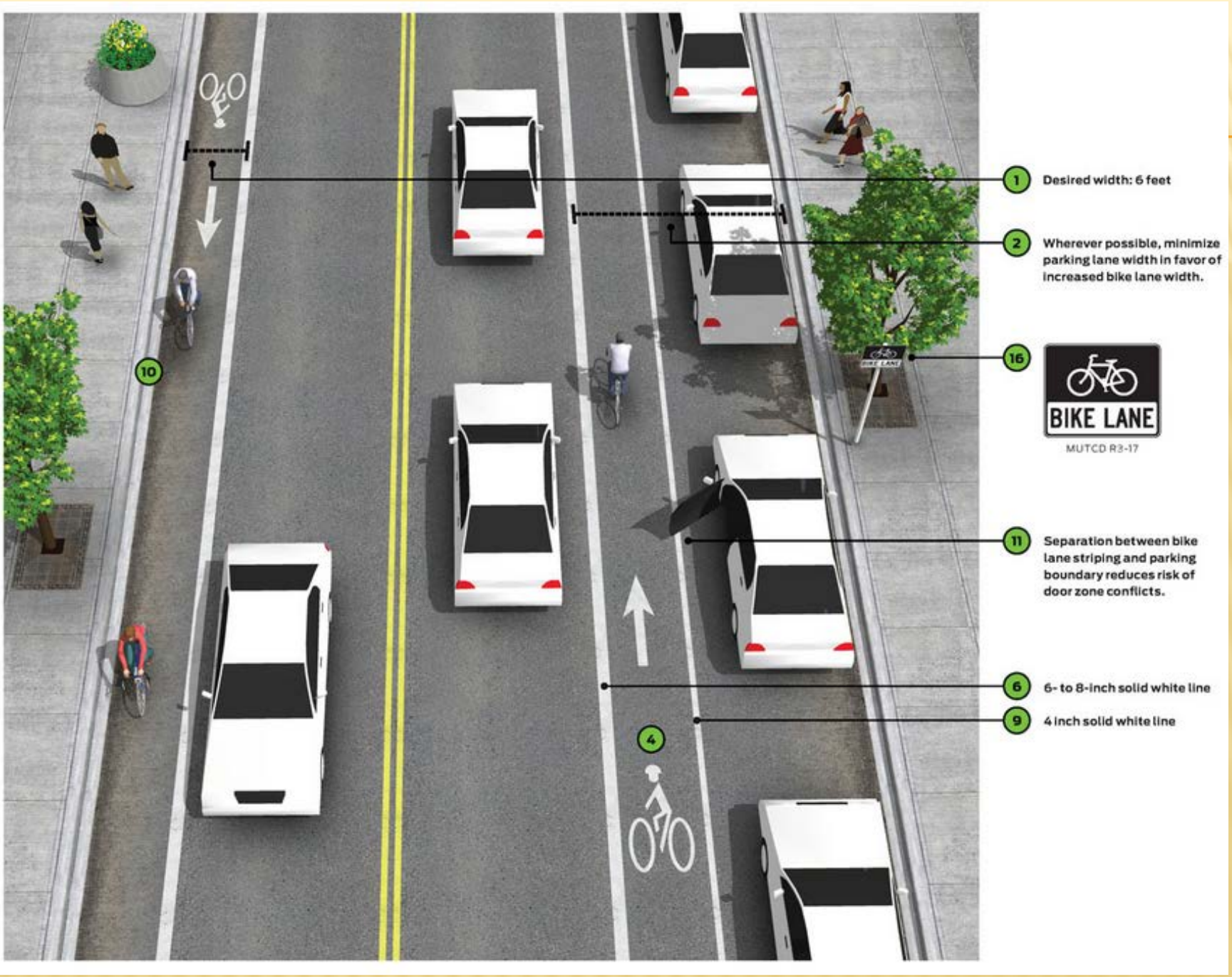


Desirable: 7 feet

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

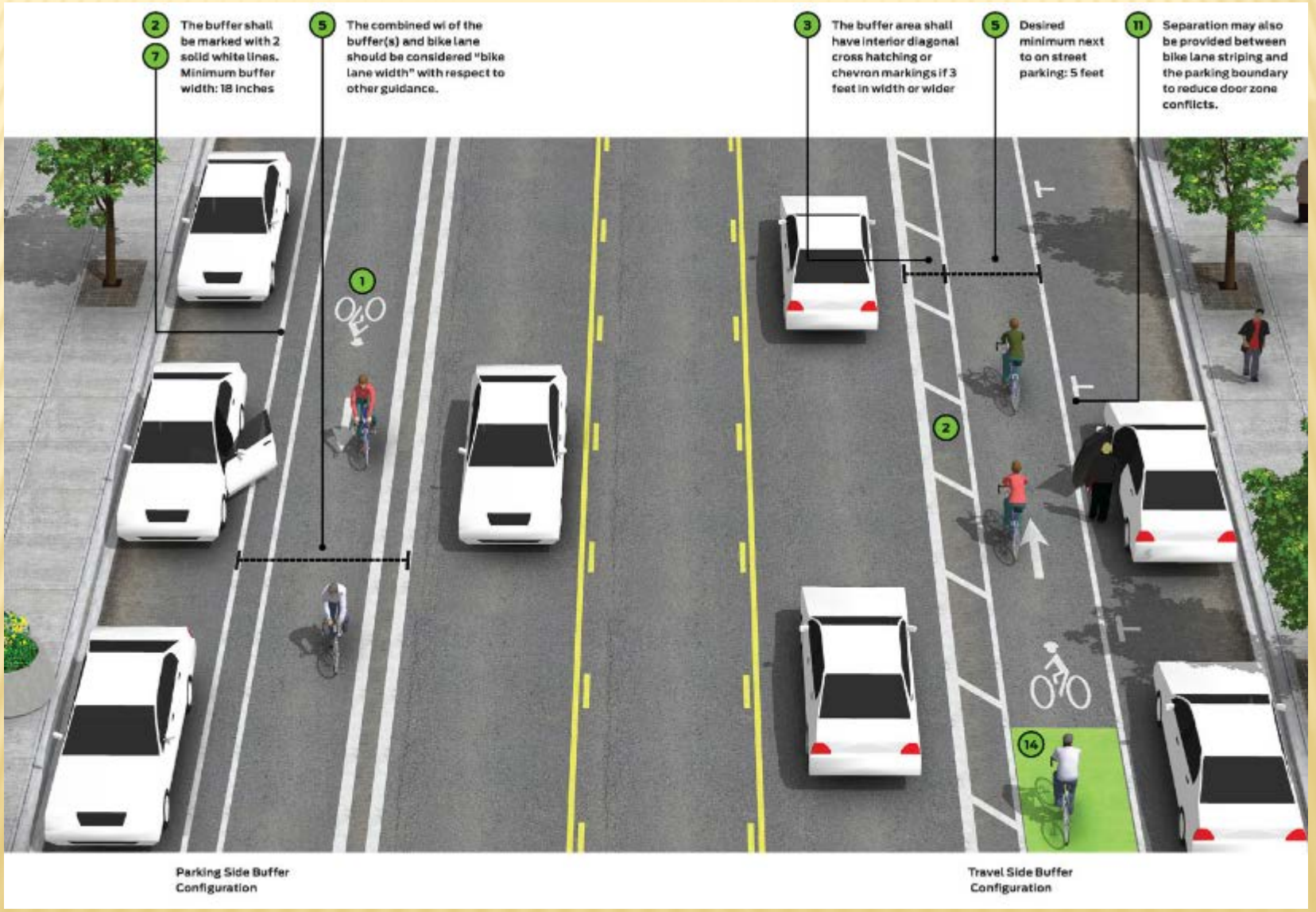
GUTTER PAN

- 4 ft preferred
- 3 ft minimum

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

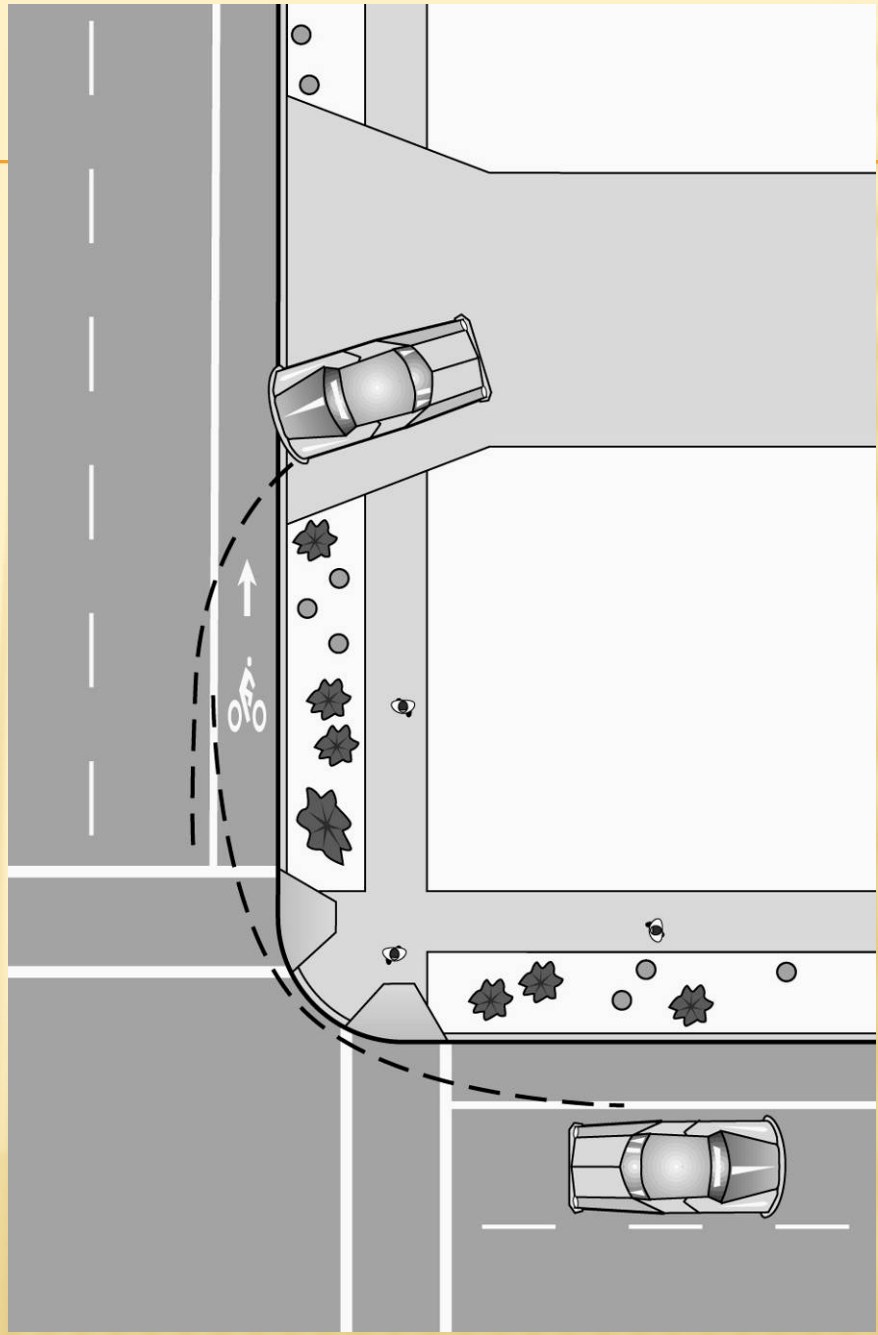
- Longitudinal marking required
  - Solid white line between bikes & motor vehicles
  - Line recommended between bikes & parking
- Symbols at beginning & interval
- Signs

PAVEMENT MARKINGS

Both sides preferred

PAVEMENT MARKINGS

- Avoid premature wear




ONLY
BIKE


BIKE

SIGNING

- Beginning, end, & interval
- Optional

1988

2000

2009

SIGNING

R3-17aP

R3-17bP

SIGNING

CONTRA-FLOW BIKE LANE

Reasons for:

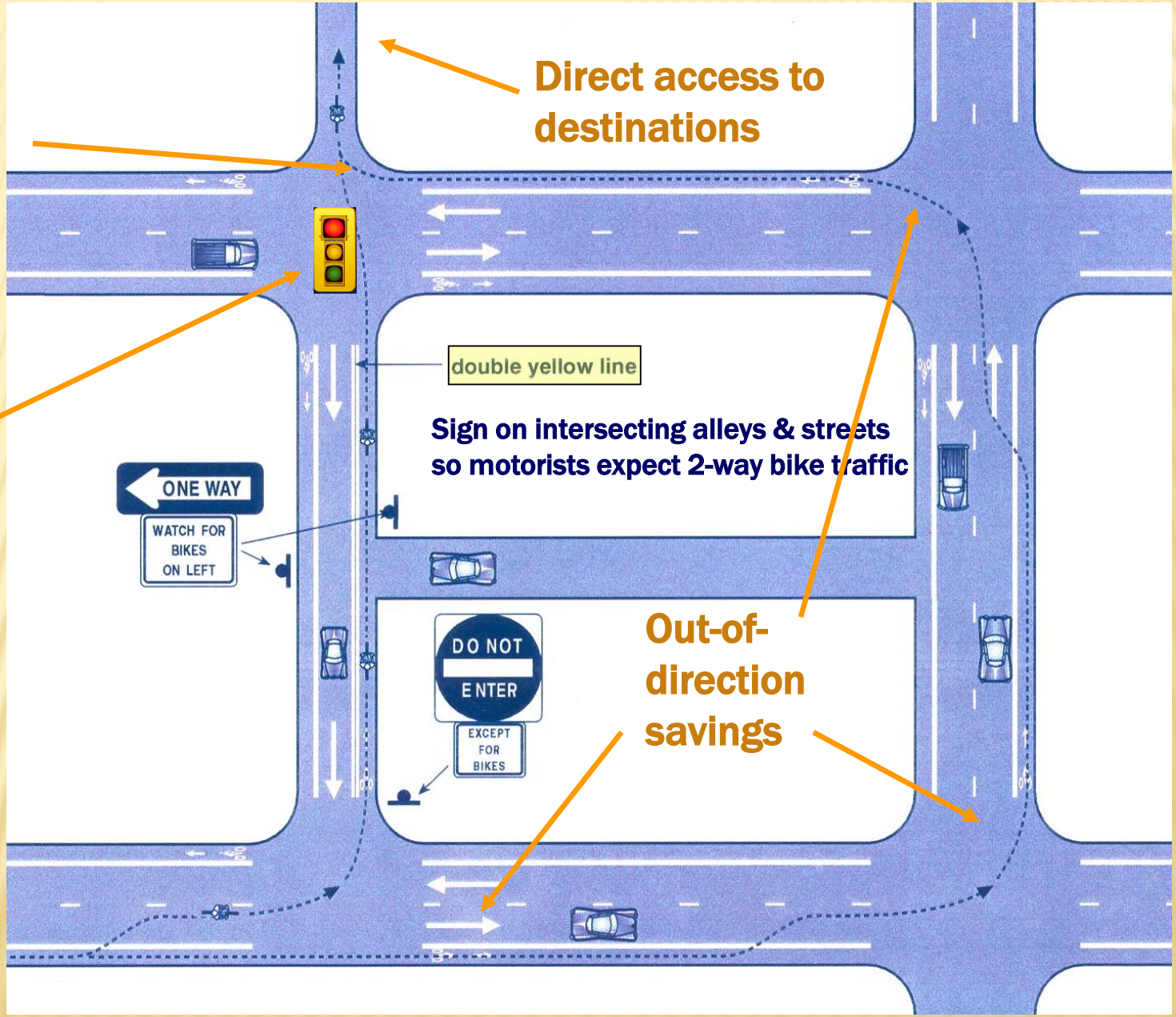
- Continuity on one-way
- Avoid conflicts
- Maximize space

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

BIKE LANE PLACEMENT

- Both sides of two-way streets

BIKE LANE PLACEMENT

- Exception – may omit on downhill

BIKE LANE PLACEMENT

- Add shared-lane for uphill
  - discourage wrong-way

BIKE LANE PLACEMENT

- Between parking and travel lane

BIKE LANE PLACEMENT

- Right side of one-way

BIKE LANE PLACEMENT

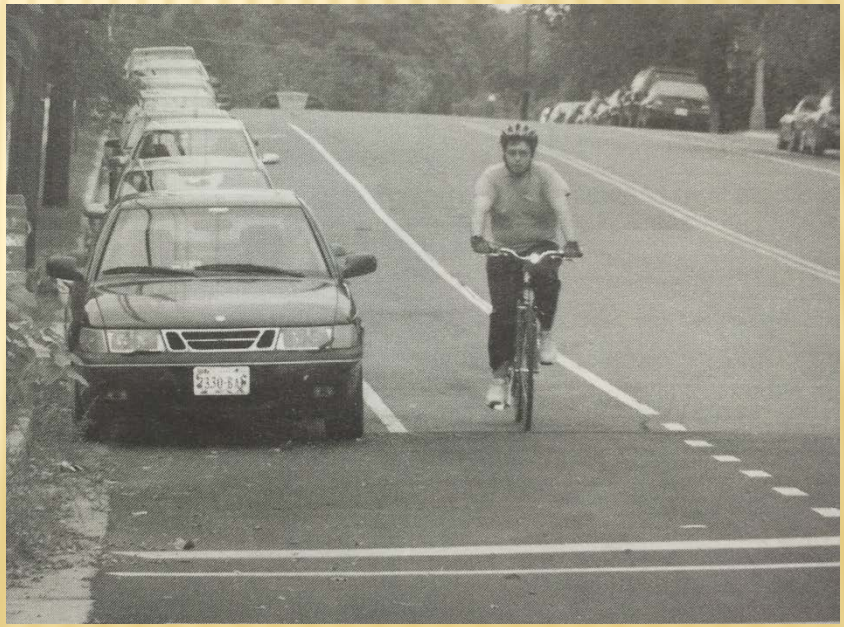
- Exception—left side to avoid conflicts

BIKE 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

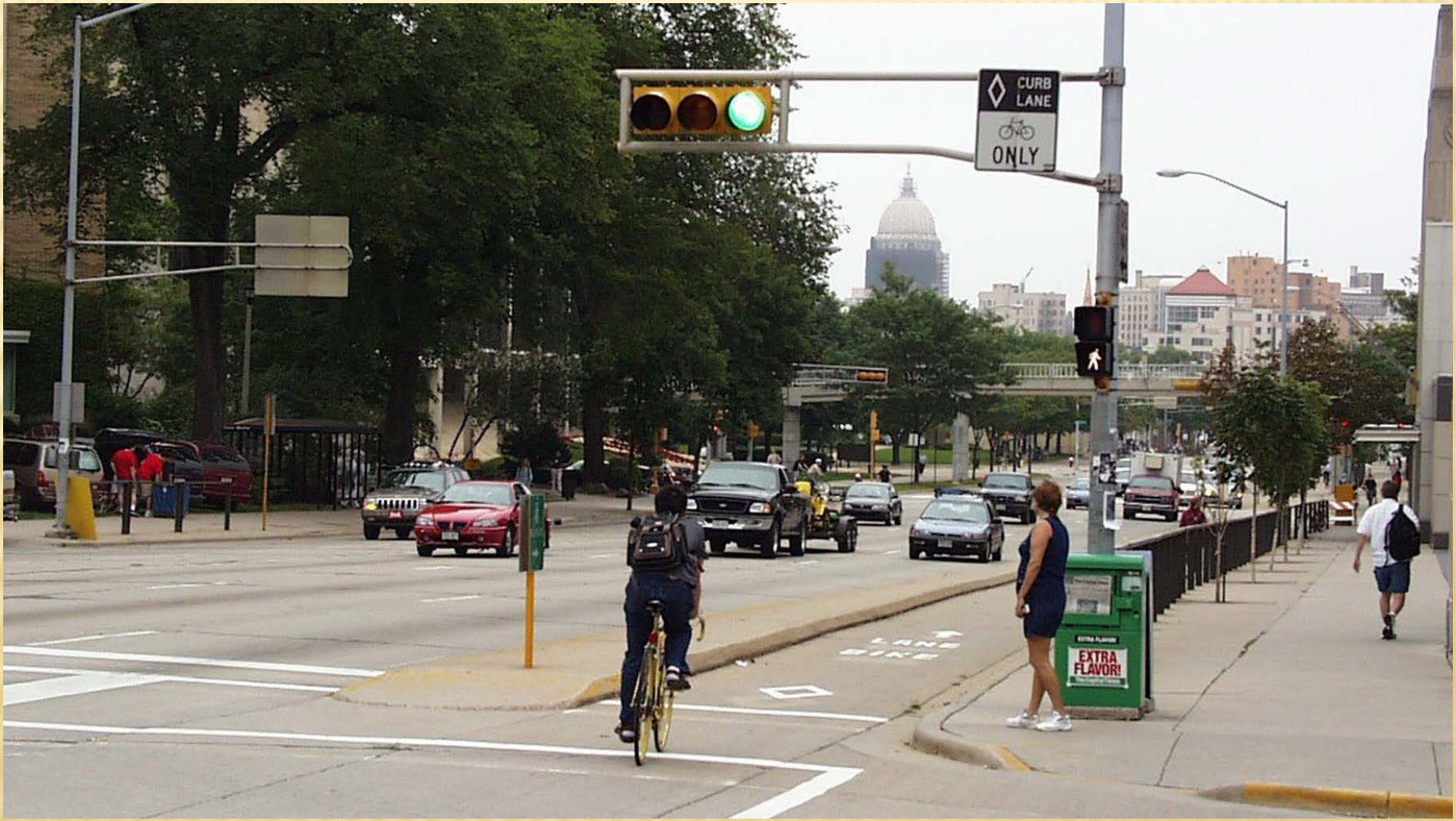
SEPARATED BIKE LANES

Mid-block (LTS 1)

SEPARATED BIKE LANES

Mid-block (LTS 1)

SEPARATED BIKE LANES



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

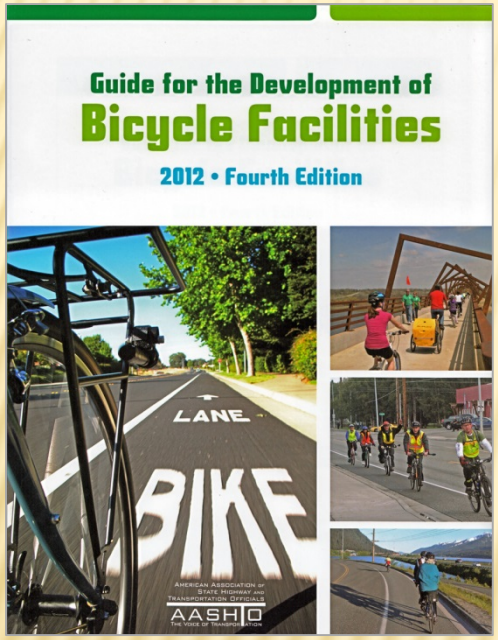
Disadvantages

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

SEPARATED BIKE LANES

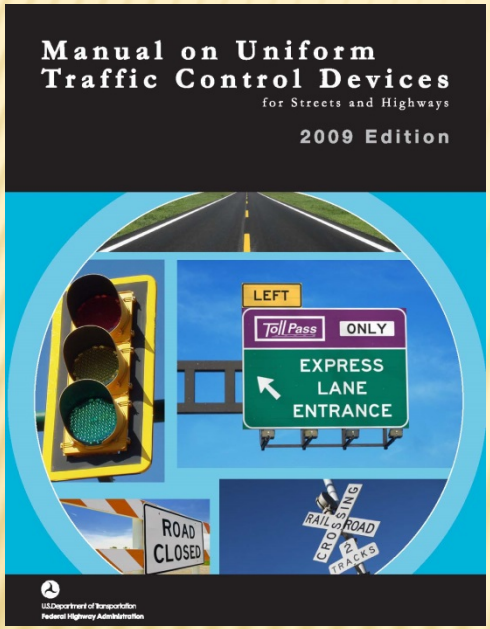
- Exclusive bike facility
- Adjacent to or on roadway
- One-way or contra-flow
- Separated from traffic by vertical element
  - Delineators
  - Bollards
  - Barrier
  - Median
  - Raised bike lane
  - Planters
  - Wheel stops
  - Parked cars

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

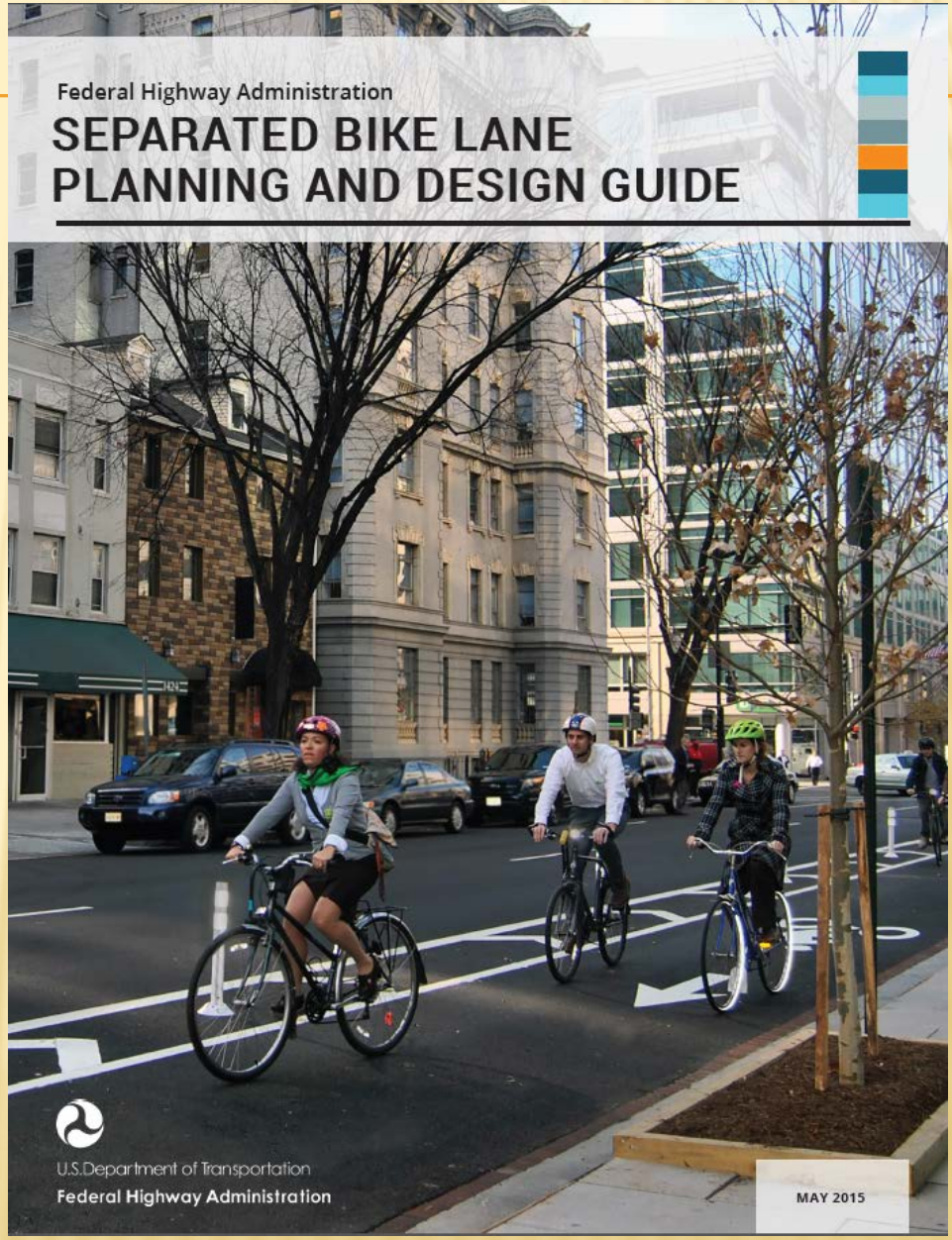


- Follow combination of shared use path & bike lane guidance (chapter 9)
  - Bike lane signs
  - Bike lane and path markings
  - Bike lane extensions
  - Signal placement
  - Contra-flow

Look beyond current MUTCD

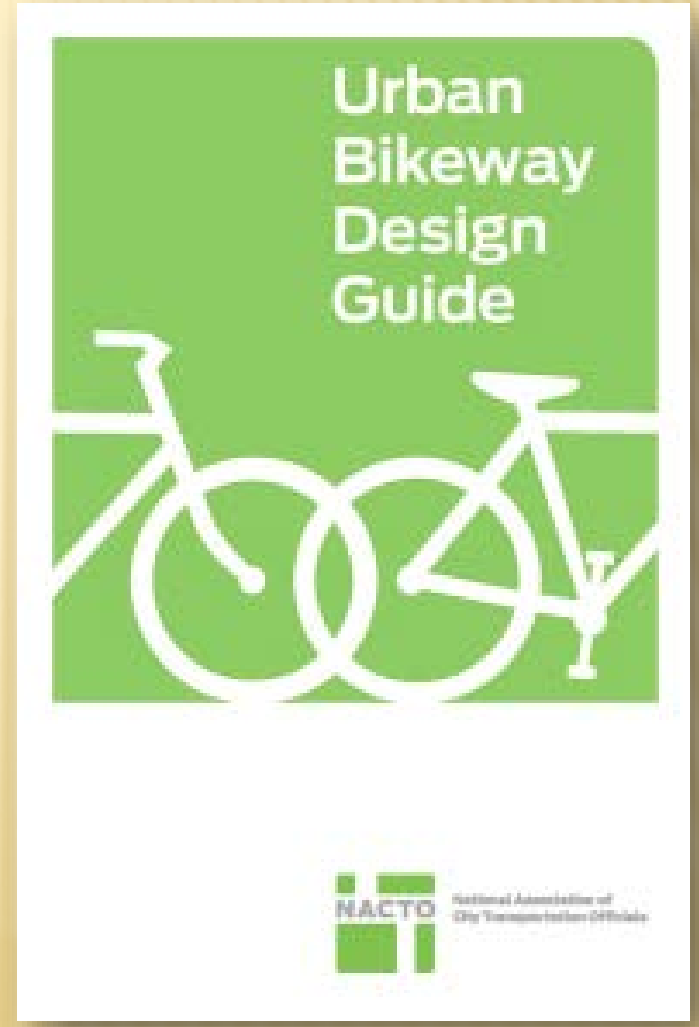
DESIGN GUIDANCE

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



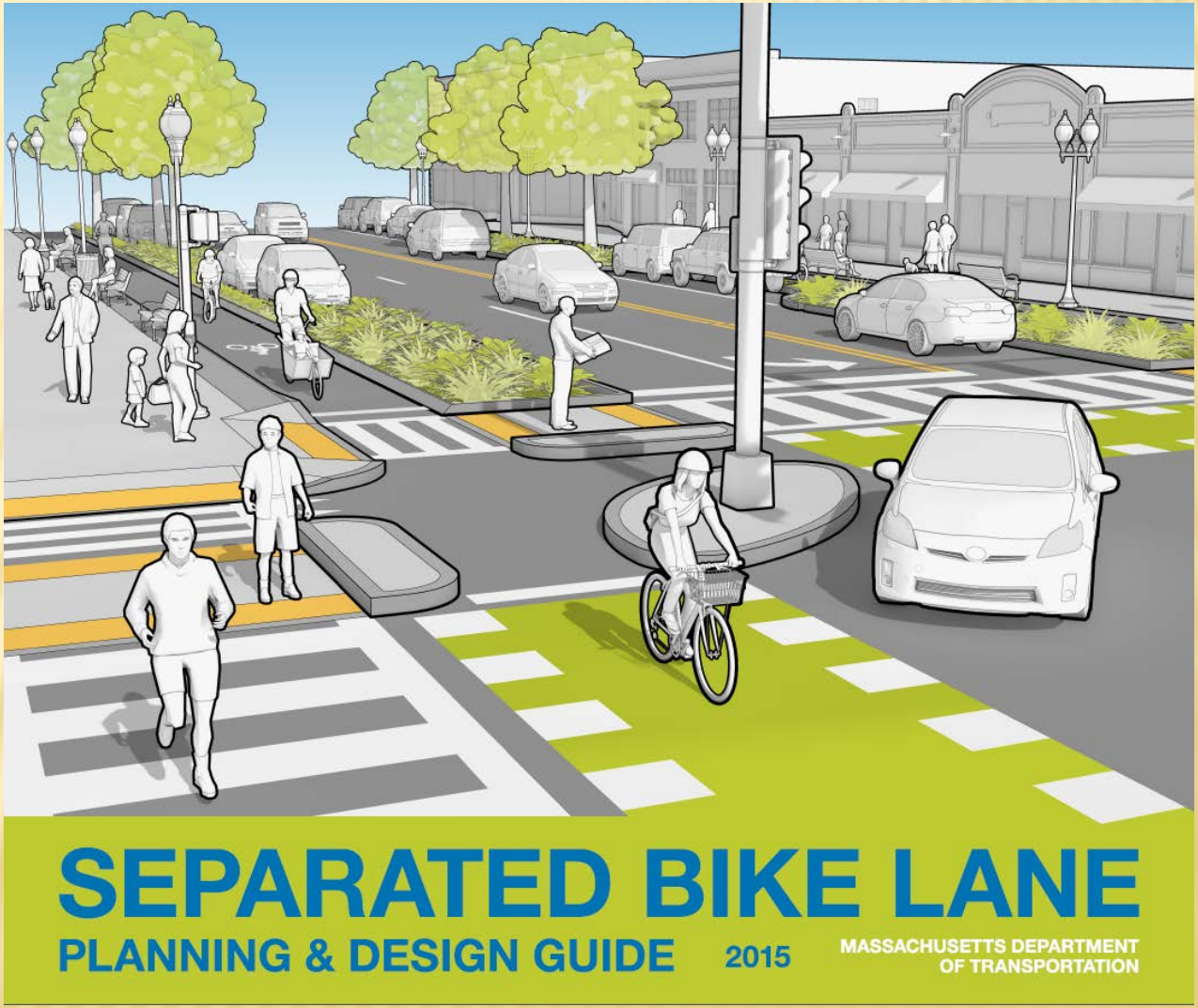
DESIGN GUIDANCE

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



DESIGN GUIDANCE

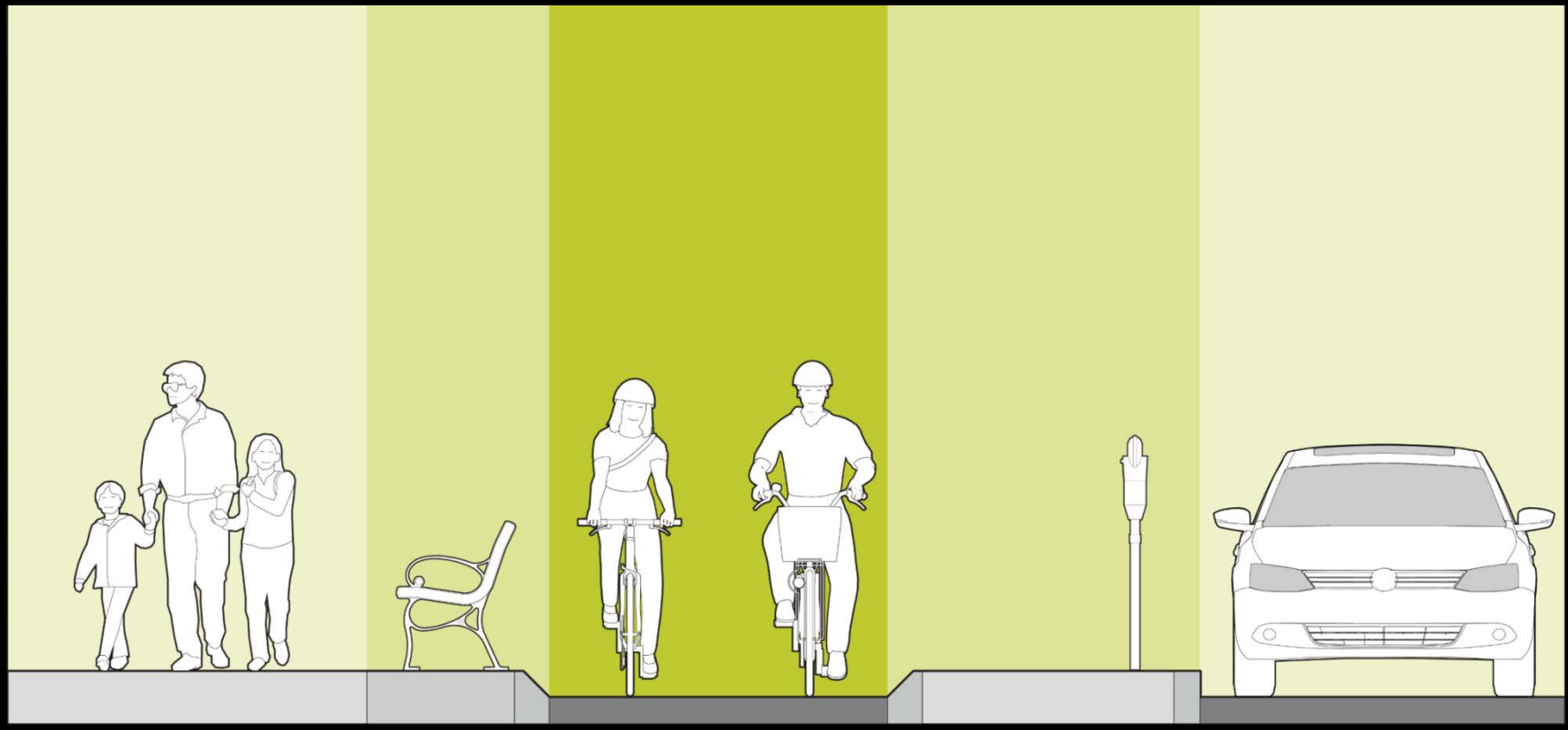
- MassDOT



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?

SEPARATED BIKE LANE ZONES



massDOT

BIKE LANE ELEVATION

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

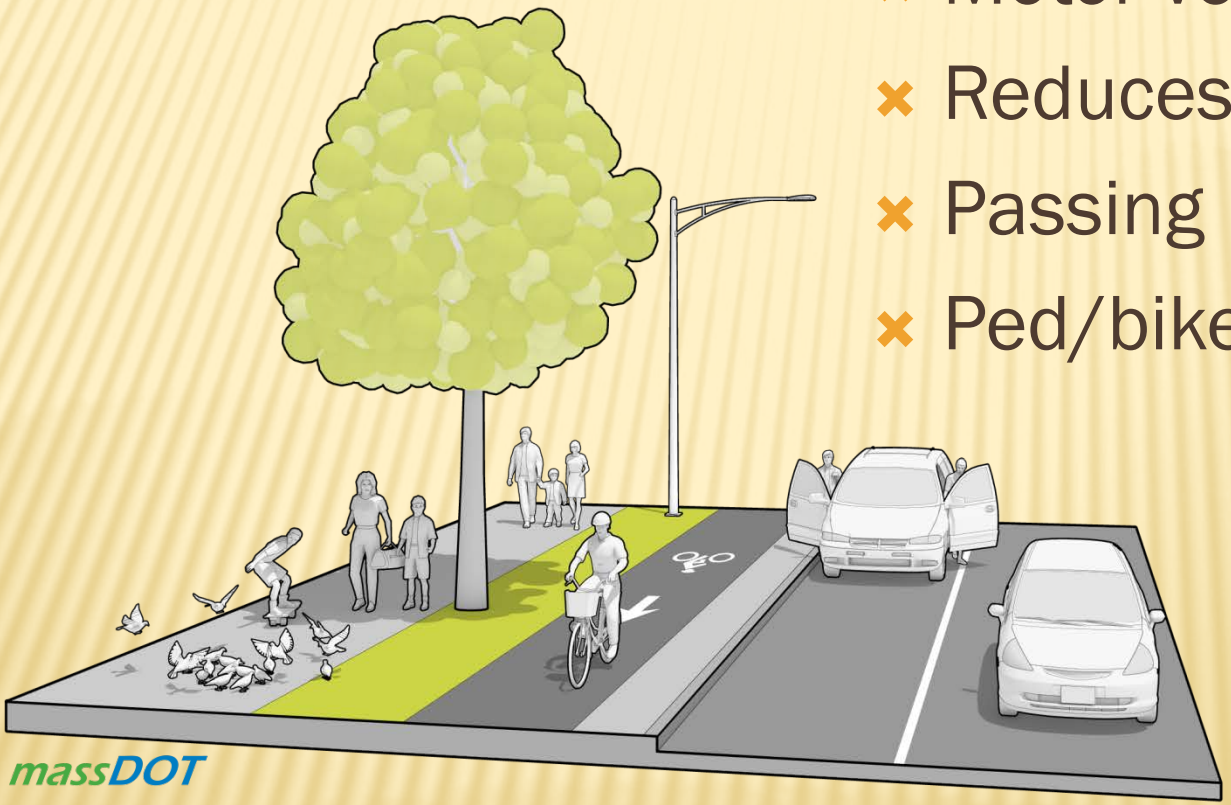
sidewalk level

intermediate level

street level

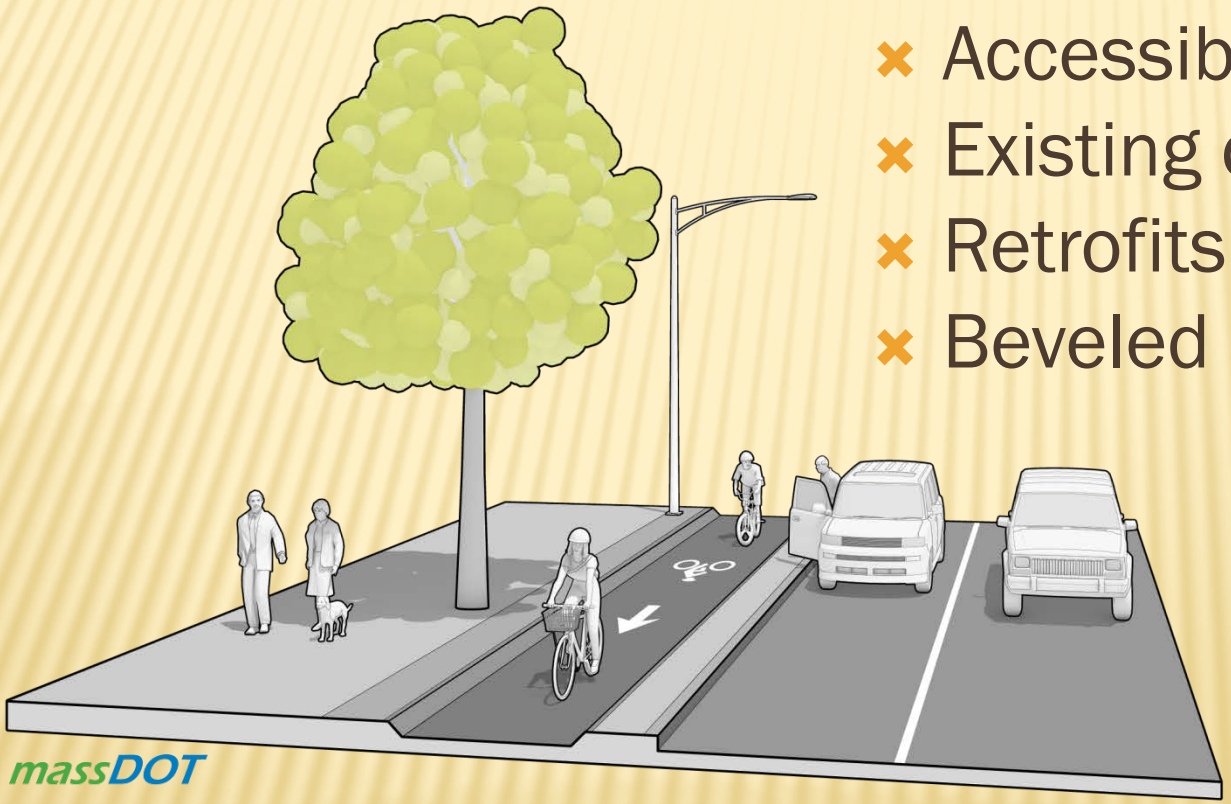
raised bike lane

SIDEWALK LEVEL



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

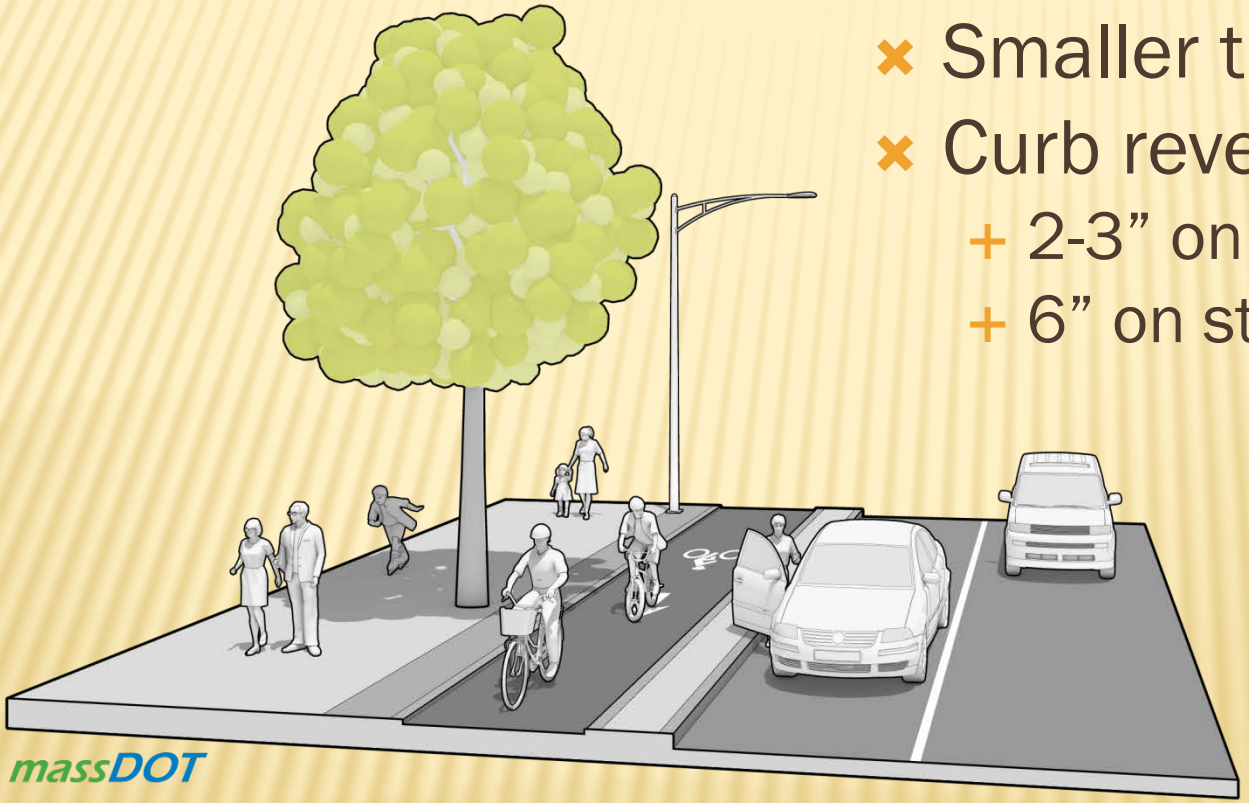
STREET LEVEL



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

INTERMEDIATE LEVEL

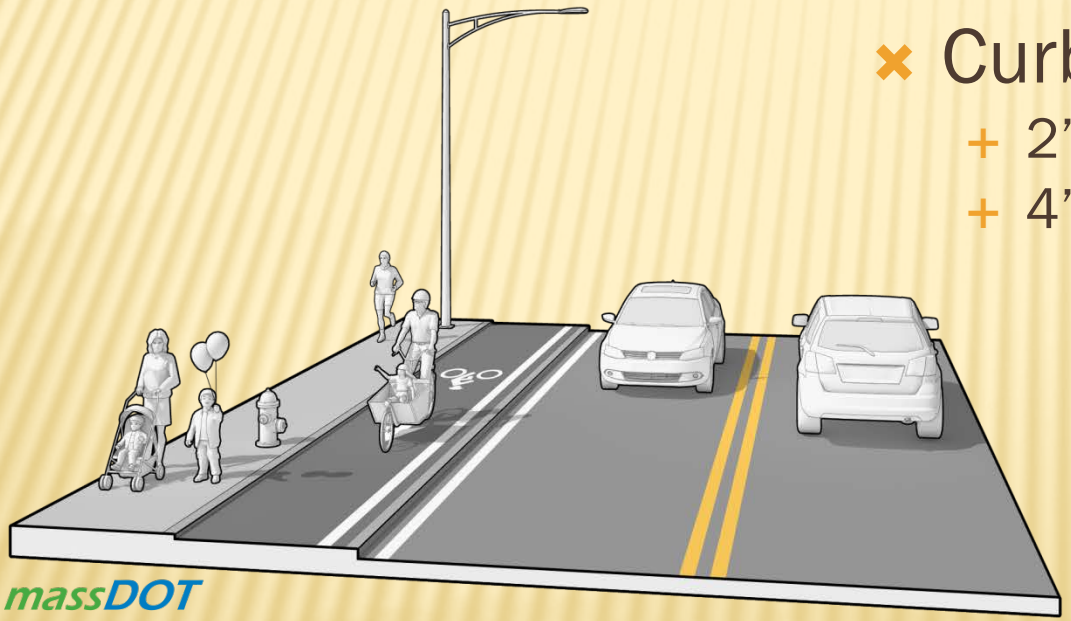
- Curb & drainage flexibility
- Smaller transitions
- Curb reveal:
  - 2-3” on bike lane
  - 6” on street



RAISED BIKE LANE

bike lane + buffer < 7 ft

- One-way
- No parking for two-way
- No protected intersection
- Curb reveal
  - 2” on bike lane
  - 4” on street

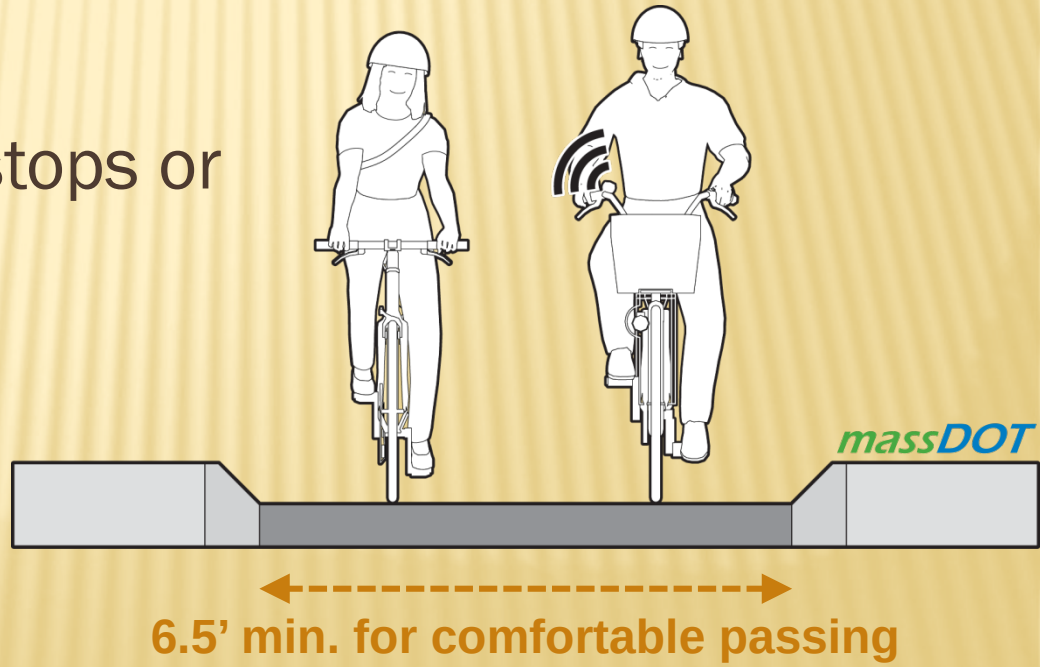


BIKE LANE WIDTH

- 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

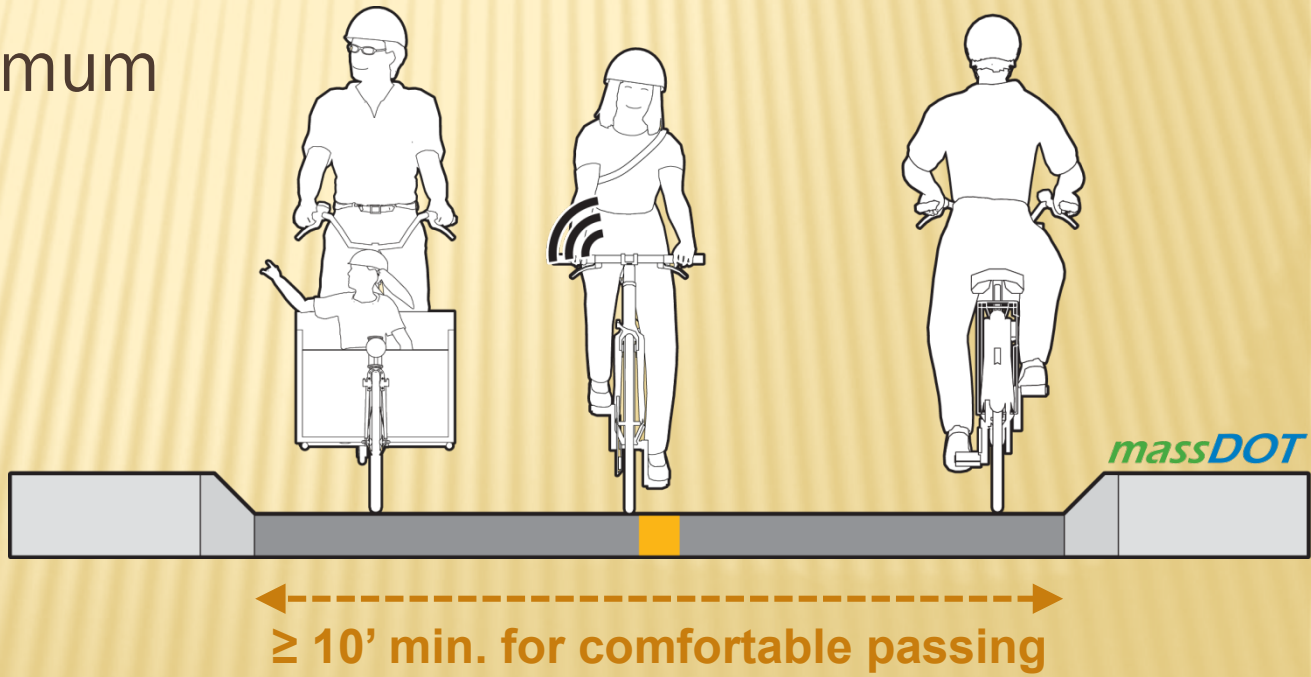


BIKE LANE WIDTH

- Two-way

Widths vary by peak hour volume

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



BIKE LANE WIDTH

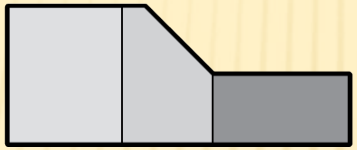
- Maintenance
  - Sweeping
  - Snow removal

VERTICAL ELEMENTS

Vertical

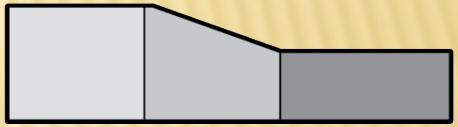
Beveled

1V:1H



Mountable

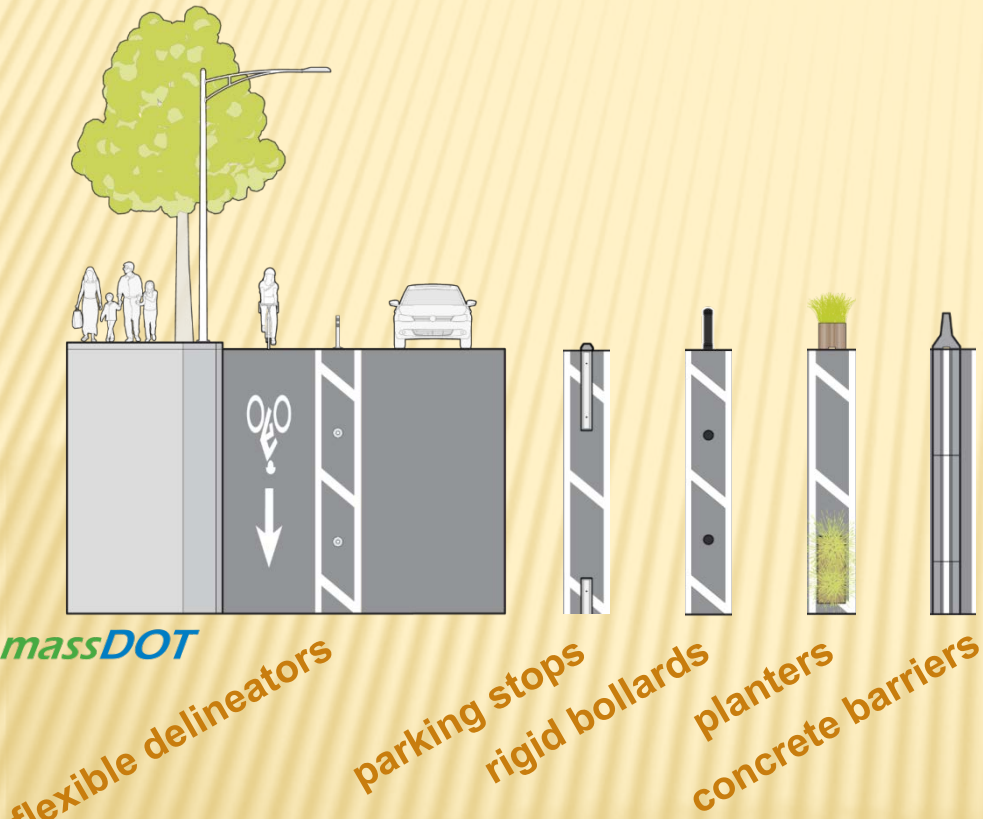
1V:4H



Curb angle & height influence:

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

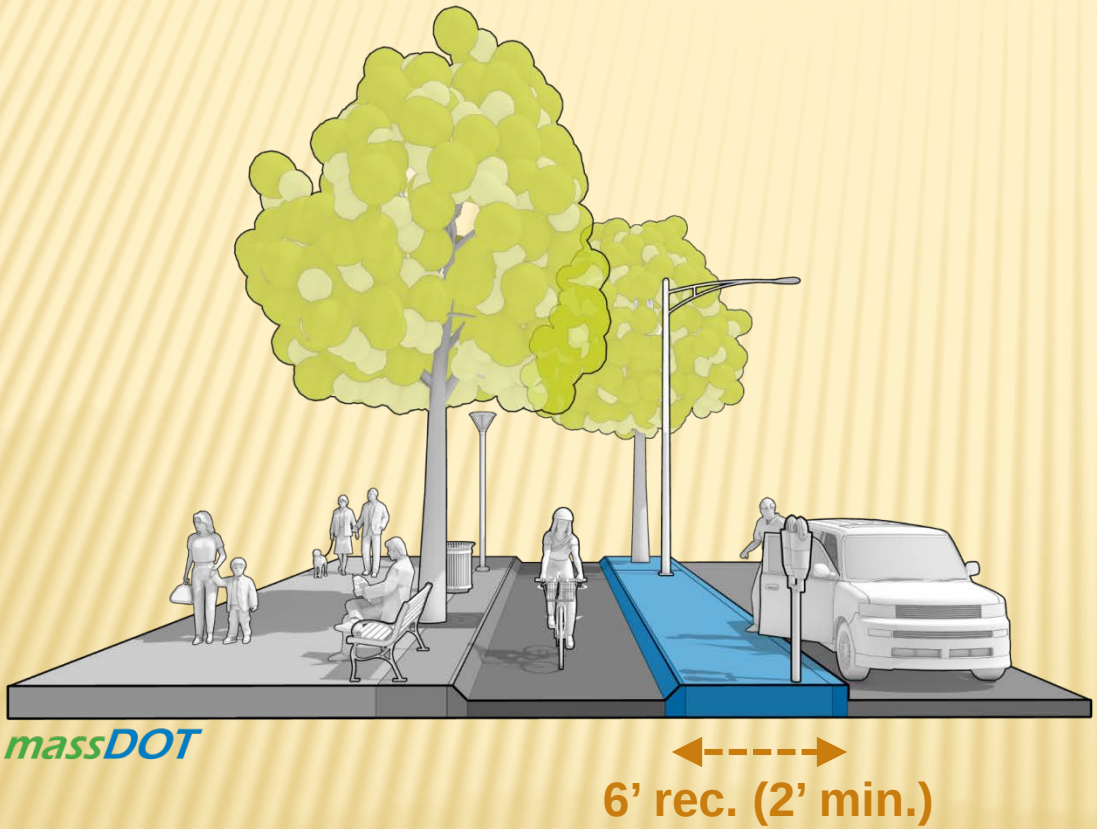
VERTICAL ELEMENTS



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

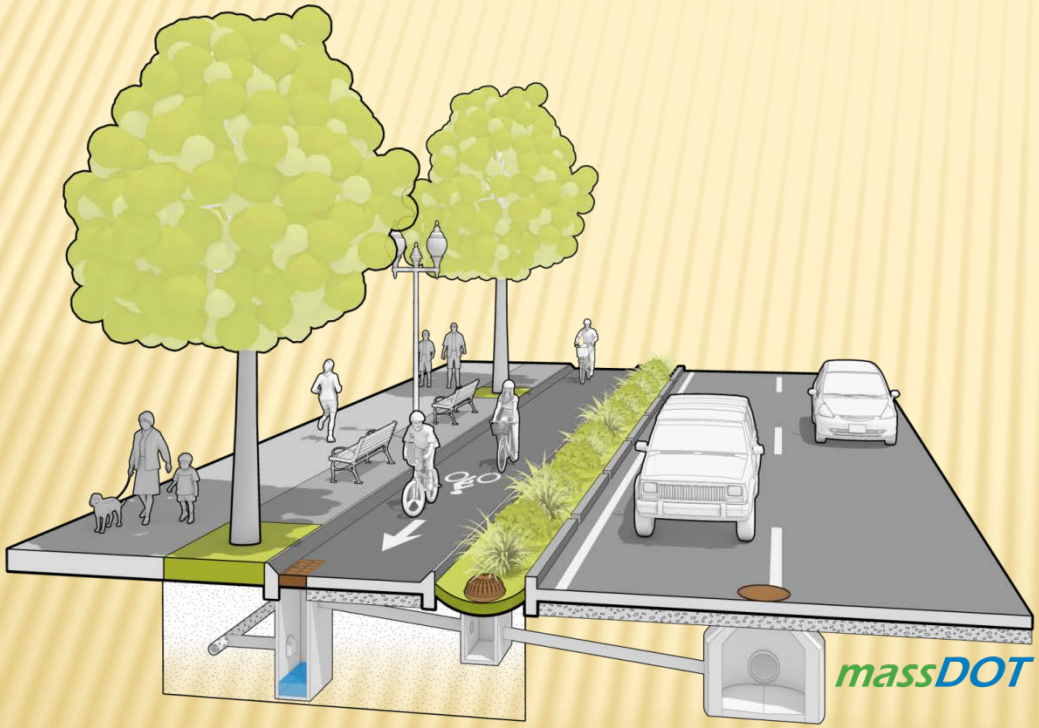

10

VERTICAL ELEMENTS



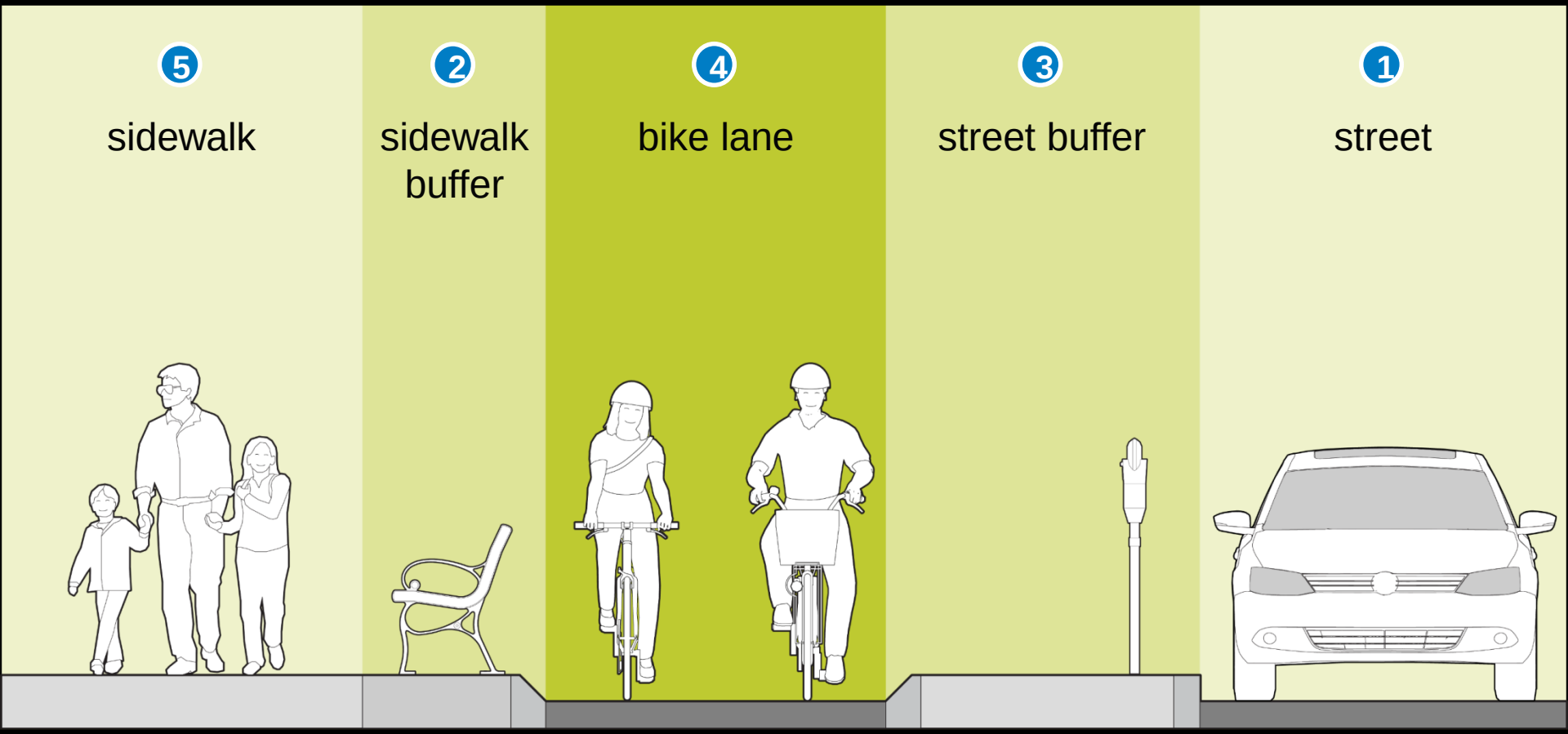
- Raised median
  - Any bike lane elevation
  - Higher cost
  - Considerations
    - Streetscape
    - Landscaping
    - Drainage

DRAINAGE



- Grates
- Stormwater management
  - Bike lane elevation
  - Roadway crown
  - Existing catch basins
  - Existing utilities
  - Median openings

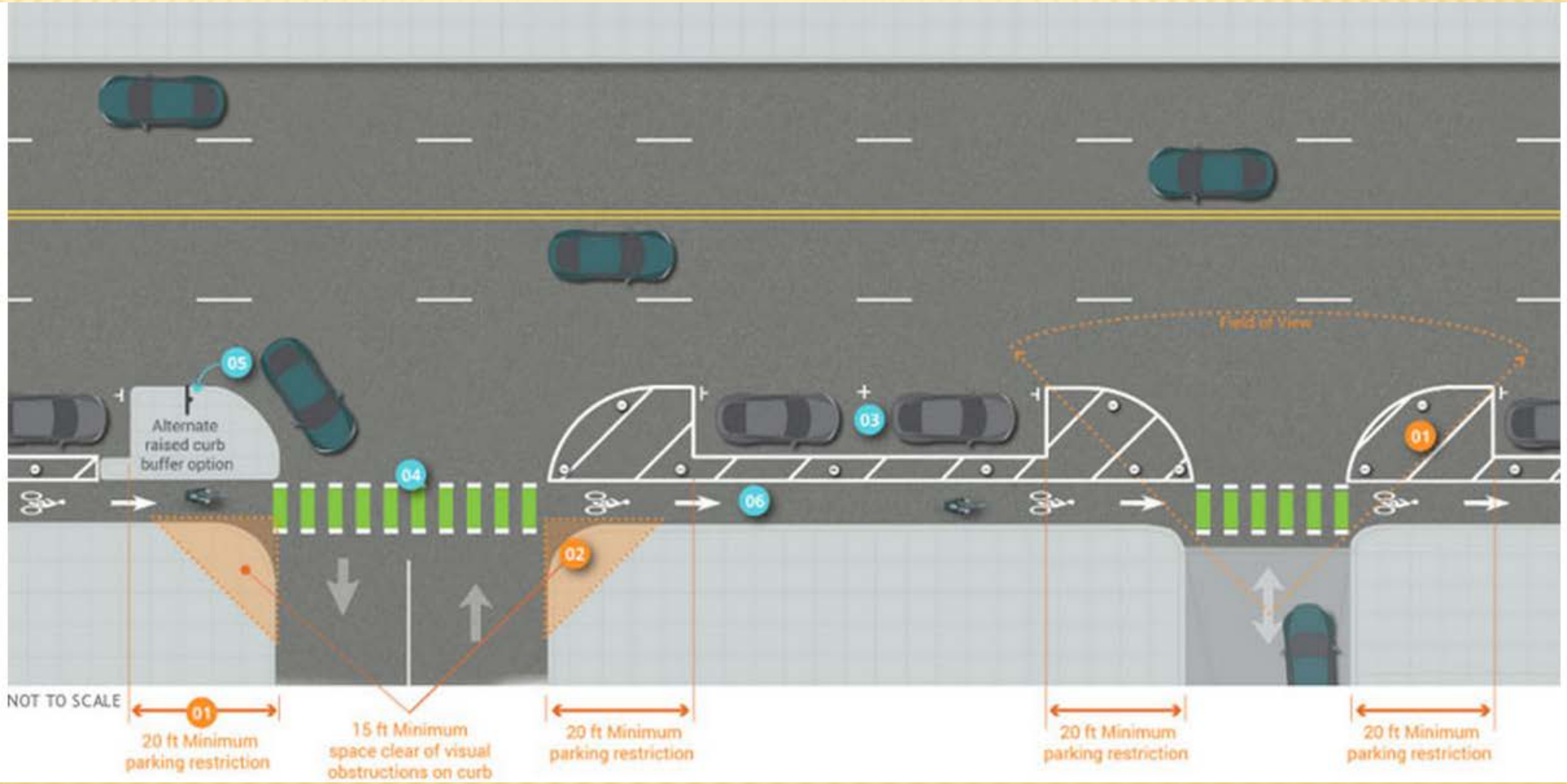
CONSTRAINED CORRIDORS



massDOT


10'
6'
7'
3'
7'
2'
10'
10'
2'
7'
3'
7'
6'
90'

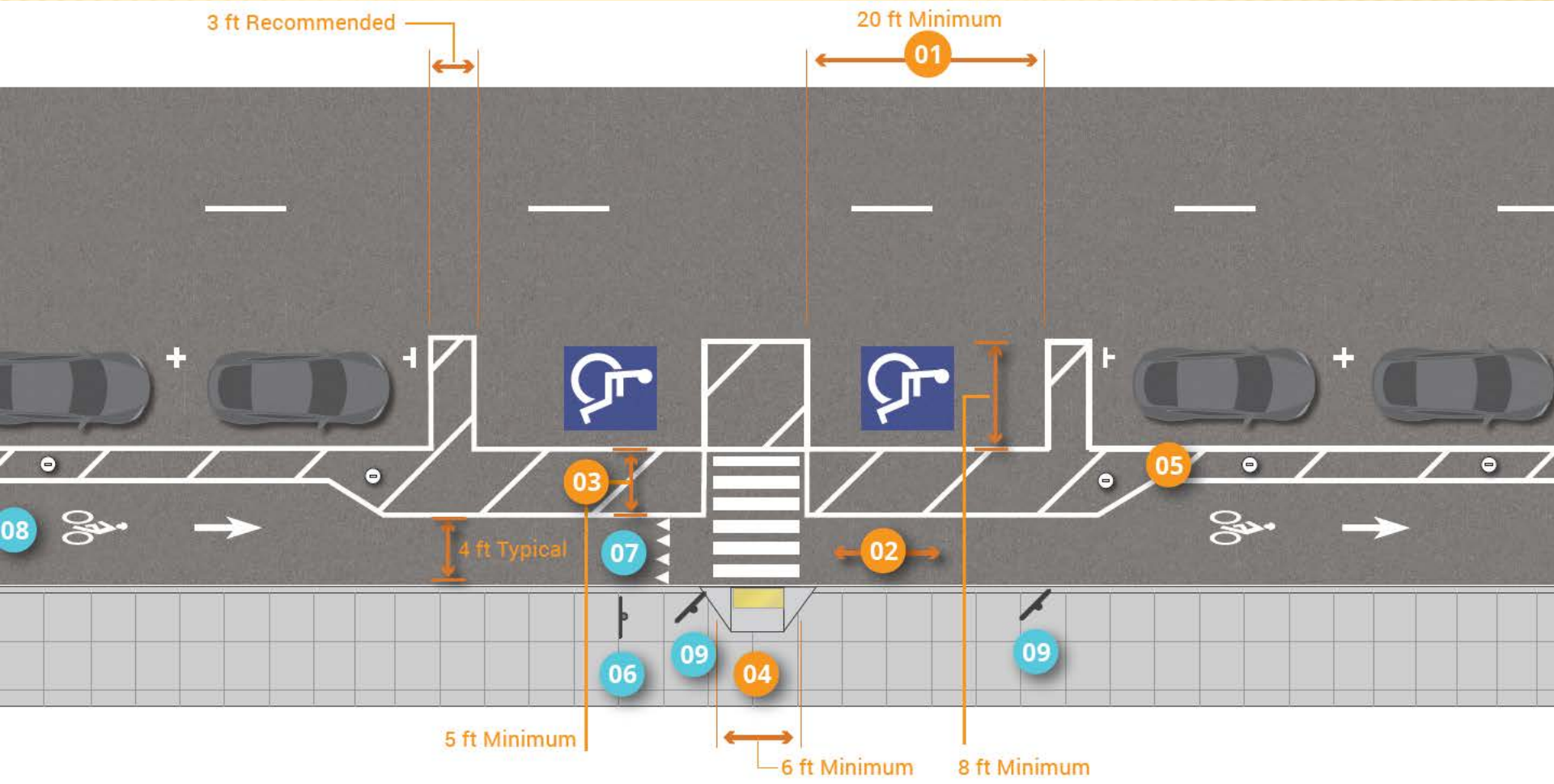
DRIVEWAYS


Alternate raised curb buffer option
05
04
03
06
02
01
Field of View
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

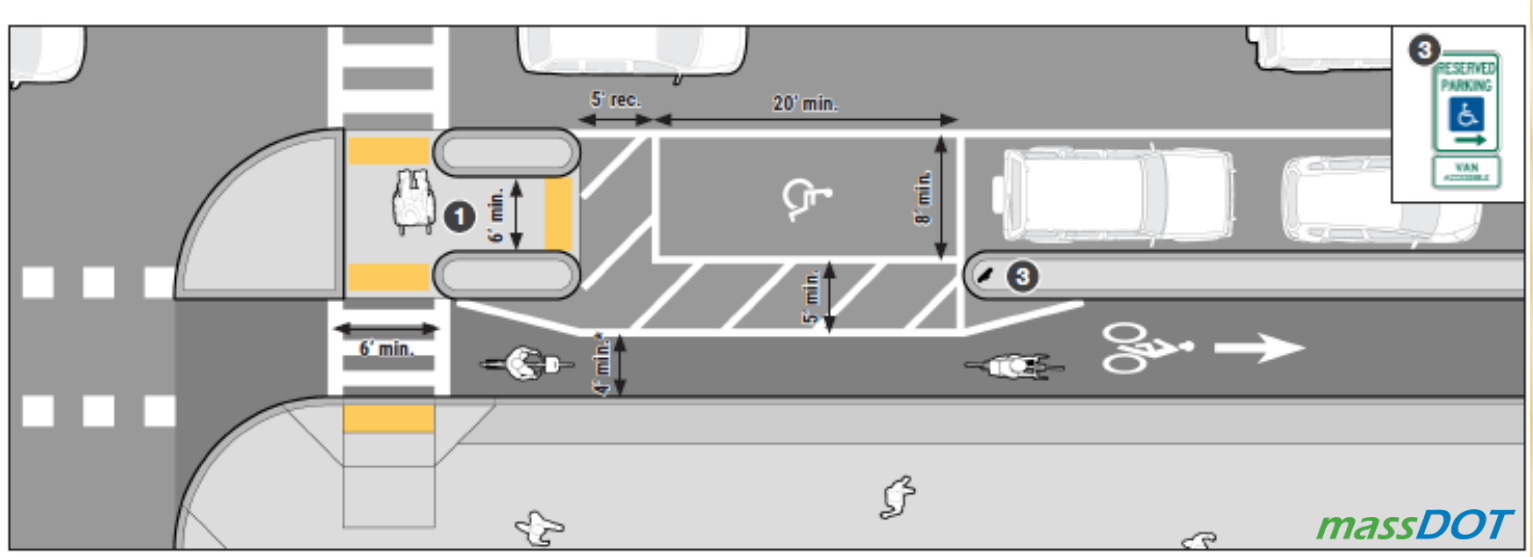
CURBSIDE ACTIVITY

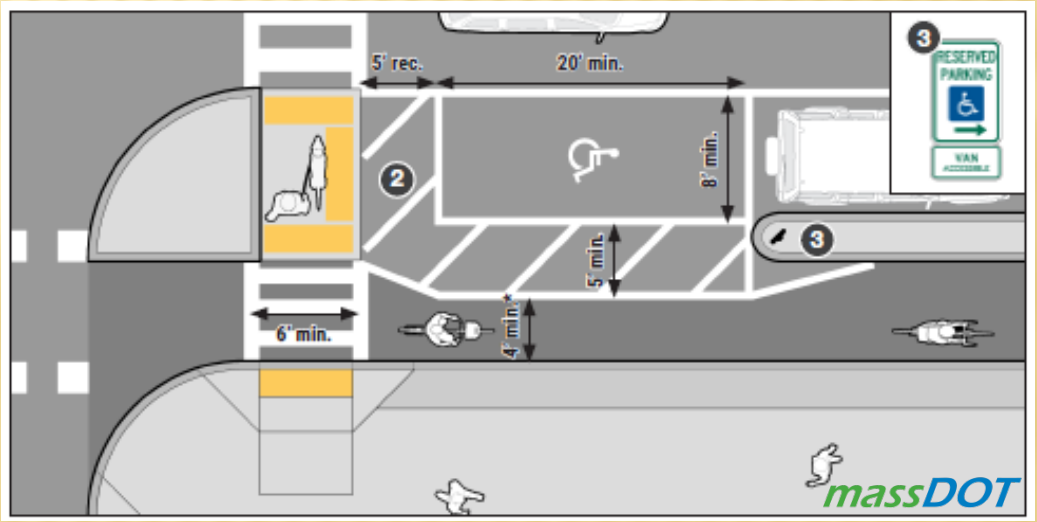
- Motor vehicle parking
- Loading zones
- Bike parking
- Bus stops

ACCESSIBLE PARKING

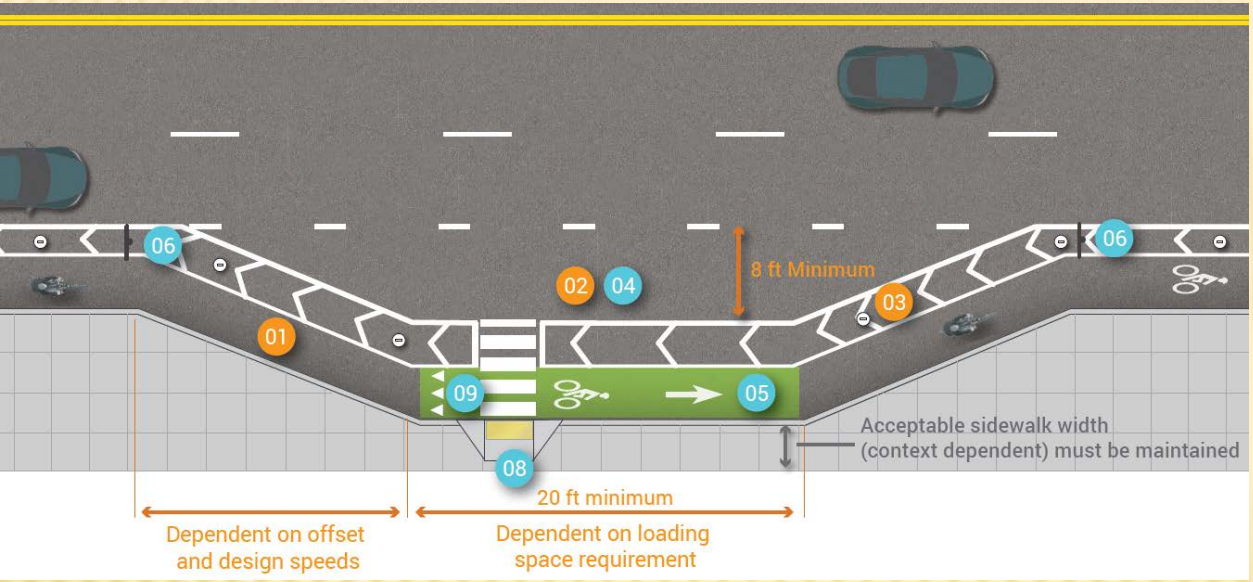


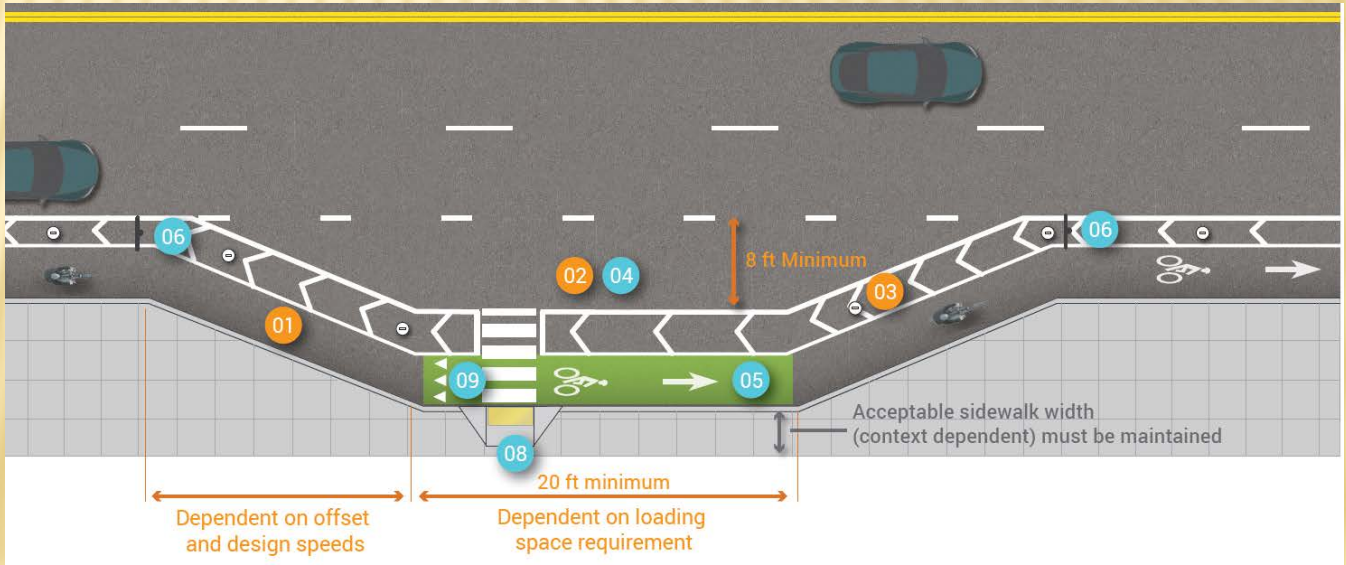
ACCESSIBLE PARKING



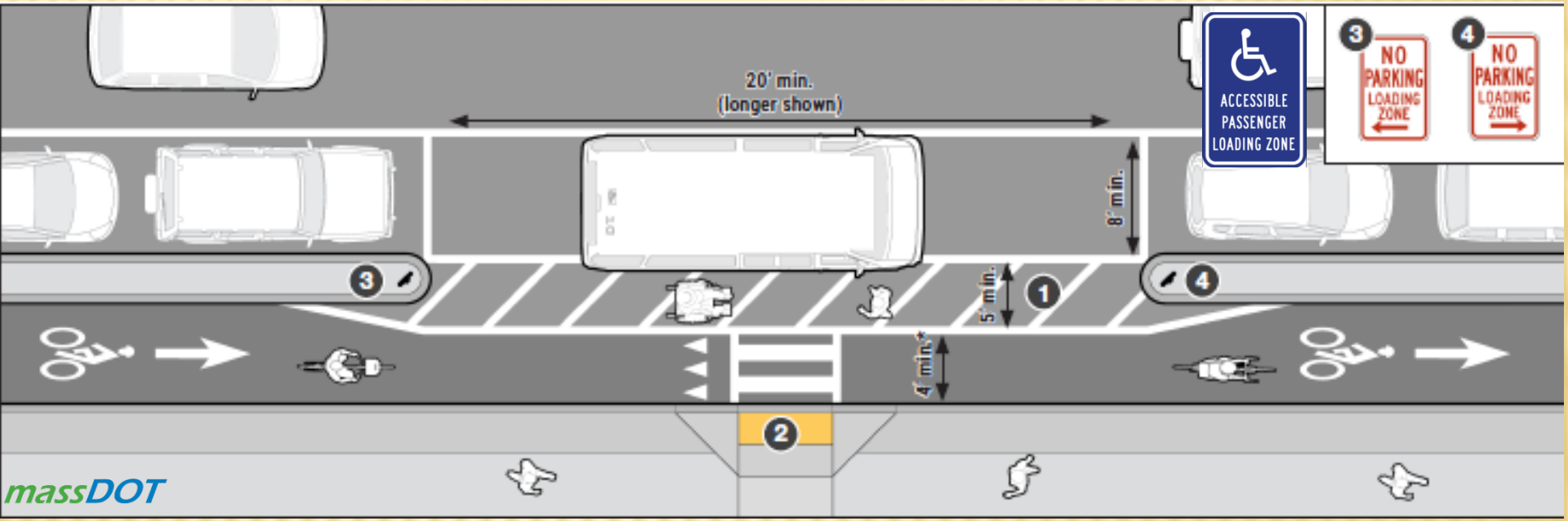


LOADING ZONES

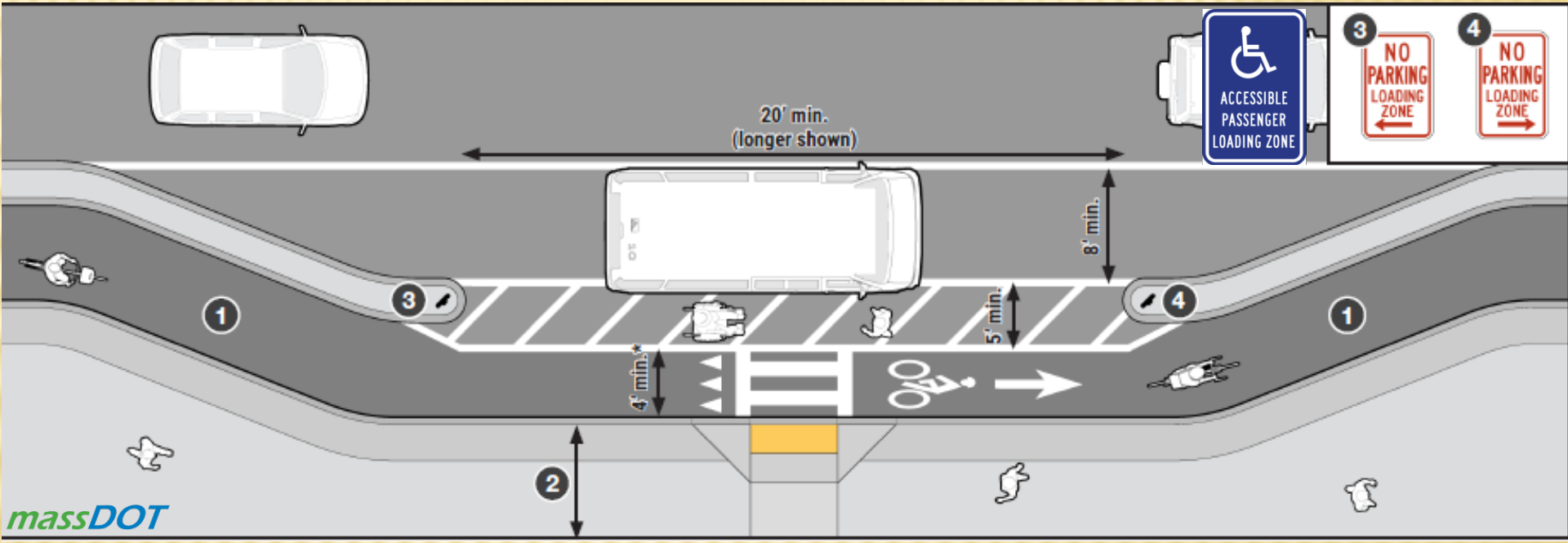




ACCESSIBLE LOADING ZONE



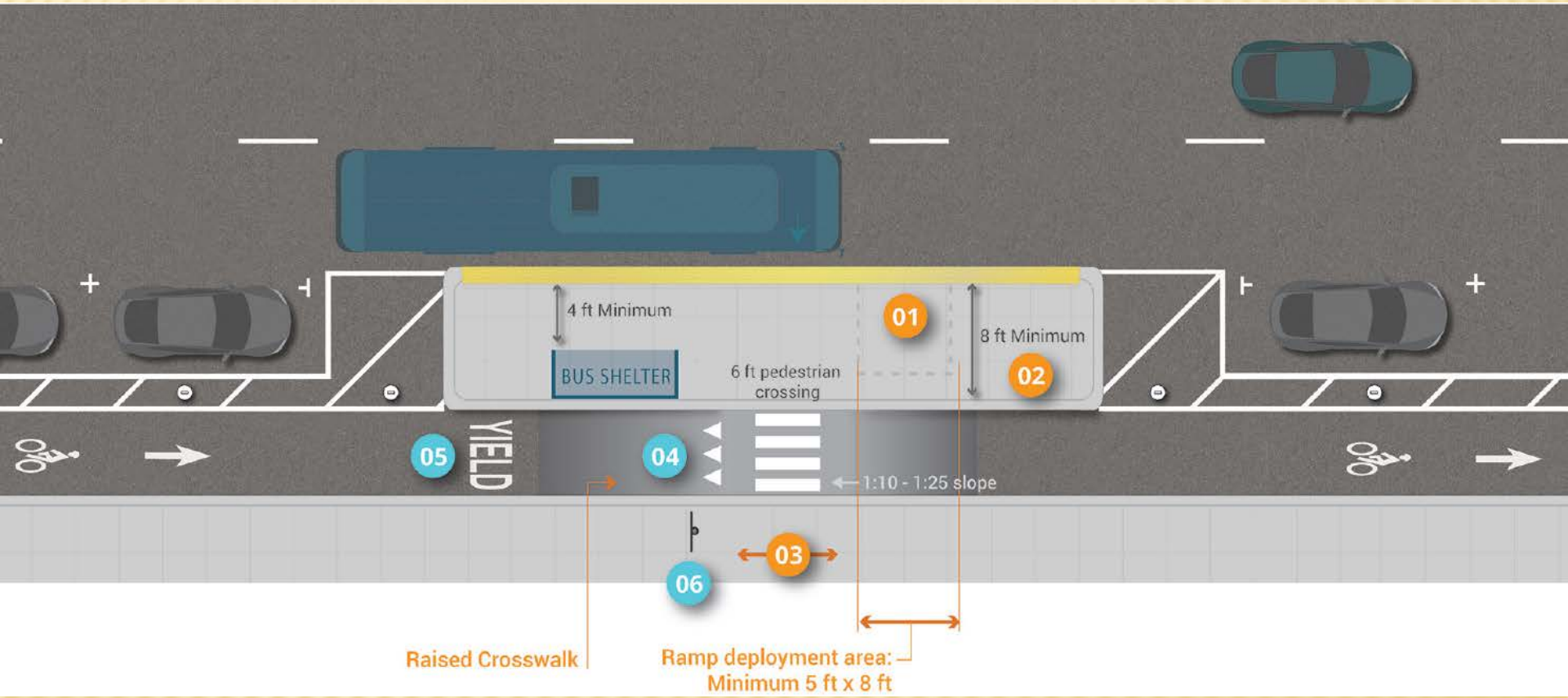
ACCESSIBLE LOADING ZONE



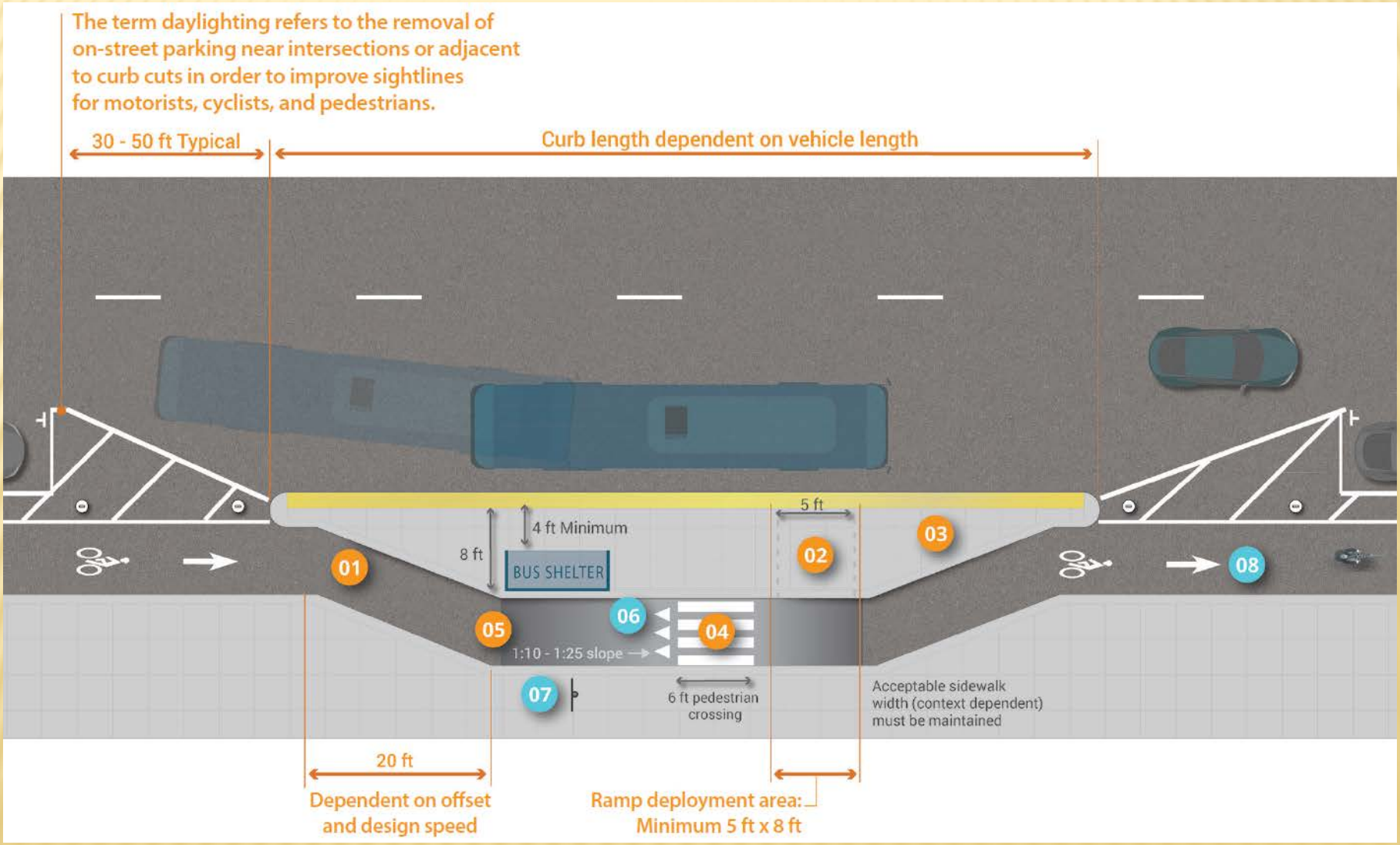
TRANSIT STOPS

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

TRANSIT STOPS

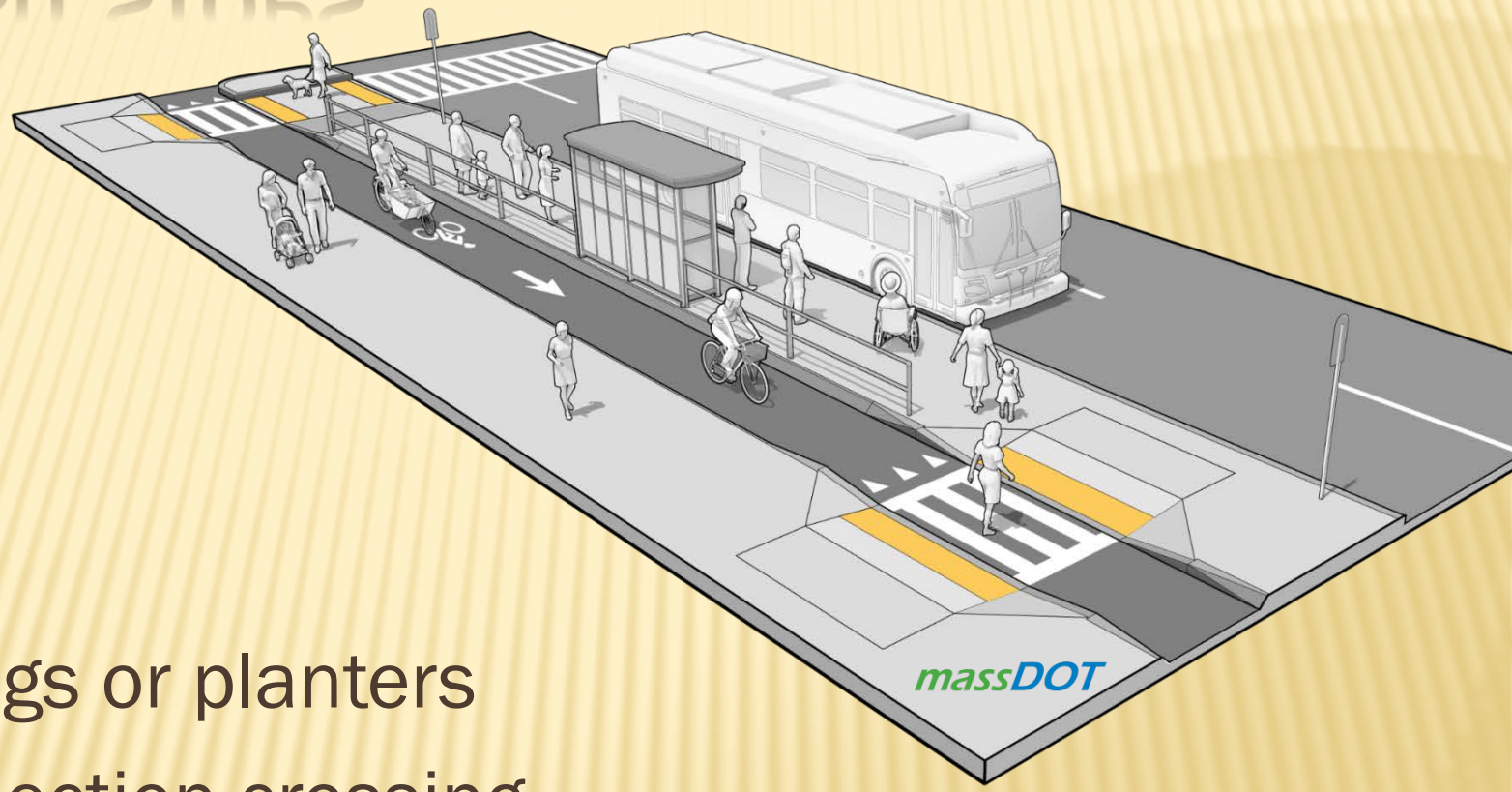


TRANSIT STOPS



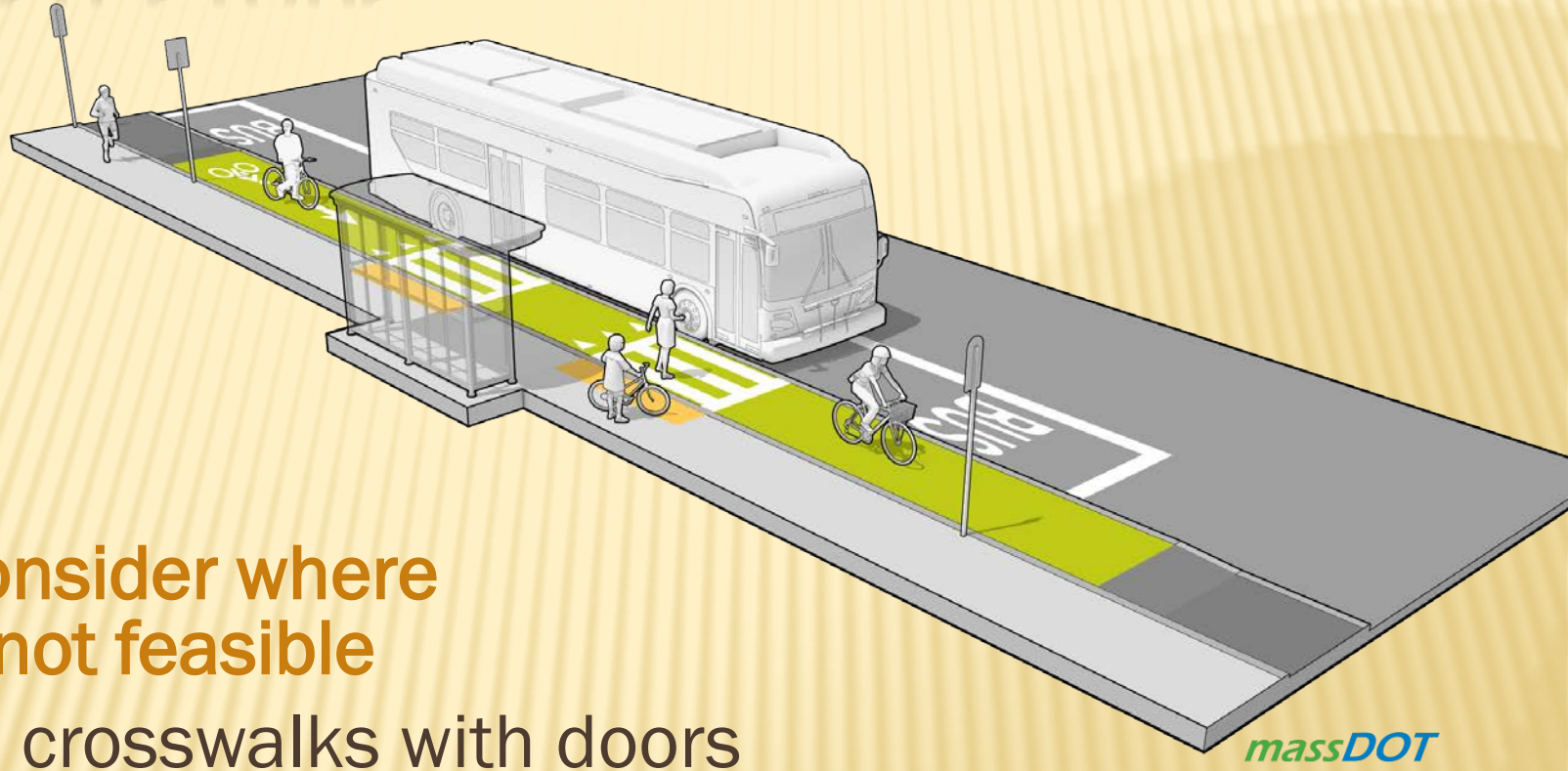
TRANSIT STOPS

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
ACE
X-ING
SCHOOL


AFTER
X-ING X-ING
SCHOOL SCHOOL