Training Wheels 2016

Bicycle Facility Design Training

May 9-13, 2016

Vicksburg | Lansing | Marine City | Roseville | Troy

Instructors:

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Introduction

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MDOT Training Wheels

Agenda

- 2 Hours — PowerPoint Presentation
- 2 Hours — Guided Bike Ride and Discussion
- 1.5 Hours — Lunch, Design Challenge
- 0.5 Hours — Review and Concluding Discussion

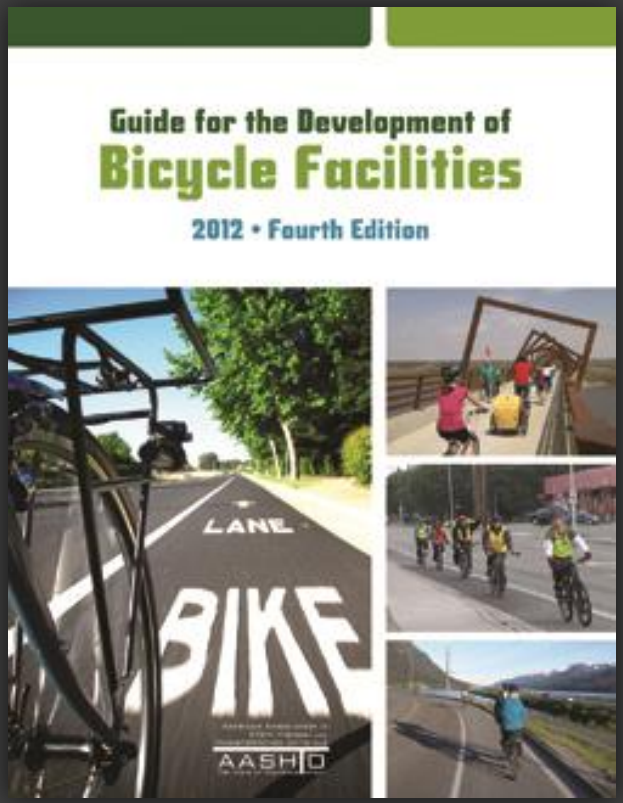
- Exits, Restrooms, Water, Snacks, Cell Phone Use

Presentation Overview

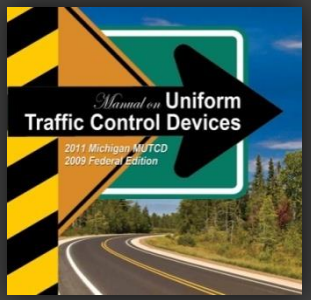
1. Introduction
2. Basic Design Principles
3. On-Street Bicycle Facilities
4. Off-Street Bicycle Facilities/Shared Use Paths
5. Intersections
6. Bike Parking

What Does This Course Introduce?

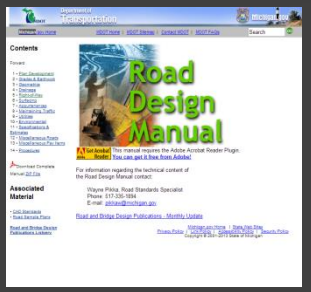
AASHTO
Bike Guide (2012)



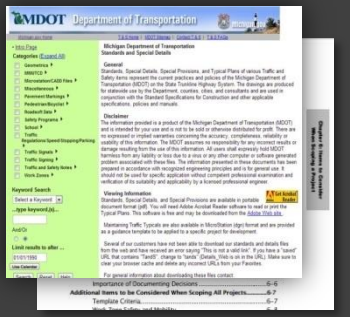
Michigan MUTCD
September 2013



MDOT Road Design Manual,
(Emphasis on Chapters 3, 12)
Updated Periodically

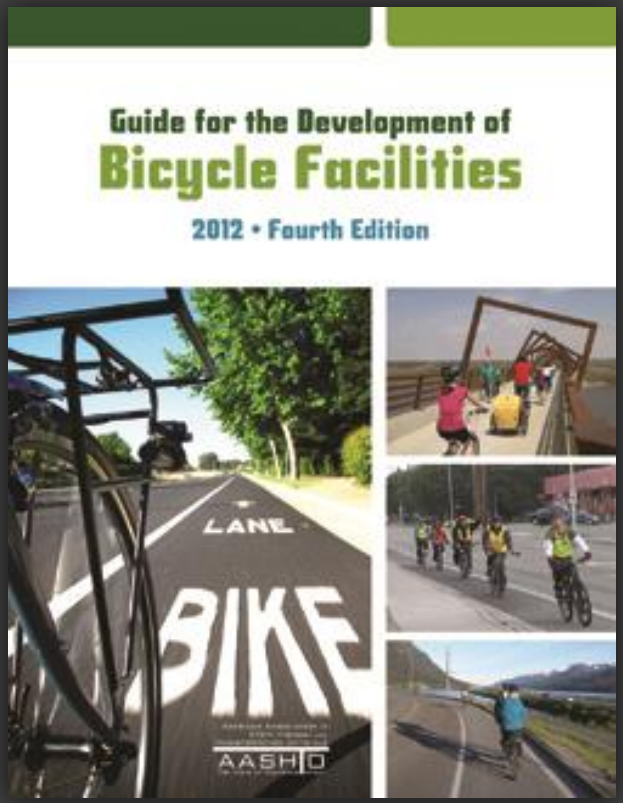


Additional MDOT Manuals
Updated Periodically



AASHTO Bike Guide

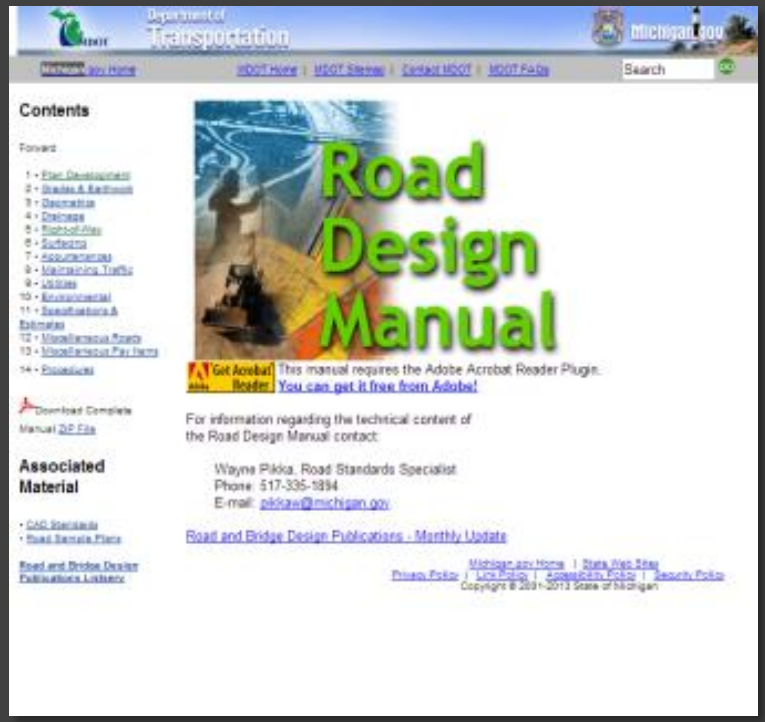
AASHTO
Bike Guide (2012)



- Officially designated design guide for bicycle facilities in Michigan
- Published in 2012, contains most current research up to 2010-2011
- Does not supercede MDOT Roadway Design Manual

MDOT Road Design Manual

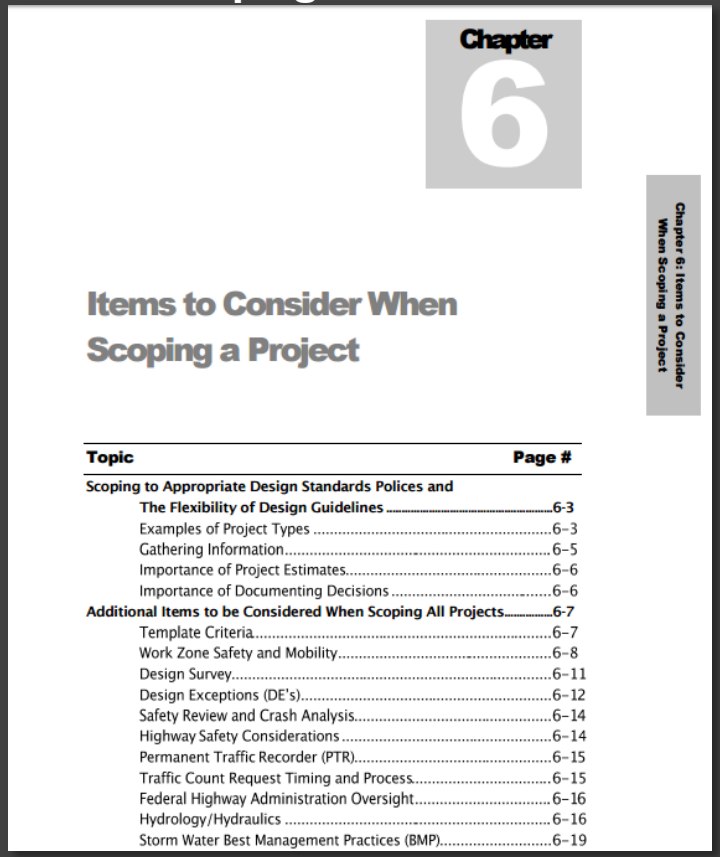
MDOT Road Design Manual



- Adopted standard for roadway design elements:
  - Width, Design Speed
  - Capacity
  - Curves, superelevation
- Email questions to:
  - MDOT-Road-Design-Standards@michigan.gov

MDOT Scoping Manual

MDOT Scoping Manual



Chapter 6

Items to Consider When Scoping a Project

Chapter 6: Items to Consider When Scoping a Project

Topic	Page #
Scoping to Appropriate Design Standards Polices and The Flexibility of Design Guidelines	**6-3**
Examples of Project Types	6-3
Gathering Information	6-5
Importance of Project Estimates	6-6
Importance of Documenting Decisions	6-6
Additional Items to be Considered When Scoping All Projects	**6-7**
Template Criteria	6-7
Work Zone Safety and Mobility	6-8
Design Survey	6-11
Design Exceptions (DE's)	6-12
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Traffic Count Request Timing and Process	6-15
Federal Highway Administration Oversight	6-16
Hydrology/Hydraulics	6-16
Storm Water Best Management Practices (BMP)	6-19

- When to consider different improvement types
- How to avoid getting "too far along to change things"
- Email questions to:
  - Vicki Weerstra
  - weerstrav@Michigan.gov

Other MDOT Documents

Best Practices for Walking and Bicycling in Michigan (2012)

Searchable online, just type: Best Practices for Walking and Bicycling in Michigan
Direct link:
https://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1572_Part6_387521_7.pdf

- MDOT wanted to know the tradeoffs between safety and mobility
- WMU and TYLI reviewed crash patterns, crash modification factors
- Quick-reference guide meant for planners, elected officials

Purpose and Need

From MDOT:

12.12.04 Non-motorized Transportation Project Review

In compliance with the State Transportation Commission Policy on Complete Streets, dated July 26, 2012 all projects regardless of scope or length should be considered for the accommodation of bicyclists, pedestrians and all legal users of the roadway.

Design Principles

- Typical Adult Bicyclist Types by Proportion of Population (Geller, 2012)

<1 % Strong & Fearless
7% Enthused & Confident
60% Interested but Concerned
33% No Way No How

Design Principles

Level of Traffic Stress (LTS): Qualitative measure of stress of a street or bicycle facility as perceived by a typical bicyclist

LTS 1	Low stress, suitable for most adults
LTS 2	Suitable for "interested but concerned" bicyclists
LTS 3	Suitable for "enthused and confident" bicyclists
LTS 4	High stress, likely only to be used by "strong and fearless" bicyclists

Legend:
- LTS 1
- LTS 2
- LTS 3
- LTS 4

Physical and Operating Width

- Occupies 30”
- Typical adult bicyclist
  - 4 feet minimum
  - 5 feet preferred
- Issues arise on roads with several trucks, extra wide vehicles

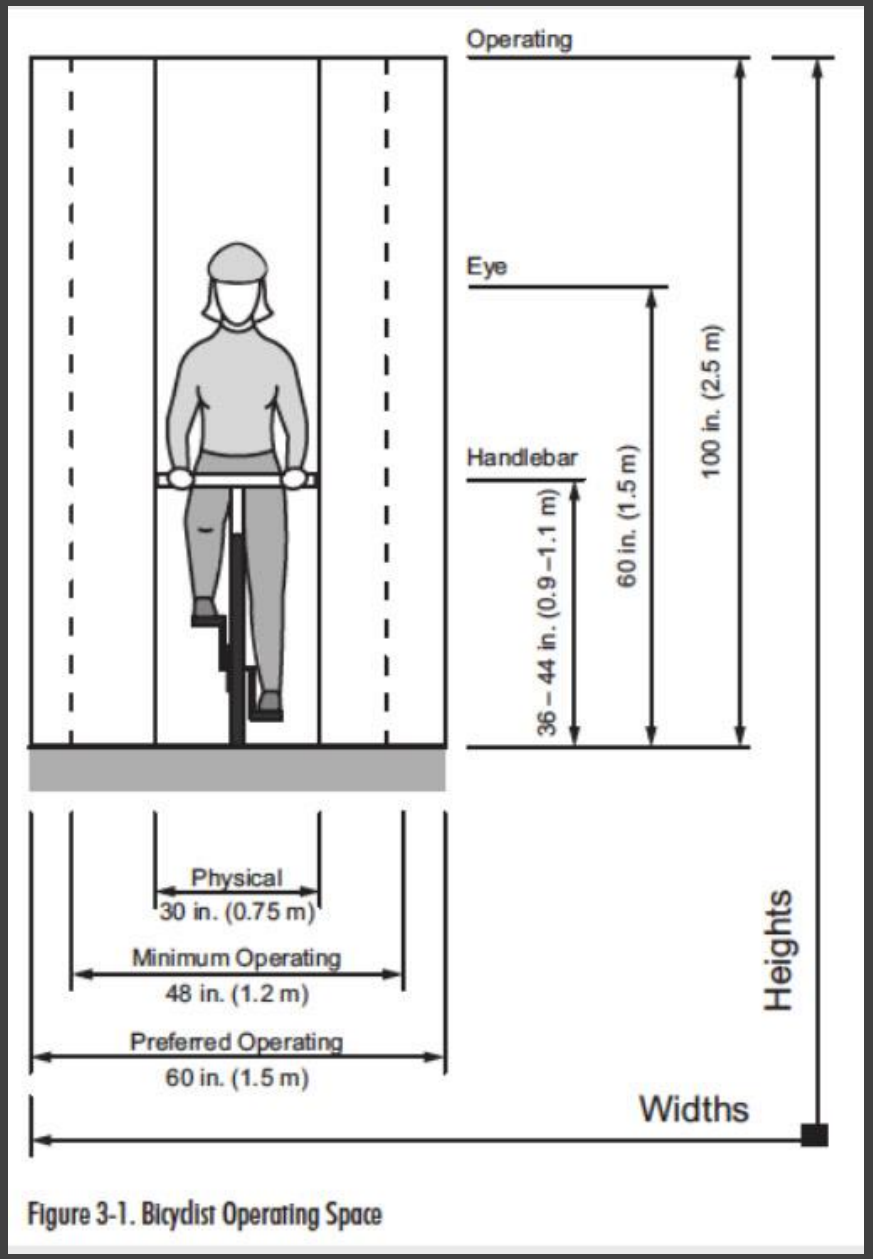
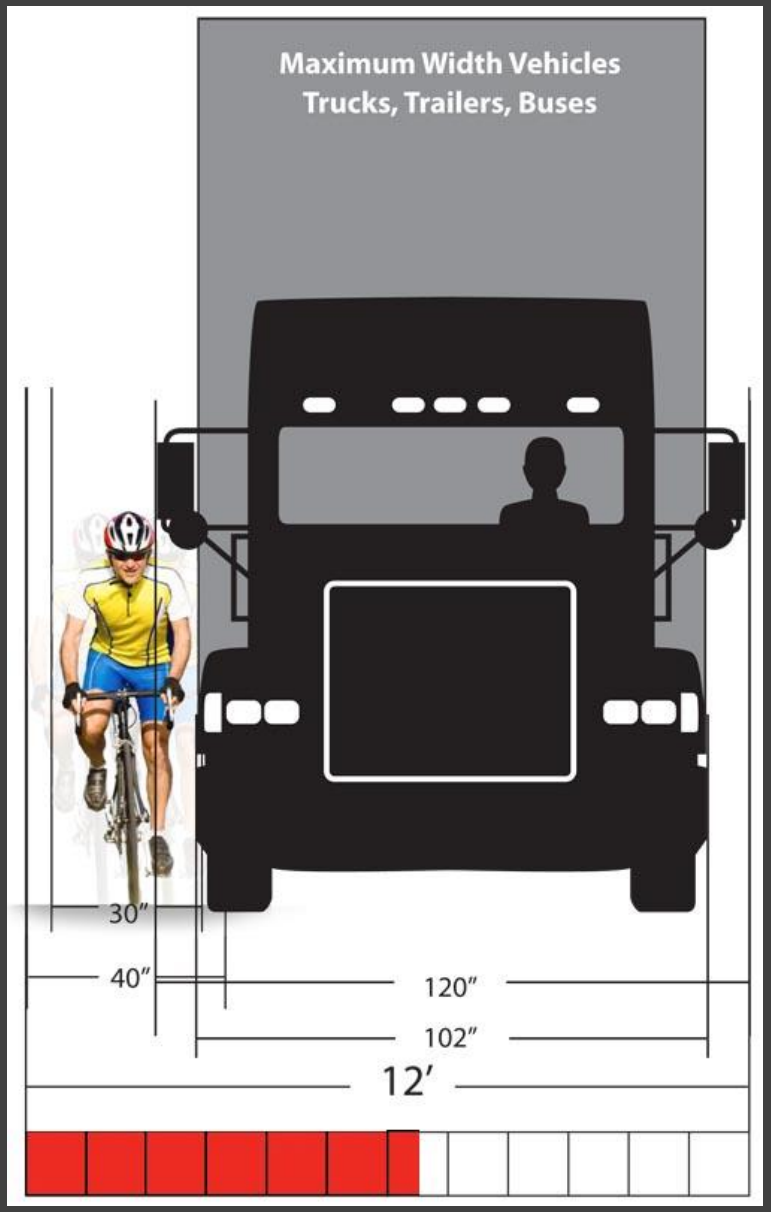
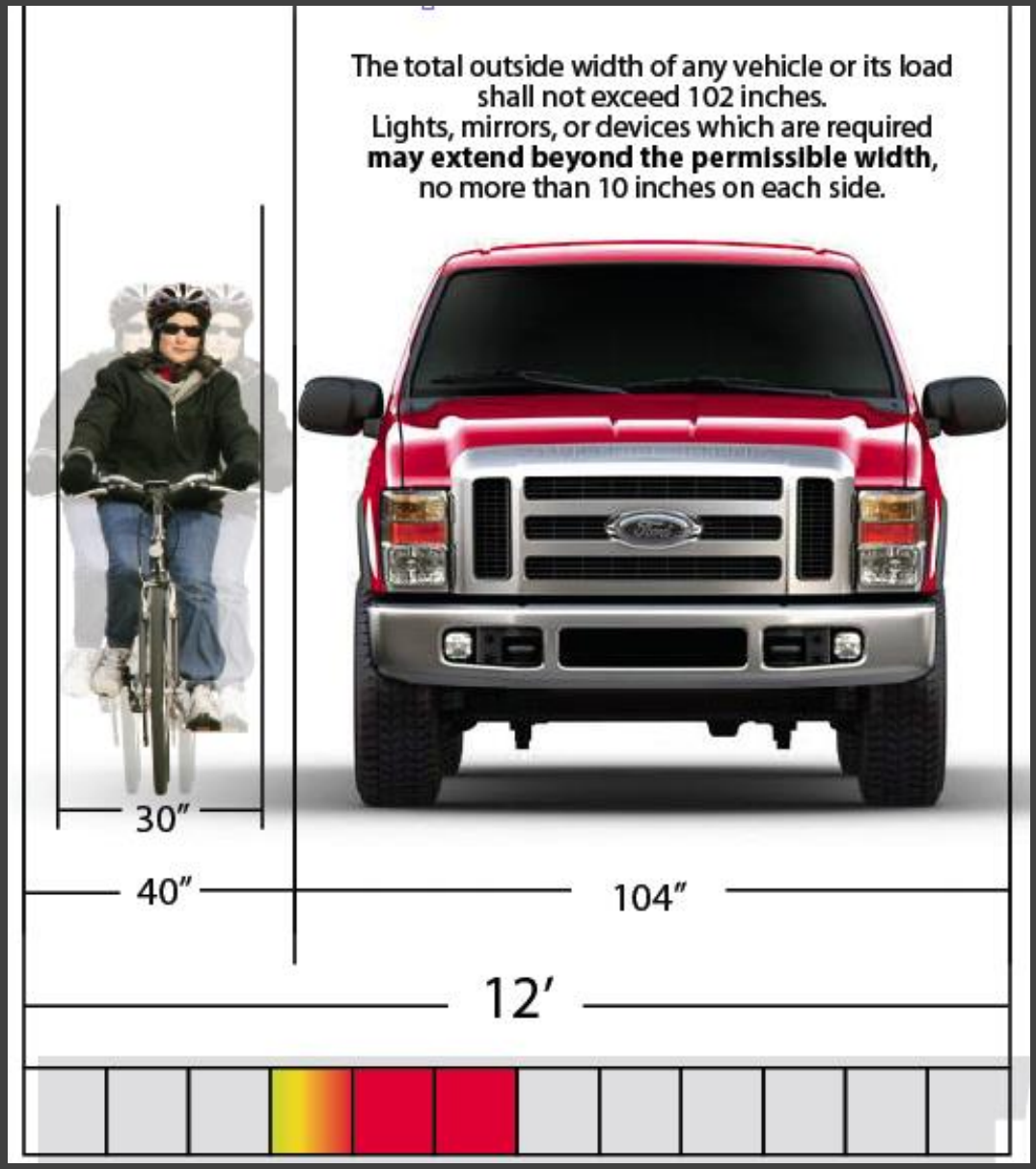


Figure 3-1. Bicydist Operating Space



Source: Keri Caffrey, *Cycling Savvy*



Source: Keri Caffrey, *Cycling Savvy*

Design Principles

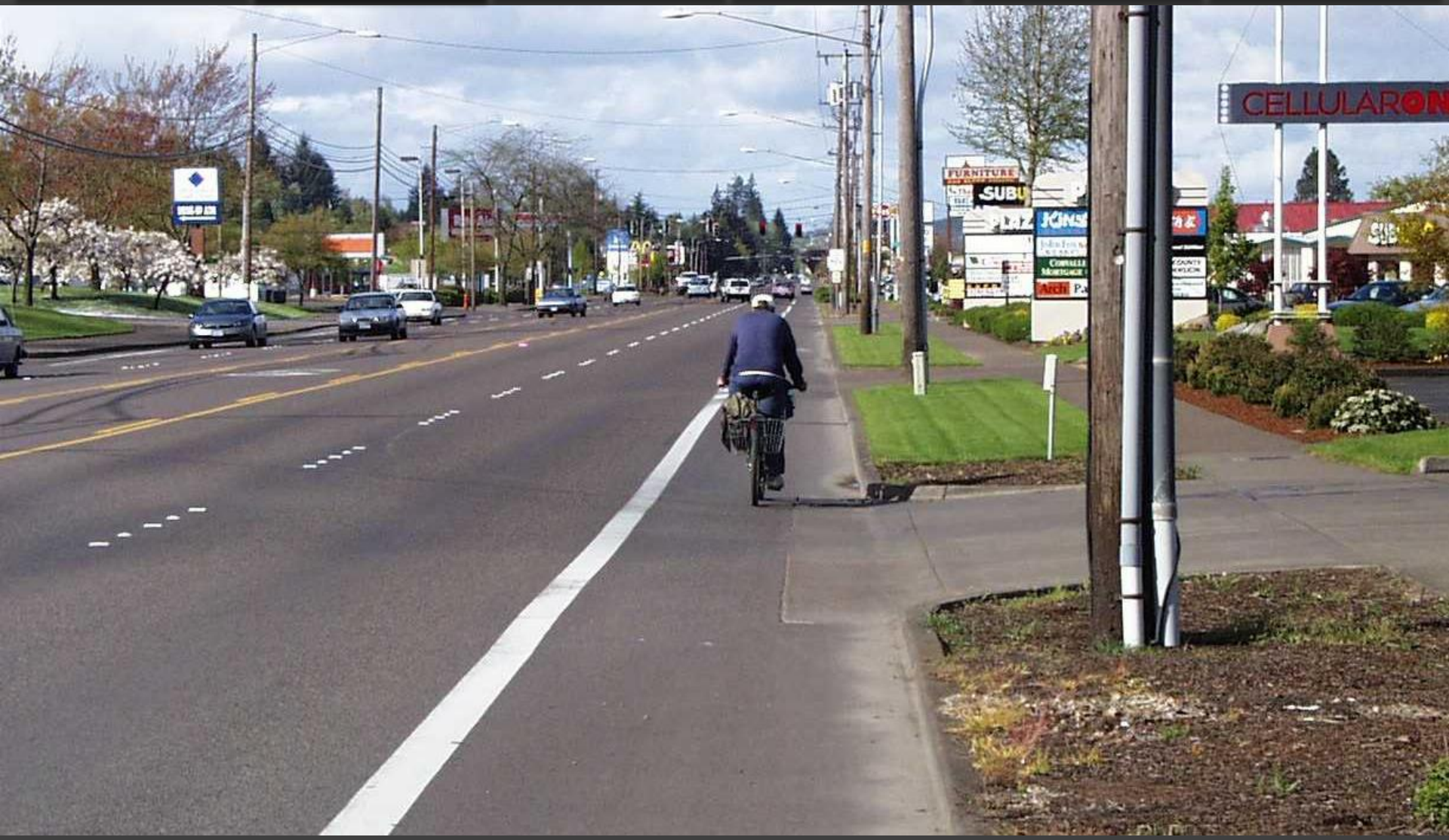
1. **Allow bicyclists to use the road**
   - Provide a smooth riding surface
   - Make adequate room for bicyclists
2. **Make the road inviting to bicyclists**
   - Slow down traffic
   - Reallocate roadway space, change lane widths
   - Designate space for bicyclists as needed
3. **Make drivers aware of bicyclists**
   - Pavement markings and signs when needed
4. **Construct paths where needed**
   - Supplement the roadway network

Bicycling on Sidewalks: Inefficient, Prone to Conflicts

May Conflict with Pedestrian Traffic

Conflict With Drivers Entering/Exiting Driveways

Bicyclist Approaching From Passenger Side While Driver Looks Left



Provide Space for On-Street Bicycling to Mitigate Conflicts

Identify Low-Speed Roads or Find Ways To Reduce Speeds To Better Accommodate Bicyclists

Typical Bicycle Facilities

- Shared Roadway
- Paved Shoulder
- Shared Lane Marking
- Bike Lane
- Buffered Bike Lane
- Separated Bike Lane
- Bike Boulevard
- Shared Use Path

Shared Roadway

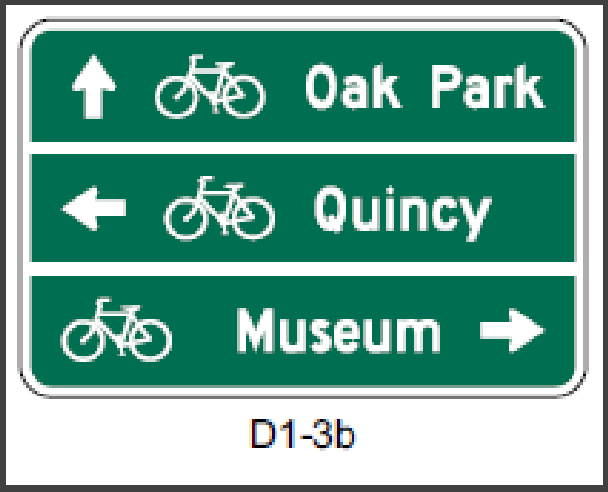
- No Specific Width
- Low Traffic Volume
- Low Posted Speed

  < 35 mph maximum <30 mph desirable
- Low Traffic Stress (1-2)
- No Additional Pavement Markings Needed
- Often Times, Residential Roads Meet These Criteria*

*But only for short distances

Shared Roadway – Signs

- Distance, Destination, Direction
- Can be used on all facility types
- Recommendation:
  - Generic "Bike Route" Sign (D11-1) should be used in addition to route information or infrastructure (neighborhood greenway)



D1-3b

D11-1

Paved Shoulder

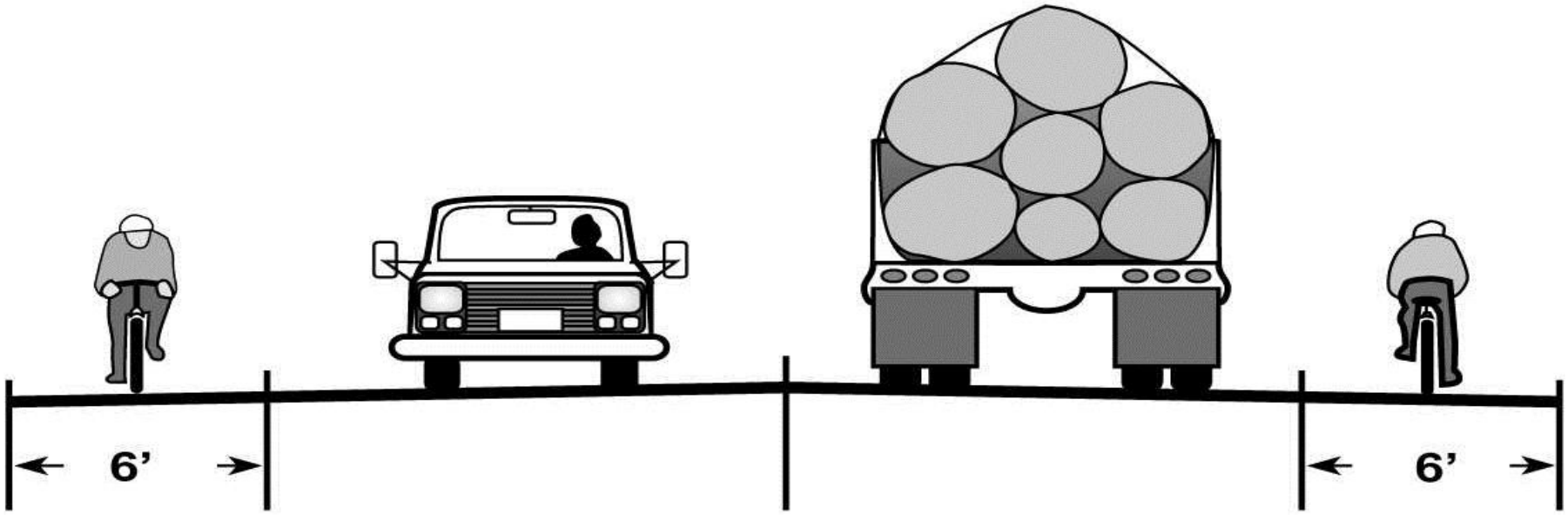
- MDOT 12.12.10
- Paved Shoulder
- Edge of Roadway
- Contiguous, Level
- Common on Rural Highways
- Unpaved Shoulders

Do Not Accommodate Bicyclists

Paved Shoulder – Minimum Width

- 4’ Open Shoulder
- 5’ Adjacent to Curb
- 6’ Desirable

- Assumes Other Travel Lanes are Standard Width

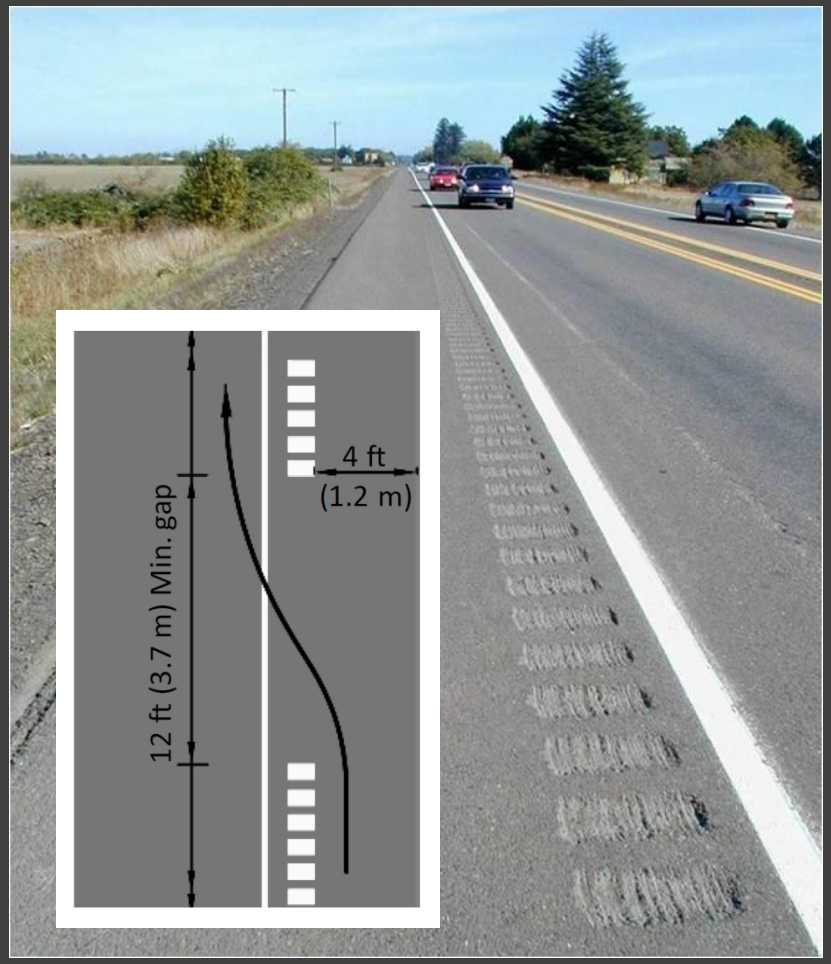


Paved Shoulder – Benefits

- Improved Safety:
  - Provides Width for Evasive Actions
- Improved Capacity:
  - Increased Turning Radius at Intersections for Automobiles, Trucks
  - Room to Pull Over
- Improved Maintenance:
  - Extend Pavement Life
  - Built-in Snow Storage

Paved Shoulders & Rumble Strips

- Maintain 4-foot Minimum Width For Bicycles
- Provide 12-foot Gap Every 48 Feet For Evasive Actions (MDOT Standard Plan R-112)
- Rumble Strip Under Edge Line = Wider Shoulder, Improved Reflectivity



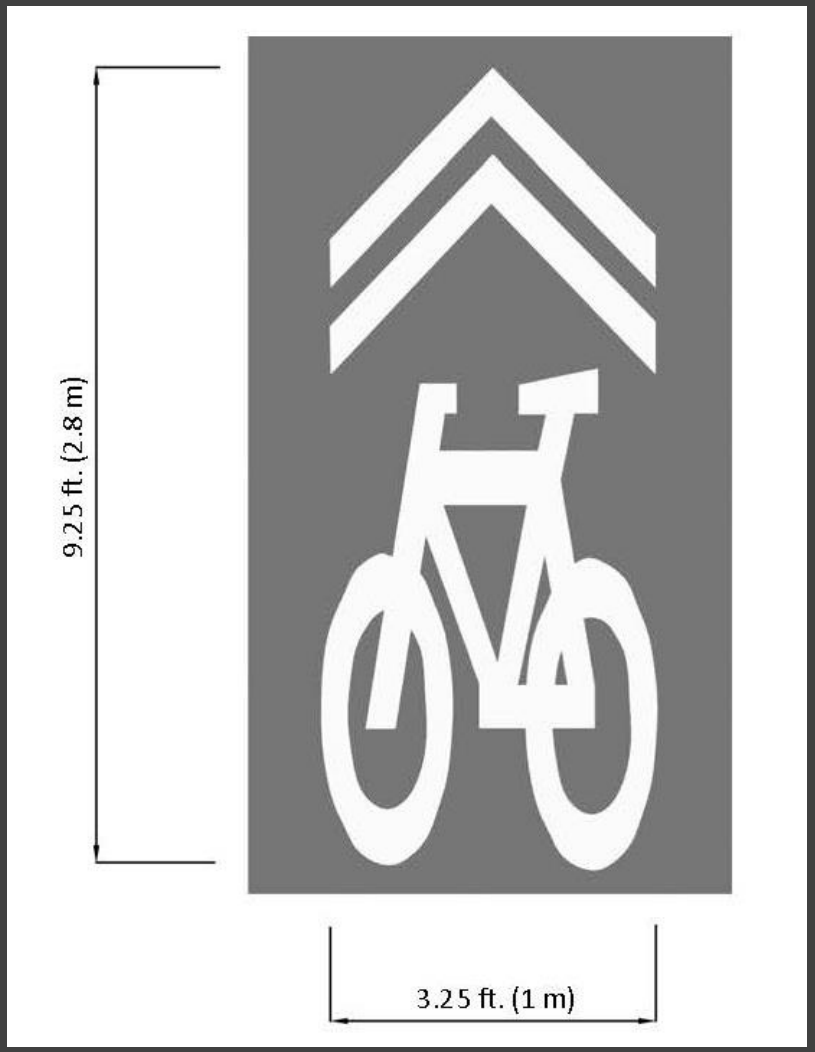
Marked Shared Lane

- Roadway Where Bikes Are Permitted
- Shared Traffic Condition
- For Use on Roads With Insufficient Width To Overtake A Bicycle

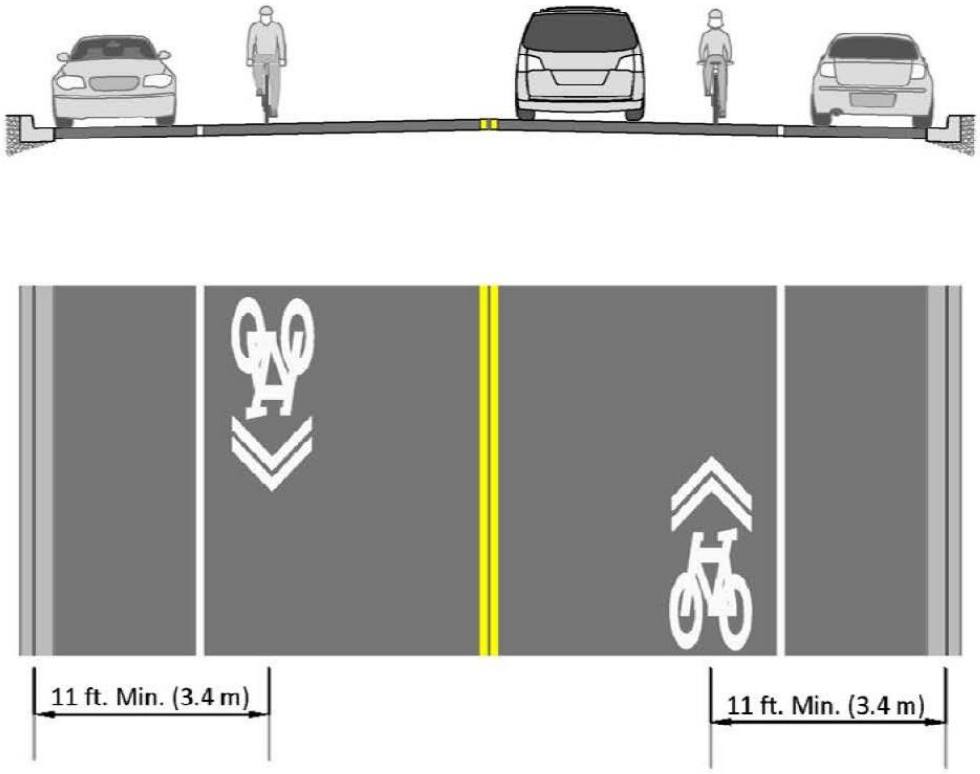
Michigan Vehicle Code Section 257.637 (2)

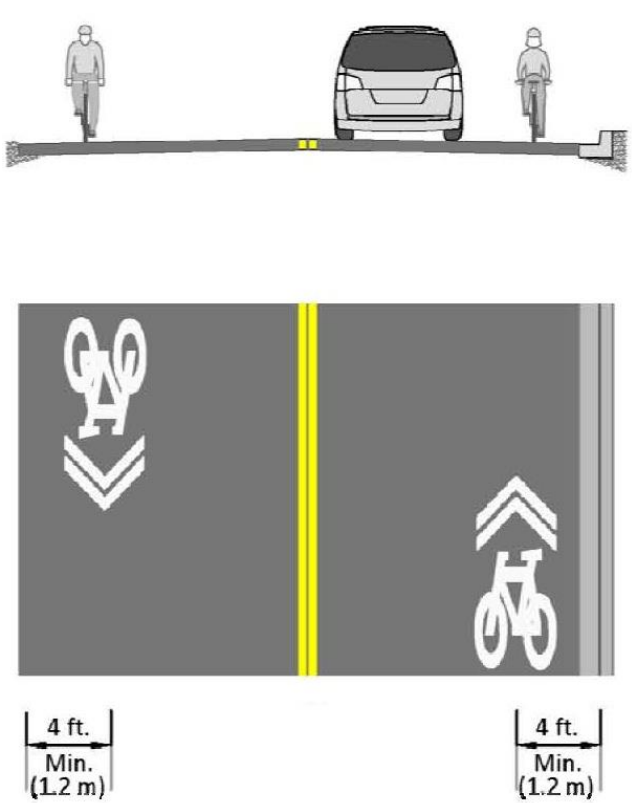
Shared Lane Markings

- "Sharrow"
- Identifies Intended Path of Bike Travel
- Keeps Bikes Out of "Door Zone" or Away From Curb
- Visual Reminder of Shared Lane Condition
- Helpful Where Parking Turnover is High



Shared Lane Markings





Shared Lane Markings

May Be Centered In Narrow Lanes

For Short Distances / At Intersections

Shared Lane Markings – Pros/Cons

- Pros
  - Helps Continue Bikeway Through Narrow Segment
  - Gentle Reminder to Motorists to Share The Road
  - Keeps Bicyclists in Visible Position and Out of Door Zone
- Cons
  - Still High Stress for Many Bicyclists (and Motorists)
  - Not Suitable on Roads With Posted Speeds Above 35 mph
  - Wide Variation in Application, Continuity = Unreliable Crash Data

Bike Lanes

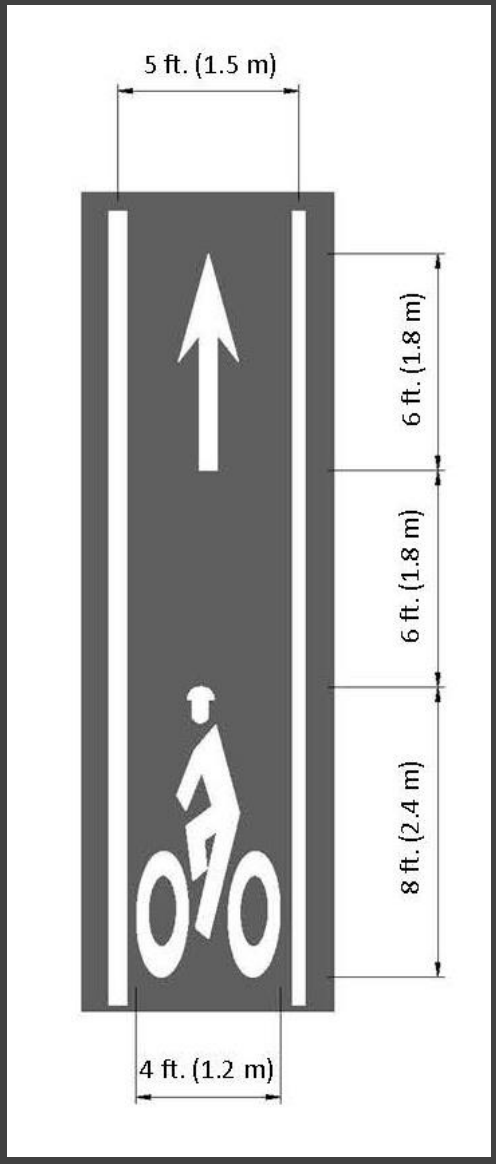
- A portion of the roadway or shoulder designated for exclusive or preferential use by bicycles
- Identified by pavement markings (and sometimes signs)

Bike Lanes

- One Edge Line and Symbols Required
- Pavement Markings on Both Sides Preferred
- Signs May Supplement Pavement Markings

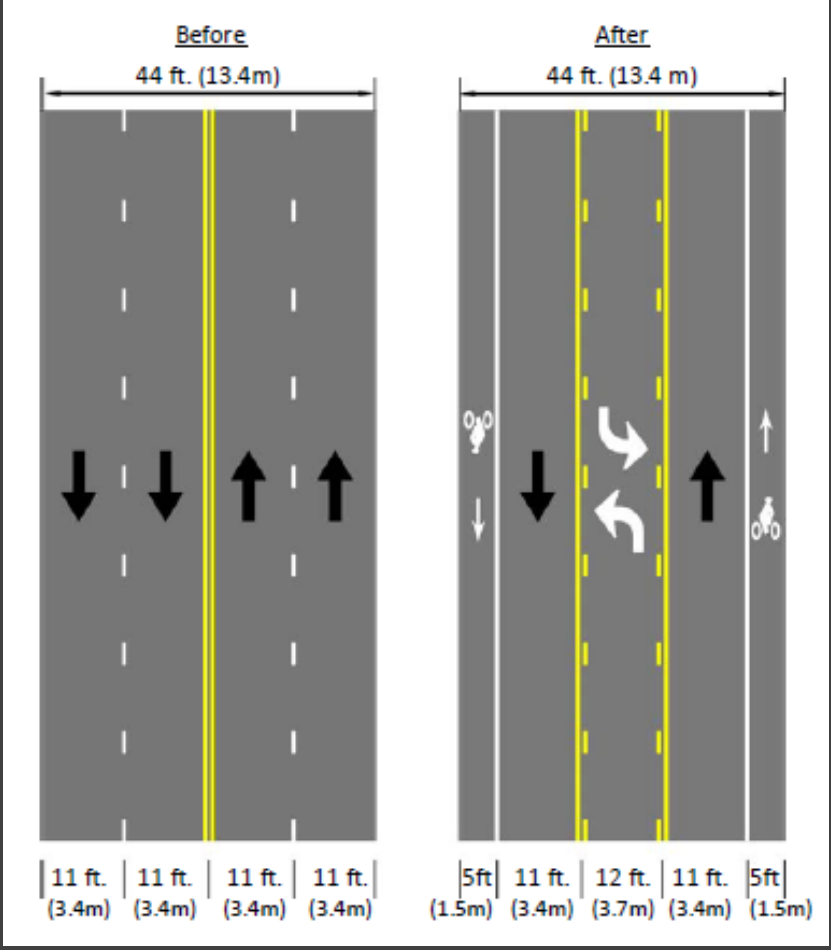
Bike Lanes

- 6” Solid White Line
- Bike Lane Symbol and Arrow Centered In Lane
- Bike Lane Sign (Optional)



Bike Lanes - Retrofits

- Road Diet
- 4-to-3 Conversion (Typ.)
- 10-12-foot Lanes (Typ.)
- Feasibility (ADT):
  - <10,000 Easy
  - 10K-15K Probably
  - 15K+ Do A Traffic Study



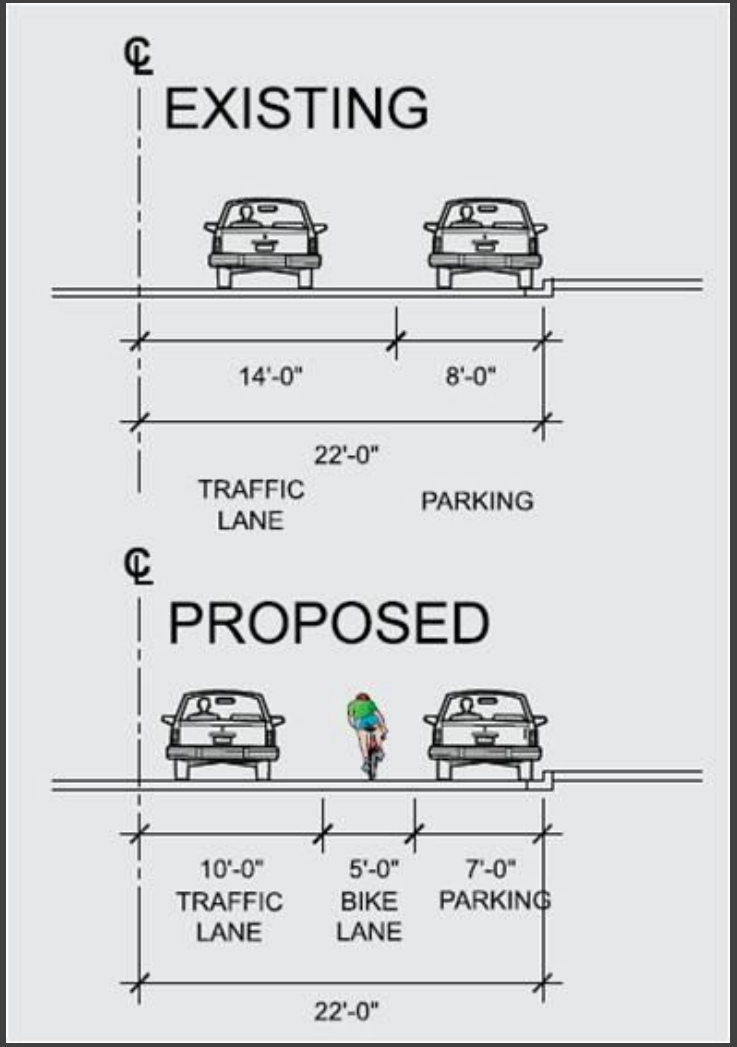
Travel Lane Width Flexibility

Michigan Design Manual, Section 3.09.02,A and B	
ADT	Lane Width
≤ 750	10’
> 750	11’ 12’ – National Truck Network and Priority Commercial Network

10' lanes may be considered in urban areas for multi-lane un-divided (regardless of ADT) and multi-lane divided (ADT < 10,000).

Bike Lanes - Retrofits

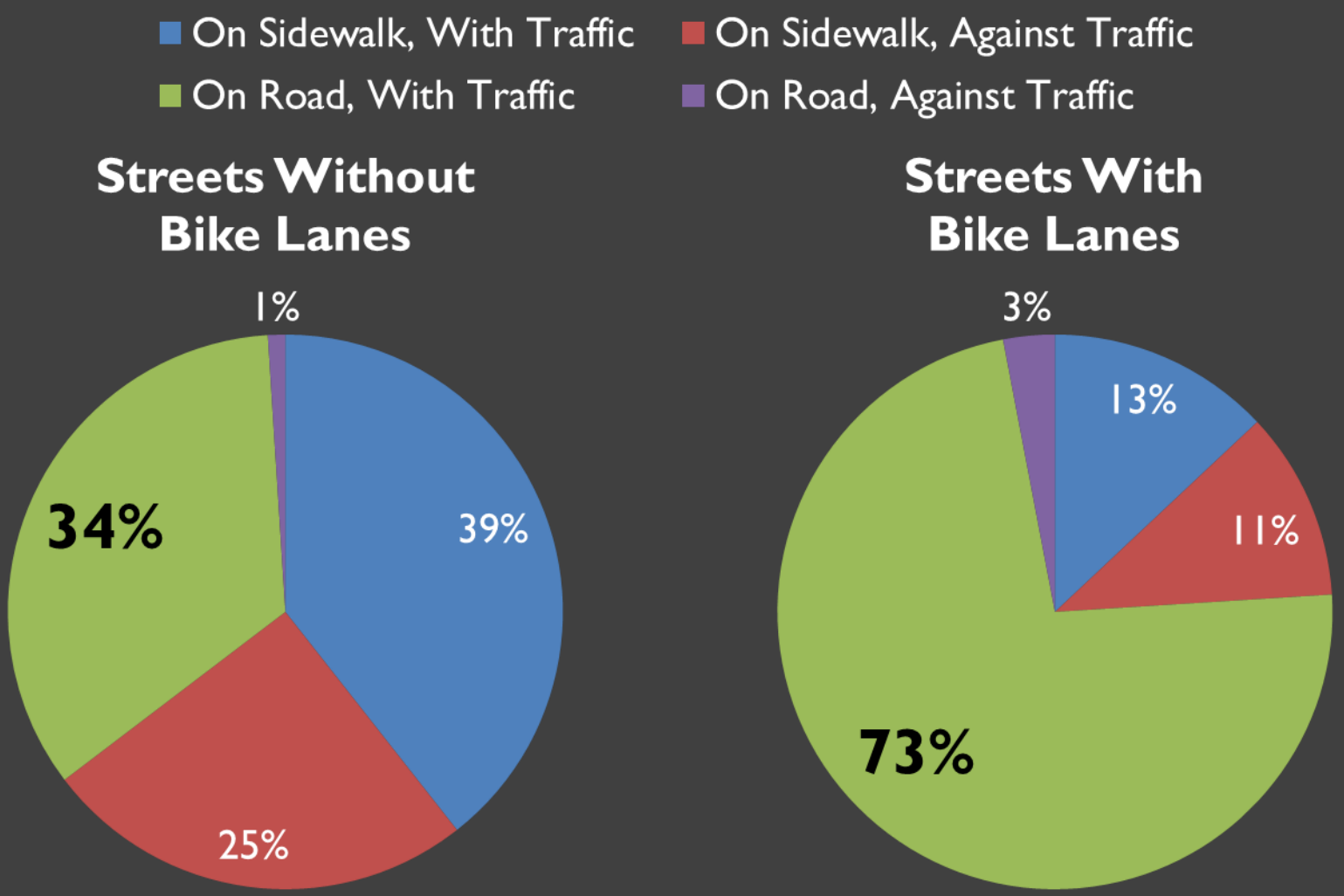
- Reduce Wide Travel Lanes
- Reduce Parking Lanes
- Bare Minimum: Chicago Cross Section
  - 10-5-7
  - 30 mph Posted Speed
  - Still fairly high stress, may be feasible for short distances
  - Chicago prefers wider alternatives



Bike Lanes - Benefits

- Creates Dedicated Space for Bicyclists, Eliminates Conflict Caused by Speed Differential
- Discourages Wrong-Way Riding
- Helps Get Adult Bicyclists Off the Sidewalk
- Useful on Collectors/Arterials
- Rarely Necessary on Locals

Bike Lanes - Benefits



Bike Lanes – Pros/Cons

- Pros
  - Lower Traffic Stress for Bicyclists, Motorists
  - More Separation Than Shared Lanes
  - Encourages Safer Behavior
  - Helps Organize Traffic
- Cons
  - May be High Stress on Wide/Fast Arterials
  - Often "shoehorned" into Narrow Roadways
  - Difficult to Sell If Parking Is Removed

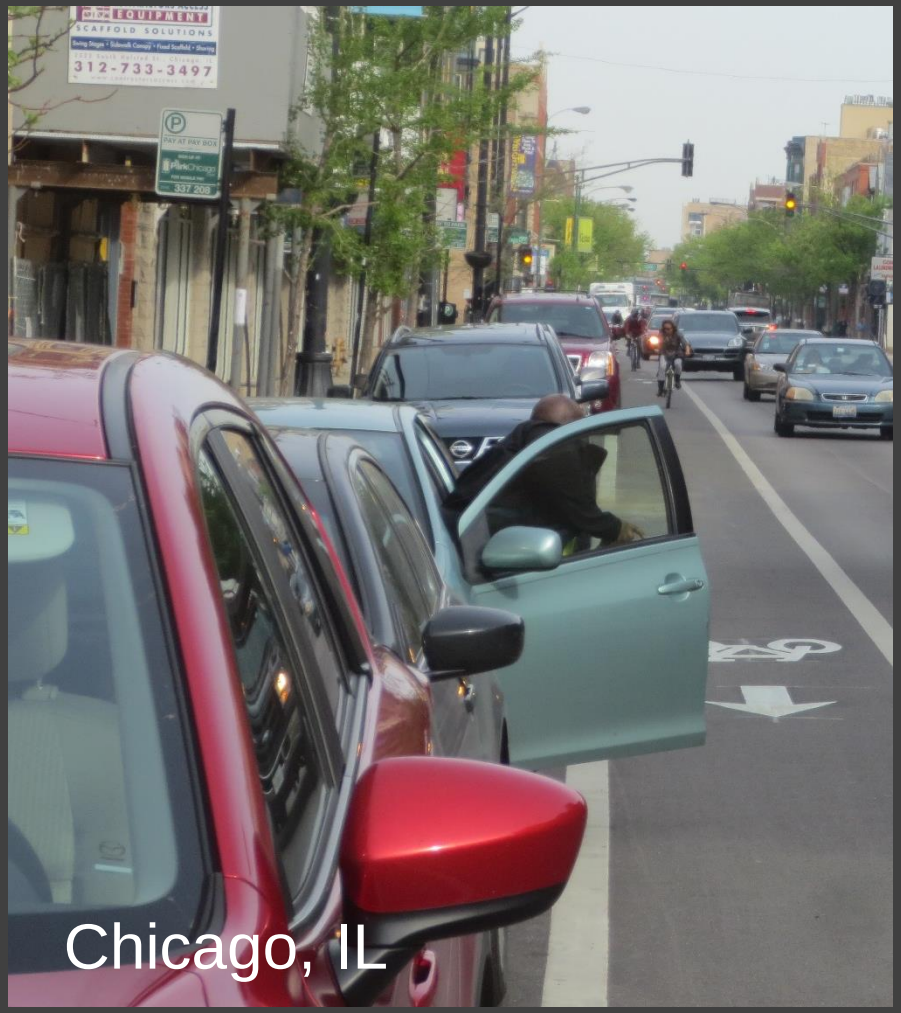
Bike Lanes – Contraflow

- Bike Lane Facing Traffic
- Rare, Used for Short Distances
- One- or Two-Way
- Recommended
  - Double Yellow Pavement Markings
  - Signs and/or Signals (Especially at Driveways/Alleys)

Buffered Bike Lanes

- Bike Lane Separated From Automobile Traffic By Buffer Pavement Markings
- MDOT Design Guidance12.12.09-A
- Proving to be very helpful on roadways above 35 mph (for motorists and bicyclists)

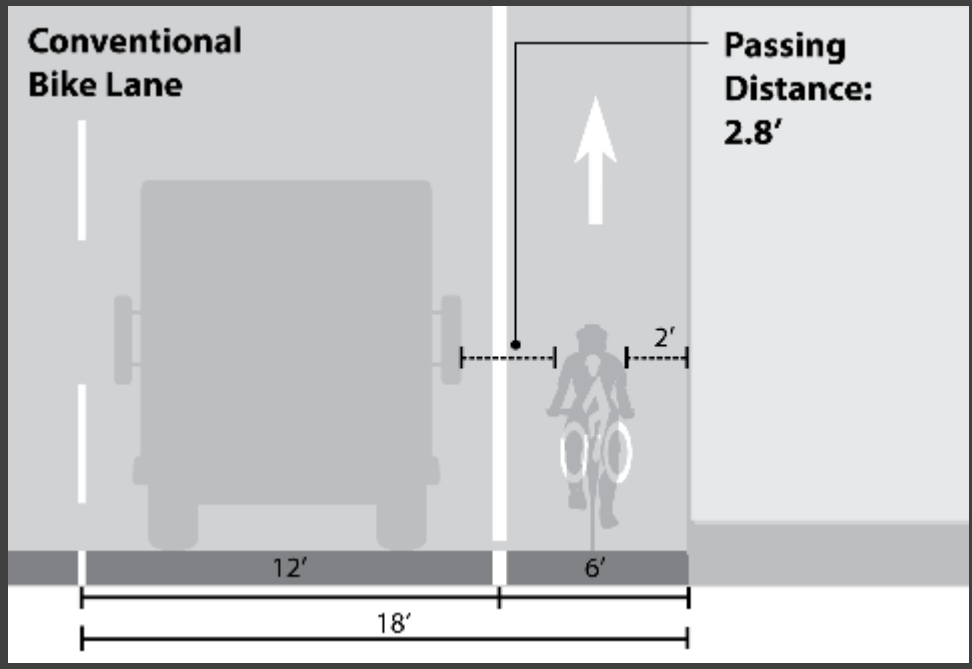
If you can, add buffers (NCHRP Report 766)



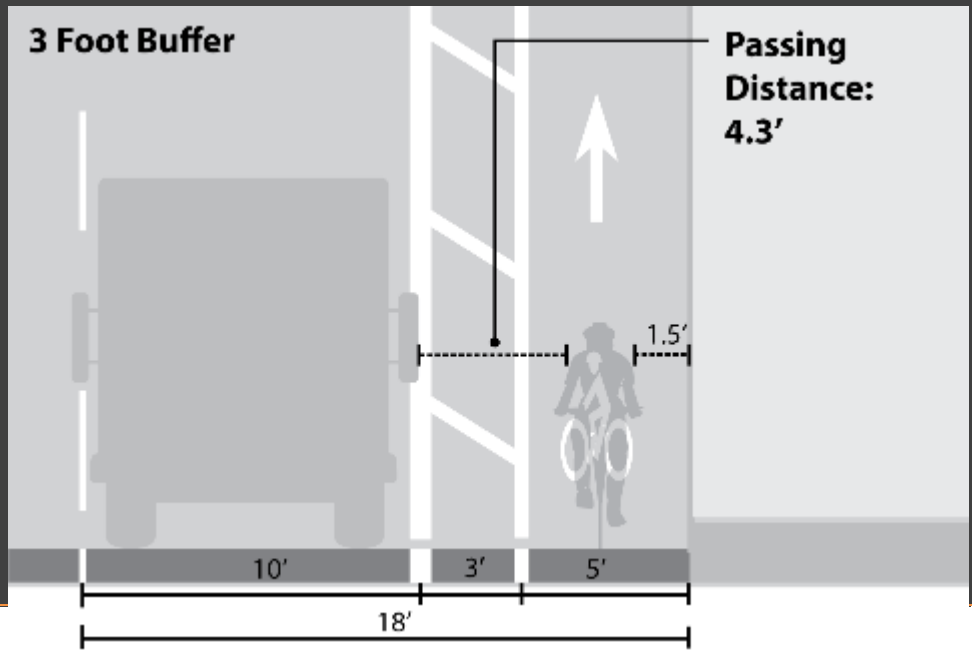
Chicago, IL


Chicago, IL

Conventional Bike Lanes



Buffered Bike Lanes

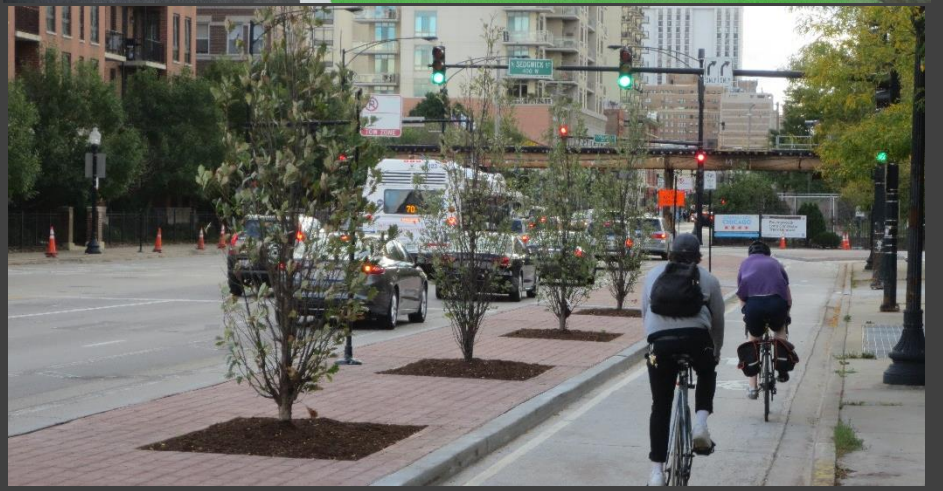


Buffered Bike Lanes – Pros/Cons

- Pros
  - Greater Separation
  - Encourages riding outside of the "door zone"
  - Lower Stress Than Traditional Bike Lane
  - Fewer Crashes Than Traditional Bike Lane
  - Great for Higher Speed Arterials
- Cons
  - Requires More Space Than Traditional Bike Lane
  - Almost As Wide As A Travel Lane, Requires More Maintenance and Enforcement To Keep Free of Automobiles

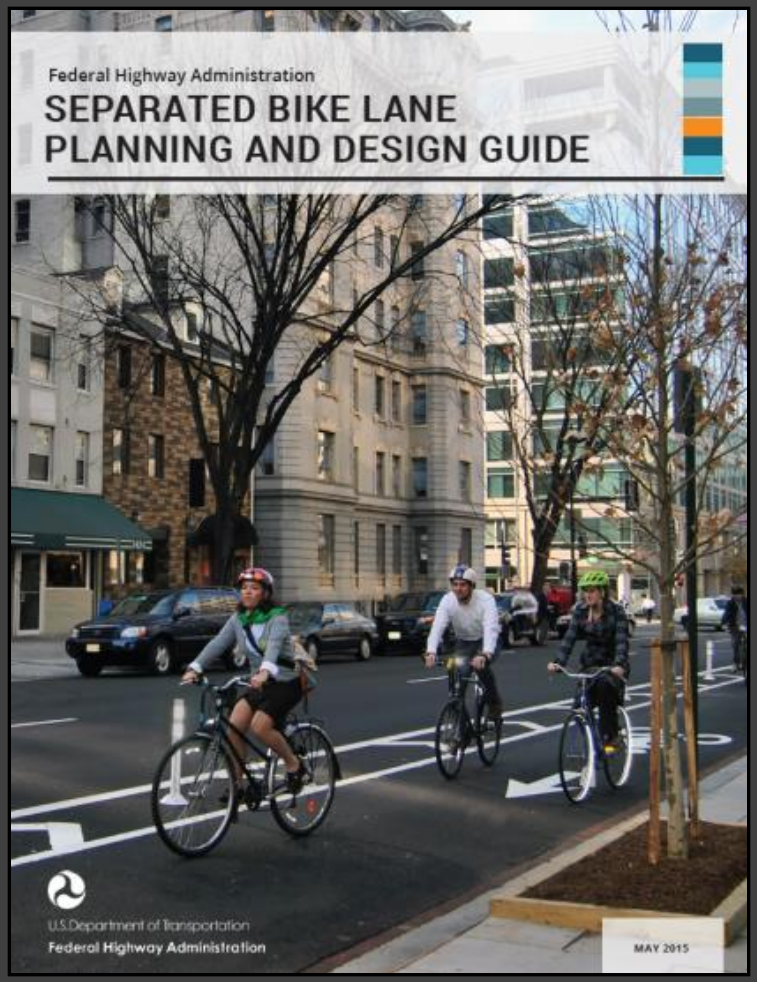
Separated Bike Lanes

- Vertical Element Separates Bike Lane from Automobile Lane(s)
  - On-Street Parking
  - Barrier Median or Planters
  - Barrier Curb
  - Bollards
- Often Accompanied By Exclusive Bicycle Traffic Control Devices



Separated Bike Lanes

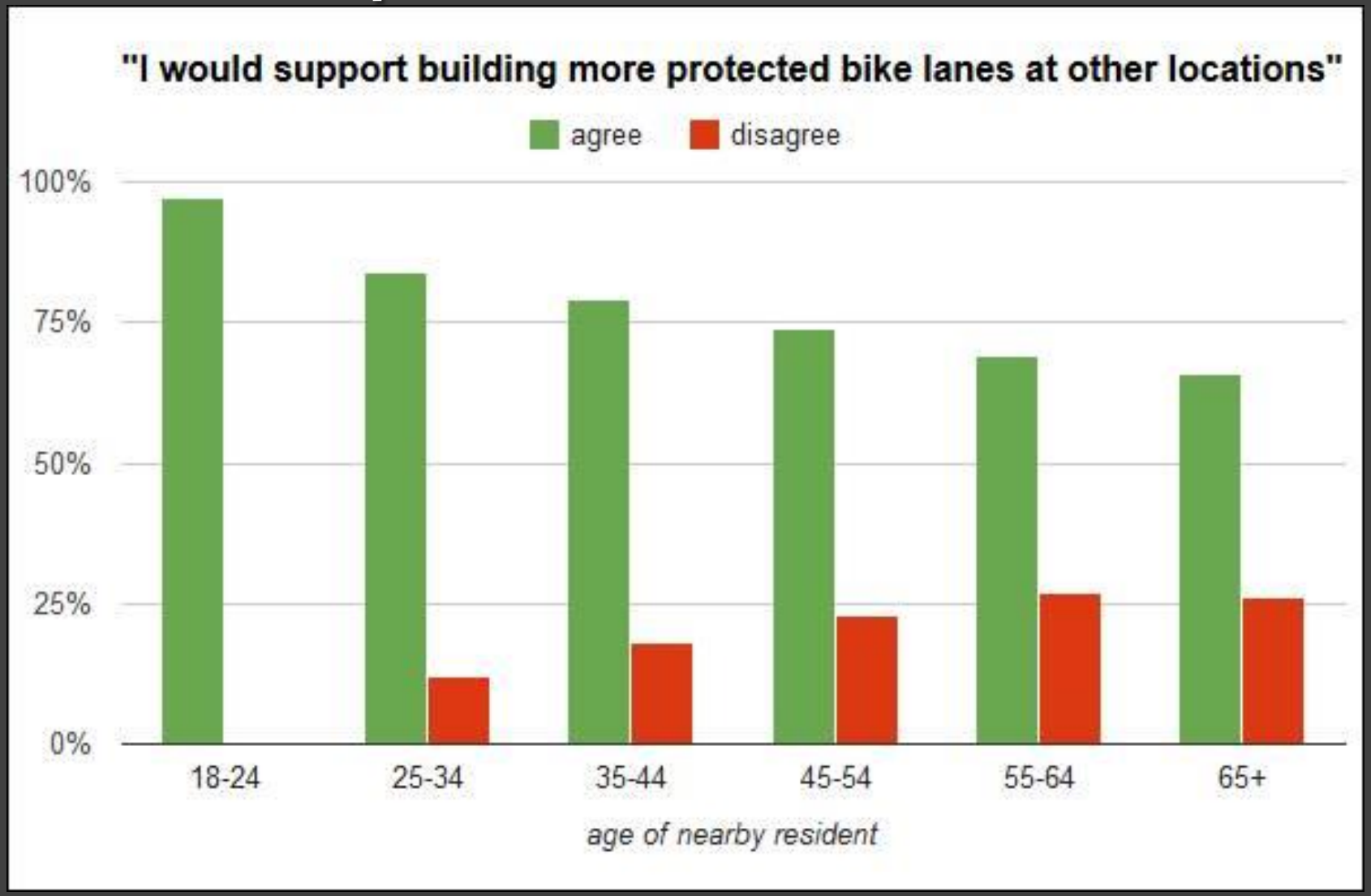
- FHWA Separated Bike Lane Planning and Design Guide – May 2015
- Resource on Separated Bike Lanes for:
  - Planning
  - Design
  - Intersections



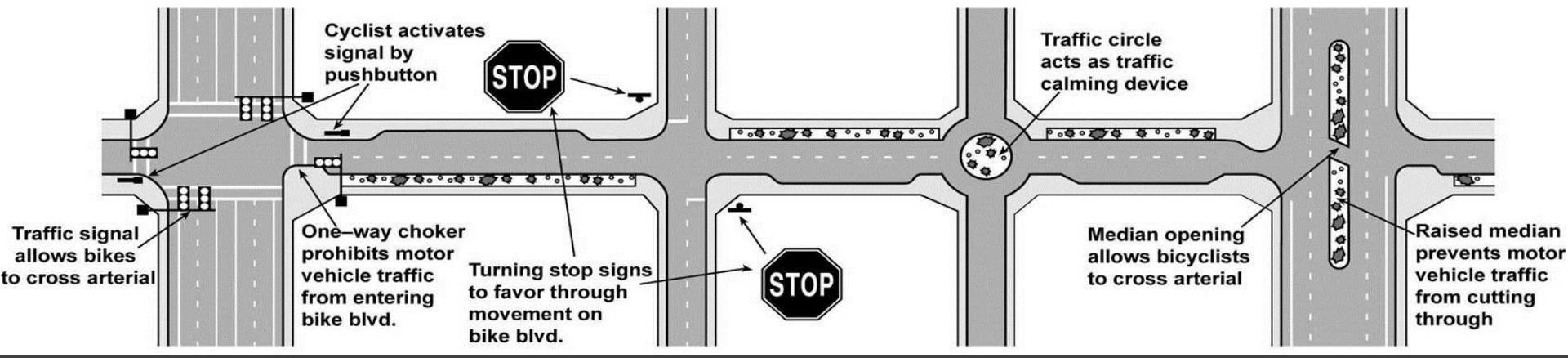
Separated Bike Lanes – Pros/Cons

- Pros
  - Greatest Separation, High Comfort On-Street Facility
  - Exclusive Traffic Control Promotes Greatest Bicyclist Compliance
  - Highly Visible Capital Improvement
- Cons
  - Can be costly
  - Requires More Space
  - Maintenance / sweeping / snow removal practices differ
  - Innovative Design Requires Approval
  - Intersection / Driveway Design More Involved

Separated Bike Lanes



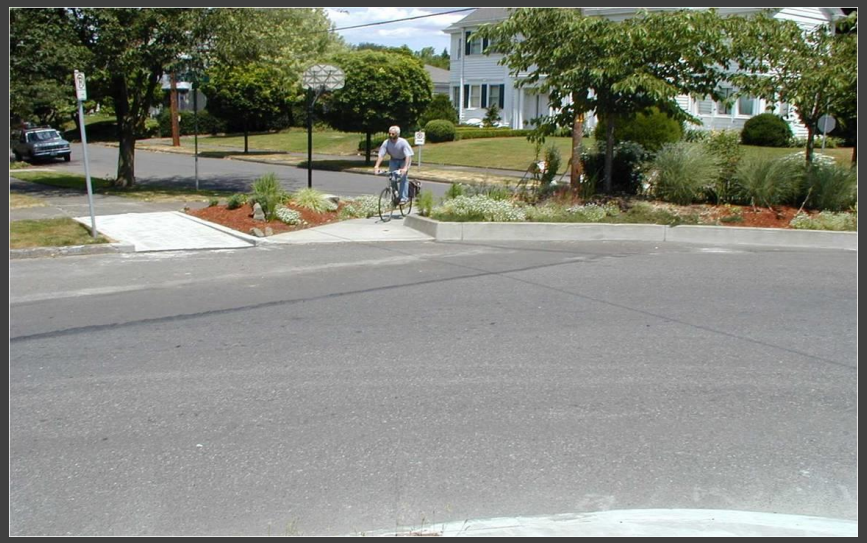
Bike Boulevard



- Road where traffic controls give priority movement to bicycles
- Automobile through traffic discouraged, traffic calming infrastructure added
- Traffic calming often reduces traffic speeds, volumes
- Requires roadway grid, alternative routes, emergency access

Bike Boulevard

- Great for streets where homeowners want traffic calming
- Traffic diverters or dead ends with ramps provide bicycle boulevard continuity
  - Changing around stop signs isn't enough as this may encourage auto cut-through traffic, speeding



Bike Boulevard

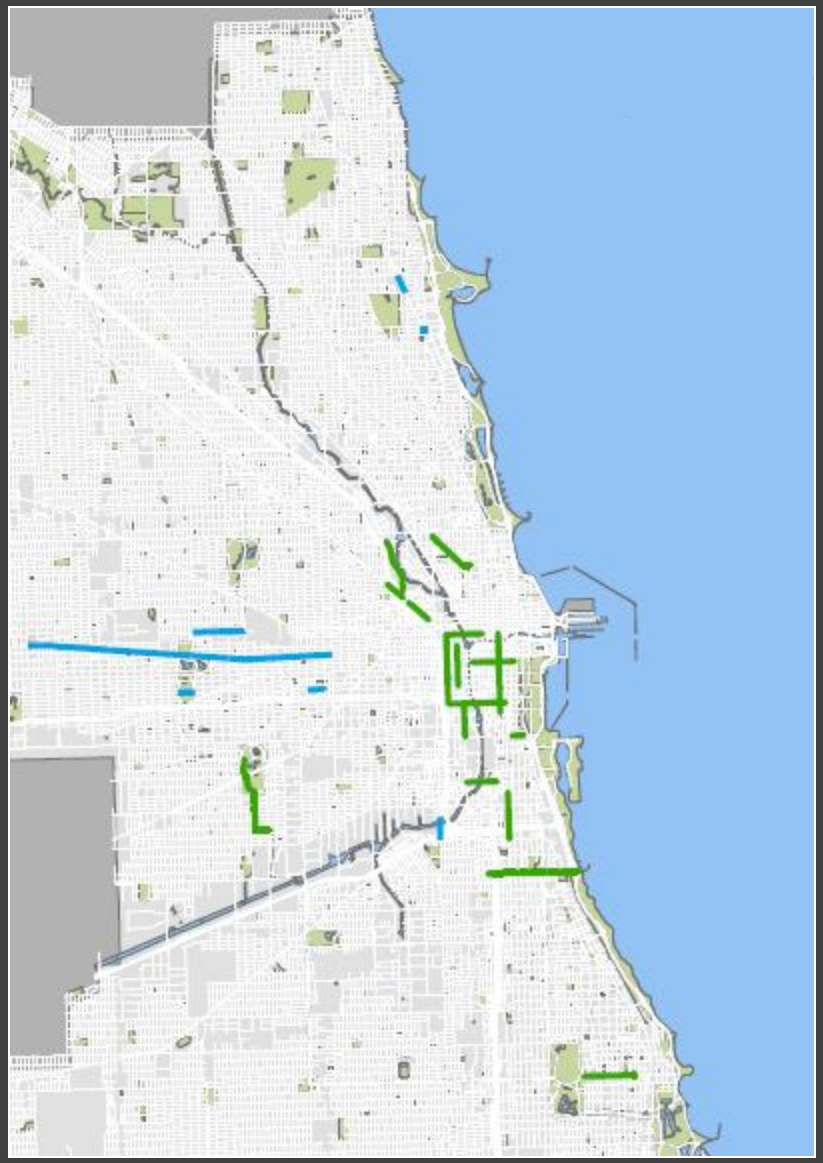
- Can be branded as neighborhood greenways
- Signs can be added to enhance identity
- Pavement markings helpful at crossings or to assist in wayfinding, but are not required

Bike Boulevard – Pros/Cons

- Pros
  - Very low stress, family friendly facility
  - Great neighborhood amenity
  - Low-end boulevards can be low cost
  - Emergency vehicle access is still possible
- Cons
  - May not be the most direct route
  - Traffic control & calming at major intersections can be costly
  - Not feasible unless alternative routes are available for emergency response, trash collection, etc.

Snow Removal Best Practices

- Coordinate with Streets and Sanitation
  - Bollard Removal
    - Streets with no on-street parking permitted
    - Streets with 2'' or 24-hour snow ban parking restrictions
  - Operations
    - Coordinate schedules
    - Extend salt spray on streets with PBL
- Build a *network* similar facilities
- Clear snow within 24 hours of snowfall



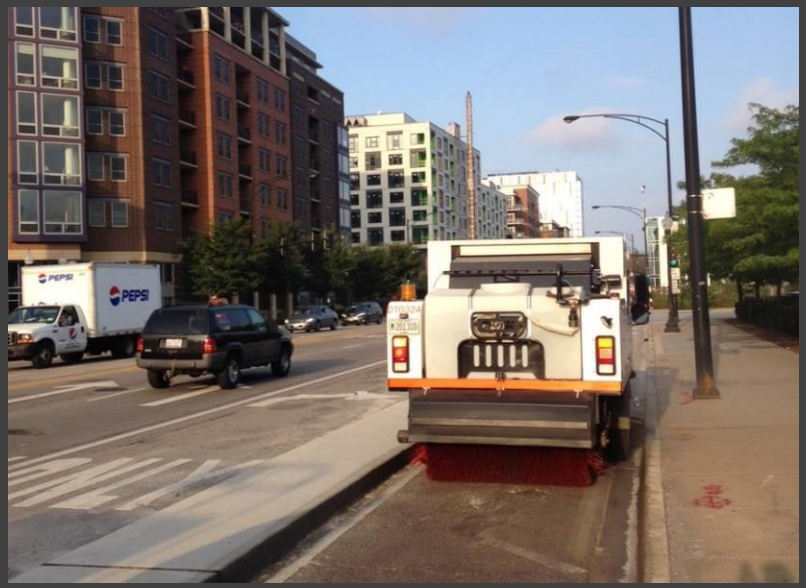
Clear Width Policy

Central Business District

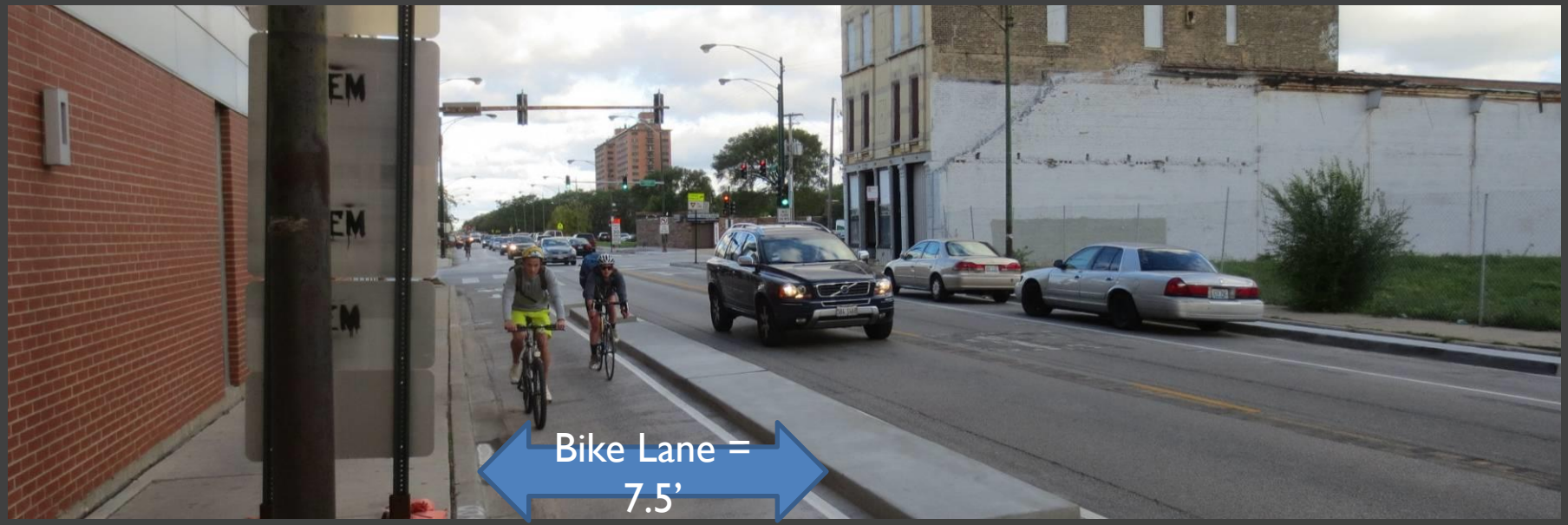
- 6’ Clear
- Smaller plows, hand sweeping
- Connected network

Outside of CBD

- 7.5’ minimum, 8’ *preferred*
- Network more spread out



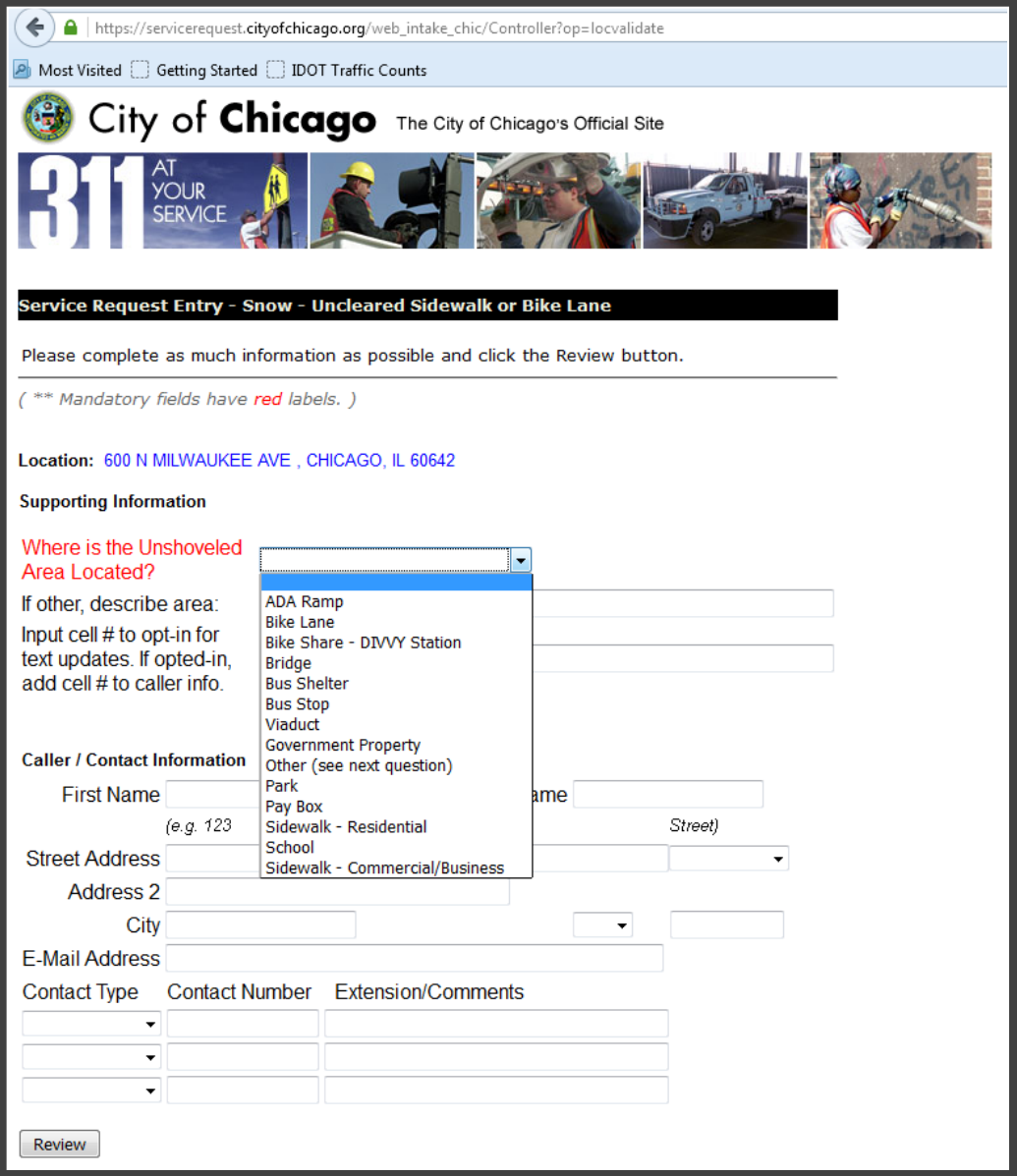
Minimum Clear Width = 9.5’



Minimum Clear Width = 7.5’

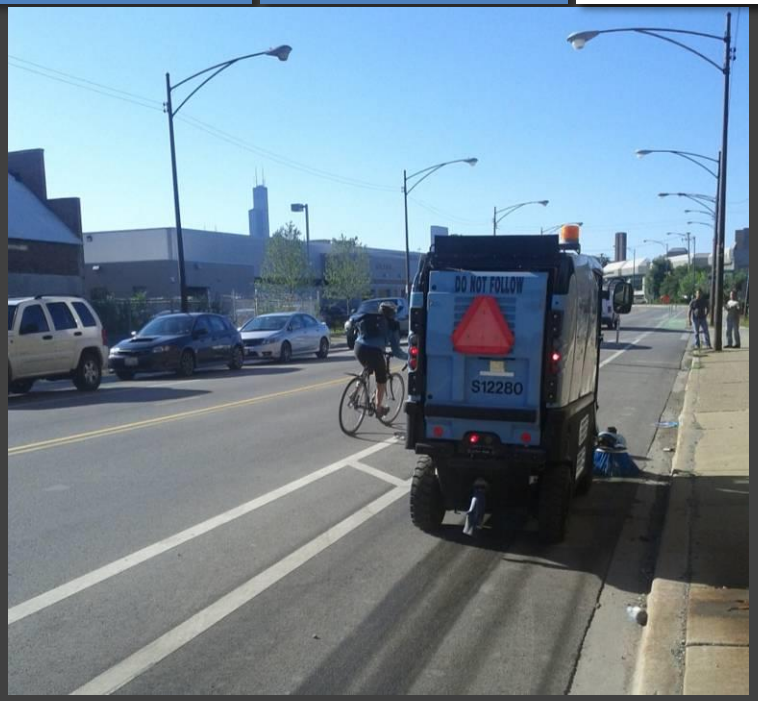
Legislative/Policy Changes

- Revised snow removal ordinance
  - Snow in bike lane
  - Snow blocking bike racks or Divvy stations
- Updates to City 311 System
  - Report snow in bike lane online or via phone
  - Report debris in bike lane via phone



Funding

- Labor
  - Existing seasonal workers
  - Initially paid through annual snow removal budget
  - $90,000/year allocated towards labor from Divvy revenues
- Equipment
  - Elgin Broom Badger street sweeper - $193,000
  - Kubota RTV 900 - $19,500
  - Prinoth Bombardier - $120,000 (2016 purchase)
  - All funded through Divvy revenues


DO NOT FOLLOW
S12280


90

Seasonal Maintenance

- Protected bike lanes ≥ 8' wide enough for smaller plows
- Narrower than that: look to college campuses for guidance.

EXHIBIT 7A: Narrow Maintenance Vehicles

Source: PeopleForBikes

Source: City of Cambridge, MA

Other Considerations

- Trash collection practices may change
- Maintenance plans and agreements
  - Sidewalk: typically adjacent property owner
  - Bike lane: City / DOT

Shared Use Paths

- Off-Street facility for exclusive use by bicyclists, pedestrians
- Bikes-only paths don't really work unless a pedestrian path is nearby
- Avoid mixing bikes, horses

Shared Use Paths

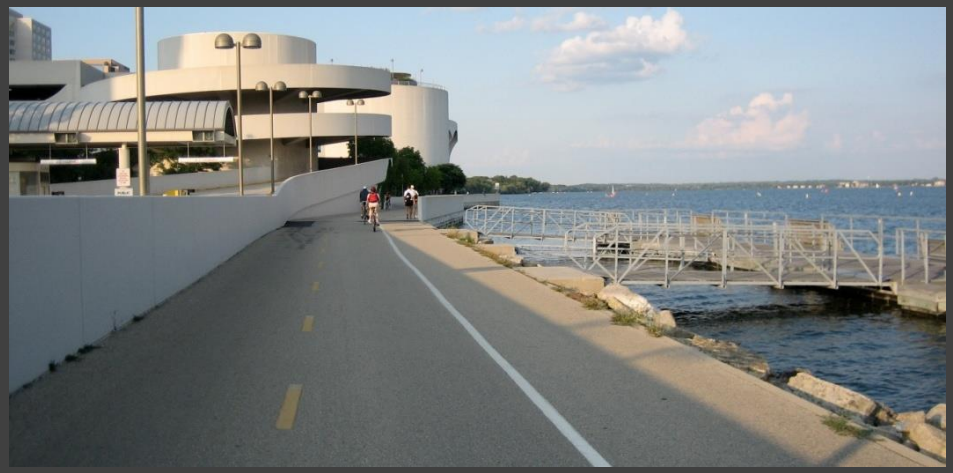
MDOT 12.12.09
"Generally, it is poor practice to attempt to utilize portions of existing sidewalks in front of homes for a shared use path."

AASHTO
"Shared use paths should be thought of as a system of off-road transportation routes for bicyclists and other users that extends and complements the roadway network."

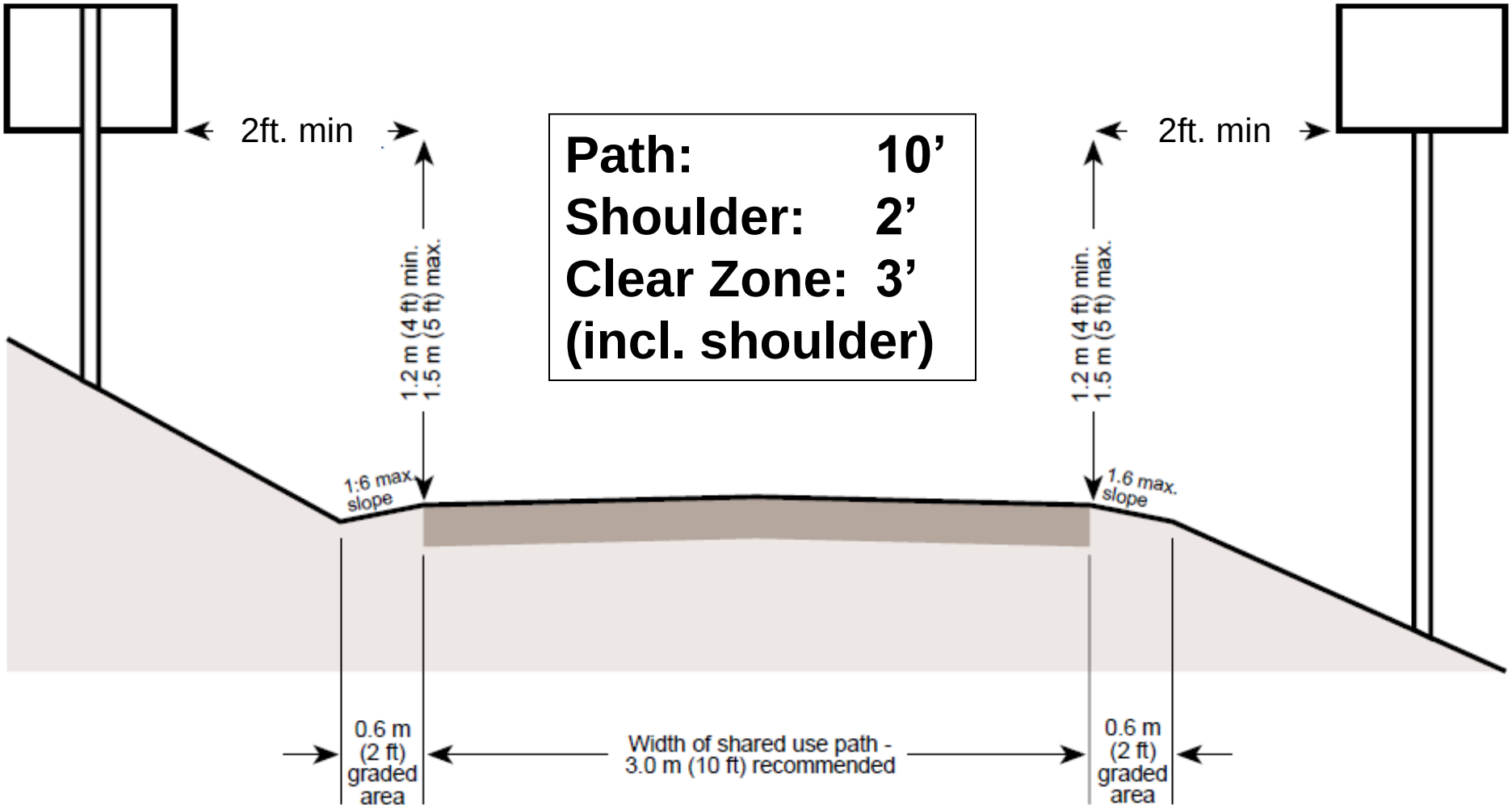
"Shared use paths should not be used to preclude on-road bicycle facilities, but rather to supplement a system of on-road bike lanes, shared roadways, bike boulevards and paved shoulders."

Shared Use Paths - Width

- Minimum width: 10’
- To avoid inordinate cost, short distances may be 8’
- High traffic locations (e.g. college campus): 11-14’
- Pursue uniform width for simpler construction



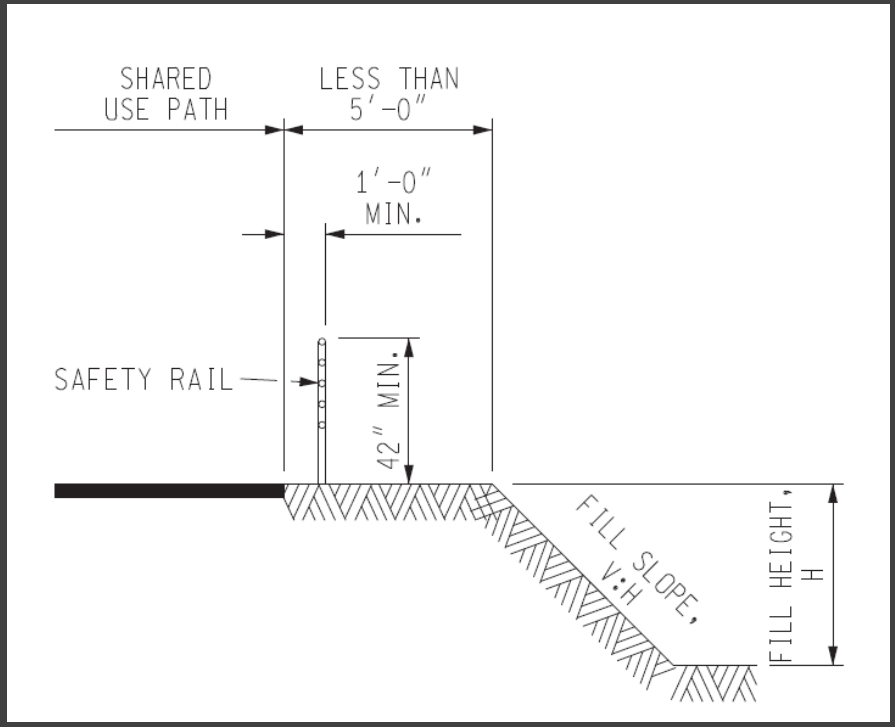
Shared Use Paths - Width



Shared Use Paths – Clear Zones

- Side slopes may require railings

Fill Slope (V:H)	Fill Height (H)
1:3 or steeper	≤ 6 ft
1:2 or steeper	≤ 4 ft
1:1 or steeper	≤ 1 ft



Shared Use Paths – Sidepaths

- Sidepath = Shared Use Path along road/rail
- 5’ separation from roadway (min.)
- Wider separation or barrier desirable in some cases
  - Grade change
  - Body of water
  - Railroad

Shared Use Paths – Design Speed

MDOT 12.12.09: 18 mph normal, 30 mph for descending grades above 6%, lower where high volumes of pedestrians are anticipated.

Shared Use Paths - Curves

Curve radius determined by lean angle, may also be used to slow bicyclists at intersection approaches

Shared Use Paths - Curves

- 12.12.09 - When curvature is required, compound or spiral curves are preferable to simple circular curves. Tight, short-radius curves should be avoided, if possible.

Design Speed (mph)	Minimum Radius (feet)
12	27
14	36
16	47
18	60
20	74
25	115
30	166

Shared Use Paths – Grade

Grades over 5% not ADA compliant

Consider switchbacks and add width at curves

Shared Use Paths - Grade

- Signs should be used to alert path users to changes in grade beyond 5%
- Warning signs for recommended descent speed optional

Shared Use Paths - Surface

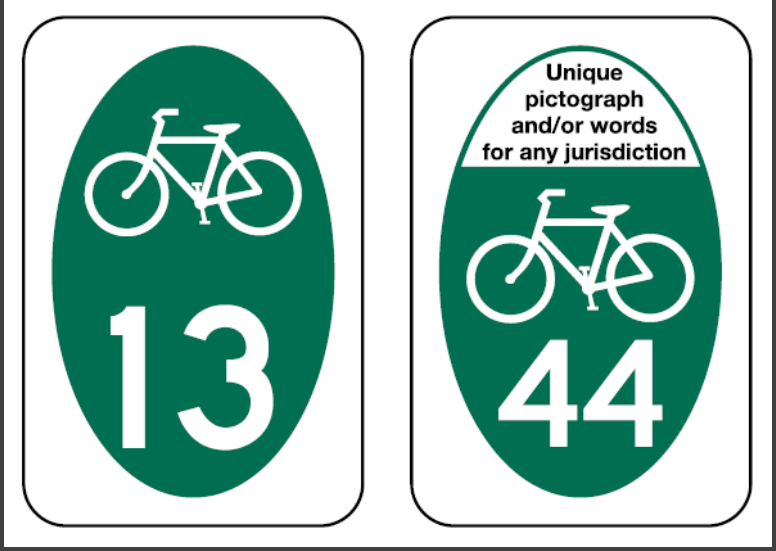
- Must be Smooth
  - Machine spreading preferred for HMA paths
- Concrete Paths Okay
  - Saw cut joints to minimize depressions caused by traditional expansion joints
  - Avoid centerline joints, unless saw cut

Shared Use Paths – Typical Construction

- Base
  - 4-6” crushed stone
- Surface
  - 2” asphalt
- Assume surface drainage unless flooding, washouts a concern

Shared Use Paths - Signs

- Standard guide sign contains
  - **Direction**
  - **Destination**
  - **Distance**
- May also include numbered or themed route signs
- When paths intersect roads, installing street signs with roadway names is recommended



Shared Use Paths - Crossings

- Crossing priority is given to nonmotorized path users
- Clearly marked crossings help clarify responsibility
- Signalization guidelines available for crossings of busy, wide, or high speed highways
- Education and enforcement are needed to address cultural concerns

Shared Use Paths - Crossings

- Stop (R1-1) signs shall be installed on shared-use paths at points where bicyclists are required to stop
- Yield (R1-2) signs shall be installed on shared-use paths at points where bicyclists have an adequate view of conflicting traffic as they approach the sign, and where bicyclists are required to yield the right-of-way to that conflicting traffic.

R1-1

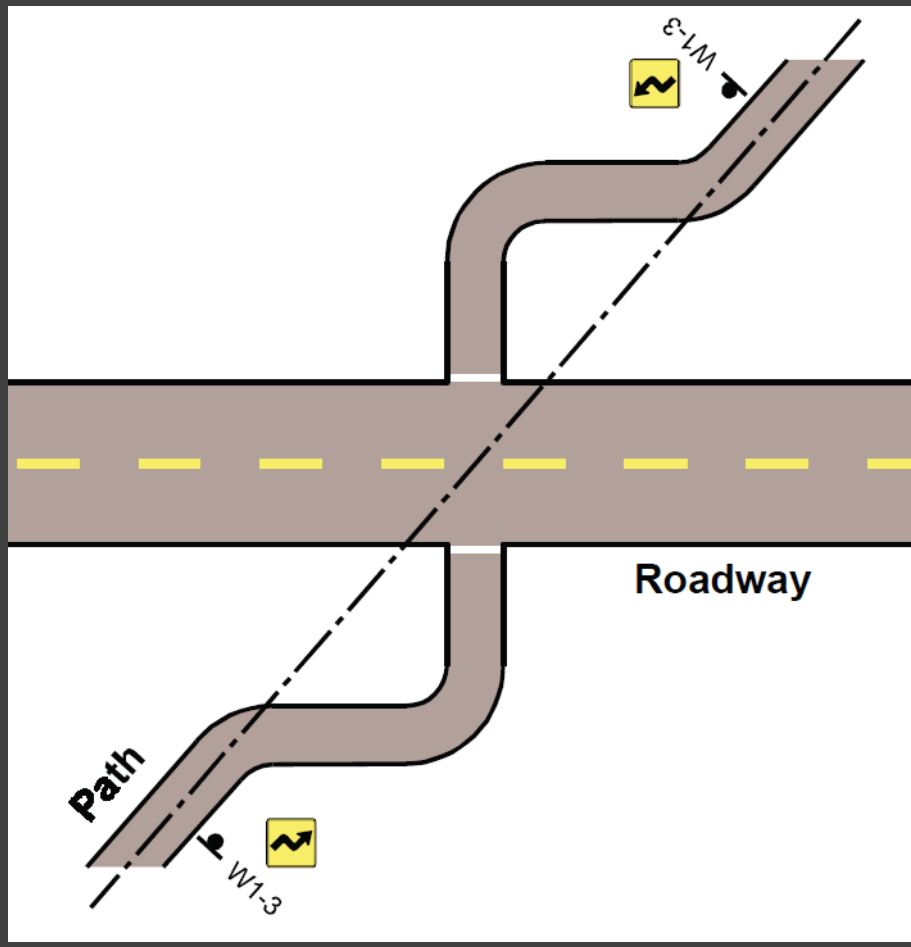
R1-2

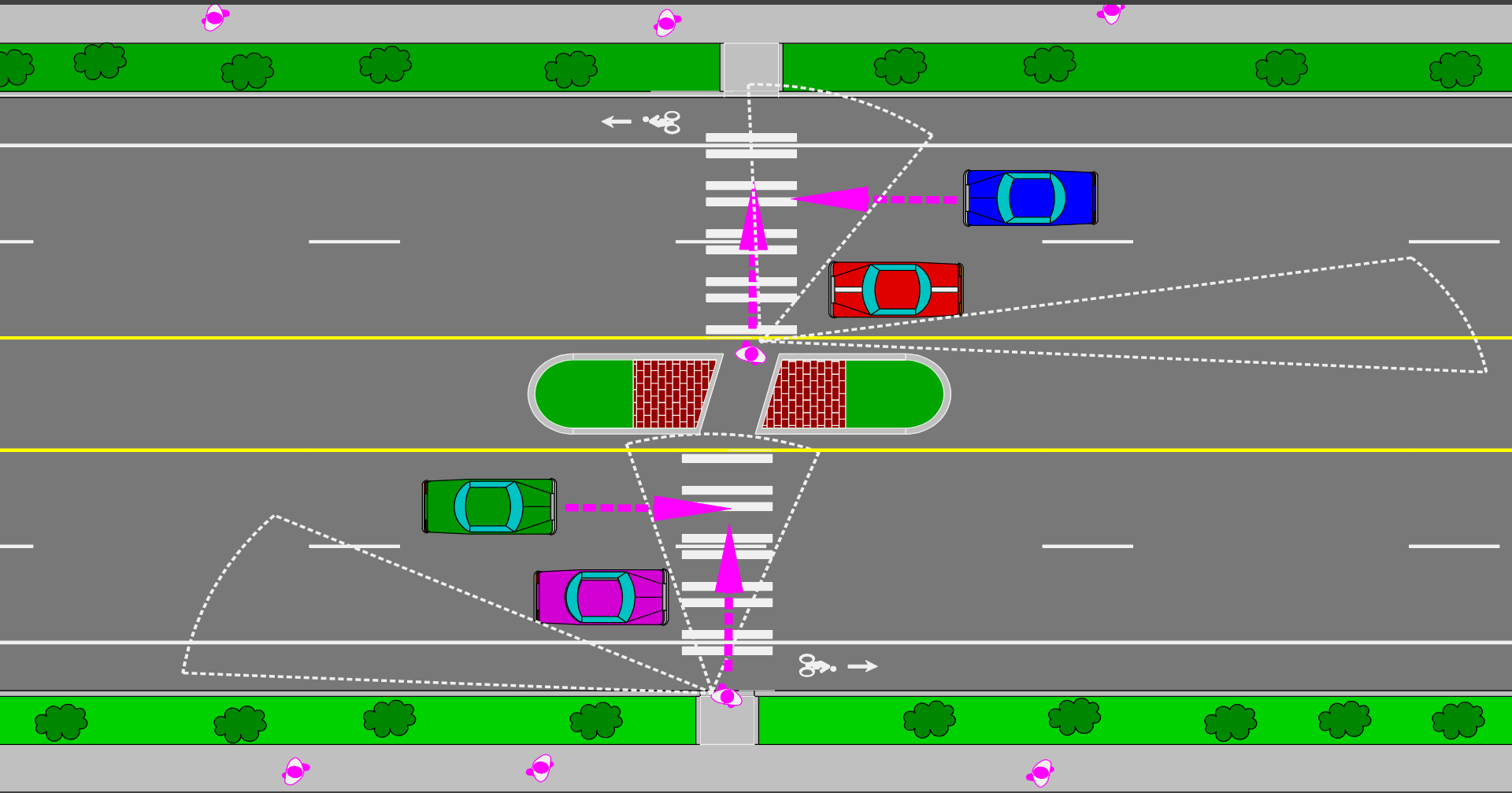
Rectangular Rapid Flash Beacons

- Pedestrian actuated, not a steady flash
- High levels of driver compliance
- Relatively Low Cost
- Compliments other crossing elements

Shared Use Paths - Crossings

- Midblock crossings should be designed to cross at right angles
- Curves in the path should slow approaching bicyclists, increasing the likelihood that they will see approaching traffic and vice versa





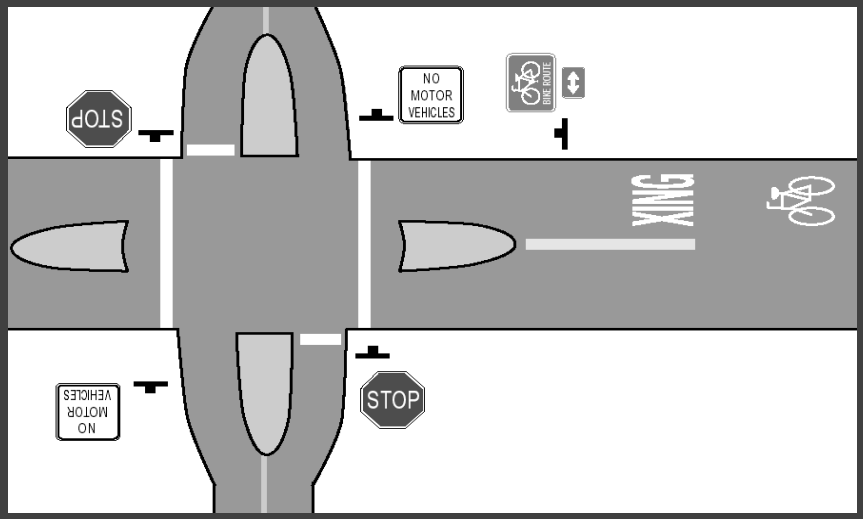
Refuge islands allow path users to cross one direction at a time
Angle the crossing in the median to orient path users toward oncoming traffic

Shared Use Paths - Crossings

- Bollards undesirable
  - Often too small to be seen by bicyclists
  - Crash hazard
  - Note: designs are intended to discourage motorized vehicles, not physically prevent them from entering
  - If bollards must be used, make them as conspicuous as possible (e.g. pavement markings, warning signs).

Shared Use Paths - Crossings

- Medians, or landscaping more desirable
  - Don't require locking/unlocking for maintenance vehicles
  - Still communicates "Do Not Enter"



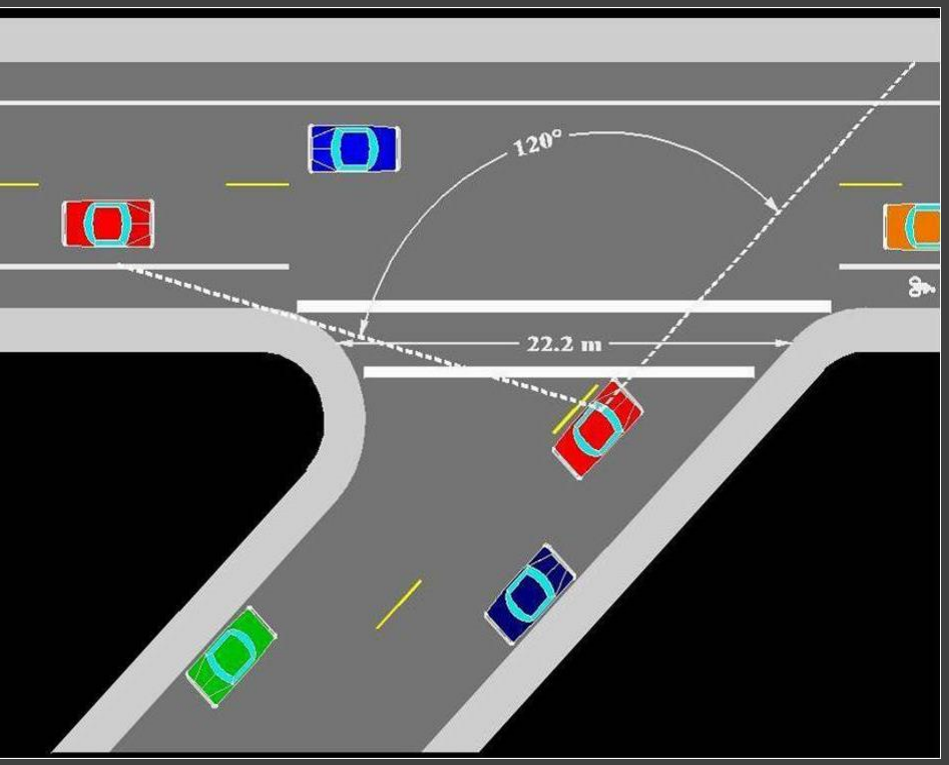
Shared Use Paths – Pros/Cons

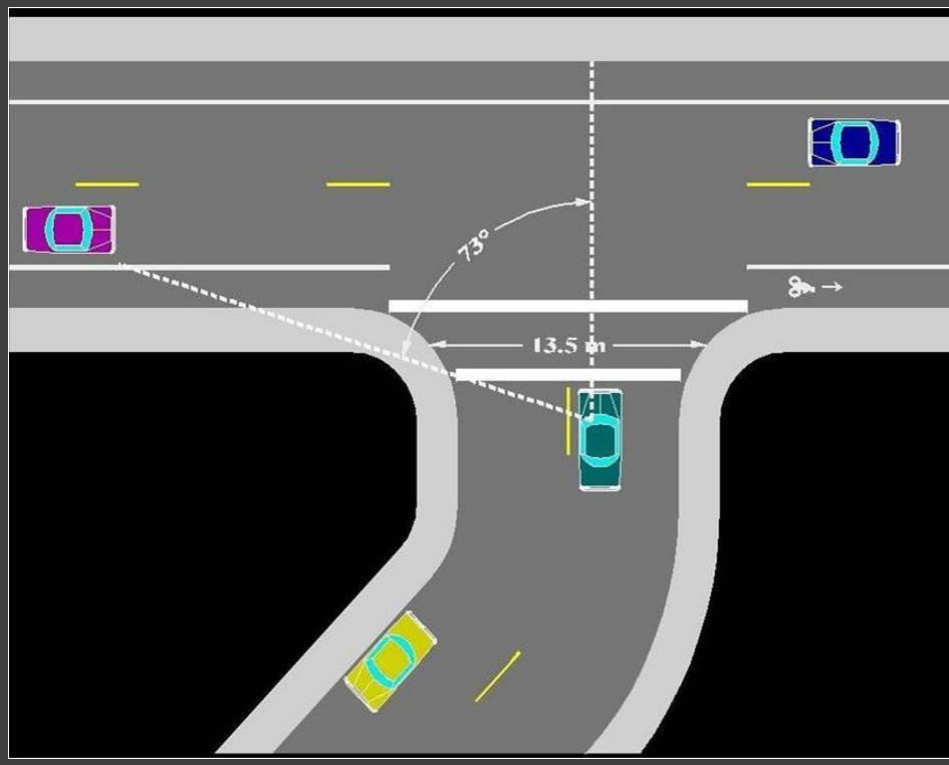
- Pros
  - Lowest stress bicycle facility
  - (Almost) completely separated from automobile traffic
  - Often attractive, scenic, and most likely to encourage bicycling
- Cons
  - Doesn't fit everywhere
  - Very expensive
  - Can create confusion, safety concerns at intersections, crossings
  - Without complementary network, adds to the perception that bicyclists aren't welcome on-street

Bicycle Facilities at Intersections

- Geometrics
- Directional Signs
- Intersection Markings
- Shared Lanes
- Bike Lanes
- Signals
- Path & Sidepath Issues
- Roundabouts
- Interchanges

Intersection Geometrics

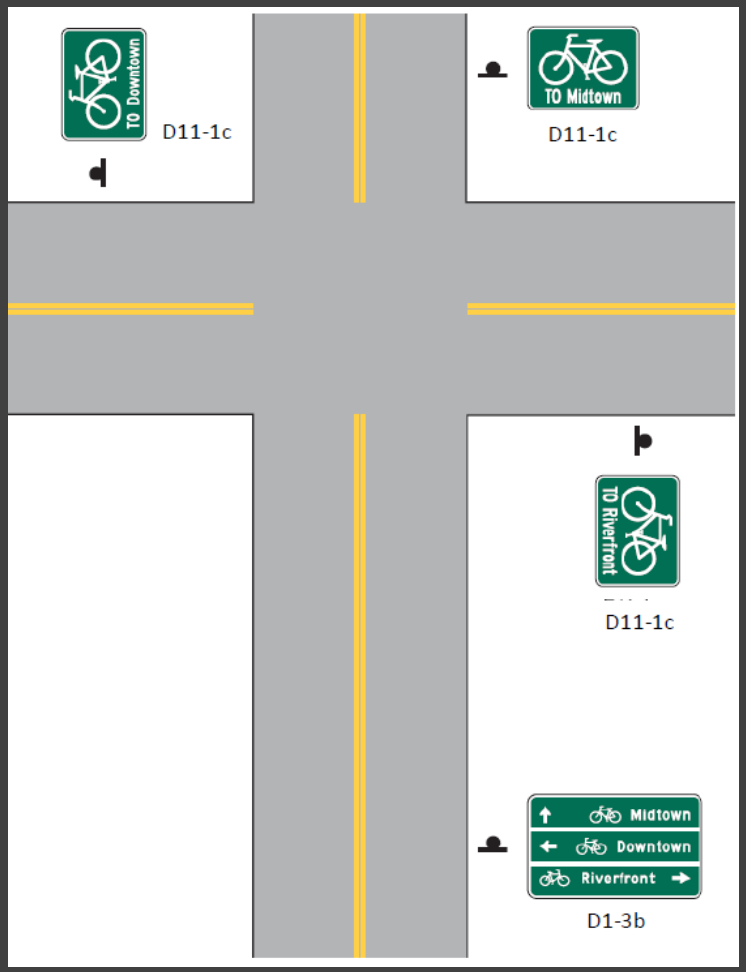




When streets are reconstructed, reduce crosswalk width, improve visibility, reduce pavement area, pavement markings, etc. Smaller corner radii encourage lower speeds at intersections.

Directional Signs

- Identify turns, cross routes
- Sign placement prior to turns:
  - Provide enough space for bicyclists to look, signal, change lanes, turn
- "Pedestrian left" acceptable for less confident bicyclists



Intersection Markings

- Sharrow identifies intended bicyclist location approaching (or through) intersection
- Generally, keep intersections clear of symbols, but creative solutions may be needed in unique cases

Shared Lanes at Intersections

Combined turn lane/bike lane is a cleaner approach
Supplement with signs, shared lane marking

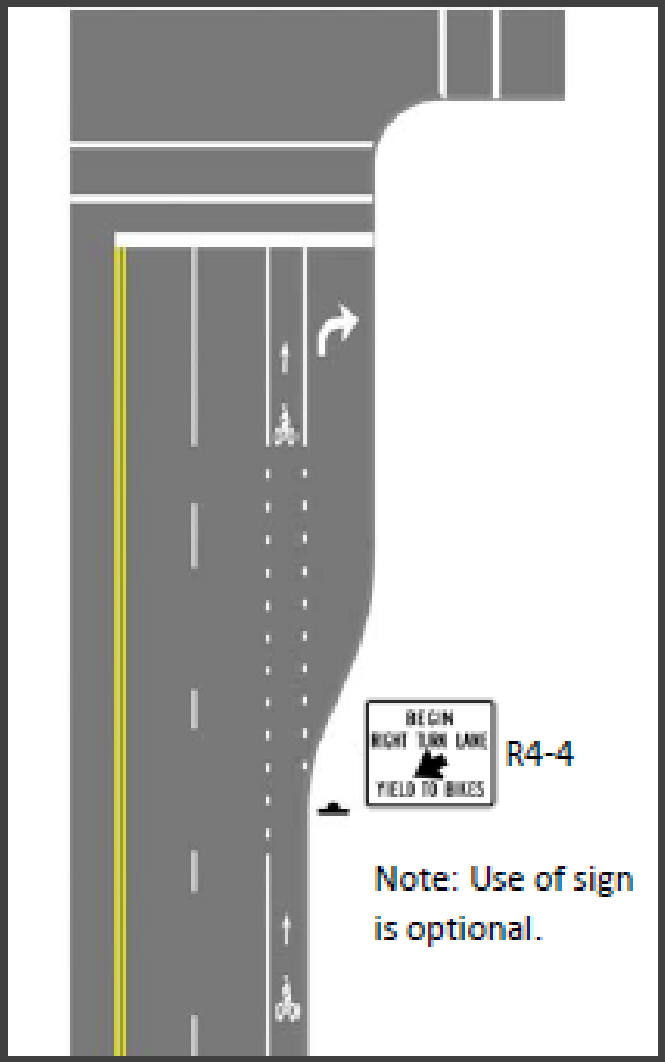
Bike Lanes at Intersections

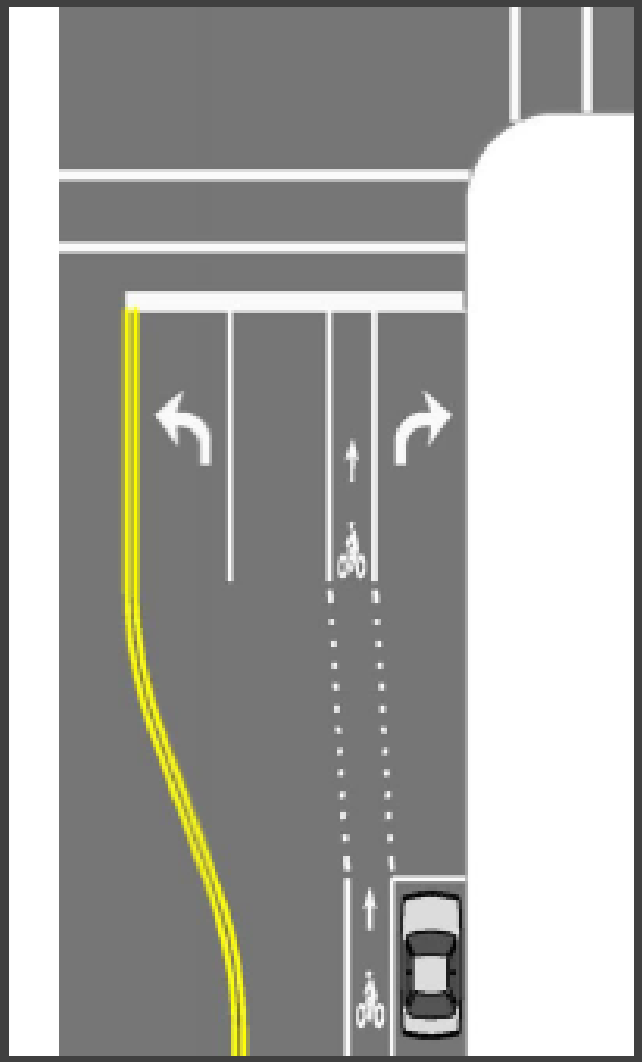
Drivers yield to bicyclists yield to pedestrians
Pavement markings should reflect this

Bike Lanes at Intersections

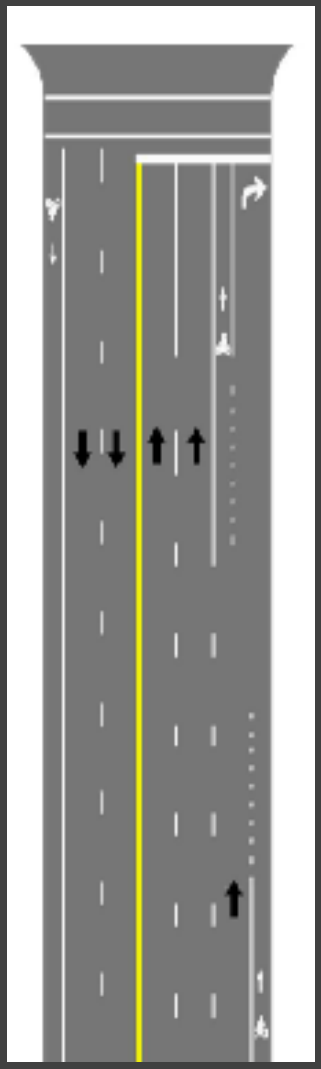
- Bike lane drop at right turn lanes
- Dashed line to show weaving section
- Begin Turn Lane – Yield To Bikes (Sign R4-4)

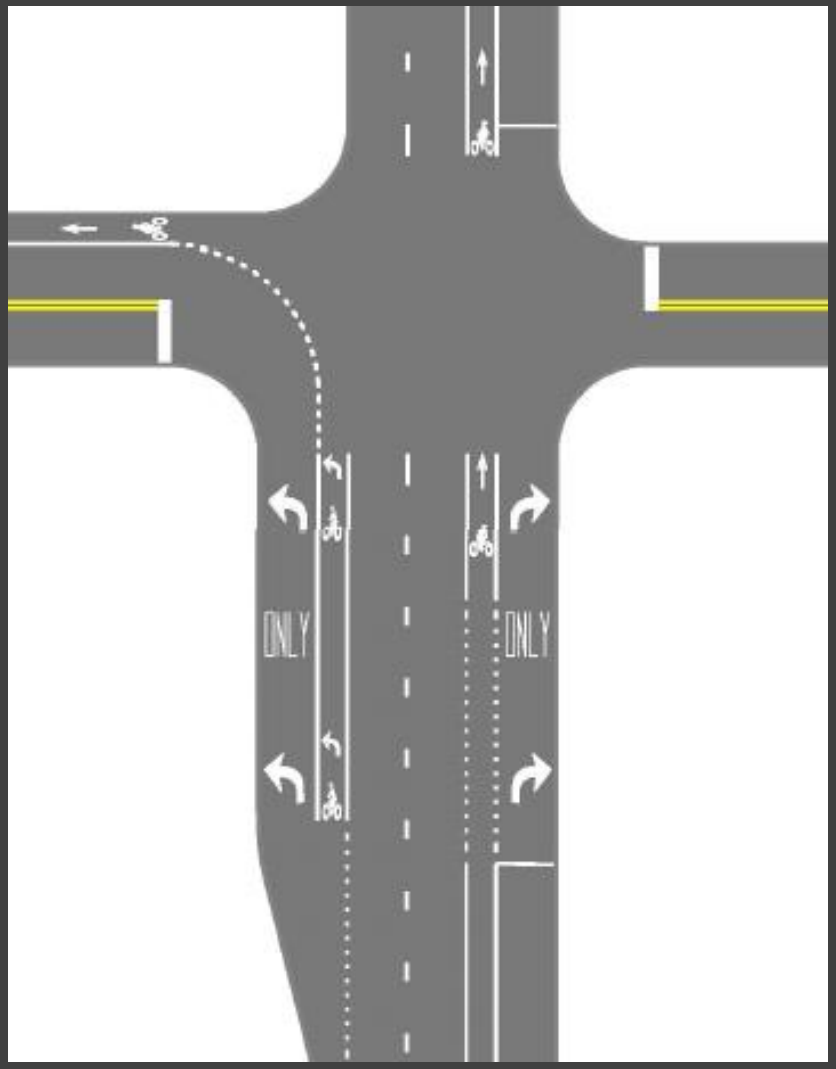
Bike Lanes at Intersections





Bike Lanes at Intersections





Use Green Pavement at Crossing / Weaving Segments

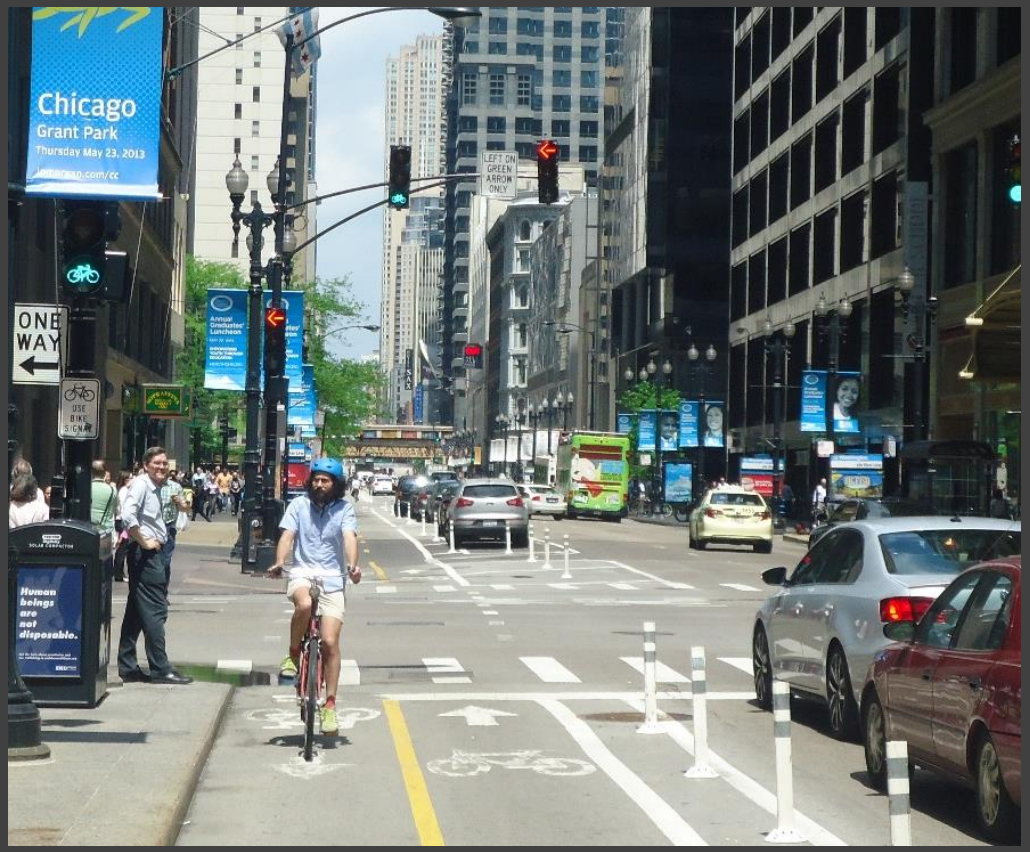
- MDOT has statewide Interim Approval (IA) to use green markings in mixing zones and crossover locations.

Bike Lanes - Tapers

- Automobile Lanes
  - 1:20 or greater, typ.
- Bike Lanes
  - 1:5 acceptable
  - 1:20 taper for a bike lane often accompanies taper for automobile turn lane

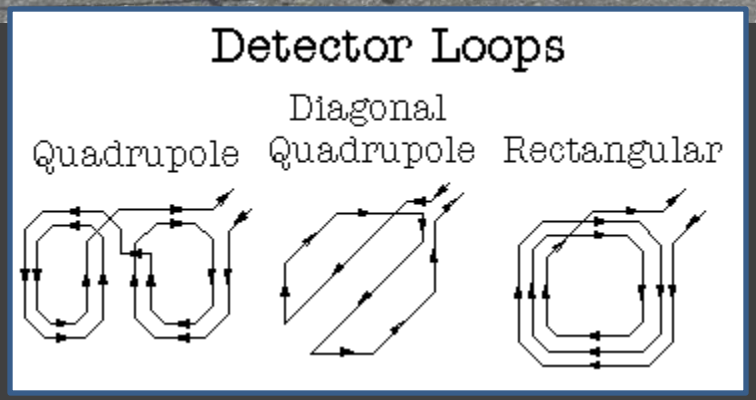
Signals

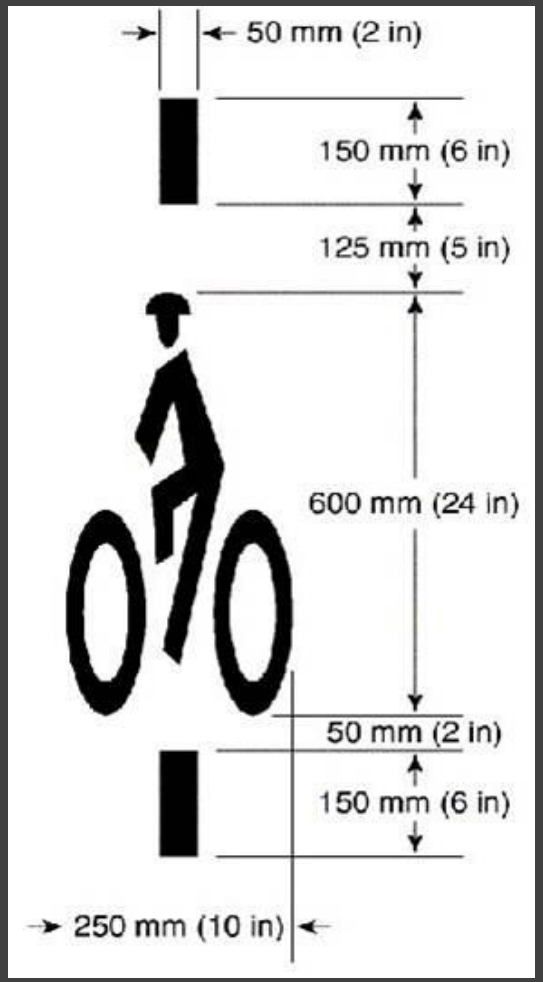
- Pre-timed signals:
  - Best for bicyclists; no changes needed
- Actuated signals
  - Adjust detection to recognize presence of bicycles
  - Make sure signal is visible to bicyclist
  - Consider bike-only phase in areas with high bicycle traffic volumes



Signals

- Loop detector pavement marking





Signals

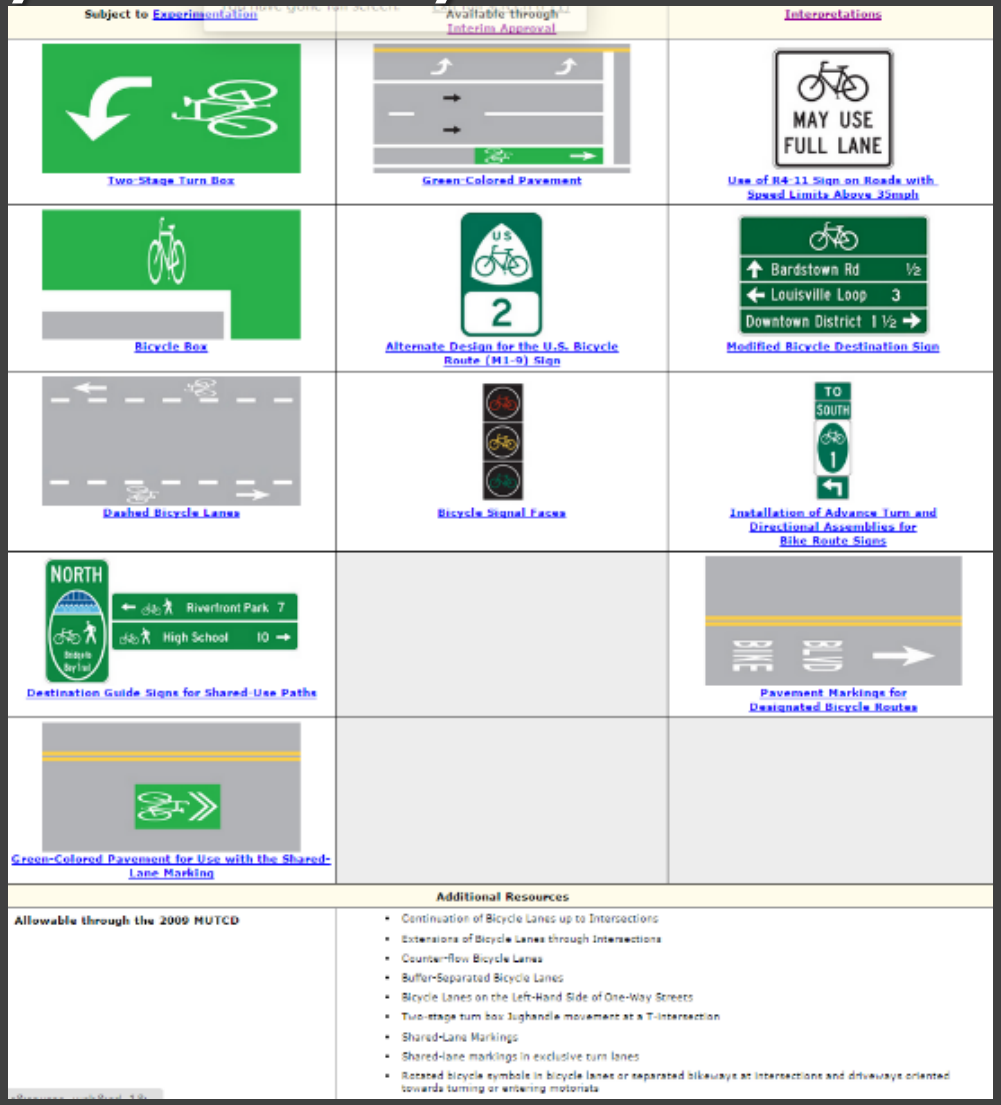
- Push button
  - Not desirable for bicyclists unless reachable directly from the bicycle facility
  - Might be ignored unless push button is for a wide, busy crossing

Bike Signals

- Separate signal control may be needed
  - Two-way, protected bike lanes
  - Contraflow facilities
- Requires Request to Experiment (RFE)

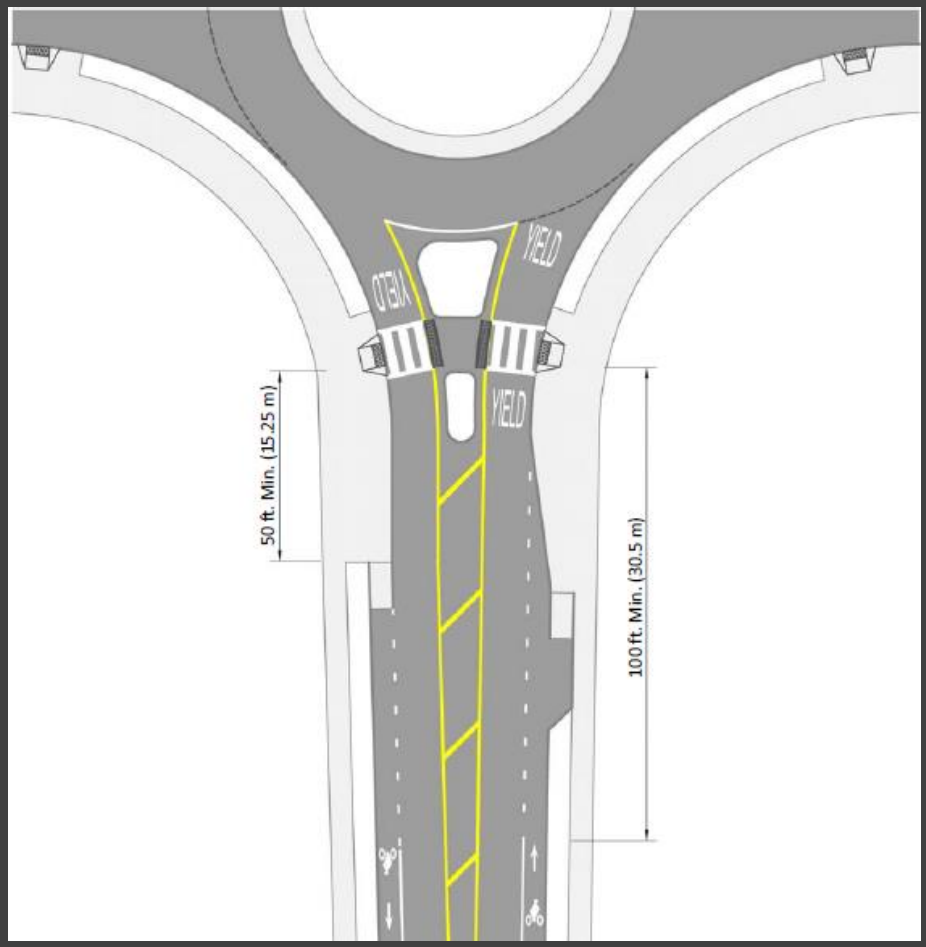
FHWA Status of Bicycle Facility Treatments

- Identifies:
  - What is approved per MUTCD
  - What types of facilities require RFE
  - Facilities that have interim approval
  - Facilities currently being studied by FHWA



Roundabouts

- Bicycle Facilities
  - **Michigan Design Manual 12.12.10**
  - Bike lane ends, becomes shared lane within roundabout (single lane only)
  - Construct wide sidewalks around the outside of the roundabout as alternative



Bike lane ends, bicyclist merges with traffic

Bike lane ends, bicyclist merges with traffic

Design speed of roundabout facilitates shared lane conditions

Design speed of roundabout facilitates shared lane conditions

Bicyclist exits the roundabout, returns to on-street facility

Bicyclist exits the roundabout, returns to on-street facility

Alternative option: Sidepath

Bicyclist takes exit ramp

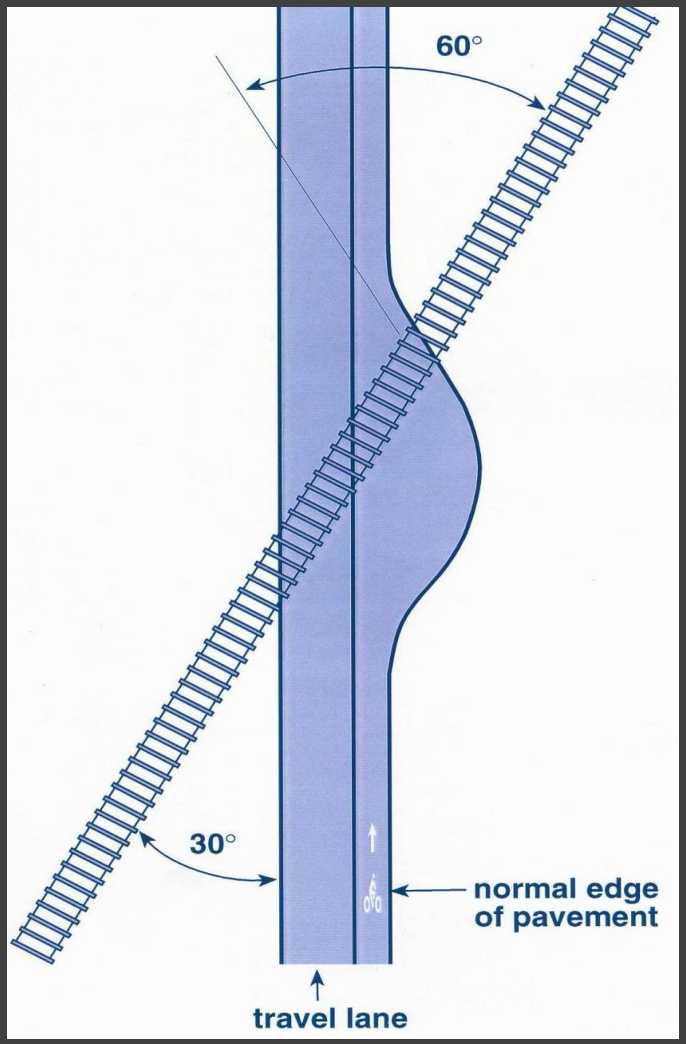
Crosses at roundabout crossing

Railroad Crossings

- Keep it smooth: concrete is best
- Rubber is okay, though slippery when wet
- Asphalt, timber okay if well maintained
- Keep flange opening as small as possible

Railroad Crossings

- Cross at 90° if possible (anything less than 45° should be improved to at least 60°)
- Create bulge in bike lane or shoulder to facilitate crossings approaching 90°



Railroad Crossings

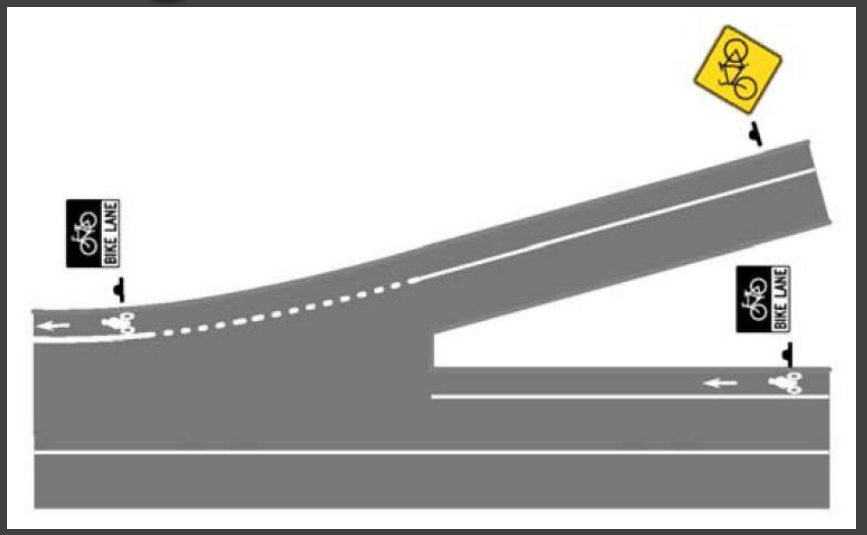
Interchanges

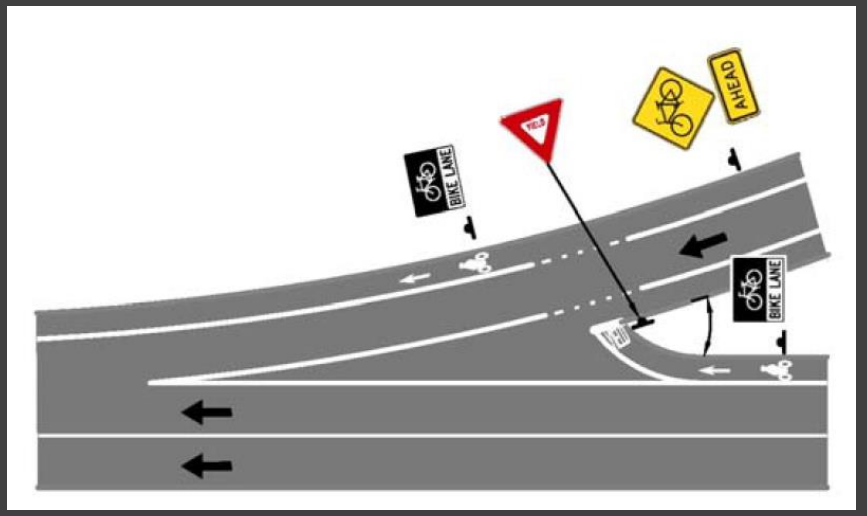
- MDOT 12.12.09 L:

An important principle in designing interchanges that accommodate shared use paths is to **reduce motor vehicle speeds** at locations where pedestrians and bicyclists either cross the road, or merge with traffic. For this reason, urban interchange design with conventional **90 degree intersections (instead of free flow merge lanes)** is preferable for pedestrian and bicycle safety. Interchange designs that enable motor vehicles to maintain speeds above 30 mph without stopping are not conducive to pedestrian and bicycle access and should be avoided. Shared use paths should cross interchange ramps at a 90° angle.

Interchanges

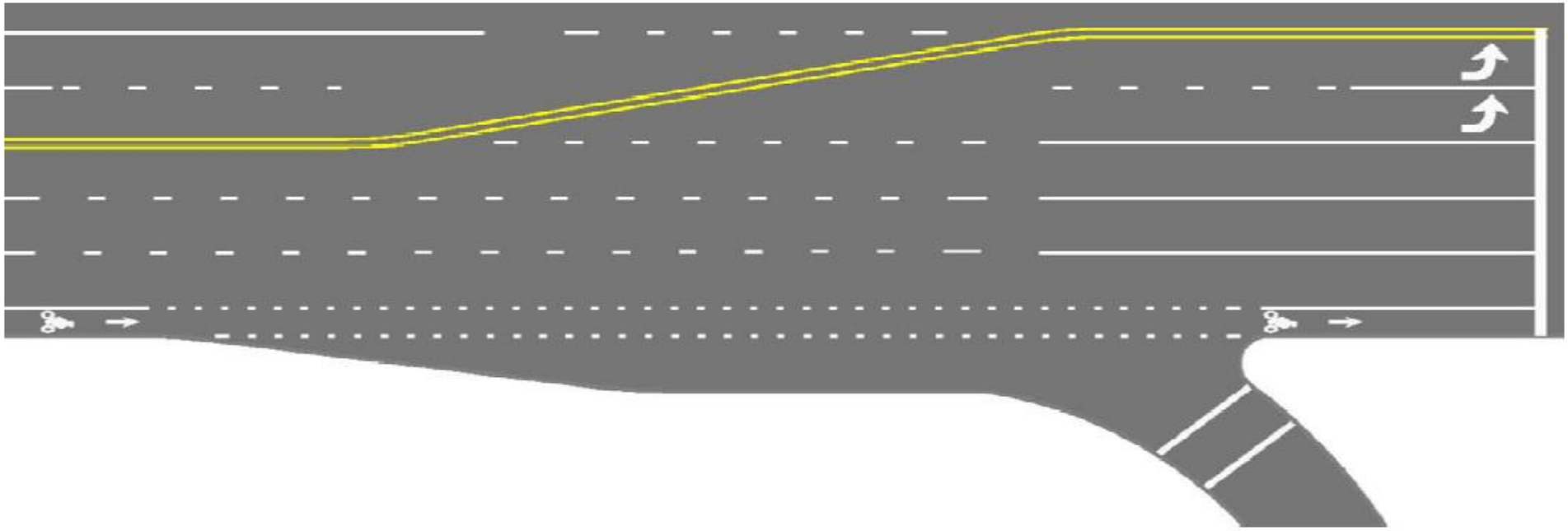
- Urban interchange desirable whenever bike facilities are being considered
- Reduce motor vehicle speeds where crossings occur
- Two options for entrance ramps in **rural** areas
- Warning and regulatory signs important at intersection





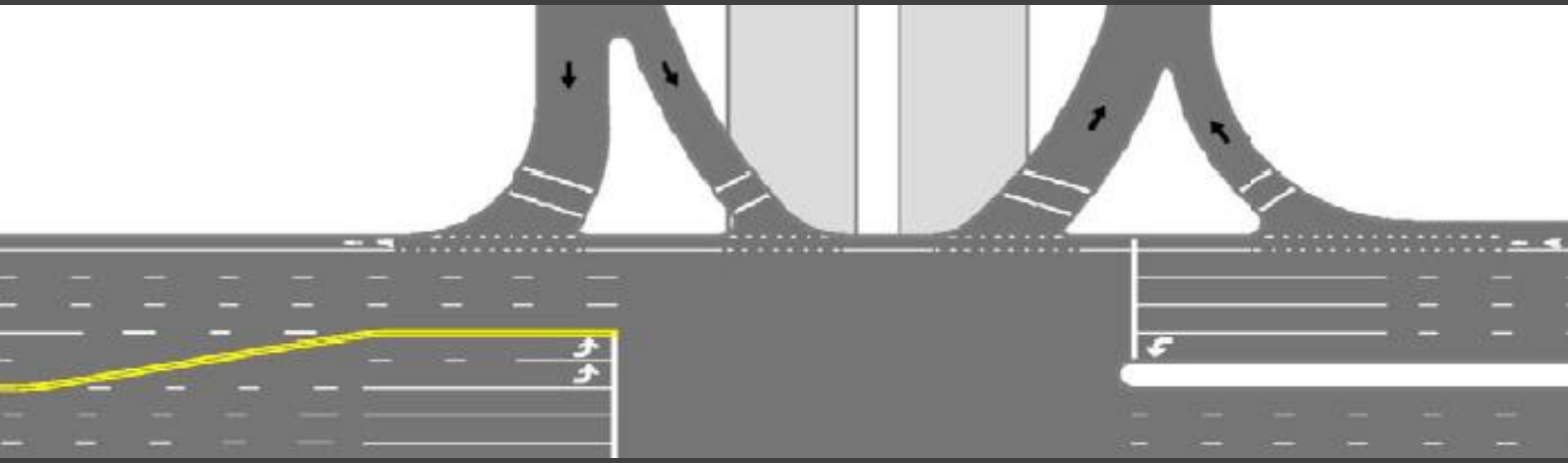
Interchanges

- Exit ramps require plenty of weave/merge room
- Provide turn lanes, add pavement markings, signs



Interchanges

- Single-point Urban Interchange (SPUI) helps limit turning conflicts
- Urban interchange design minimizes acceleration prior to ramp, best for bicycles

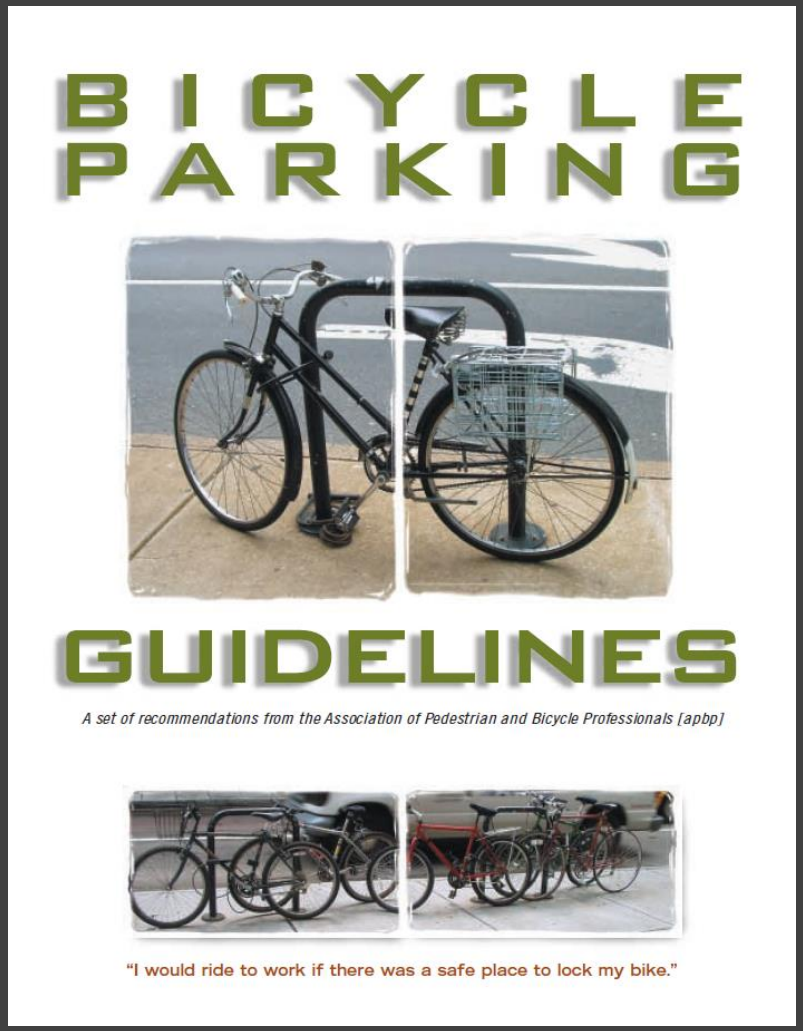


Bike Parking

- Equally as visible, accessible as automobile parking
- Desirable: visible near building entrances

Bike Parking

- Should enable secure locking
- Does not damage wheels, frame
- Creativity is encouraged
- Association of Pedestrian and Bicycle Professionals (APBP), helpful guide



Bike Parking – Bike Corral

- One rack at a time
  - traditional parking space holds 12 bikes
- Prefab
  - Good for temporary, seasonal installations

References

1. Geller, R. (2012). Four Types of Cyclists. Portland Office of Transportation.
2. Moritz, W. (1995). Survey of North American Bicycle Commuters; Design and Aggregate Results. Transportation Research Record 1578.
3. Association of Pedestrian and Bicycle Professionals. n.d. Bicycle Parking Guidelines.
4. Wisconsin Department of Transportation. (2004). Wisconsin Bicycle Facility Design Handbook.
5. Federal Highway Administration. Bicycle Facilities and the Manual on Uniform Traffic Control Devices. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/mutcd_bike.cfm
6. National Association of City Transportation Officials. (2012). Urban Bikeway Design Guide, 2nd Edition.
7. Highway Tort Liability in Michigan. (2005). State of Michigan. http://www.michigan.gov/documents/MDOT_Appx_D_Policies__Procedures_11-13_Highway_Tort_Liabili_160136_7.pdf

References – Sample Projects

Buffered Bike Lanes

Oakland County, M-10 Northwestern Highway, between Inkster Road and 14 Mile.
http://www.lmb.org/index.php?option=com_content&view=article&id=756:lmb-commends-mdot-on-their-new-bicycle-awareness-materials&catid=96:lmb-news7&Itemid=94&highlight=YToxOntpOjA7czo0OiJtZG90Ijt9

Lansing, M-43/Saginaw Highway, Stanley Street to the Grand River.
http://www.lmb.org/index.php?option=com_content&view=article&id=739:1st-buffered-bike-lanes-come-to-michigan-cyclists-celebrate-in-lansing&catid=145:community-news&Itemid=94&highlight=YToxOntpOjA7czo0OiJtZG90Ijt9

East Lansing, M-143/Michigan Ave, Morgan Ln to Harrison (eastbound)/Grand River (westbound)
http://www.youtube.com/watch?v=IsQhWHH8vdo and http://www.youtube.com/watch?v=S0etwlUHcL4

Green Pavement Markings

Oakland County, M-10 Northwestern Highway, between Inkster Road and 14 Mile.
http://www.lmb.org/index.php?option=com_content&view=article&id=756:lmb-commends-mdot-on-their-new-bicycle-awareness-materials&catid=96:lmb-news7&Itemid=94&highlight=YToxOntpOjA7czo0OiJtZG90Ijt9

Contra-flow bike lane

Lansing Moores River Drive, between northbound MLK and southbound MLK
http://www.lmb.org/index.php?option=com_content&view=article&id=858:mdot-s-small-project-make-big-improvements-for-lansing-area-bicyclists&catid=144:general-news&Itemid=94&highlight=YToxOntpOjA7czo0OiJtZG90Ijt9

Thank You!
Any Questions?

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