

# Countermeasure Strategies for Pedestrian Safety

## Pedestrian Safety at Interchanges



**Meghan Mitman**  
Fehr and Peers

**December 10, 2015**



**Pedestrian and Bicycle  
Information Center**



# Today's Presentation

- ⇒ Introduction and housekeeping
- ⇒ Audio issues?  
Dial into the phone line instead of using “mic & speakers”
- ⇒ PBIC Trainings and Webinars  
[www.pedbikeinfo.org/training](http://www.pedbikeinfo.org/training)
- ⇒ Registration and Archives at  
[pedbikeinfo.org/webinars](http://pedbikeinfo.org/webinars)
- ⇒ PBIC News and updates on Facebook  
[www.facebook.com/pedbike](http://www.facebook.com/pedbike)
- ⇒ Questions at the end

Countermeasure Strategies for Pedestrian Safety Webinar Series

## **Upcoming Webinars**

### **Lighting Strategies for Pedestrian Safety**

Tuesday, December 15 (1:00 – 2:30 PM Eastern Time)

### **Traffic Calming**

Thursday, December 17 (1:00 – 2:30 PM Eastern Time)

### **Pedestrian Safety at Roundabouts**

Wednesday, January 6 (1:00 – 2:30 PM Eastern Time)

To view the full series and register for the webinars, visit

[www.pedbikeinfo.org/training/webinars\\_PSAP\\_countermeasurestrategies.cfm](http://www.pedbikeinfo.org/training/webinars_PSAP_countermeasurestrategies.cfm)

# PEDESTRIAN ACCOMMODATIONS AT INTERCHANGES

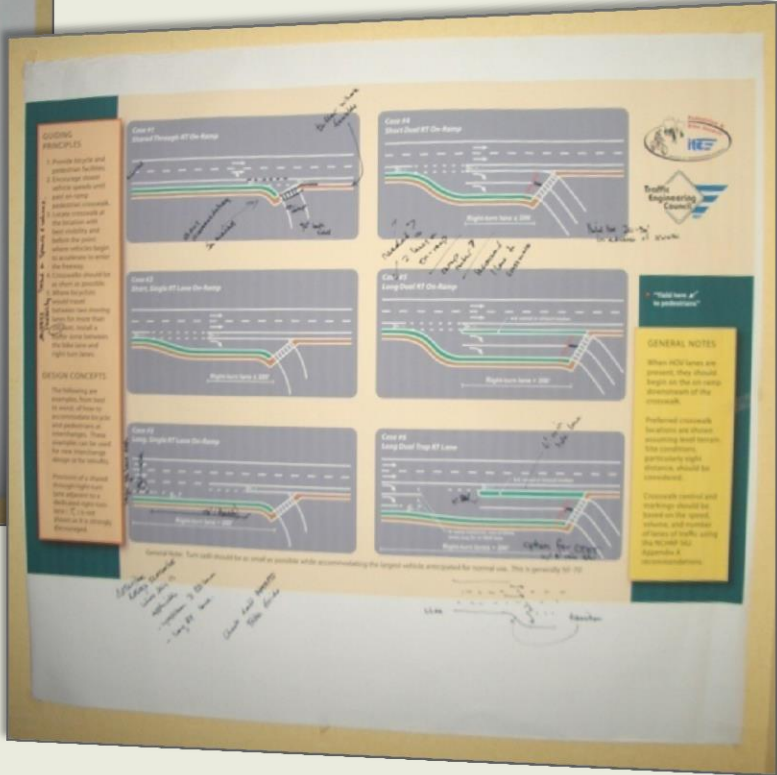
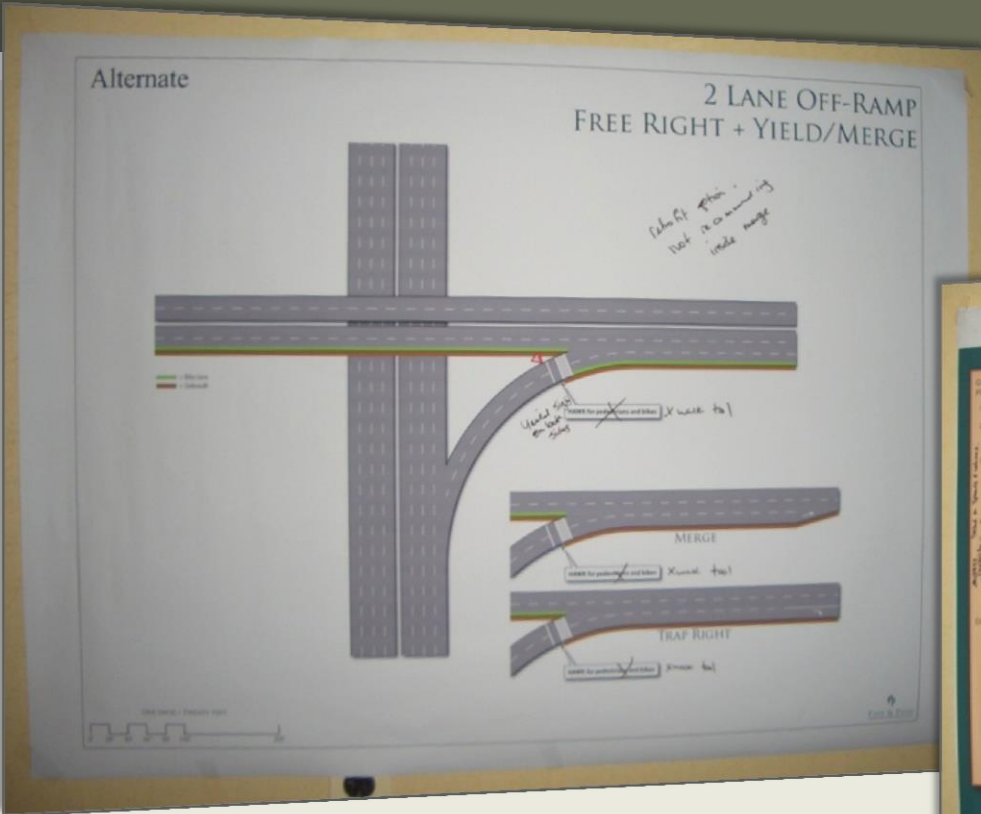
DPS 201  
Webinar  
Series

Meghan Mitman, AICP  
Principal,  FEHR & PEERS

December 10, 2015



# BACKGROUND



# WHERE DOES THE FREEWAY END?



# UNDERSTANDING THE ISSUES

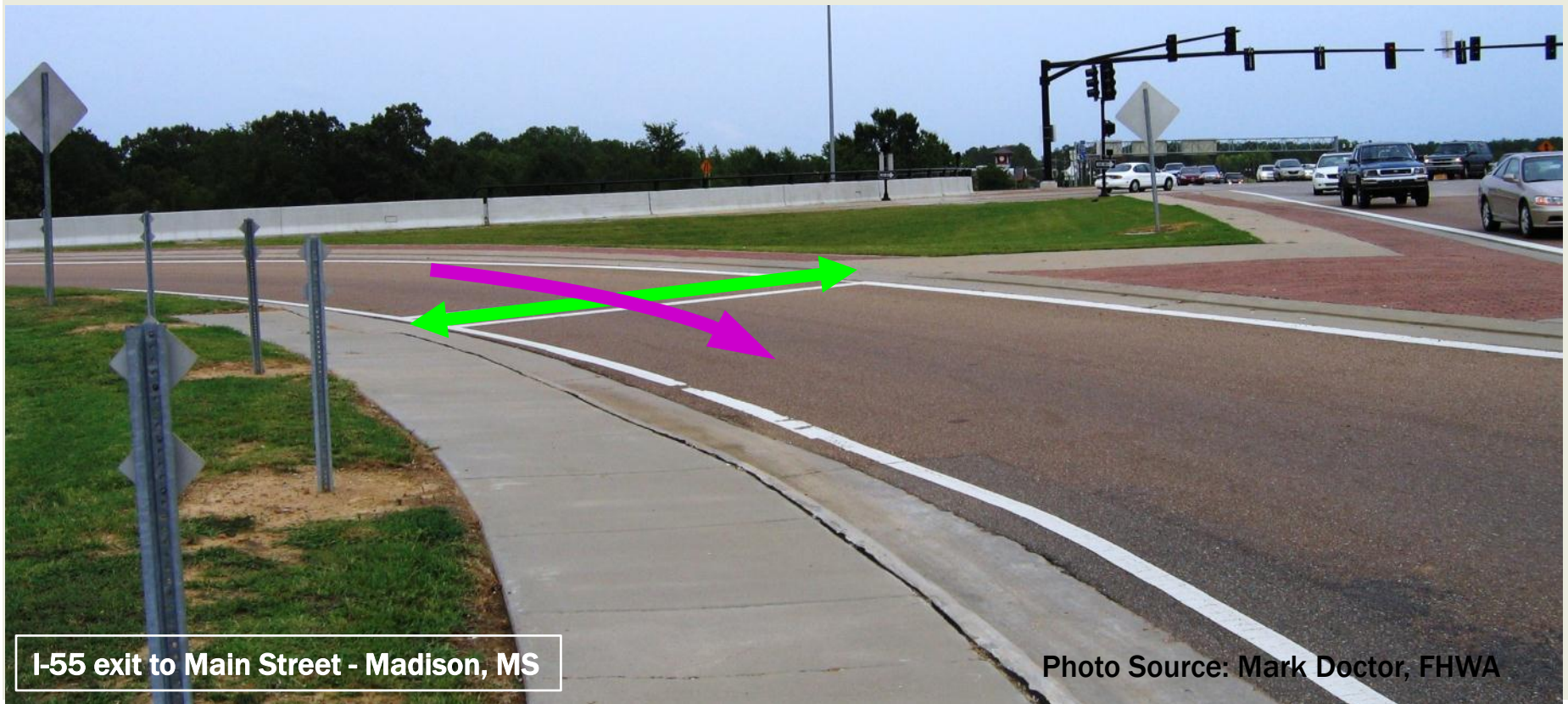
- Intersections of freeway ramp terminals at crossroads are the most critical components of an interchange
  - Challenge: balance mobility and safety of peds & bicycles with movement of vehicles





# UNDERSTANDING THE ISSUES

Free-flow ramp movements can be very challenging for pedestrians to cross



I-55 exit to Main Street - Madison, MS

Photo Source: Mark Doctor, FHWA

# UNDERSTANDING THE ISSUES

- Drivers do not expect pedestrians around interchanges
  - There is safety in numbers; but pedestrian numbers are usually low around interchanges
- After coming off freeway 45 mph appears to be a slow speed
  - Provide visual cues
- Discontinuous facilities
- Free-flowing entry and exit ramps
- Insufficient lighting
- Unmarked crossings
- Poor sight distance
- Long crossing distances

# RESOURCES



## Bicycle and Pedestrian at Grade-Separated Interchanges

Prepared by:  
New Jersey Bicycle and Pedestrian Resource Center

Prepared for:  
New Jersey Department of Transportation

Funded by:  
NJDOT & FHWA

Revised August 2008

## Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians

California Department of Transportation

2010



## Alternative Intersections/Interchanges: Informational Report (AIR)

PUBLICATION NO. FHWA-HST-09-050

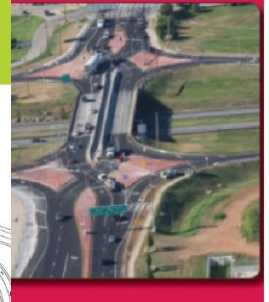
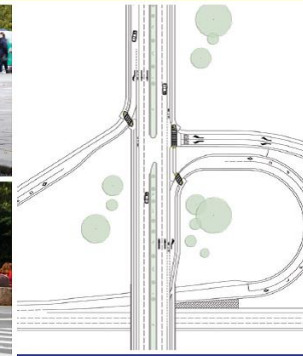
APRIL 2009



INSTITUTE OF TRANSPORTATION ENGINEERS

## Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges

AN ITE PROPOSED RECOMMENDED PRACTICE





# LACK OF NATIONAL GUIDELINES

## AASHTO - A Policy on Geometric Design of Highways and Streets 2011 6<sup>th</sup> Edition

### ■ 10 Grade Separations and Interchanges

#### ■ 10.1 Introduction and general Types of Interchanges

- To reduce conflicts between vehicles, pedestrians, or bicycles within interchanges, it is preferable to separate their movements. When separation of pedestrians and bicycle movements from vehicle traffic is not practical, each interchange site should be studied and alternate designs considered to determine the most appropriate arrangement of structures and ramps to accommodate bicycle and pedestrian traffic through and interchange area.

#### ■ 10.9 Interchanges

- The accommodation of pedestrian and bicyclists also should be considered in the selection of an interchange configuration



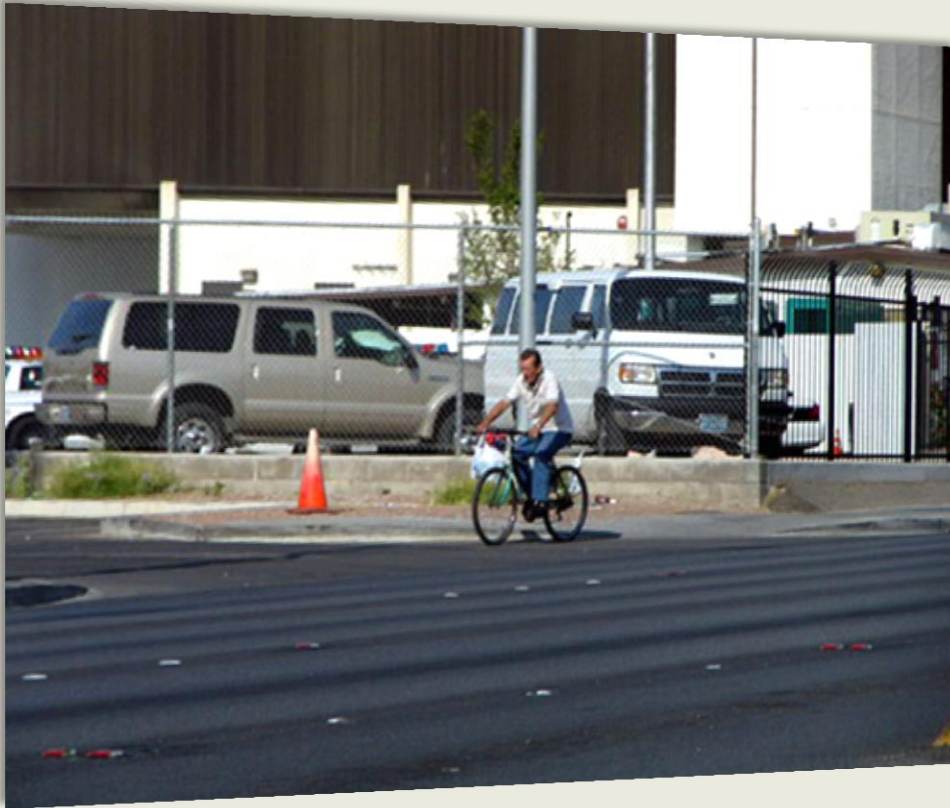
# GUIDING PRINCIPLES



- Provide bicycles and pedestrian facilities
- Design ramp geometries to encourage slower vehicle speeds until past crosswalk
- Locate the crosswalk at the location with the best visibility and before the point where vehicles begin to accelerate
- Crosswalks should be as short as possible



# GUIDING PRINCIPLES



- Where bicyclists would travel between moving vehicles for more than 200 feet, install a buffer zone
- Where bicyclists merge across a vehicle lane allow flexibility to transition when/where safe
- Use a decision tool to select appropriate crossing treatments

# PEDESTRIAN & BICYCLE ACCOMMODATIONS

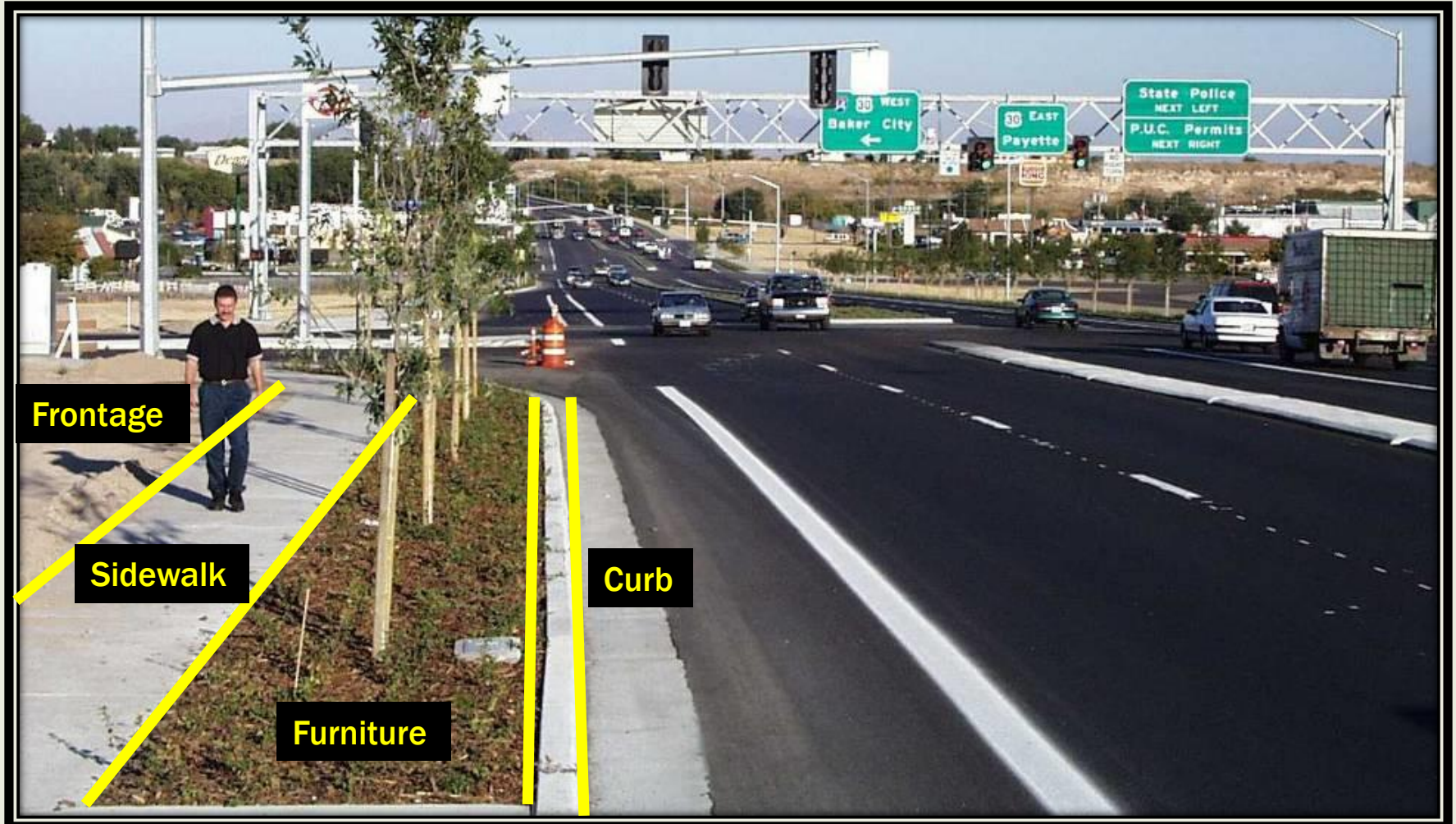
Just do it!

# PEDESTRIAN TREATMENTS

Apply Principles from DPS 101 & DPS 201

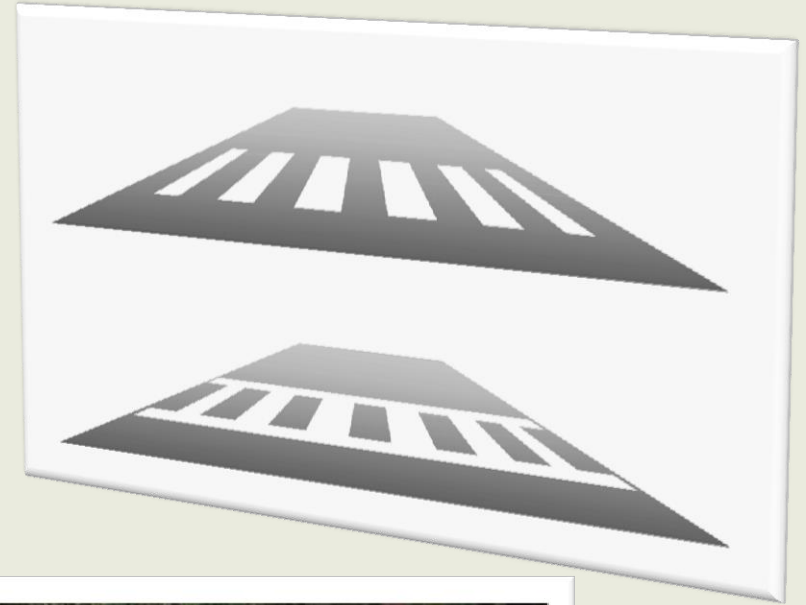
- Sidewalks or shoulders
  - Zone System when designing sidewalks
- Crosswalks
  - High visibility crosswalks
  - Optimal placement
- Advance stop/yield bars
- Signing
  - Florescent yellow-green for pedestrian warning signs
  - Rectangular Rapid Flash Beacon (RRFB)
- Pedestrian crossing islands

# ZONE SYSTEM





# HIGH VISIBILITY CROSSWALKS



# SIGNING





# RAISED ISLANDS

Pedestrian pass through on channelization island



Photo Source: Mark Doctor, FHWA

# SIGNING RRFB & CROSSING ISLAND





# AVOID EXCESSIVE USE OF SIGNS



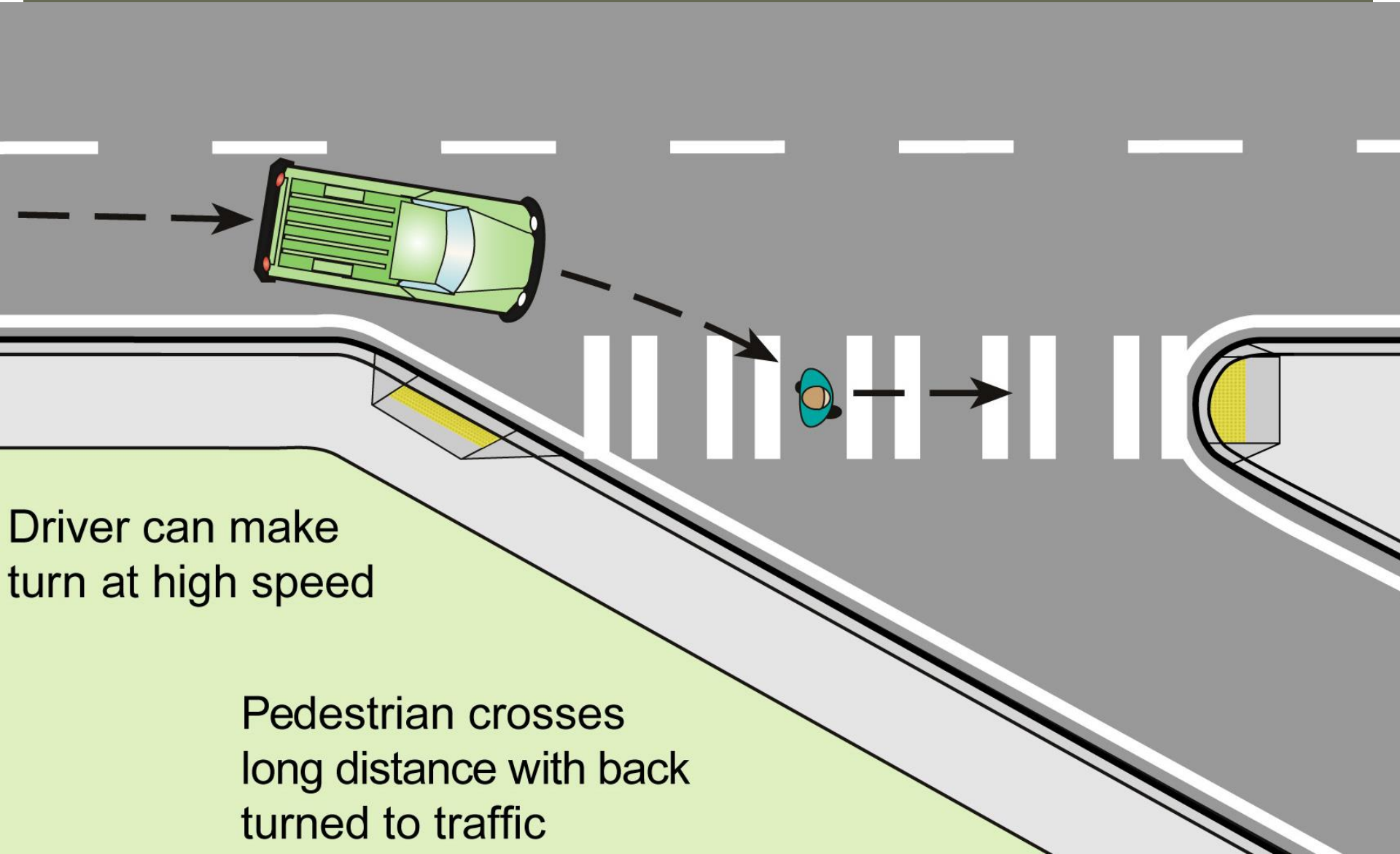
# CROSSWALK PLACEMENT

Choosing the best crosswalk placement where it's not clear what's most logical for the driver or the pedestrian:

3 choices:

- Most direct route
- Shortest crosswalk
- “Compromise” - midway solution

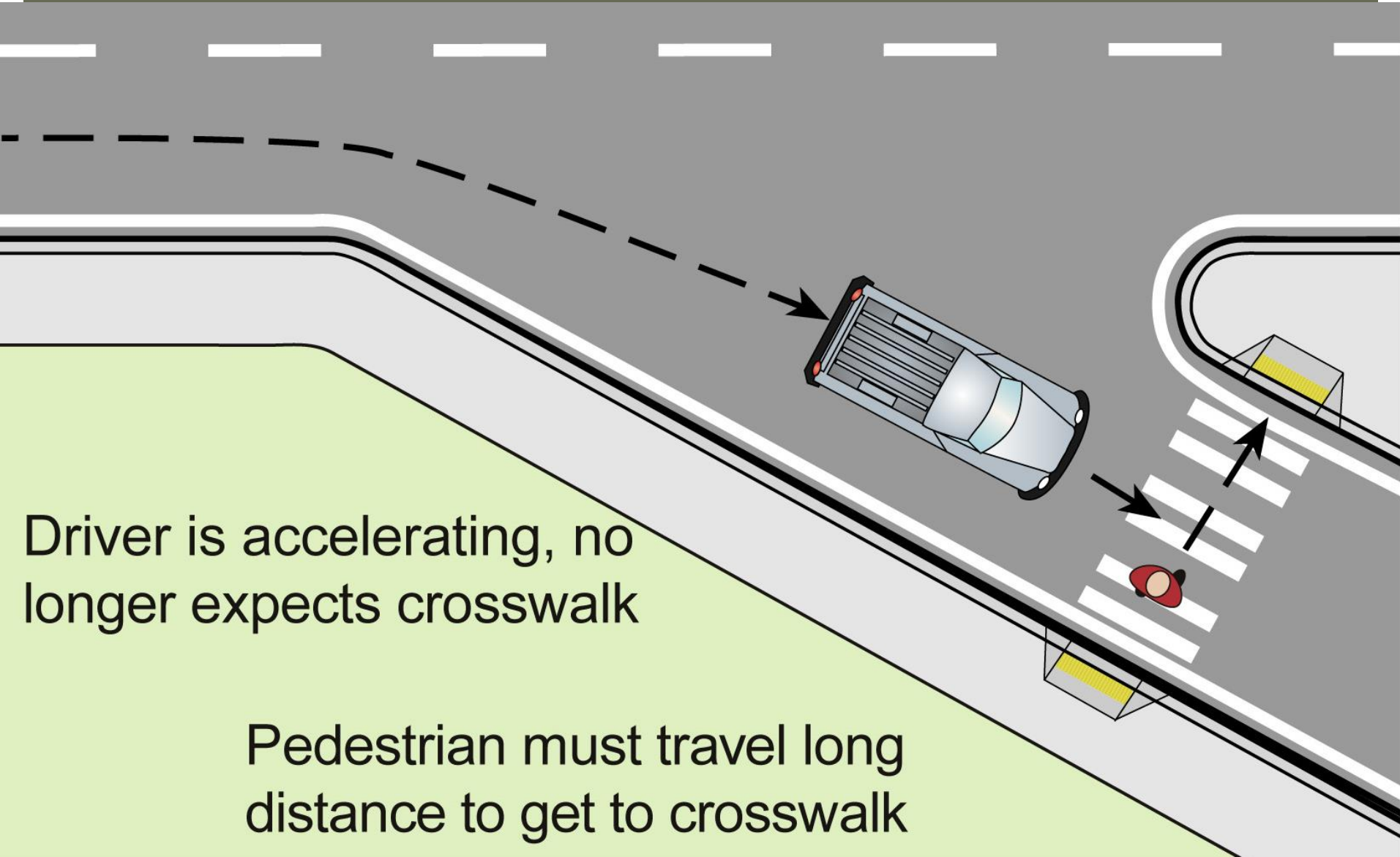
# MOST DIRECT ROUTE



Driver can make  
turn at high speed

Pedestrian crosses  
long distance with back  
turned to traffic

# SHORTEST CROSSWALK

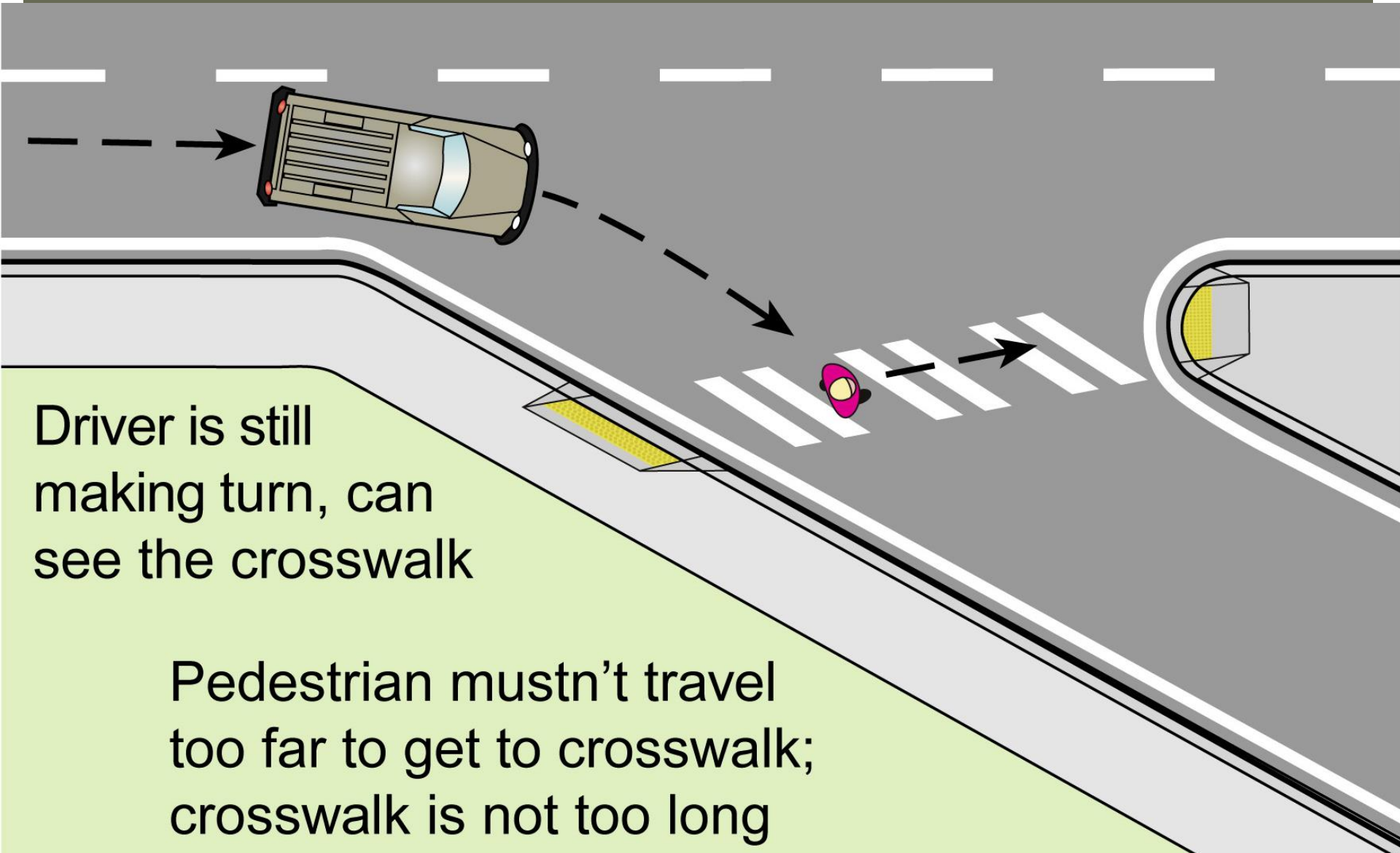


Driver is accelerating, no longer expects crosswalk

Pedestrian must travel long distance to get to crosswalk



# MIDWAY SOLUTION – BALANCES GOALS



Driver is still making turn, can see the crosswalk

Pedestrian mustn't travel too far to get to crosswalk; crosswalk is not too long

# DESIGN INTERCHANGES FOR BICYCLISTS



I-75 exit ramp to Bruce B Downs Blvd – Tampa FL

Photo Source: Mark Doctor, FHWA

# INTERCHANGE CASES

On-Ramps

Off-Ramps

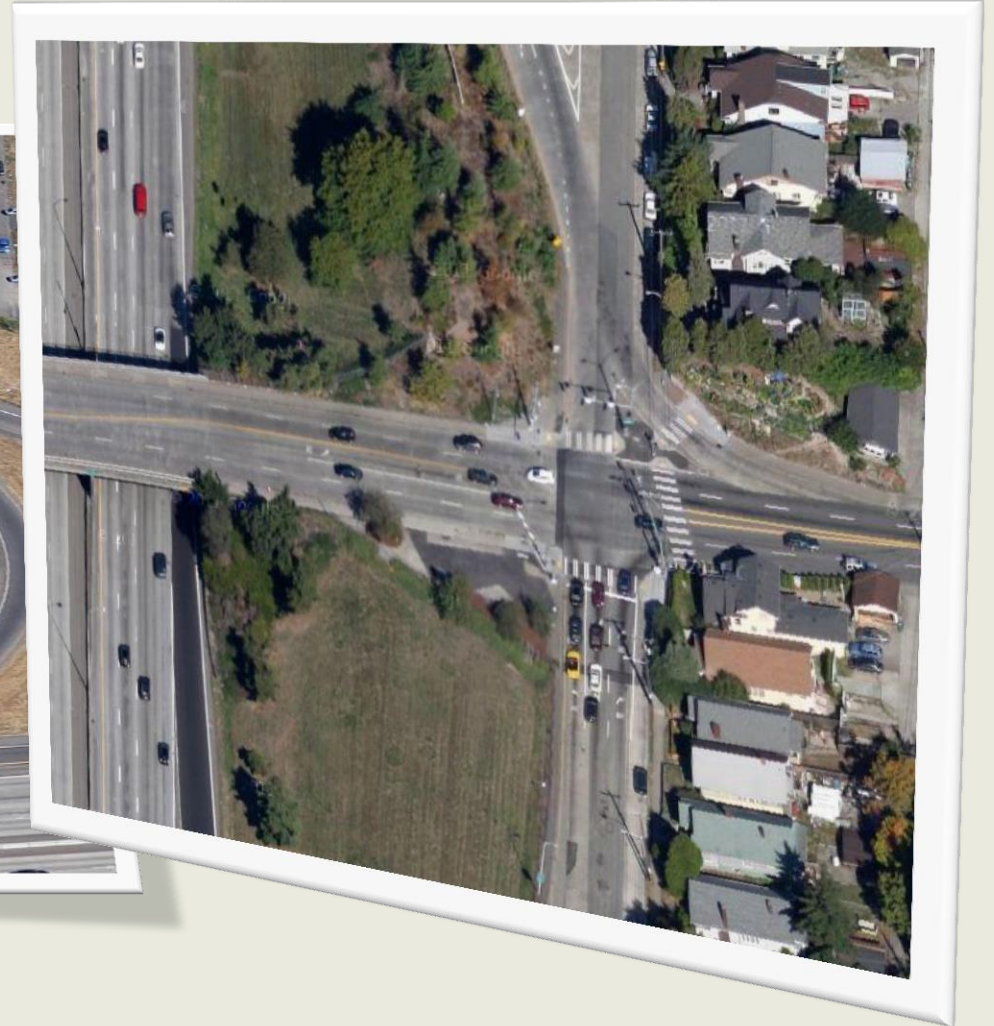
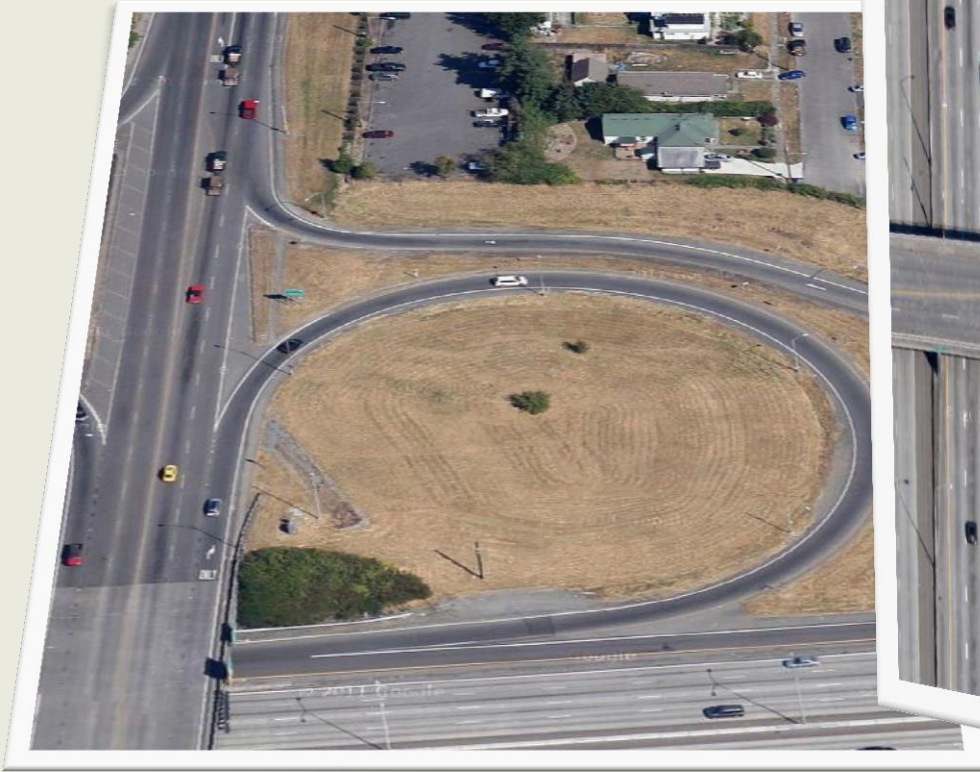
DDIs

SPUIs

Roundabout

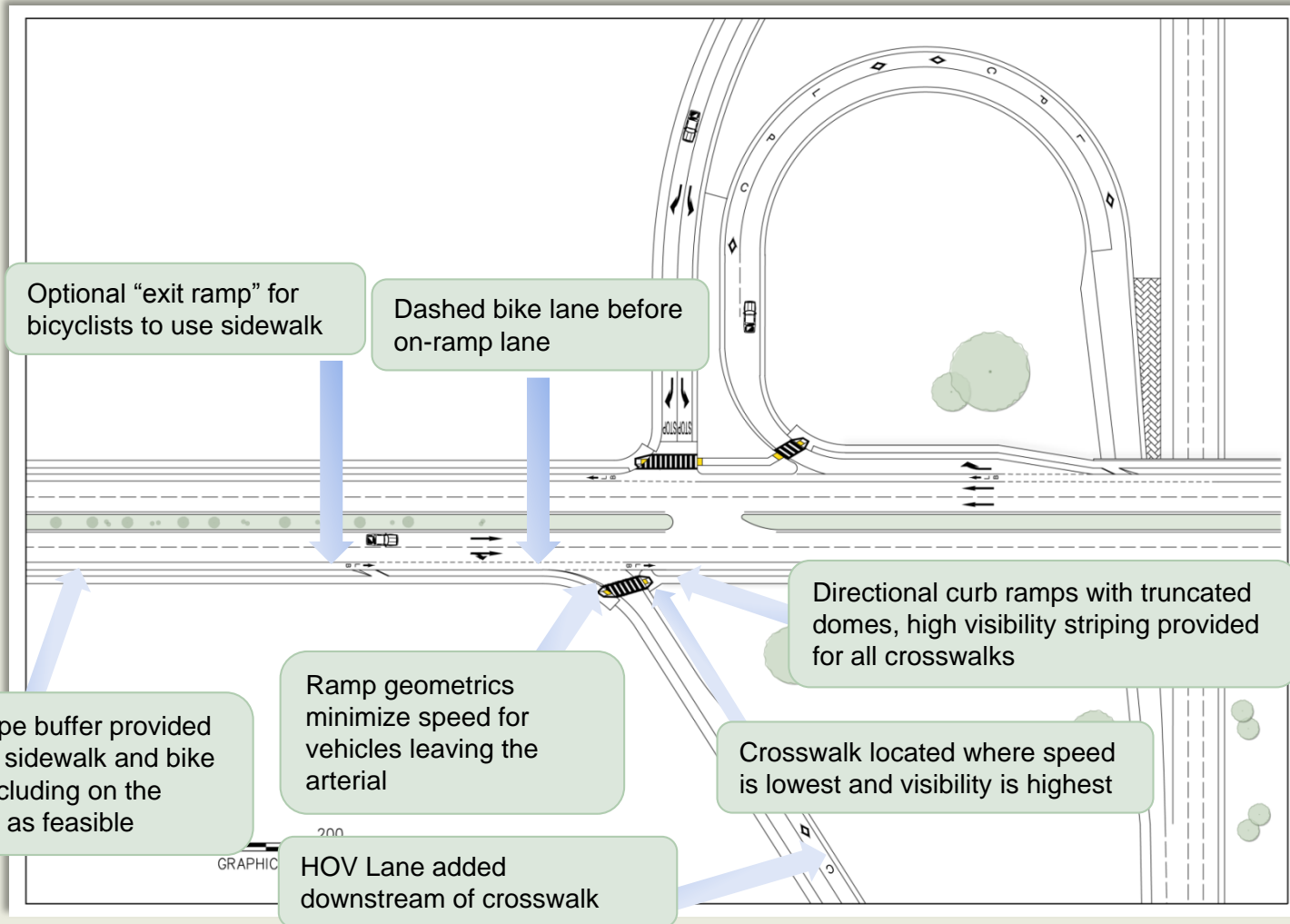
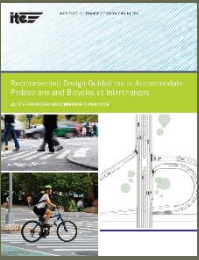


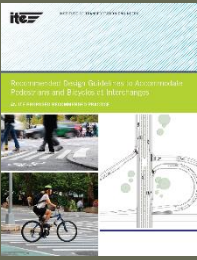
# ON-RAMPS



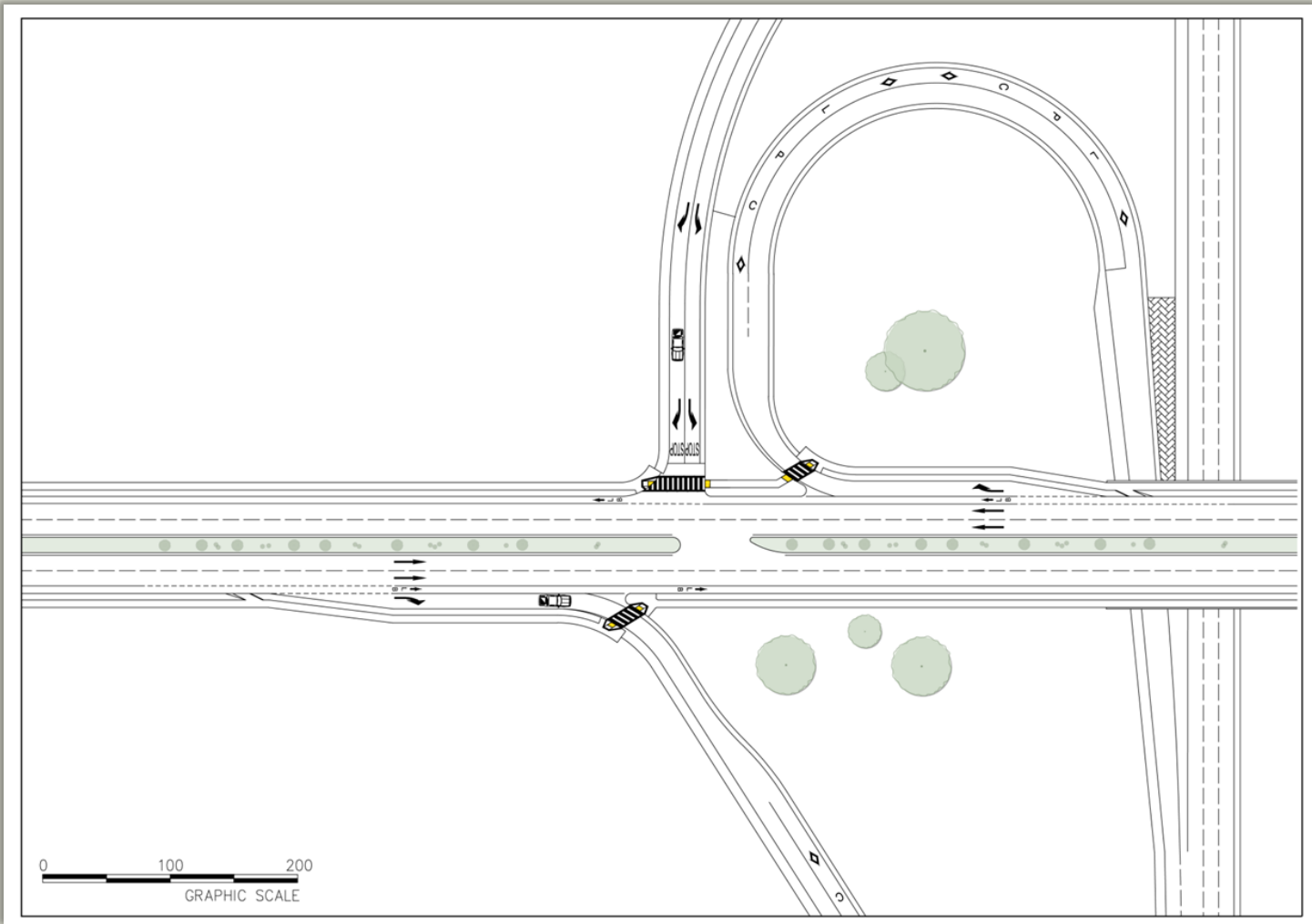


# TREATMENTS FOR ON-RAMP ENTERED FROM SHARED-THRU RIGHT LANE

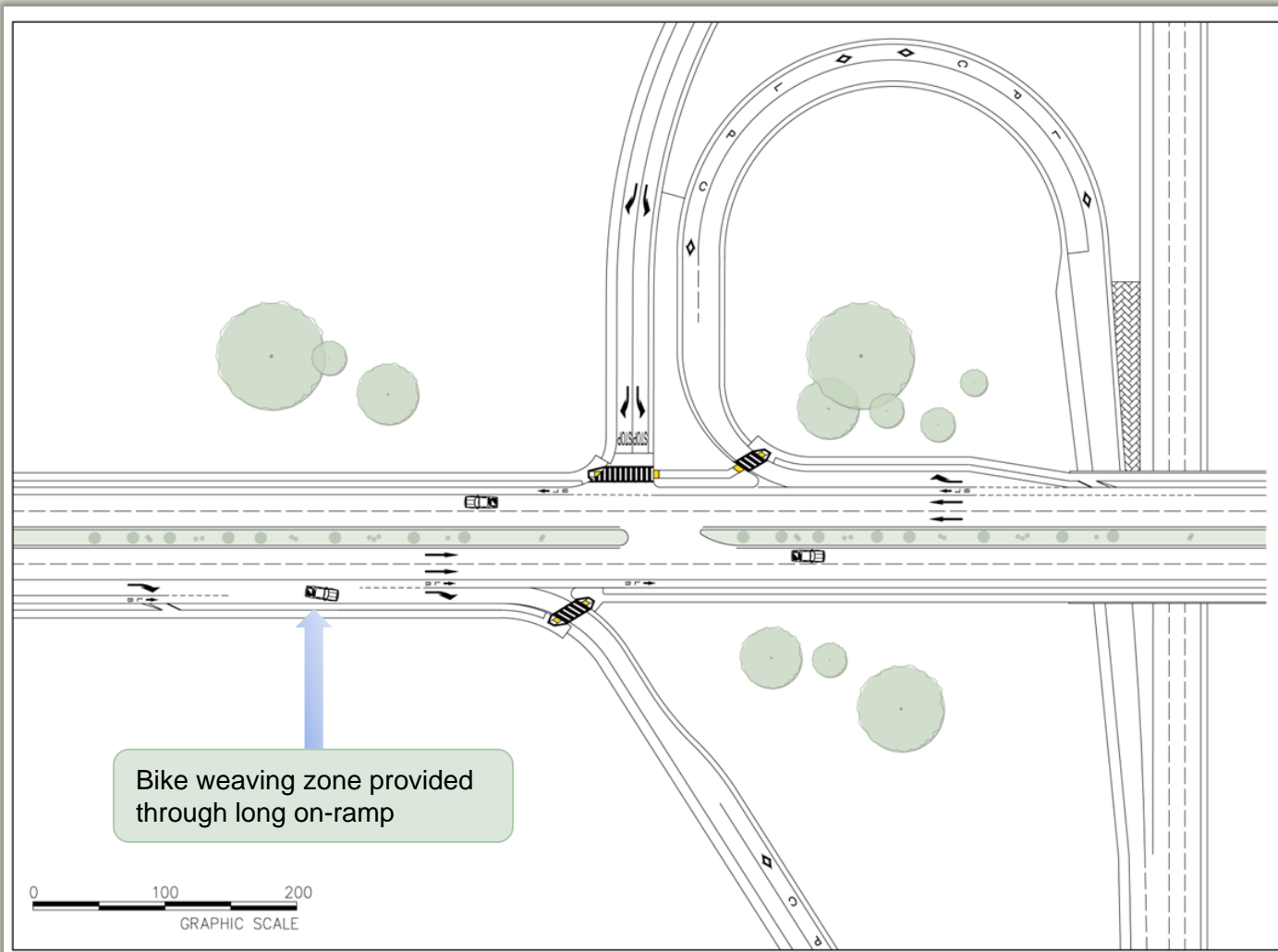
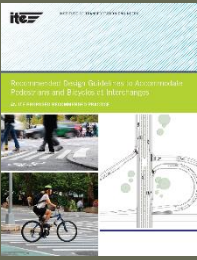


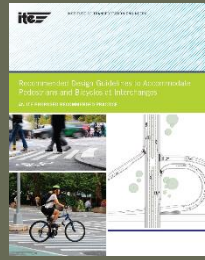


# TREATMENTS FOR ON-RAMP ENTERED FROM SHORT, SINGLE RIGHT LANE

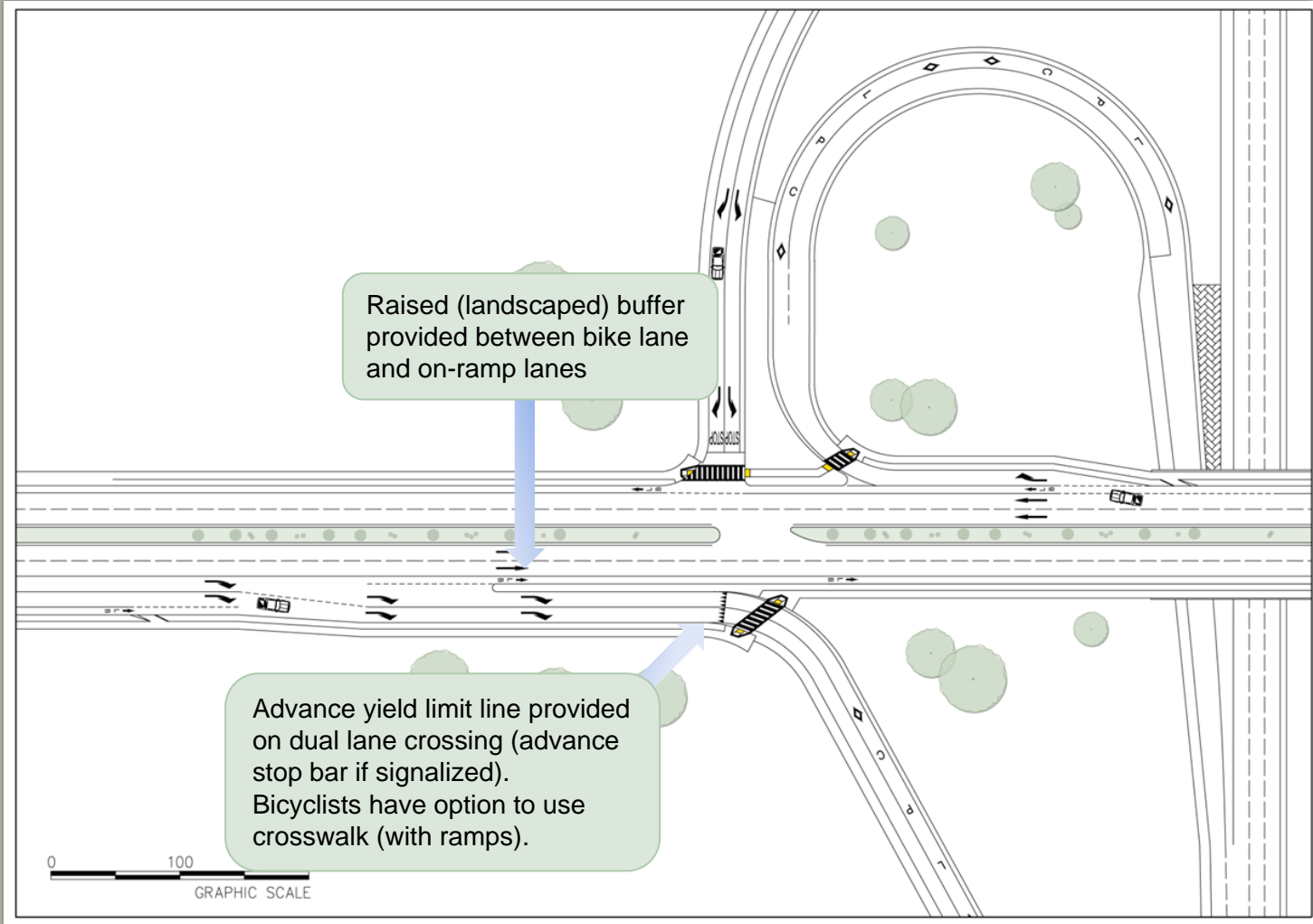


# TREATMENTS FOR ON-RAMP ENTERED FROM LONG, SINGLE RIGHT LANE





# TREATMENTS FOR ON-RAMP ENTERED FROM LONG, DUAL RIGHT LANE



# TREATMENTS FOR DUAL-LANE ON-RAMPS





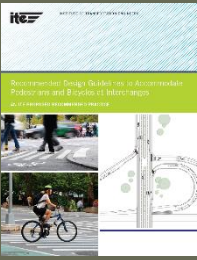
# WHAT'S MISSING?

RIGHT TURN LANE ADJACENT TO SHARED RIGHT-THRU

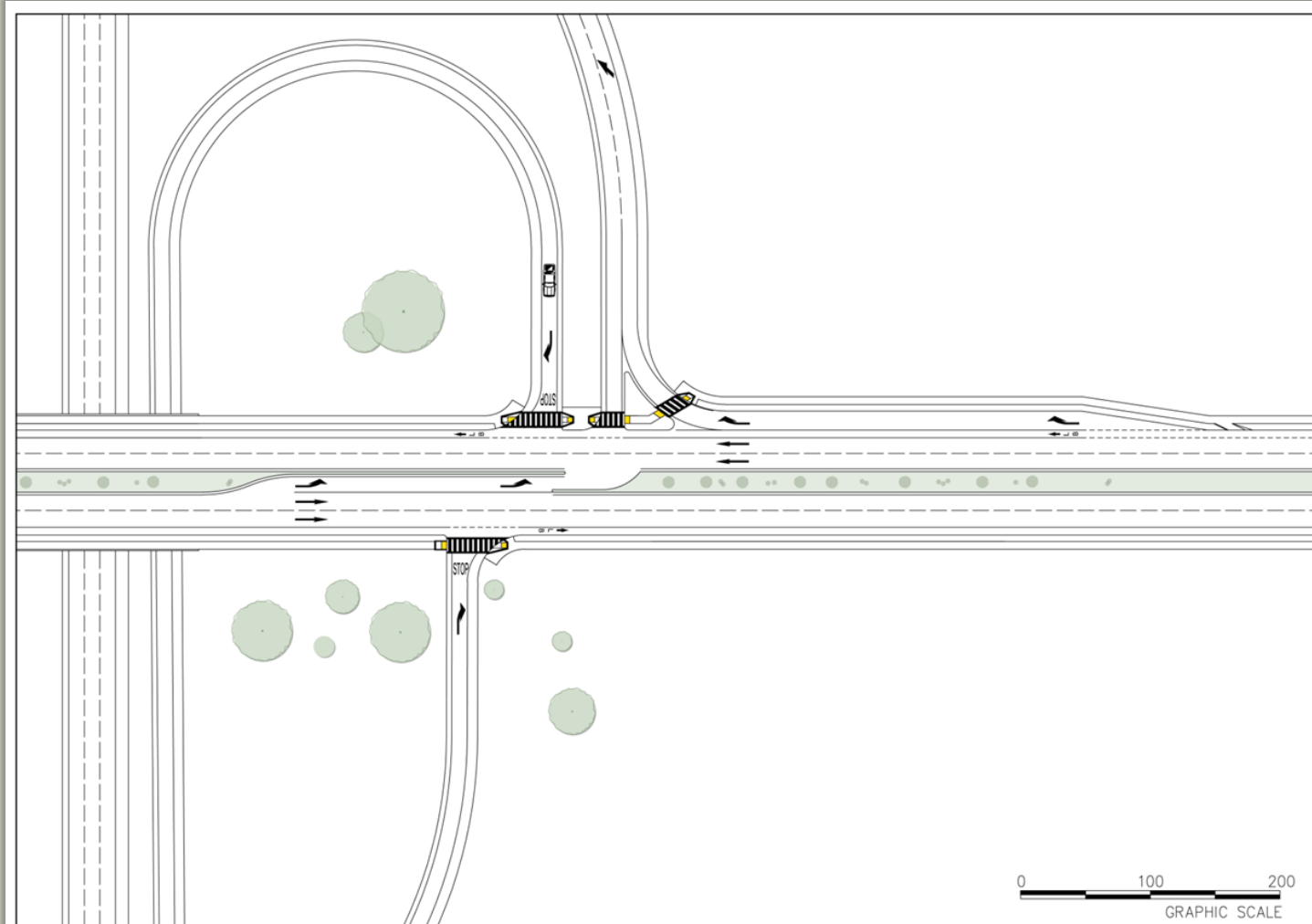


# OFF -RAMPS

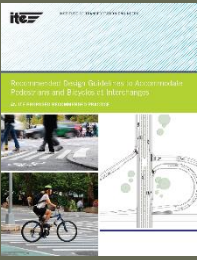




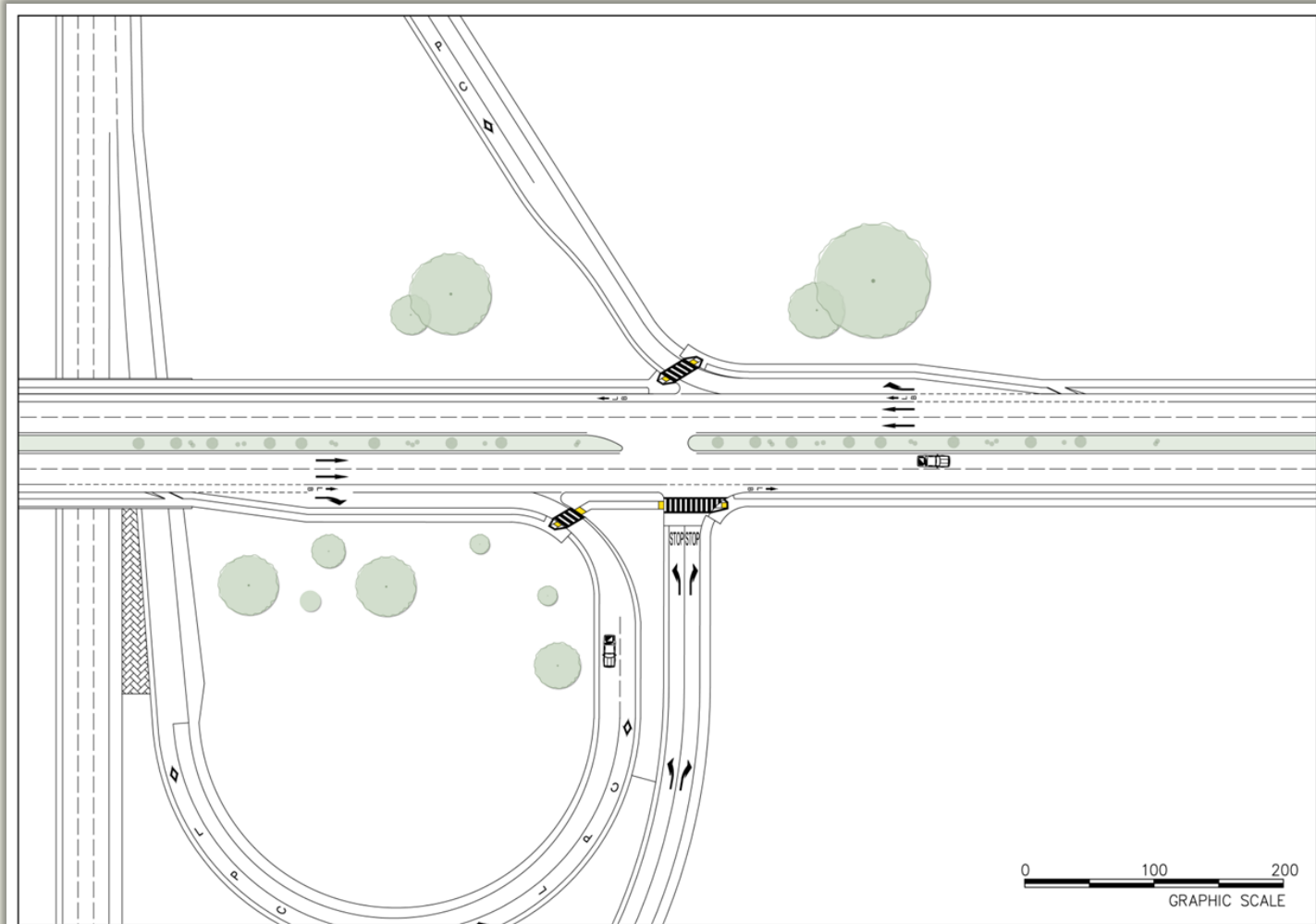
# TREATMENTS FOR ARTERIAL ENTERED FROM STOP/MERGE (SPLIT RAMPS)



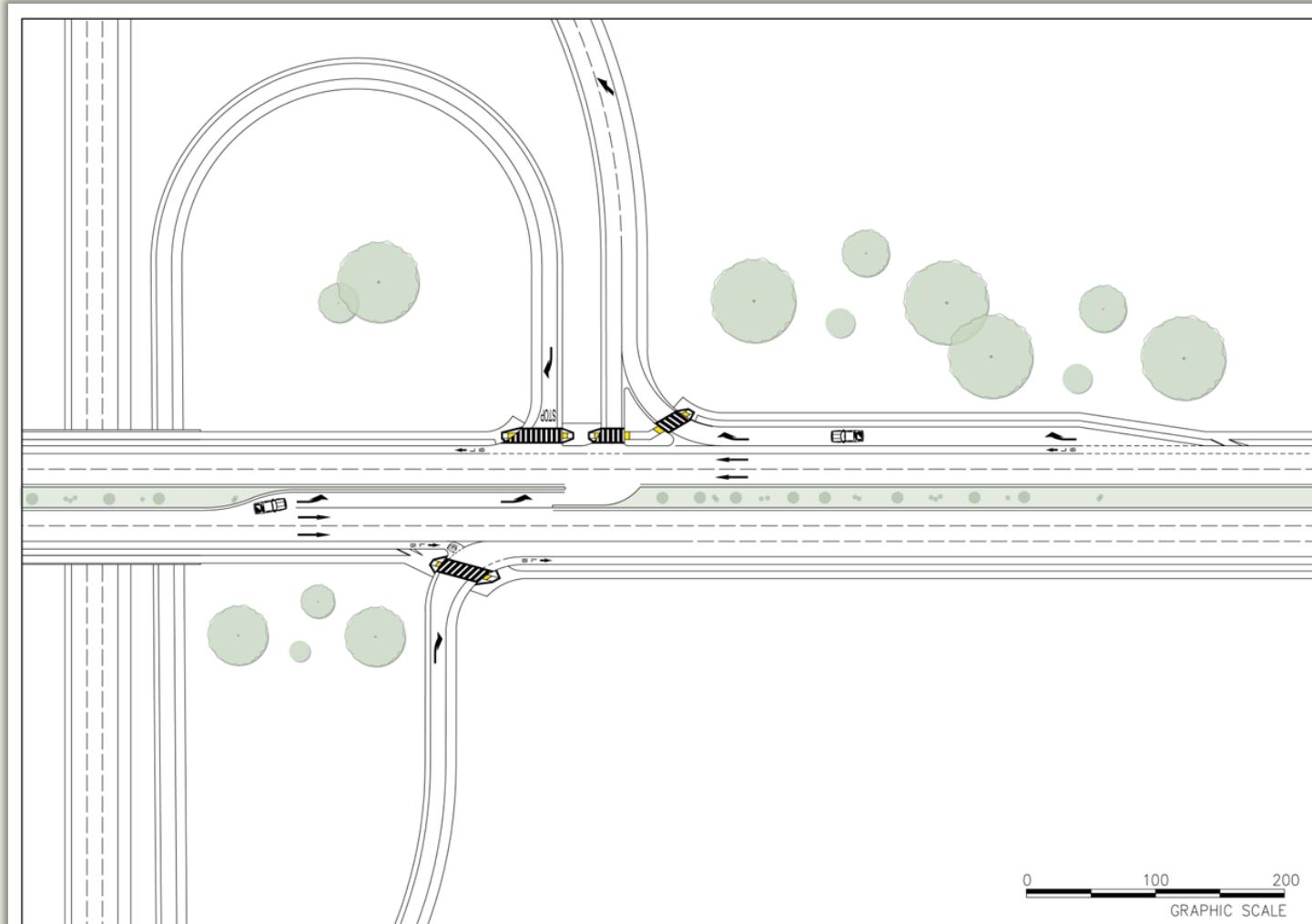
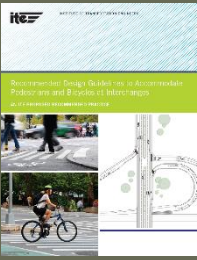


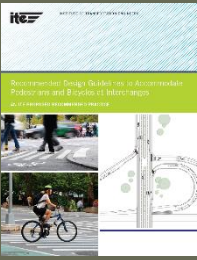


# TREATMENTS FOR ARTERIAL ENTERED FROM STOP/MERGE (COMBINED RAMPS)

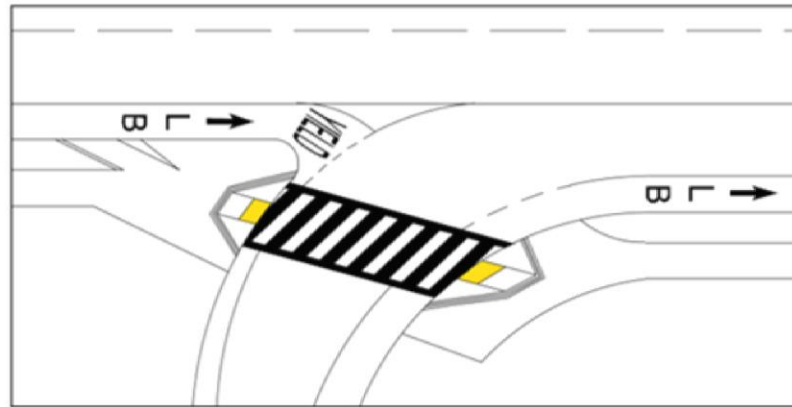


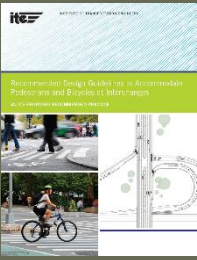
# TREATMENTS FOR ARTERIAL ENTERED FROM FREE OFF-RAMP



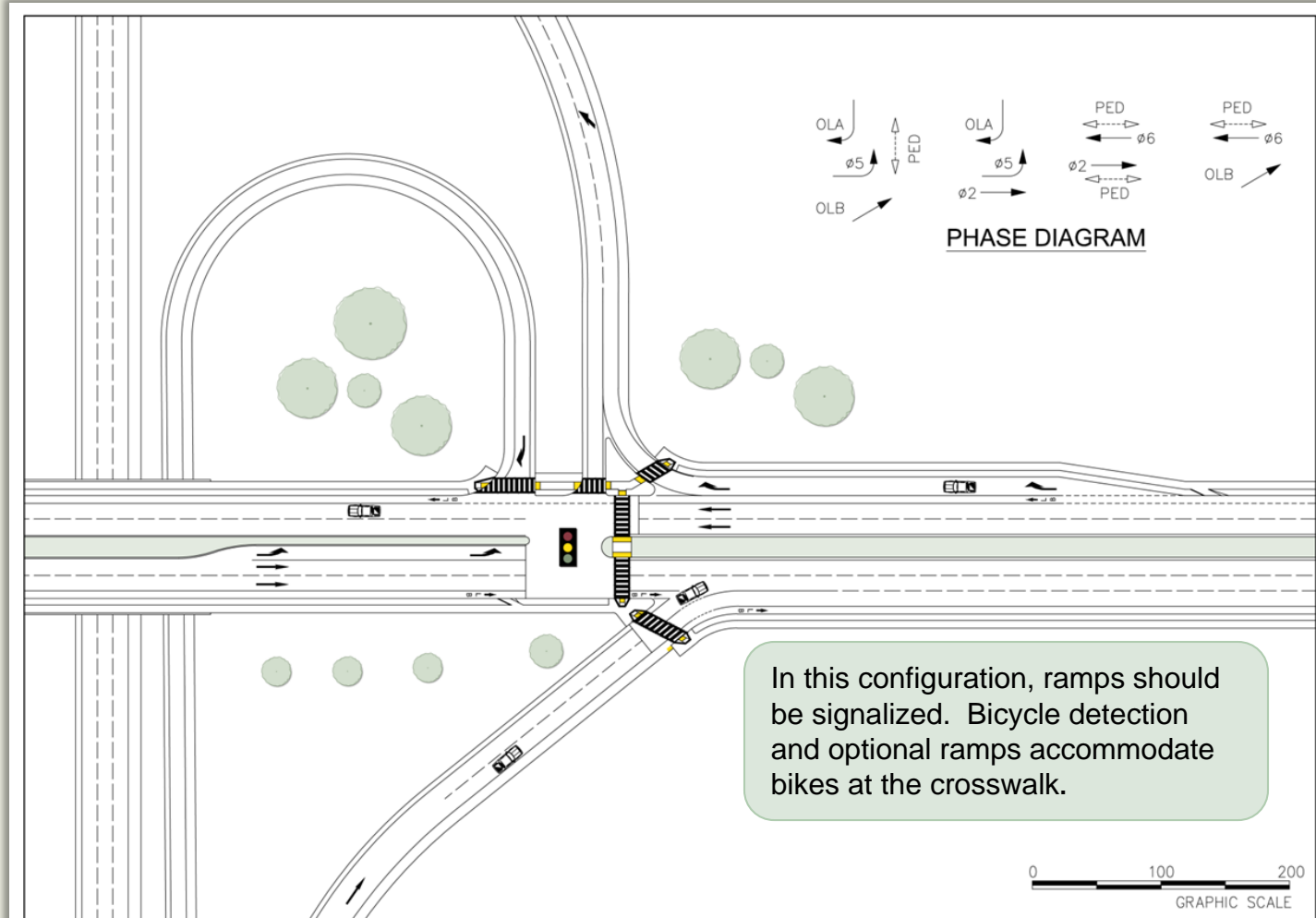


# BIKE LANE CROSSING DETAIL

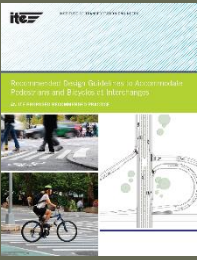




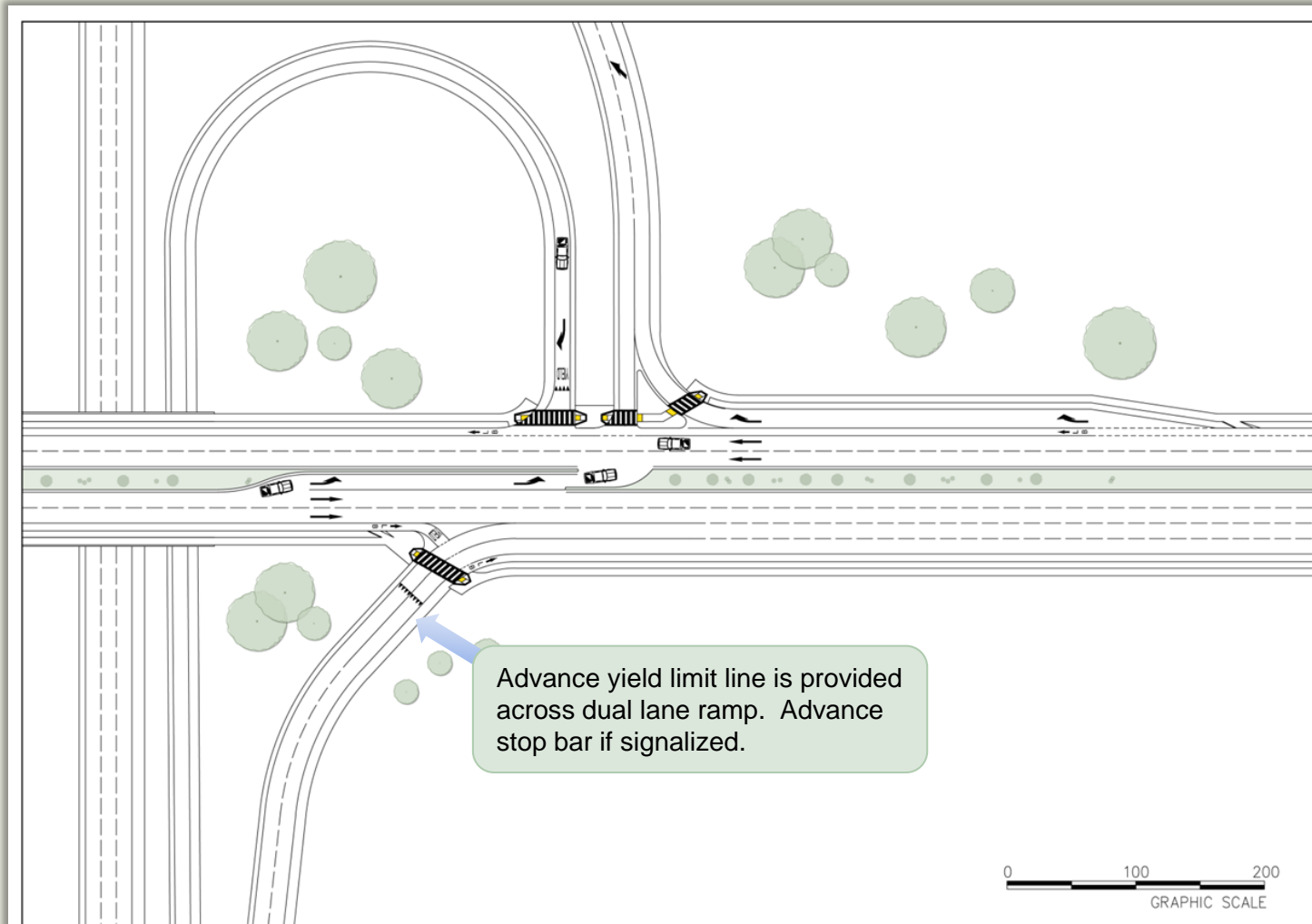
# TREATMENTS FOR ARTERIAL ENTERED FROM TWO- LANE OFF-RAMP (SIGNALIZED)

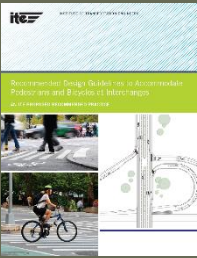






# TREATMENTS FOR ARTERIAL ENTERED FROM TWO- LANE OFF-RAMP (FREE RIGHTS)





# ENHANCING UNCONTROLLED CROSSWALKS

XWalk+

Location \_\_\_\_\_  
 User \_\_\_\_\_ Date: 6-15-2015

Type: Uncontrolled Intersection

Input Parameters	Value	Intersection Characteristics	Yes	No
Speed Limit	35	Frequent at-grade transit?	<input type="radio"/>	<input type="radio"/>
Peak Hour Pedestrian Vol	78	Bicycle lanes?	<input type="radio"/>	<input type="radio"/>
Major Road Peak Hour Volume Total	450	Heavy bicycle traffic?	<input type="radio"/>	<input type="radio"/>
Major Road Peak Hour Vol Dir 1	150	Major/minor road intersection?	<input type="radio"/>	<input type="radio"/>
Major Road Peak Hour Vol Dir 2	300	Midblock/off-set intersection?	<input type="radio"/>	<input checked="" type="radio"/>
Avg Pedestrian Walking Speed	3	Heavy truck traffic?	<input type="radio"/>	<input checked="" type="radio"/>
15th Percentile Crossing Speed	3	Existing infrastructure limit treatments?	<input type="radio"/>	<input checked="" type="radio"/>
Ped start-up/end clearance time	3	On-street parking?	<input type="radio"/>	<input checked="" type="radio"/>
Pedestrian Crossing Distance	65	Downtown area?	<input type="radio"/>	<input checked="" type="radio"/>
1st Half Crossing Distance	30	Built-up area of an isolated community?	<input type="radio"/>	<input checked="" type="radio"/>
2nd Half Crossing Distance	35	Median refuge island?	<input type="radio"/>	<input checked="" type="radio"/>
Number of Lanes	4	Sufficient width for a median?	<input type="radio"/>	<input checked="" type="radio"/>
Actual Total Pedestrian Delay	_____			
Expected Motorist Compliance	Moderate			

◀ 2 of 2 Recommendations ▶

RRFB

Signalized or Unsignalized Crossing?	Unsignalized Crossing
Pedestrian LOS	F
Candidate Pedestrian Treatment Identified	RRFB
Candidate for Median Refuge Island?	NO
Candidate for Road Diet?	YES
Other Treatments for Consideration**	RRFB
Paired Treatments for Consideration**	Curb Extensions, Bus Bulb, Reduced Curb Radii, Staggered Pedestrian Refuge, High Visibility Crosswalk Markings, Advance Yield Lines, Advance signage

# OFF RAMP SIGNING



# INTERCHANGE GEOMETRY



# HIGH SPEEDS, POOR VISIBILITY

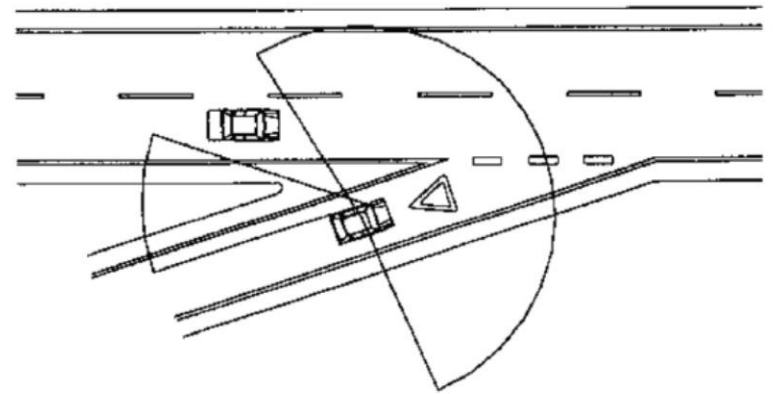


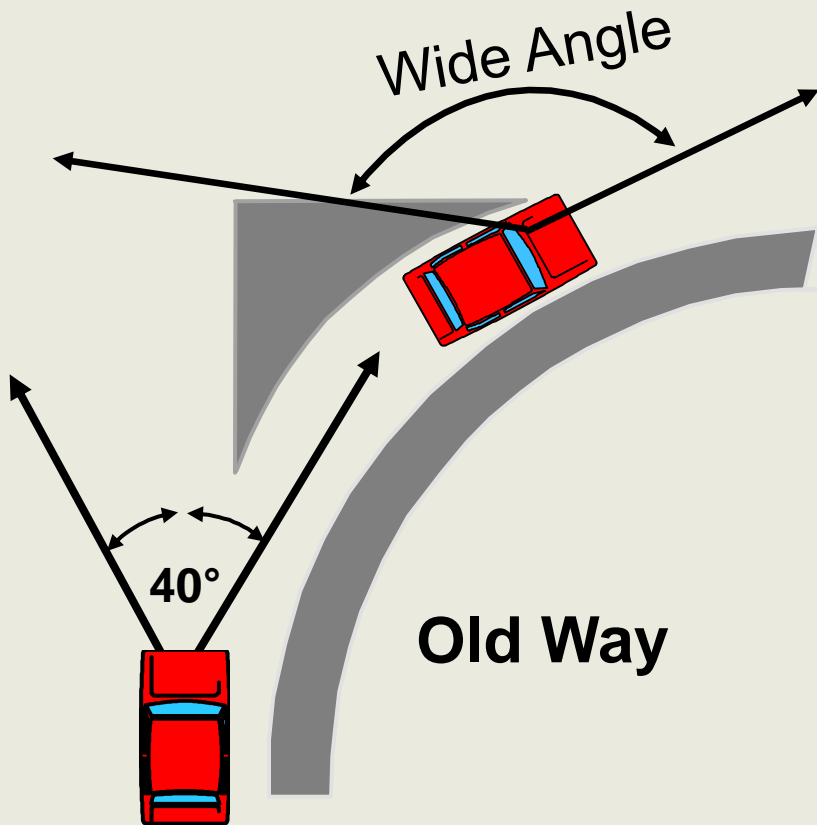
FIGURE 2 Visibility problem at merging areas

# BEFORE & AFTER

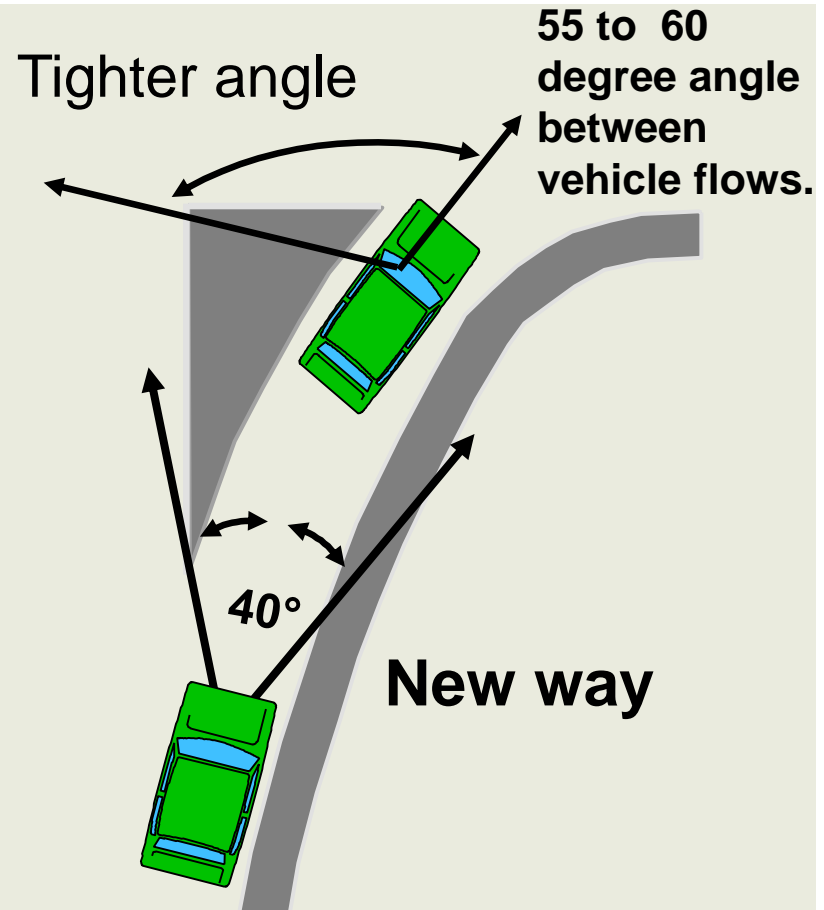
- Flat angle = wide crossing & high-speed turns
- Tight angle = short crossing & slow speed turns
- Red arrow = old crosswalk
- Green arrow = new crosswalk



# DESIGN DETAILS SLIP LANES W/ISLAND



High speed, head turner =  
low visibility of pedestrians

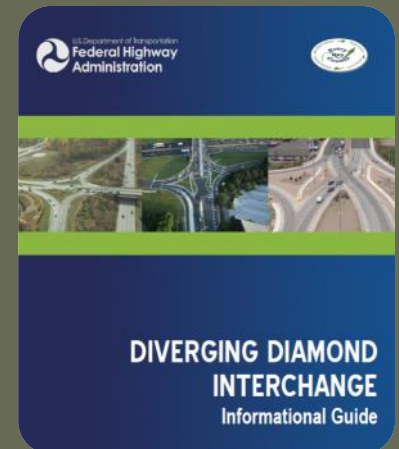


Slow speed, good angle =  
good visibility of pedestrians



# ALTERNATIVE INTERSECTIONS/ INTERCHANGES INFORMATION REPORT

# DIVERGING DIAMOND INTERCHANGE INFORMATION GUIDE



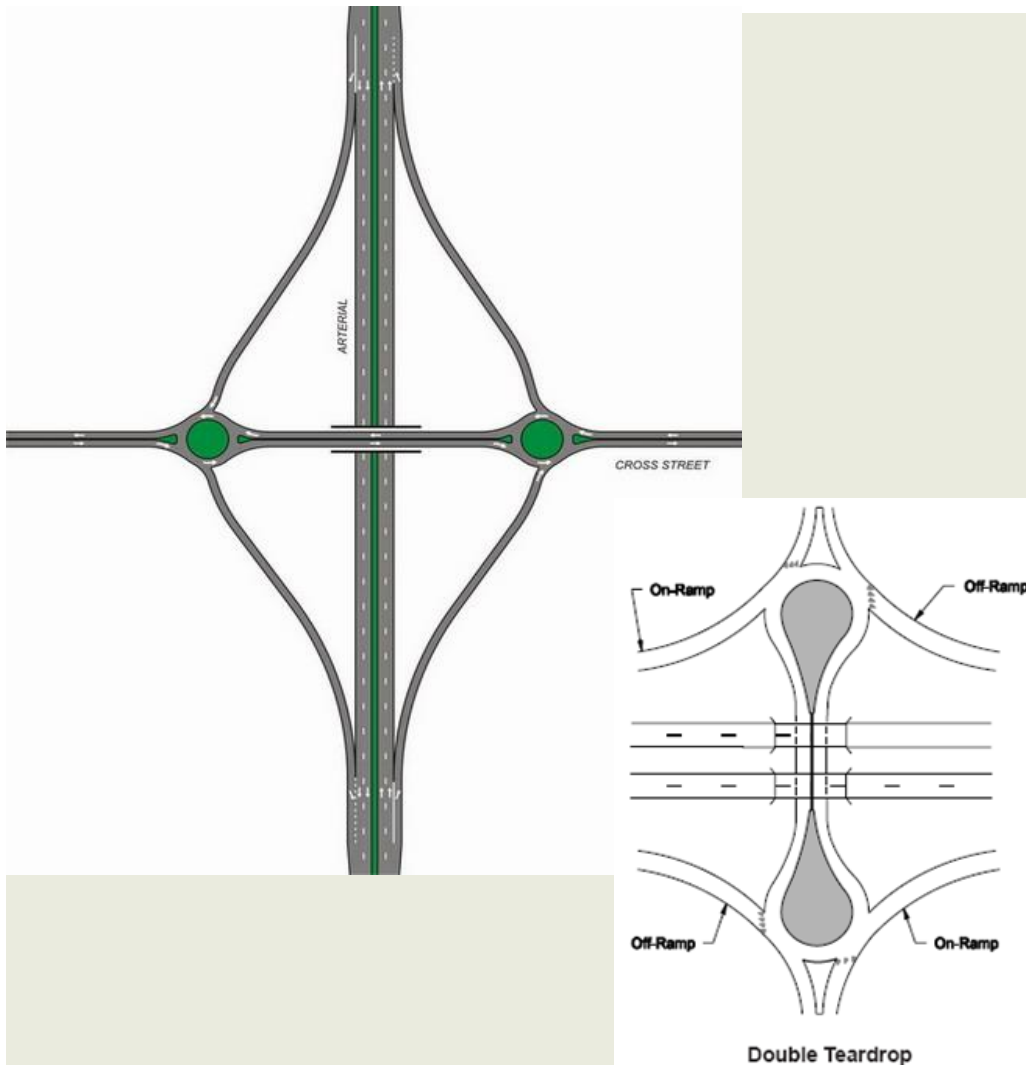




I-680 at  
Monument  
Blvd

# SINGLE POINT URBAN INTERCHANGES (SPUI)

# ROUNDBABOUTS AT INTERCHANGES



## “Dog Bone” Diamond

- Compared to signalized intersections, roundabouts require fewer lanes on the crossroad (no need for turn lanes) resulting in a narrower bridge
- Roundabouts can have either a true circular shape or a “raindrop” shape
- Raindrop-shaped islands eliminate direct U-turn movements (U-turns can be made by circulating around both roundabouts)

# RETROFITTING EXISTING INTERCHANGES



Photo Source: Mark Doctor, FHWA



# PROVIDING PEDESTRIAN PATHWAYS AS PART OF AN INTERCHANGE IMPROVEMENT PROJECT

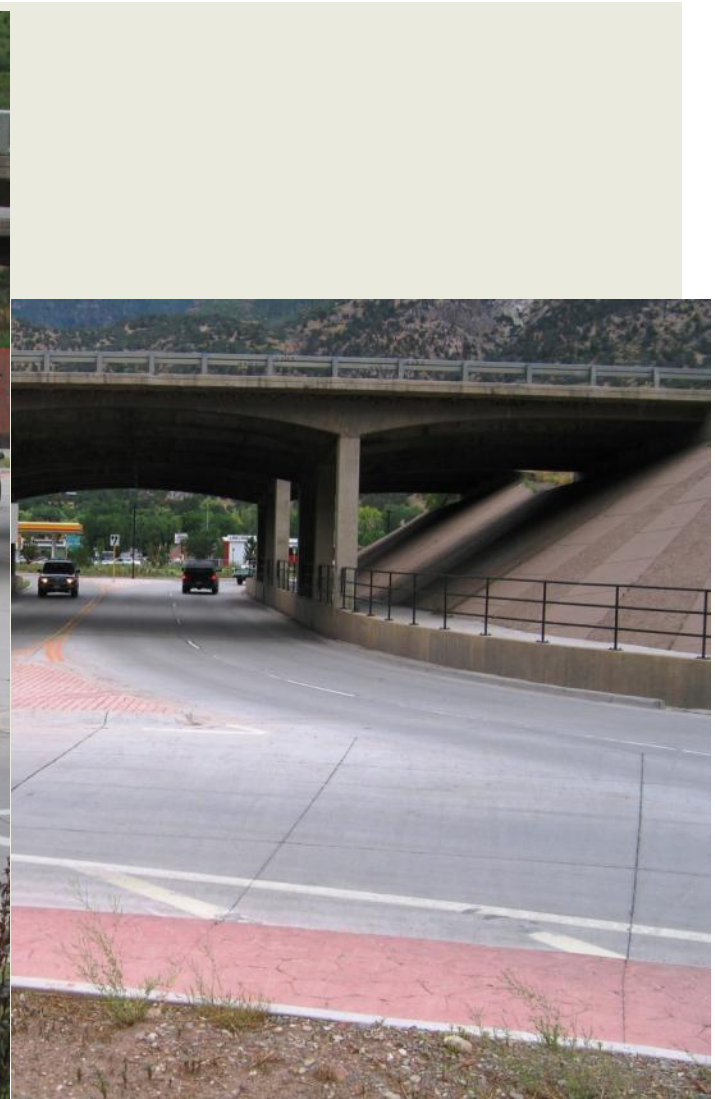


Photo Source: Mark Doctor, FHWA



# QUESTIONS?

Meghan Mitman

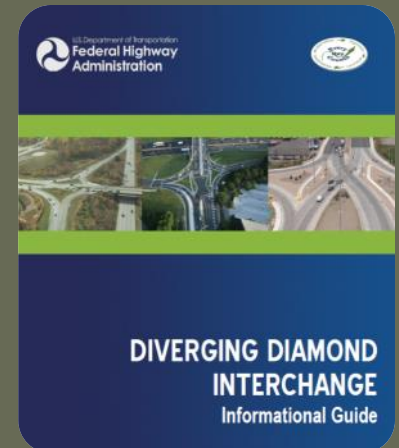
[m.mitman@fehrrandpeers.com](mailto:m.mitman@fehrrandpeers.com)

925.930.7100



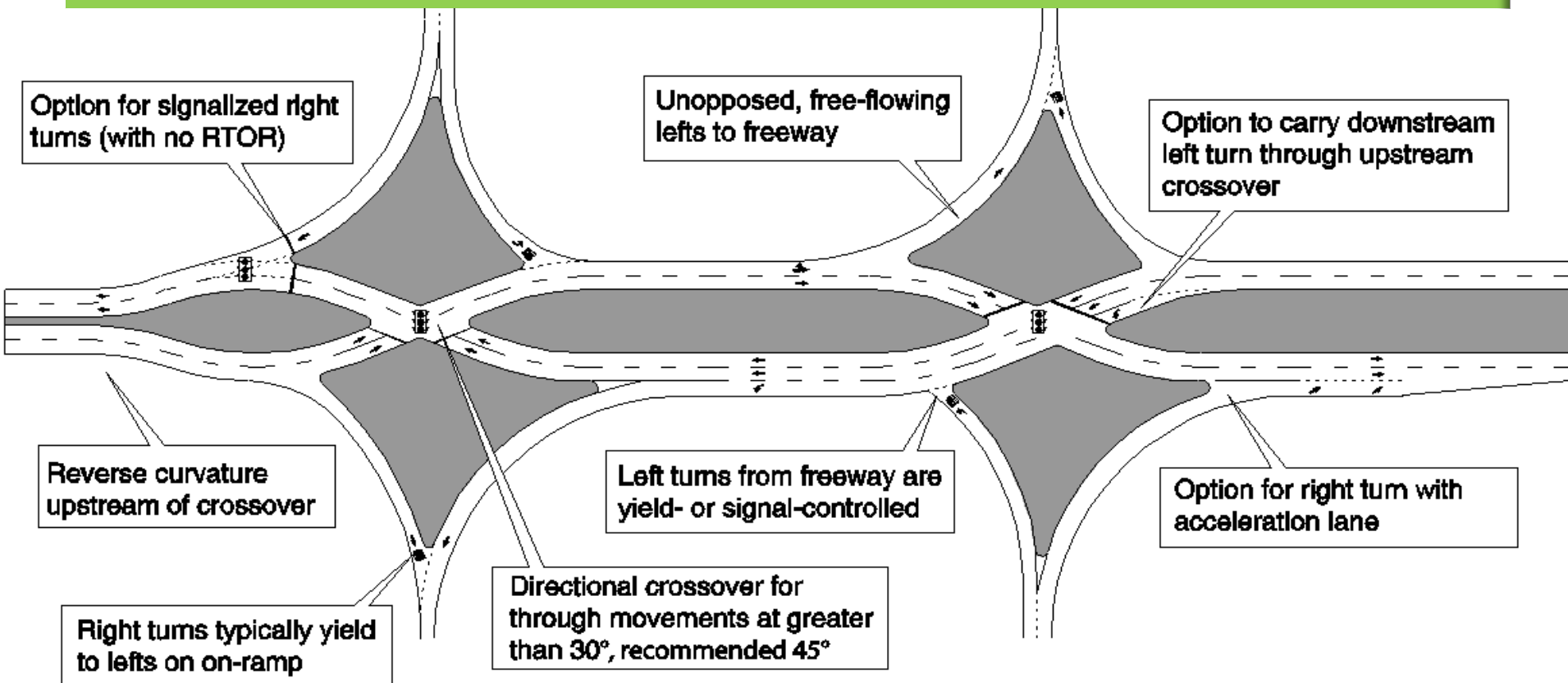
# ALTERNATIVE INTERSECTIONS/ INTERCHANGES INFORMATION REPORT

# DIVERGING DIAMOND INTERCHANGE INFORMATION GUIDE (COMING LATE OCTOBER 2014)

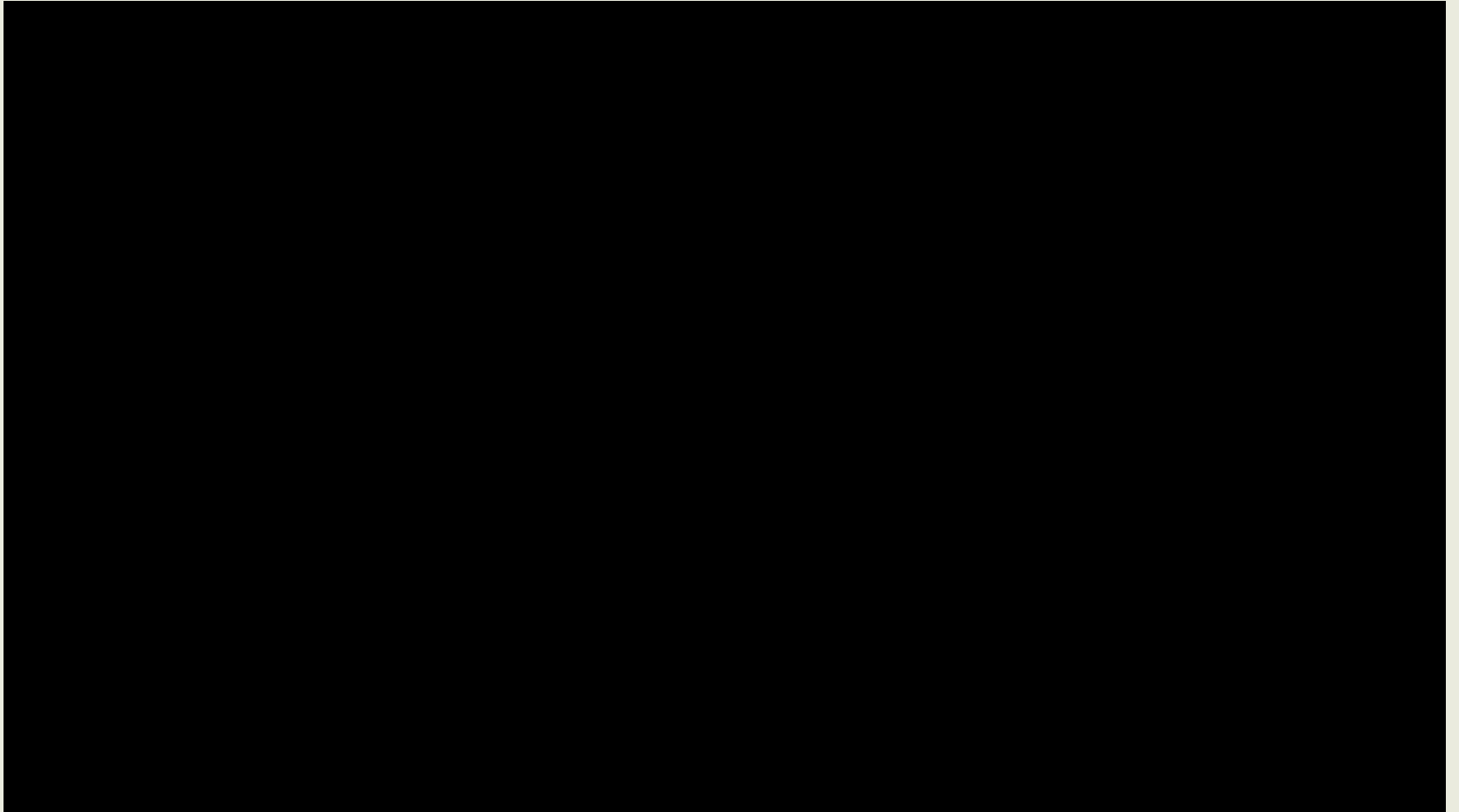


# WHAT IS A DIVERGING DIAMOND INTERCHANGE?

An interchange form that allows two directions of traffic on the crossroad to temporarily cross to the opposite side to gain access to and from the freeway more easily



# FHWA VIDEO ON HOW A DDI WORKS



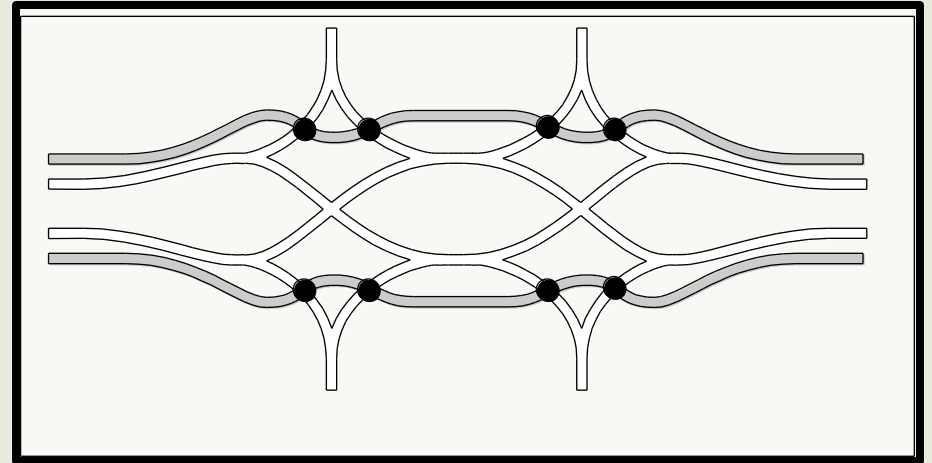
# OUTSIDE VS. INSIDE PEDESTRIAN PATH

- Pedestrian facilities on the inside minimizes conflicts with left-turning traffic to and from the freeway and allows crossing the interchange in all directions (along the arterial and crossing the arterial)
- For underpass DDIs, existing center bridge columns may dictate putting pedestrian walkways on the outside

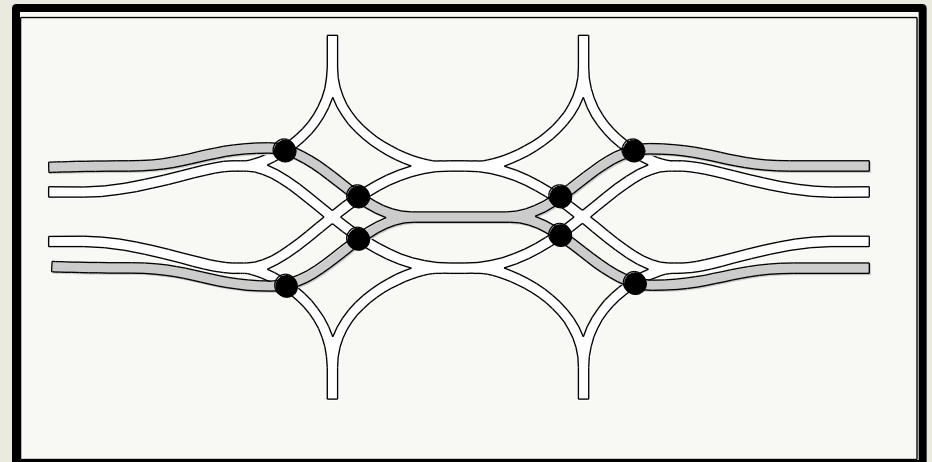


# PEDESTRIAN - VEHICLE CONFLICT POINTS

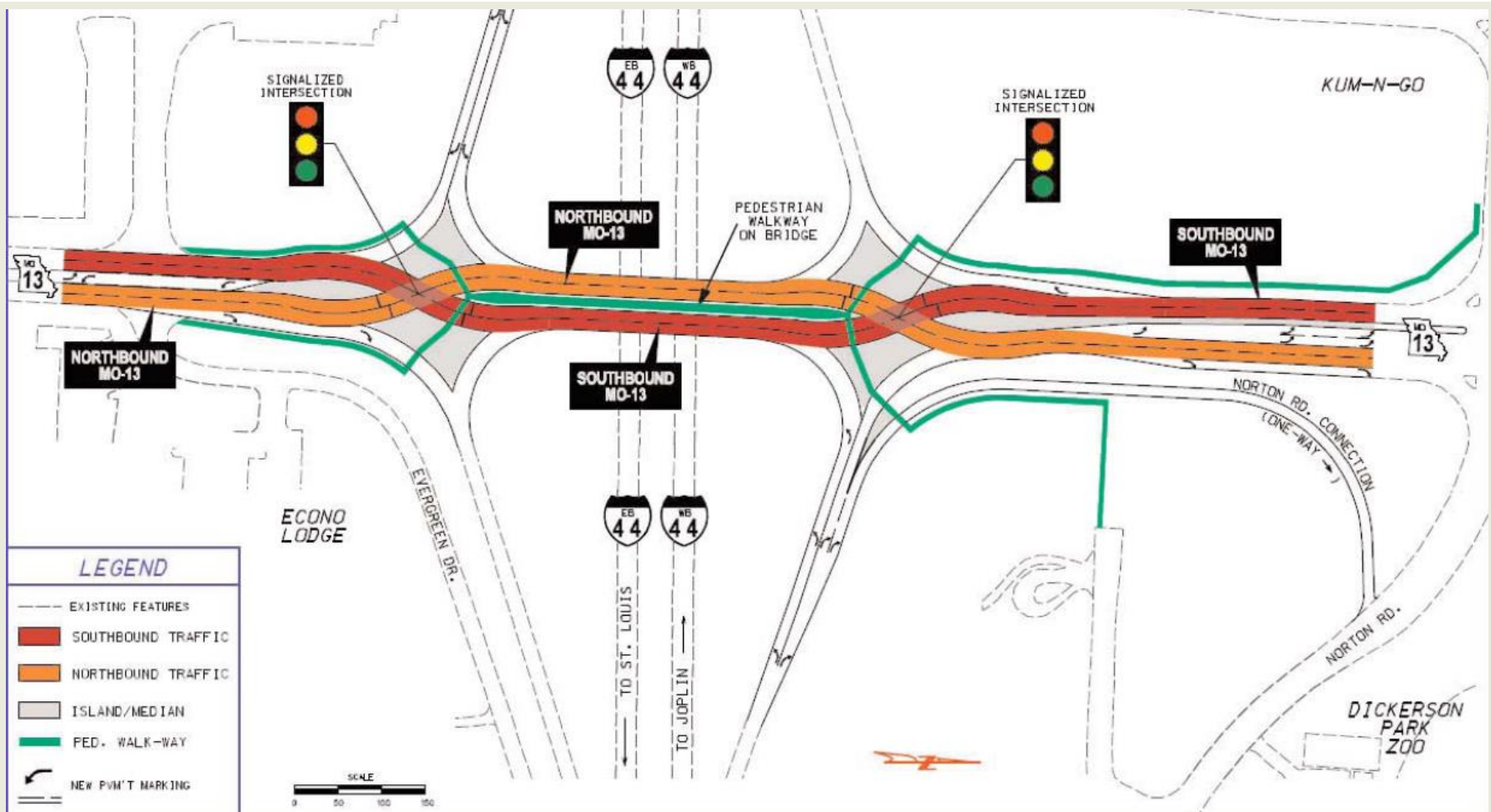
**Outside  
Walkway**



**Center  
Walkway**



# PEDESTRIAN PATH IN CENTER



Source: MoDOT

# PEDESTRIANS “DOWN THE MIDDLE”

- Very positive feedback from user surveys
- Saves bridge width
- May require structural capacity considerations



# DIVERGING DIAMOND INTERCHANGES



Photo Source: Mark Doctor, FHWA

I-44 at SR 13 – Springfield, MO



# PEDESTRIAN PATH ALONG OUTSIDE



Source: MoDOT



# PEDESTRIANS HAVE DIFFICULTY VIEWING IF THERE IS AN APPROPRIATE GAP IN APPROACHING TRAFFIC



DDI – I-15 at American Fork, UT

Photo Source: Mark Doctor, FHWA

# PEDESTRIAN'S LIMITED VIEW OF APPROACHING VEHICLES



Photo Source: Mark Doctor, FHWA

DDI – I-15 at American Fork, UT

# PEDESTRIAN SIGNAL

- Limited Sight Distance - use Pedestrian Signal





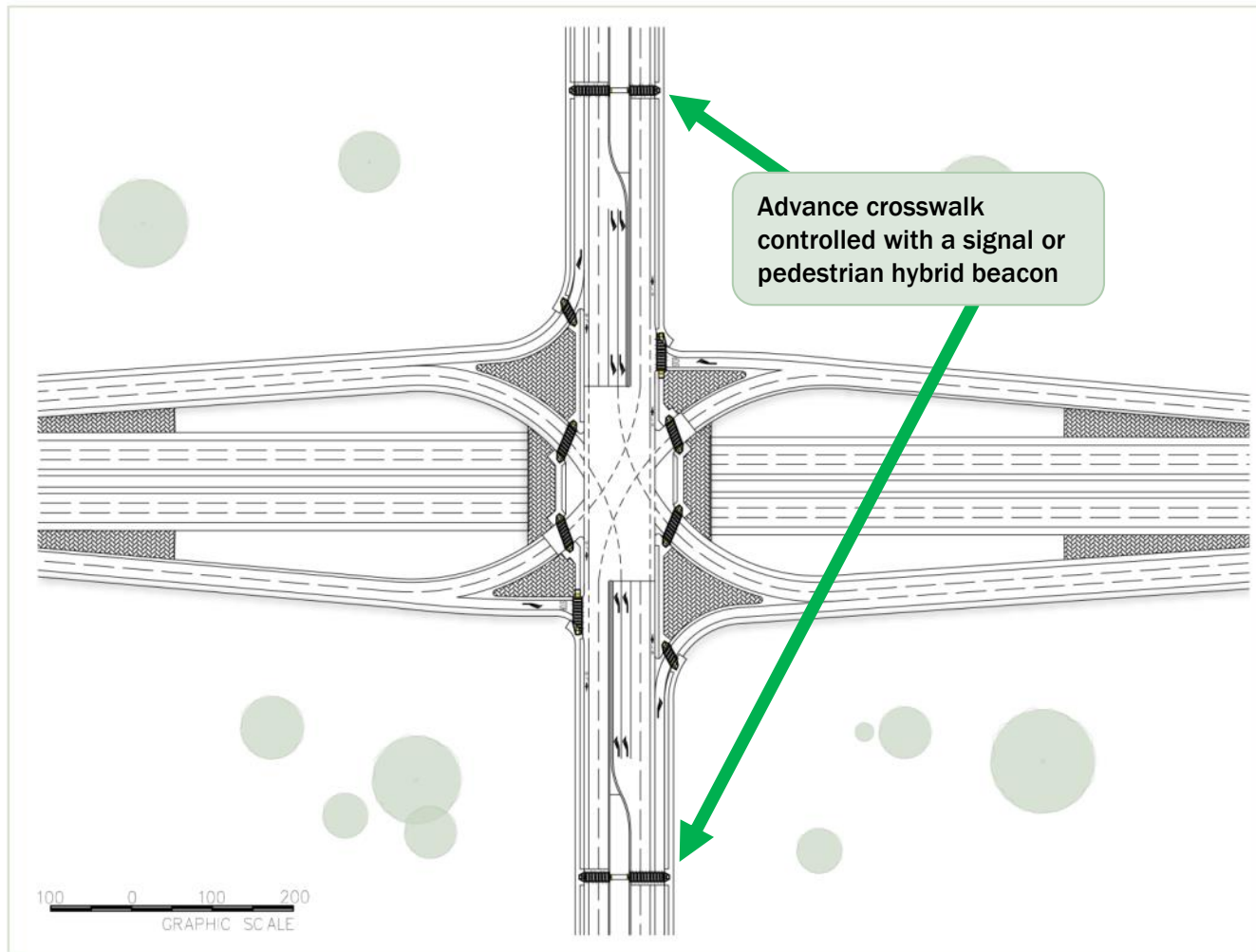


I-680 at  
Monument  
Blvd

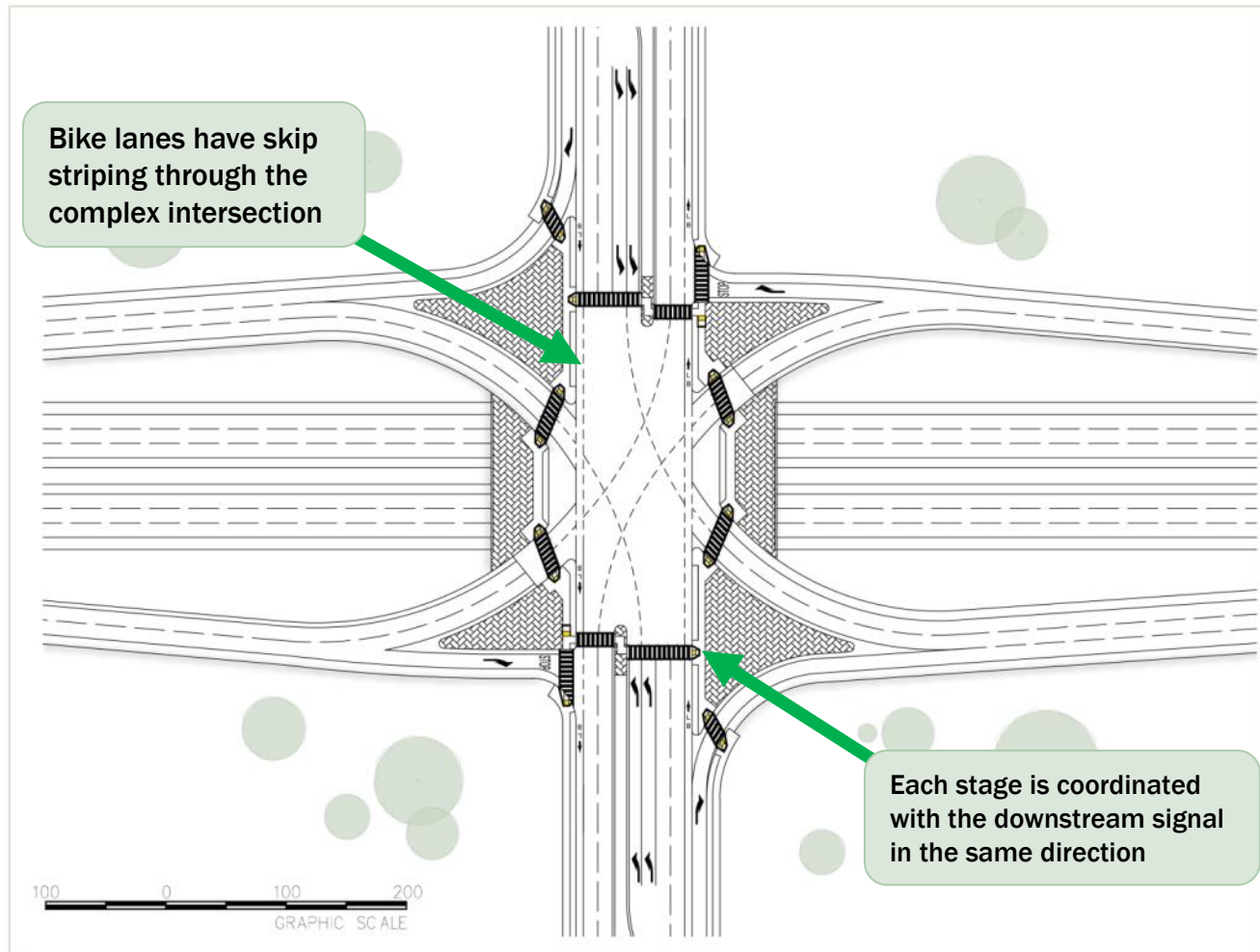
# SINGLE POINT URBAN INTERCHANGES (SPUI)



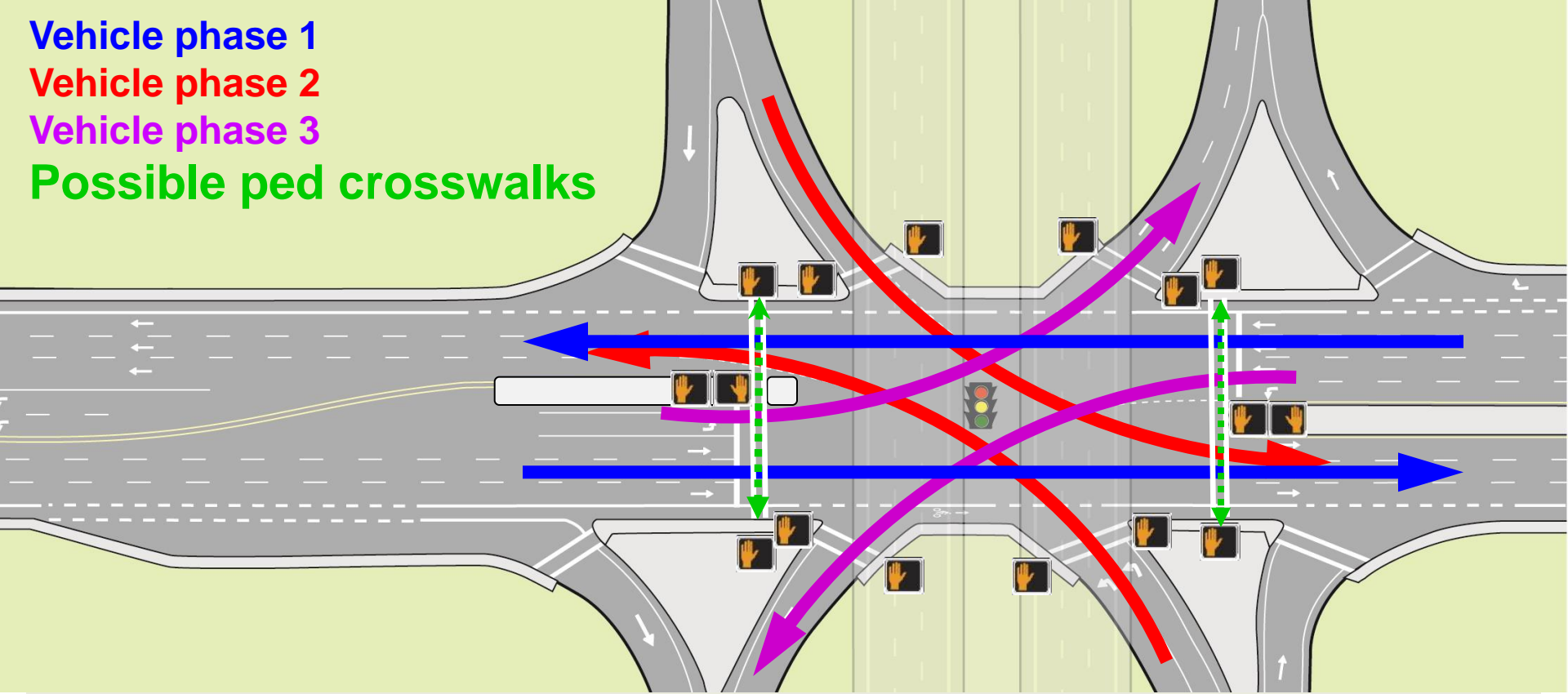
# SPUI 2 - ADVANCE CROSSWALK



# SPUI 1 - TWO-STAGE CROSSING



Vehicle phase 1  
Vehicle phase 2  
Vehicle phase 3  
Possible ped crosswalks

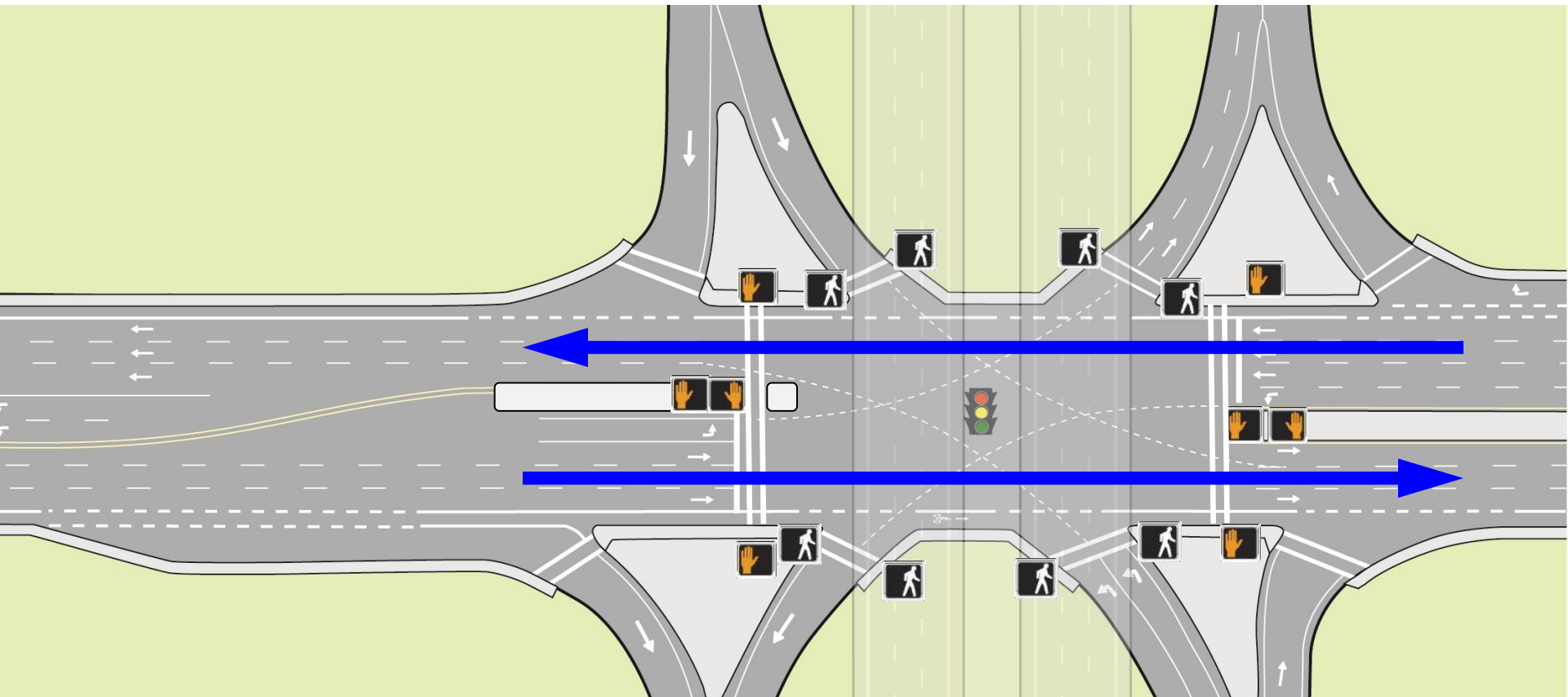


With most SPUIs there is never a phase when pedestrians can cross the urban arterial without conflict

Solution 1: Two-step crossing (one step during vehicle phase 2 and the other during vehicle phase 3) NOTE: requires median refuge & Ped Signals

Solution 2: Nearby midblock signalized ped crossing, or nearby signalized intersection with crosswalks

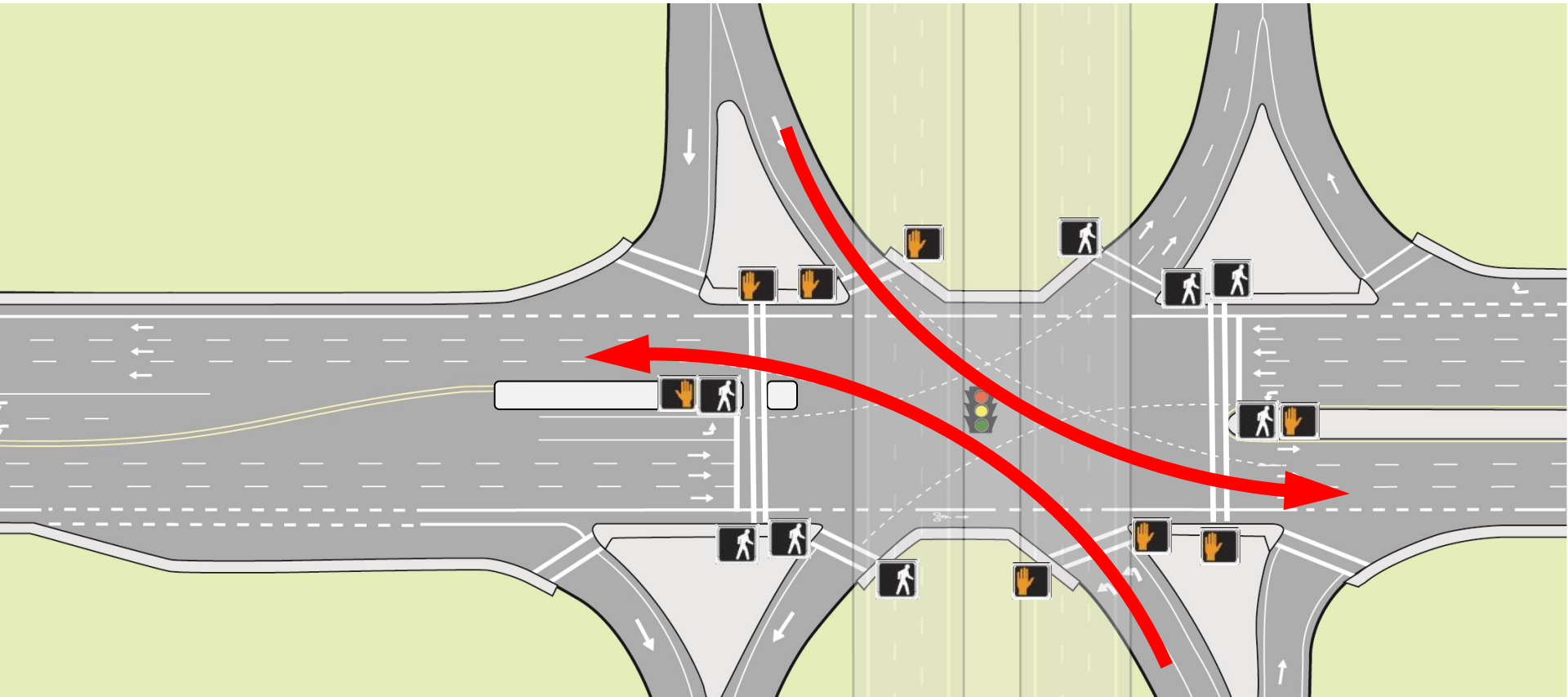
# GETTING PEDESTRIANS ACROSS A SPUI



**Vehicle phase 1**

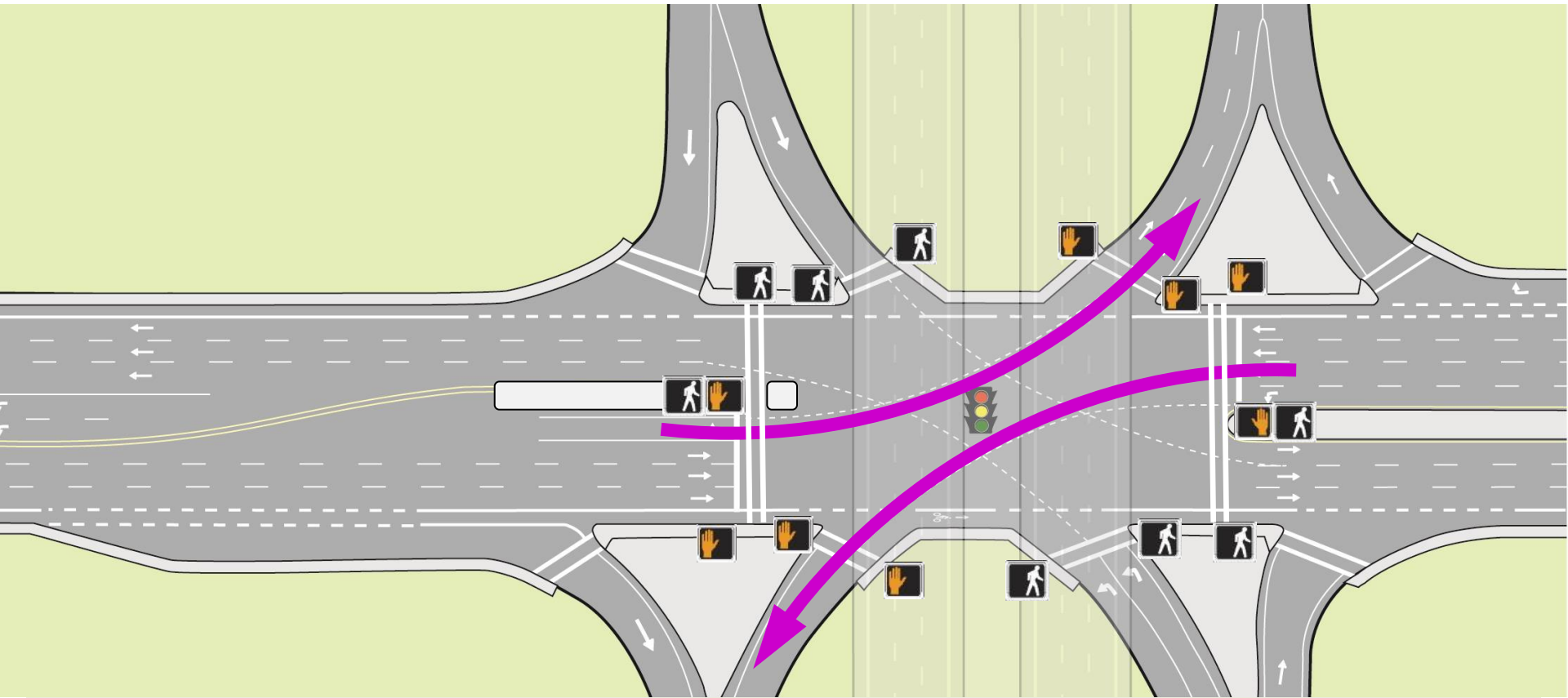


# GETTING PEDESTRIANS ACROSS A SPUI



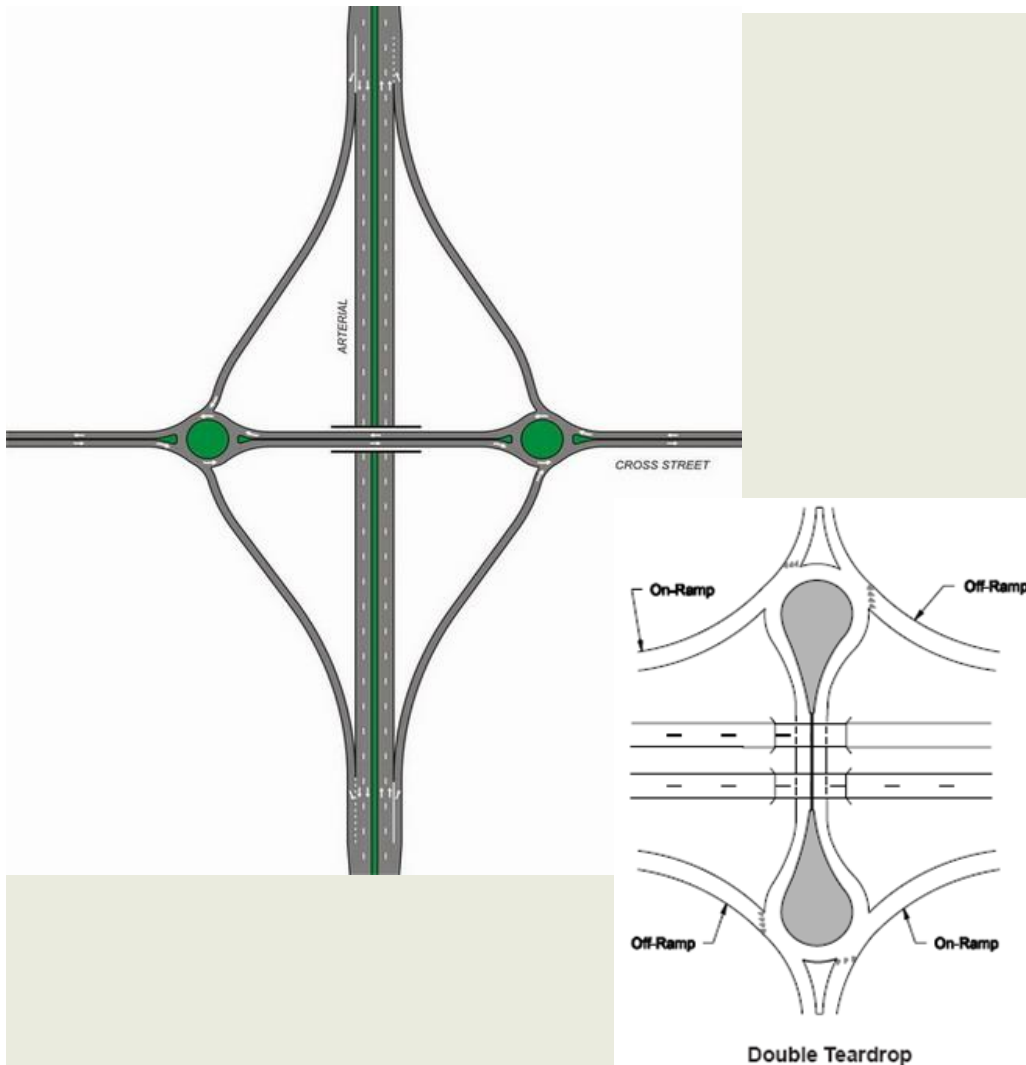
**Vehicle phase 2**

# GETTING PEDESTRIANS ACROSS A SPUI



Vehicle phase 3

# ROUNDBABOUTS AT INTERCHANGES



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- Compared to signalized intersections, roundabouts require fewer lanes on the crossroad (no need for turn lanes) resulting in a narrower bridge
- Roundabouts can have either a true circular shape or a “raindrop” shape
- Raindrop-shaped islands eliminate direct U-turn movements (U-turns can be made by circulating around both roundabouts)





City of Carmel, Indiana

Photo Credit: American StructurePoint, Inc. [www.structurepoint.com](http://www.structurepoint.com)



# THE "PEANUT" INTERCHANGE



# Thank You!

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⇒ **Questions?**

[webinars@hsrc.unc.edu](mailto:webinars@hsrc.unc.edu)