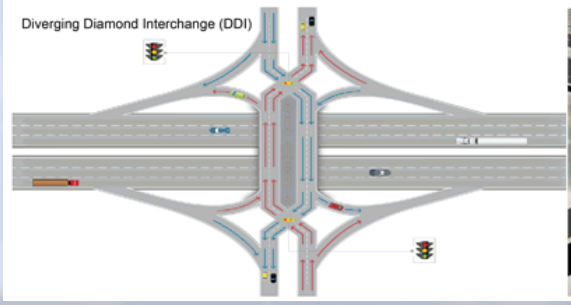
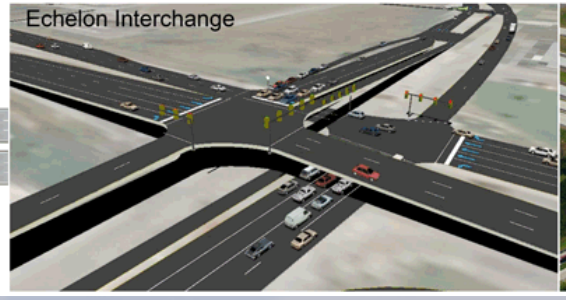
Overview of Reduced Conflict Intersection Design & Operations

WisDOT Webinar

December 16 & 18, 2013





What are We Talking About?

Reduced Conflict Intersections

Unconventional Intersections

Innovative Intersections

Non-Traditional Intersections

Alternative Intersections

Intersection Design and Operations Task Force

- **Purpose**
  - Obtain and disseminate information on emerging intersection and interchange design and operations concepts
  - Work with project teams on communication and implementation.
  - Develop mechanisms to successfully implement new intersection types in Wisconsin

Intersection Design and Operations Task Force

Members:

- **BPD**: Jerry Zogg, John Bridwell, Pat Fleming
- **BTO**: Bill McNary, Rebecca Szymkowski, Travis Feltes
- **BHM**: Todd Matheson
- **Regional PDS**: Brian Roper
- **Regional Ops**: Angela Adams, Brian Bliesner
- **FHWA**: Dave Kopacz
- **Communications**: Mae Knowles, Kathleen Scholl, Steve Theisen

Overview

Why Intersection & Interchange Geometrics?

Congested Intersections

Rural High Speed Intersections

Wisconsin Statistics (05-09)

37% of all Crashes
26% of all traffic fatalities
49% of all non-fatal injuries
37% of all incapacitating injuries

Congested Interchanges

Geometric and/or Multimodal Challenges

2

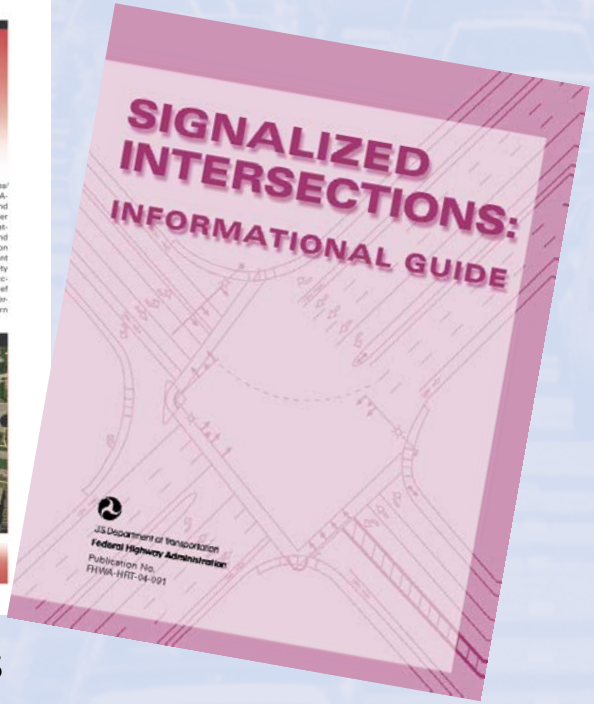
Overview

- Diverging Diamond Interchange (DDI)
- J-turn Intersection
- Single Point Interchange (SPI)
- Continuous Flow Intersection (CFI)
- Echelon Interchange
- Turbine Interchange
- Grade-Separated Quadrant Interchange

FHWA Publications

(1) Alternative Intersections Informational report

(2) USDOT Tech Briefs



(3) Signalized Intersections: Informational Guide

(1) http://www.fhwa.dot.gov/publications/research/safety/09060/
(2) http://www.fhwa.dot.gov/publications/research/safety/09054/index.cfm
(3) http://safety.fhwa.dot.gov/intersection/signalized/13027/index.cfm

Unconventional Design Principles

RE-ROUTE left turn movements

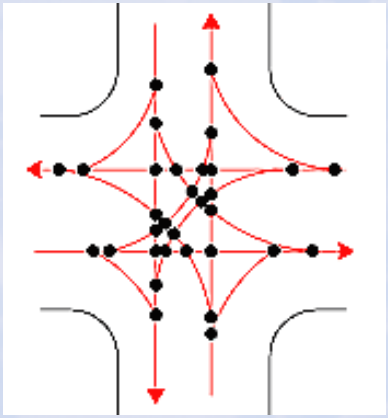
- Move left turns away from main conflicts
- Improve overall signal timing for all movements
- Serve thru traffic more efficiently

REDUCE signal phases

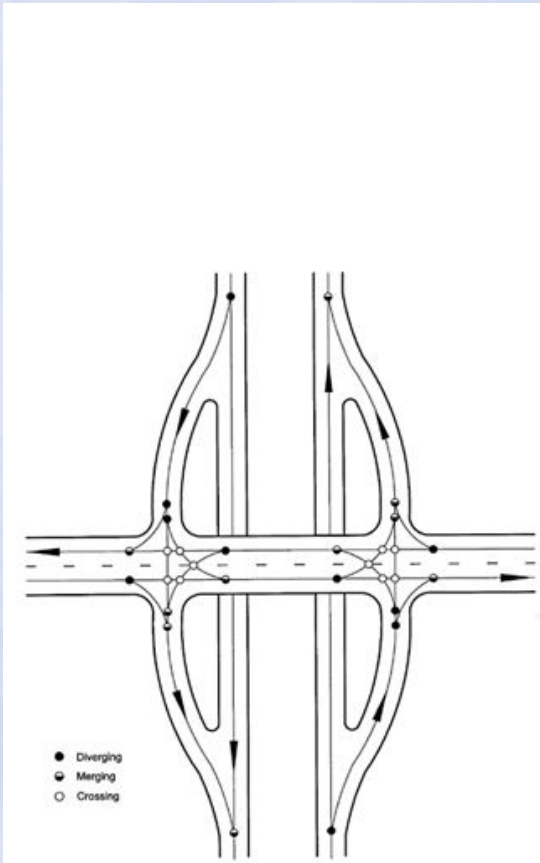
- Shorter cycle length, service times, queuing & average delay

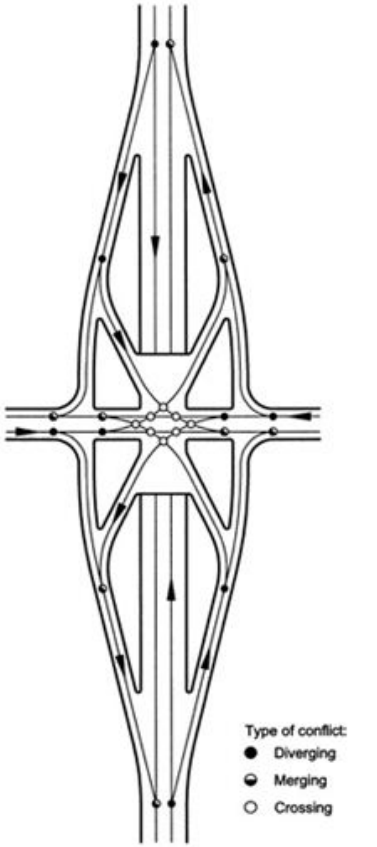
REMOVE and separate conflicts

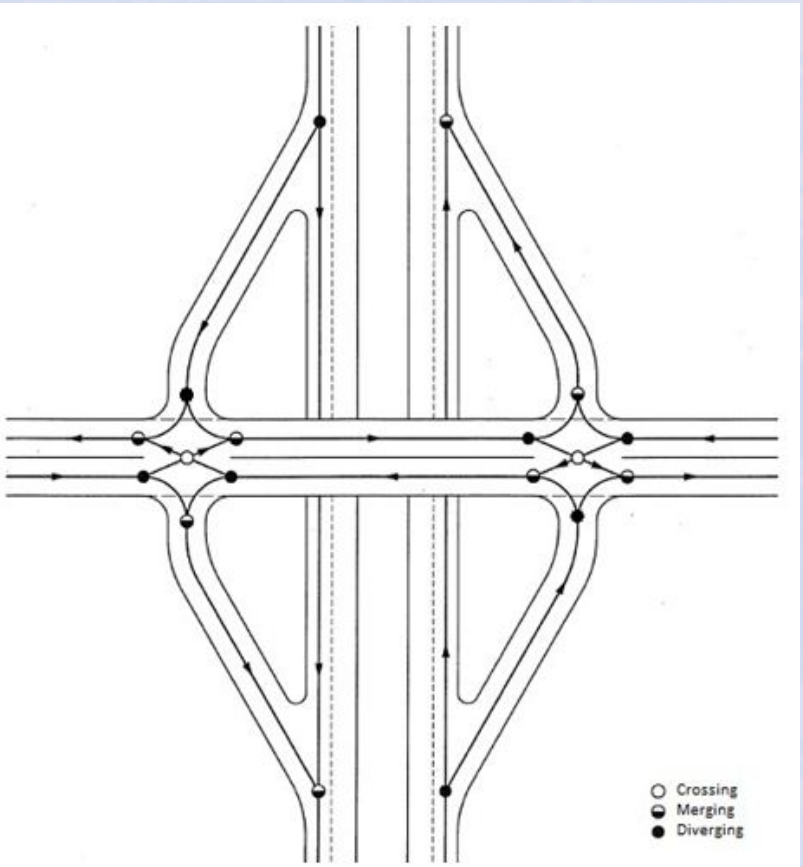
- Reduce number of conflict points
- Separate conflict points



Reduced Conflict Points = Increased Safety





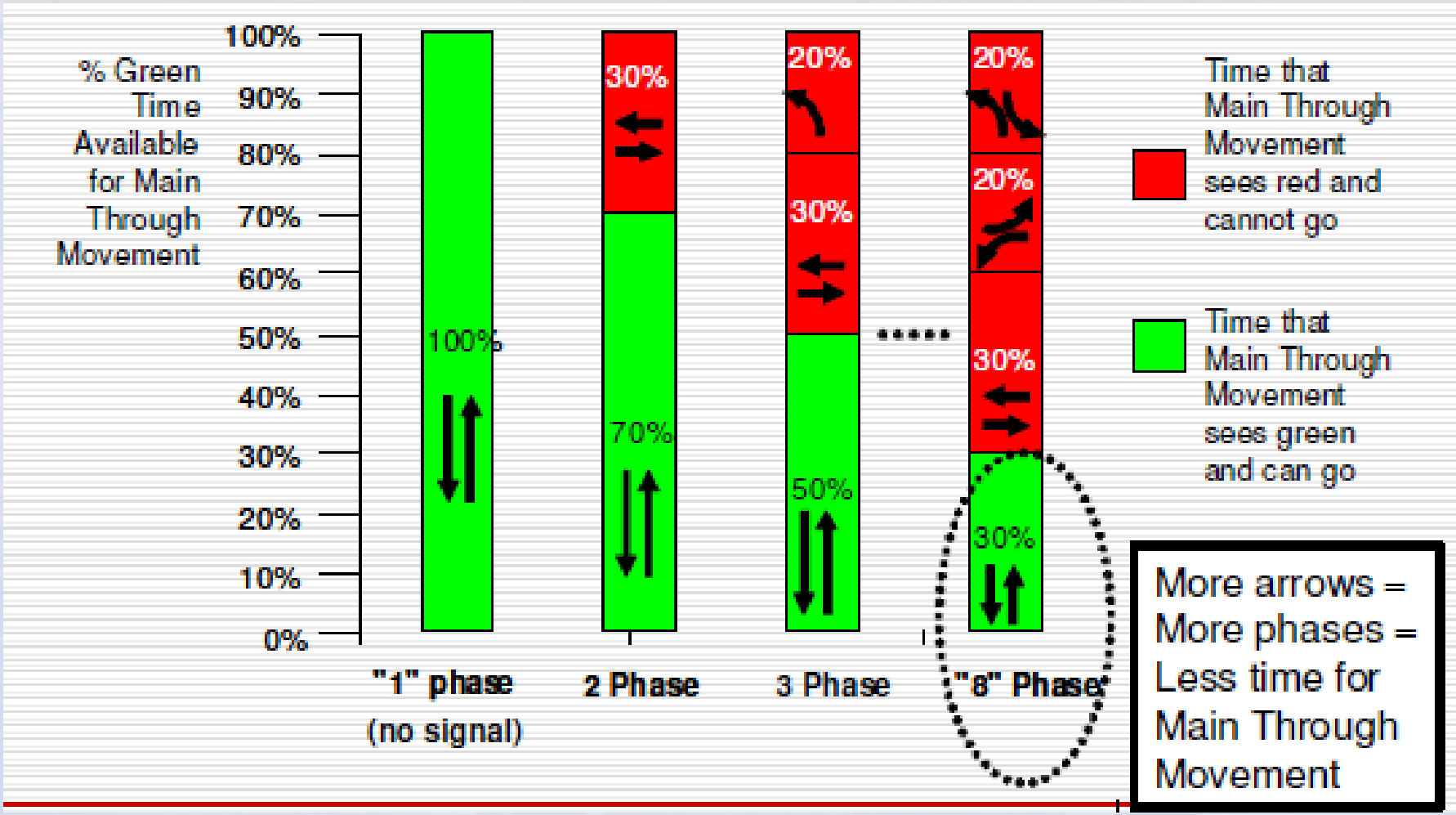


Diamond = 30

SPI = 24

DDI = 18

The Benefits of Two-Phase Signals

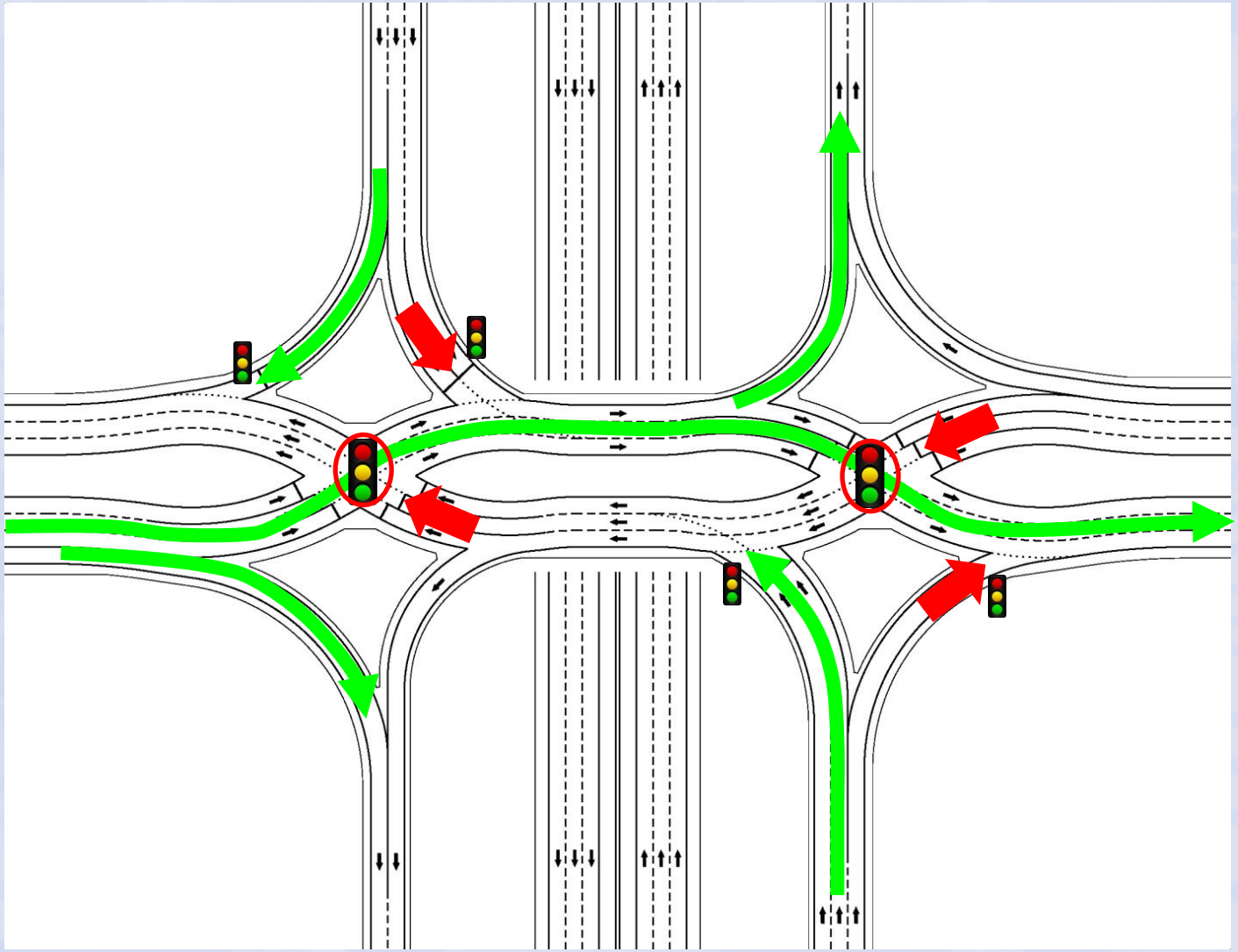


Diverging Diamond Interchange (DDI)

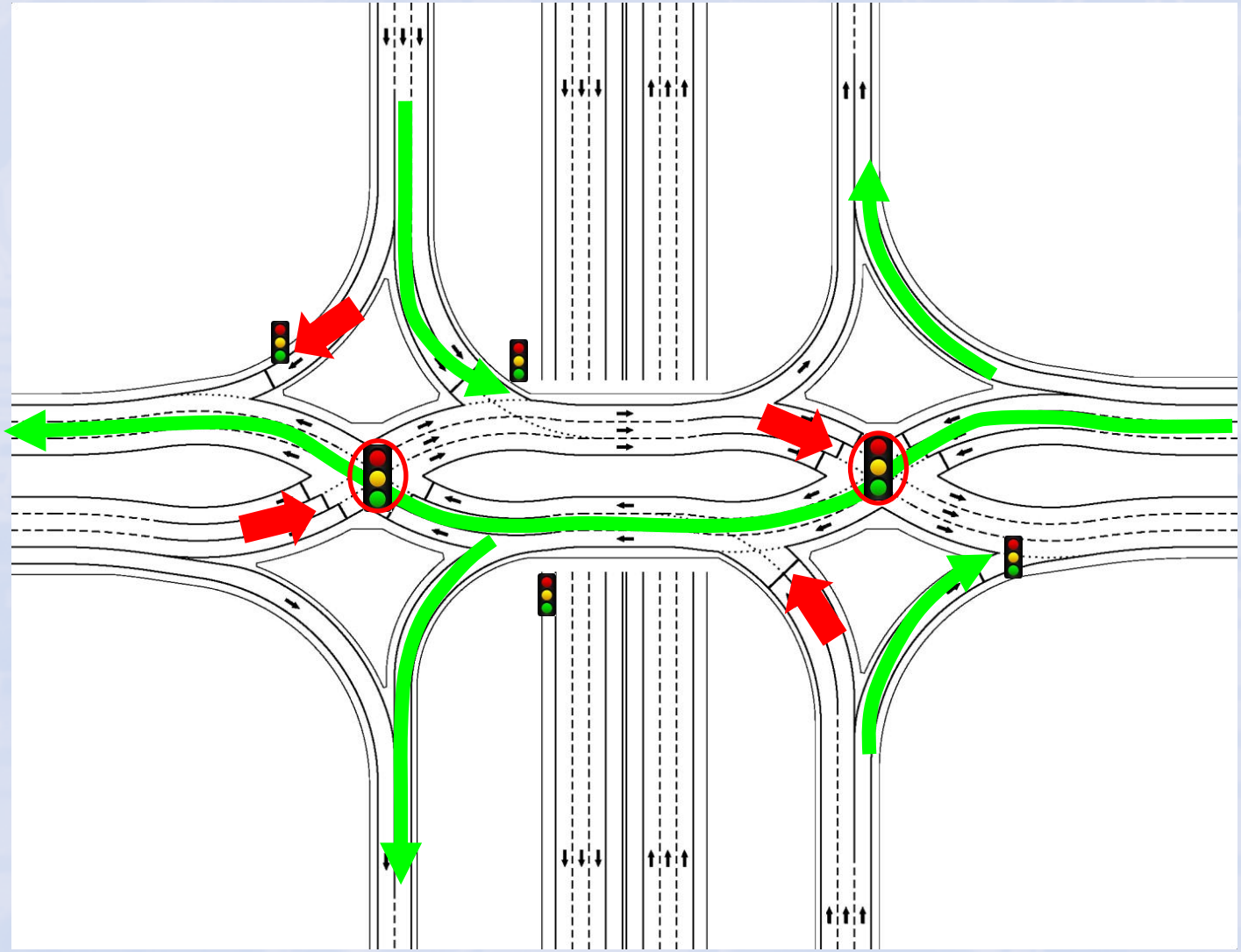
What is a Diverging Diamond Interchange?

- Essentially a diamond interchange with cross-over intersections at the ramp terminals

DDI Signal Phasing



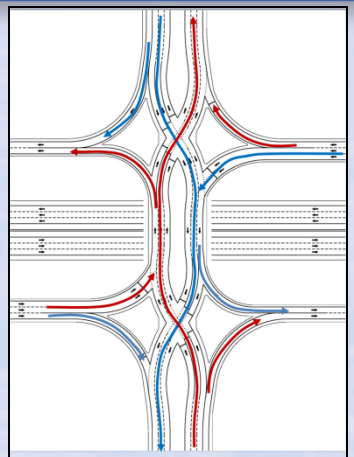
DDI Signal Phasing



Diverging Diamond Interchange (DDI)

Typical Application:

Service interchange between a freeway and a high-volume arterial with heavy left turn movements



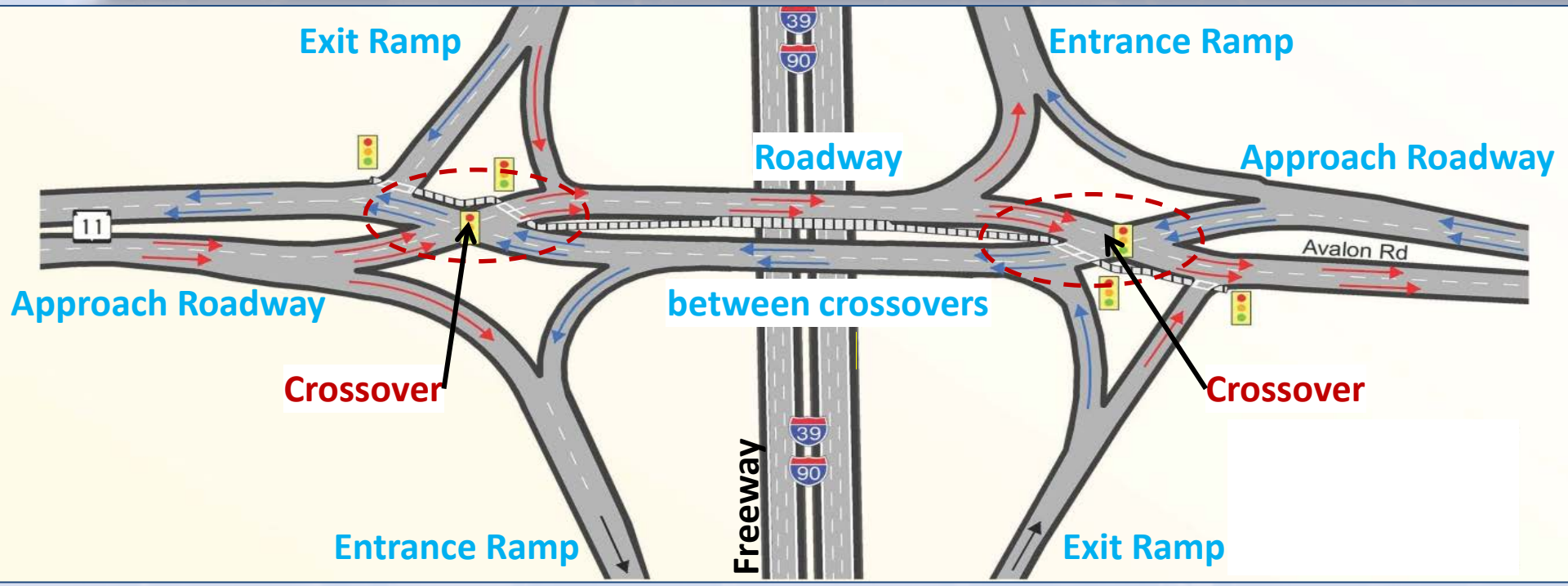
Advantages

- Handles more turning traffic
- Eliminates left-turn conflicts/signals
- Minimizes right of way impacts
- Safer design

Disadvantages

- Not well suited for arterials with high through volumes
- Typically no ramp off/ramp on movements allowed
- Interchange layout is unfamiliar to drivers

Diverging Diamond Interchange (DDI)

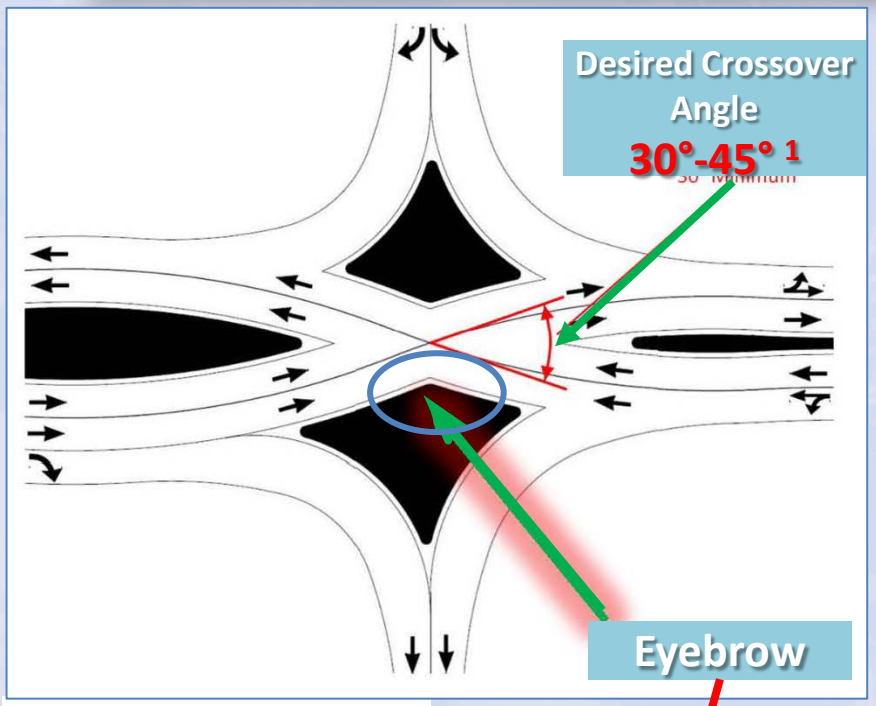


General Design Standards

- **Design speed** is based on the design class and regulatory speed of the roadway
- **Vertical alignment** and **sight distance** are based on the **design speed**
- **Intersection design vehicles** and **check vehicles** and **OSOW checks** are per FDM 11-25-2
- **Cross sections** on the approach roadways are based on the design class
- **Bridge width** is based on the design class of the roadway
- **Ramp designs** are based on FDM requirements

Original graphic per IH 39/90 project team

DDI - Crossover Angle & Eyebrow



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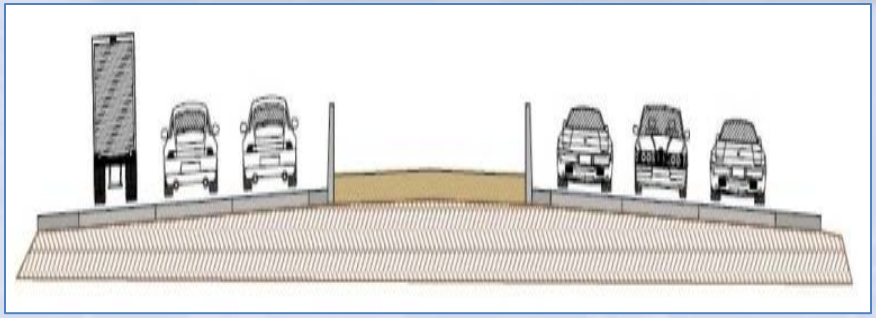
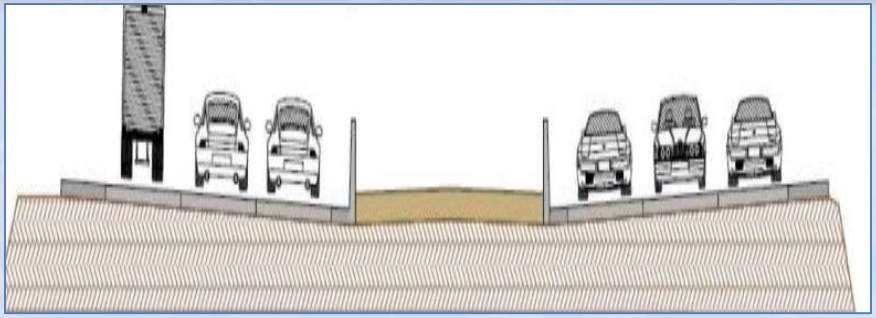
The eyebrow helps prevent wrong way movement:

- **Makes a right turn difficult**
- **Head-On collision obstructed**

1 Page 10 of July 2013 Jacobs-peer-review of proposed DDI at IH 39-90 and STH 11 (Avalon Road)
Page 13 of May 2013 HDR Peer review of proposed DDI at WIS 441 and US 10 shows acceptable range of 25-50 degrees

DDI - Crossover – Cross slope





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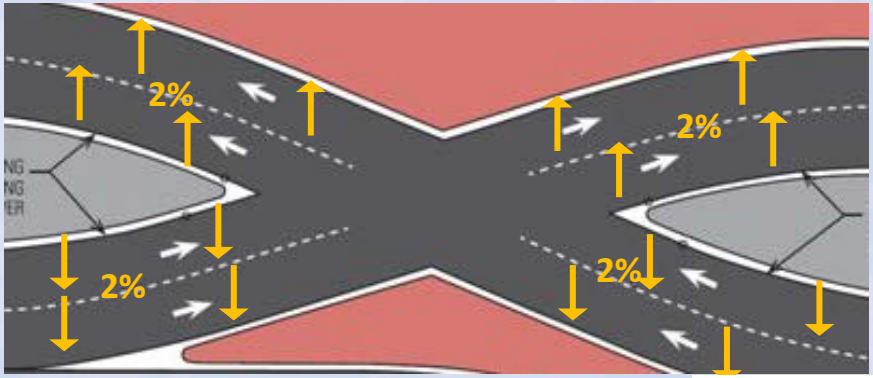

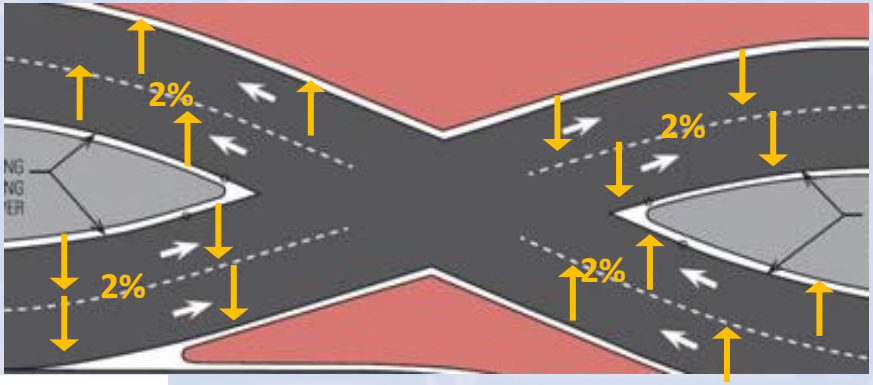

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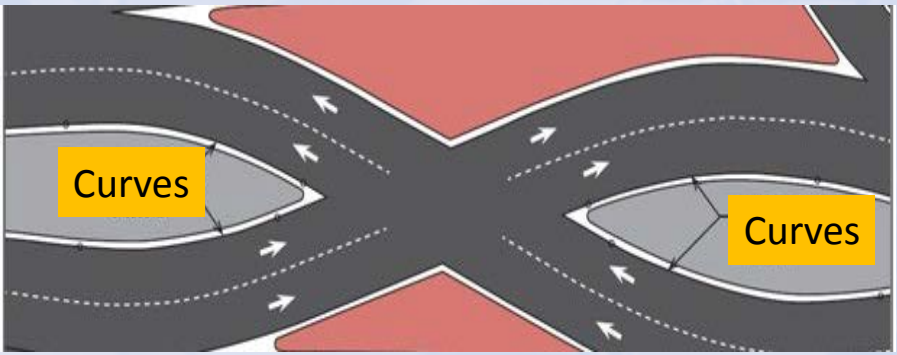
High-center crown, aka table-top

- Driver experiences change in cross slope
- Common for retrofits
- Can cause snow removal issues
- Drainage on outside

Low-center crown, aka reverse-crown

- Slopes to drivers' right
- Snow removal without blade switch
- Drainage in center

DDI – Crossover - Reverse Curve & Tangent



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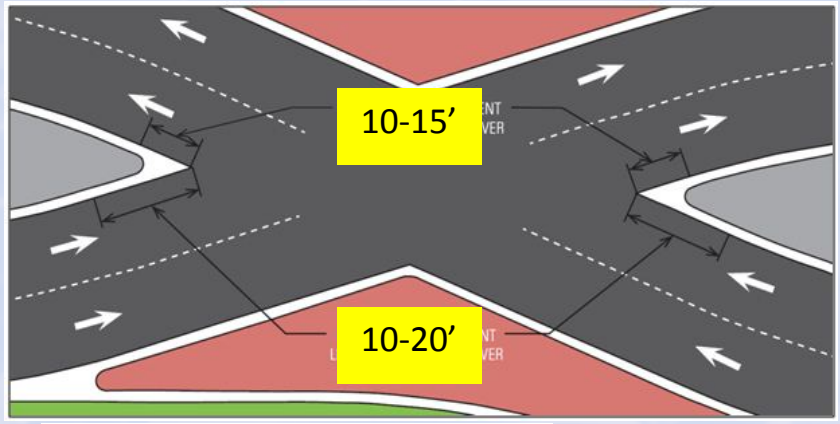
Horizontal Curve and Superelevation

- Based on Low-Speed Urban design
- 10 mph below posted speed **(desirable min.)**
- 15 mph below posted speed **(absolute min.)**
- NC or RC superelevation
- Widen travel lanes to accommodate truck off-tracking



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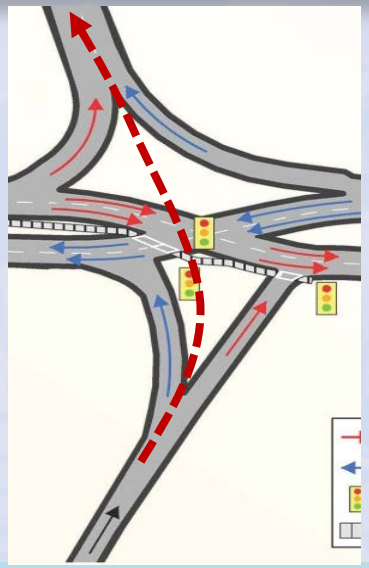
Tangent Thru Crossover

- 15-20 feet min. in advance of the stop bar
- 10-15 feet beyond the last transverse travel path[1]

1 Page 10 of July 2013 Jacobs-peer-review of proposed DDI at IH 39-90 and STH 11 (Avalon Road)

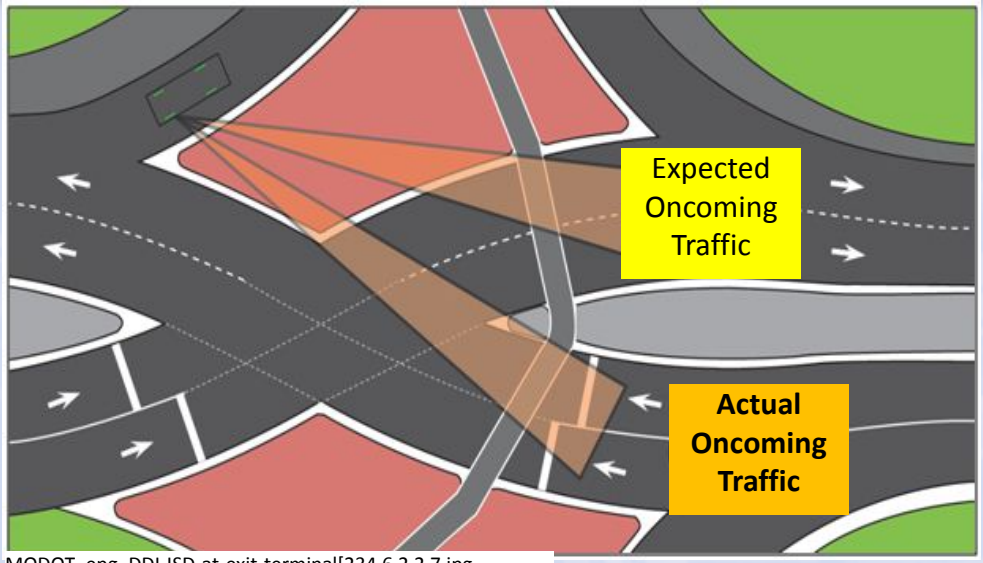
DDI - Ramp Terminals

1



Exit ramp to Entrance Ramp movement
Requires special design

2



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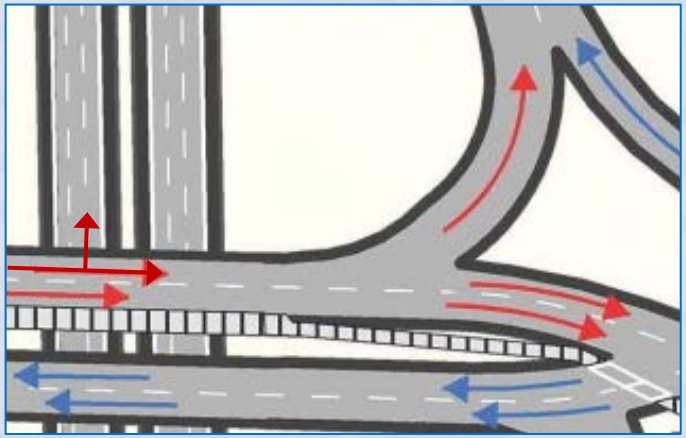
ISD for right turn at Exit ramp terminal
Driver expectancy issue

3

Approach to free flow left turn entrance ramp
Avoid excessive speed differential between thru traffic and left turning traffic



Original graphic per IH 39/90 project team

DDI - Pedestrians

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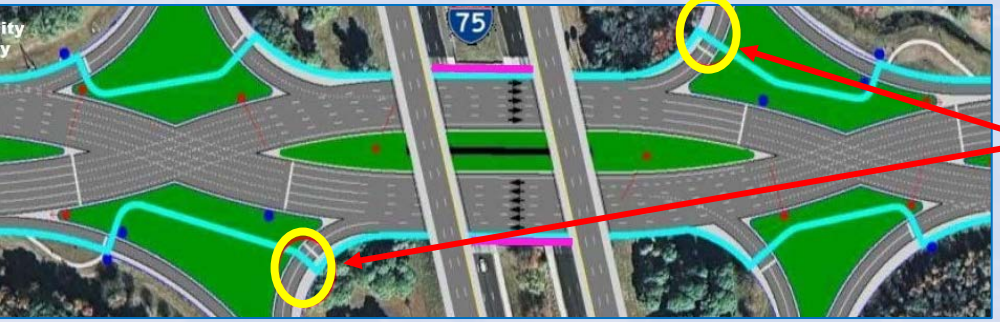


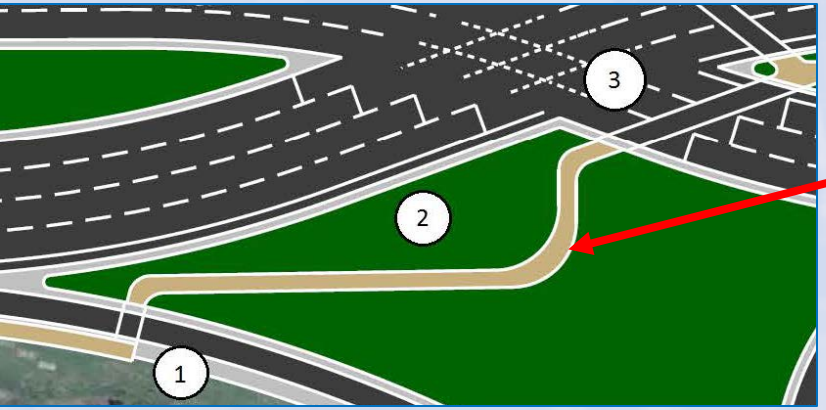
Pedestrians in Median

No conflict with left turns

Barrier protected

Pedestrians on Outside

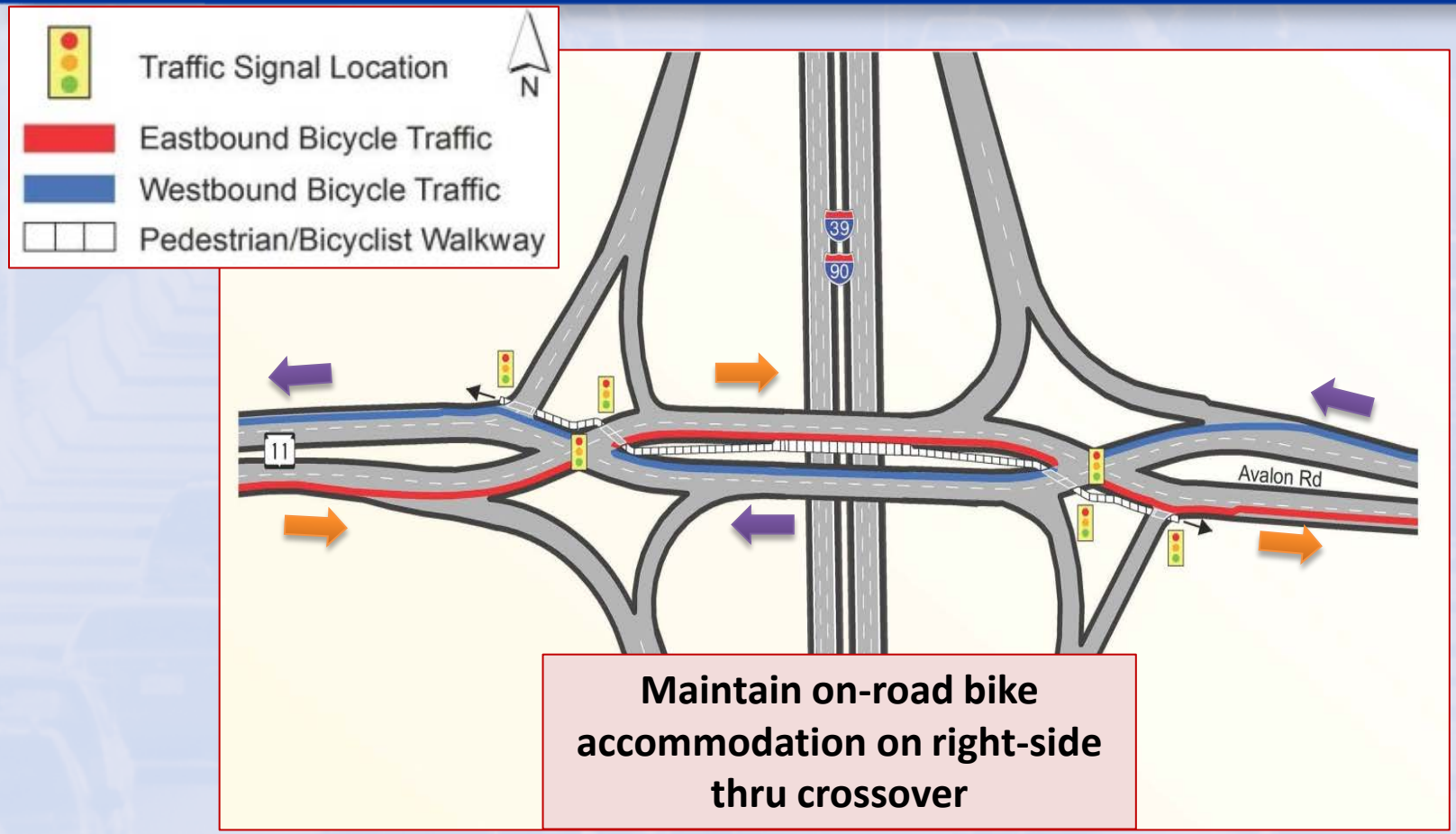
Potentially unsafe because of conflicts with free-flow left-turn entrance ramp



Pedestrians path thru island

Kinked to make it clear that a safe two-stage crossing cannot be made one immediately after the other

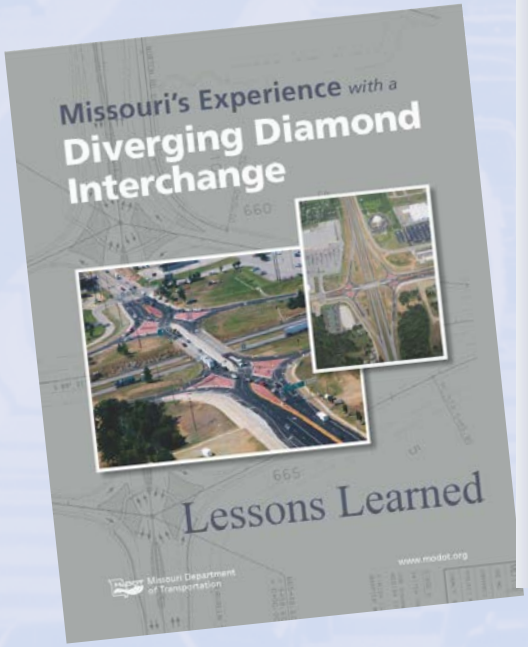
DDI - Bikes



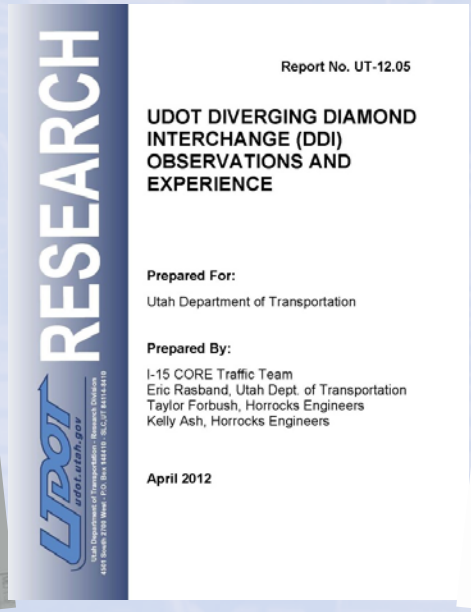
- Bicyclists use the on-road bicycle lane to navigate through the DDI, or
- Bicyclists may use the shared-use path if one is provided

Original graphic per IH 39/90 project team

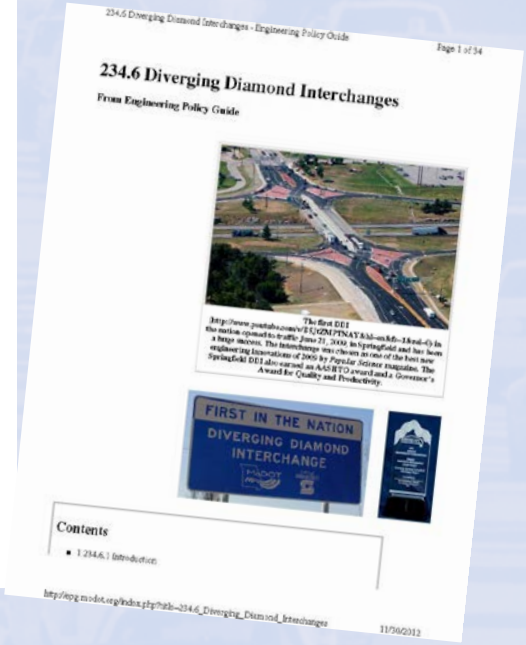
Design & Operations DOT References



(1) Missouri DOT



(2) Utah DOT



(3) Missouri DOT

- **WisDOT DDI Projects -** Peer Reviews
- **HDR workshop presentation** - February 2013

(1) http://library.modot.mo.gov/RDT/reports/UnNumbrd/or10021.pdf
(2) http://www.udot.utah.gov/main/uconowner.gf?n=10172614219775523
(3) http://epg.modot.org/index.php?title=234.6_Diverging_Diamond_Interchanges#234.6.2.2_Design_Elements

SW Region Experience

Diverging Diamond Interchange

Wis 11 (Avalon Rd) Interchange

39/90
IMPROVING
a gateway to Wisconsin

IH 39/90 & STH 11 (Avalon Road)

- 3 interchange types evaluated through the ICE process:
  - Diamond Interchange
    - Traffic signals
    - Roundabouts
  - Diverging Diamond Interchange

- IH 39/90 CMT Decision in coordination with:
  - WisDOT:
    - SWR
    - BTO
    - BPD
    - OSOW Group
  - FHWA

Why a DDI at the Avalon Road Interchange

Good traffic flow at interchange

- Design allows better traffic flow for turning vehicles
  - 85% of traffic destined for Interstate
- Fewer lanes needed than signalized diamond

Improved Safety

- Fewer conflict points

Large Vehicle Accommodation

- Trucks stay in their lane through cross-over intersections
- Need to accommodate Oversize / Overweight vehicles

Positive results with other DDIs constructed around the country

Avalon RD - DDI

http://www.youtube.com/watch?v=1pMopeJp1Uk

Lessons Learned in DDI Presentations

- Focus on the driver's eye view
- Discuss DDI as two one-way streets
- Emphasize "easy" and "simple"
- Use personal stories
- Prepare for roundabout questions

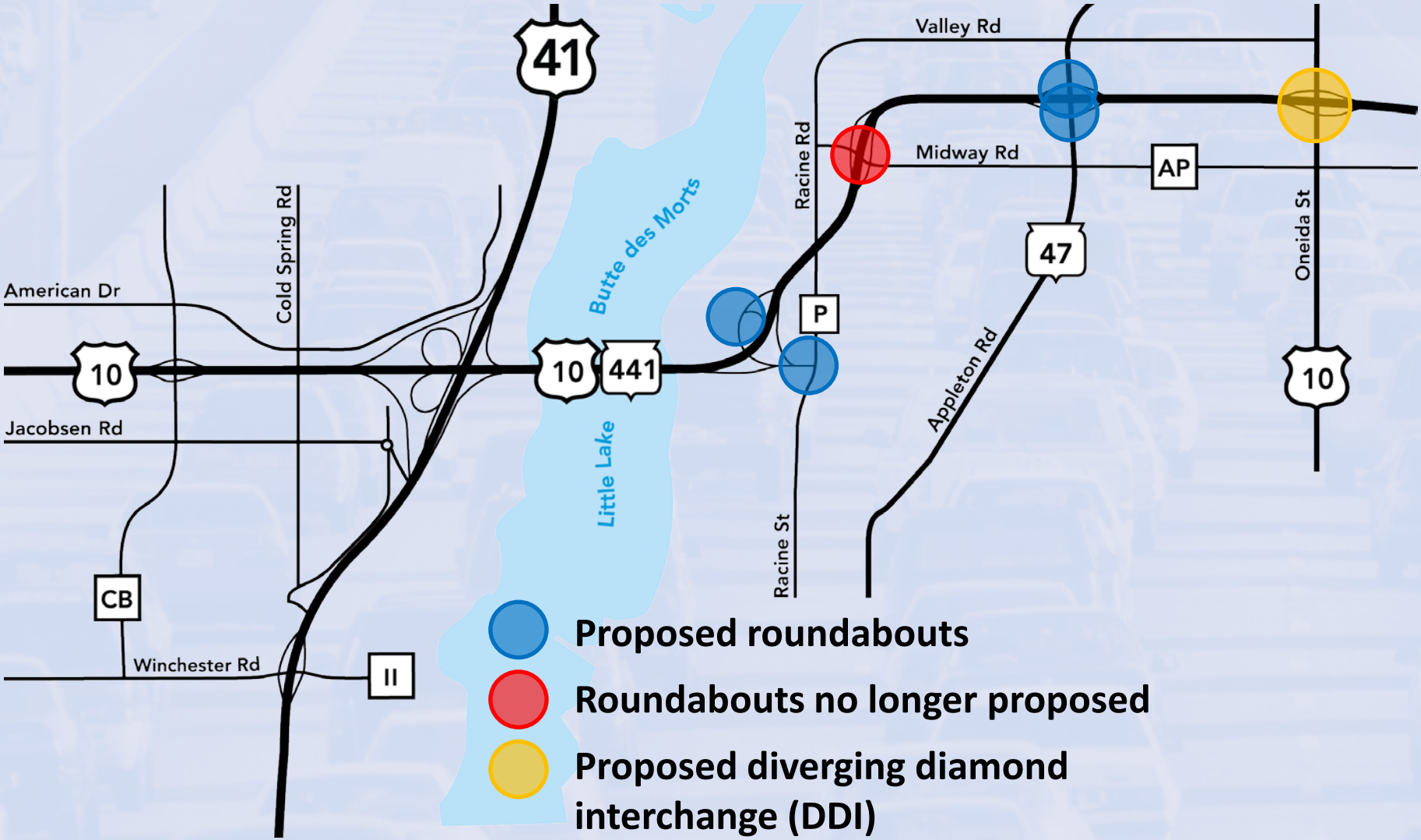
WIS 441 Tri-County Project

Diverging Diamond Interchange (DDI)
NE Region
Oneida Street

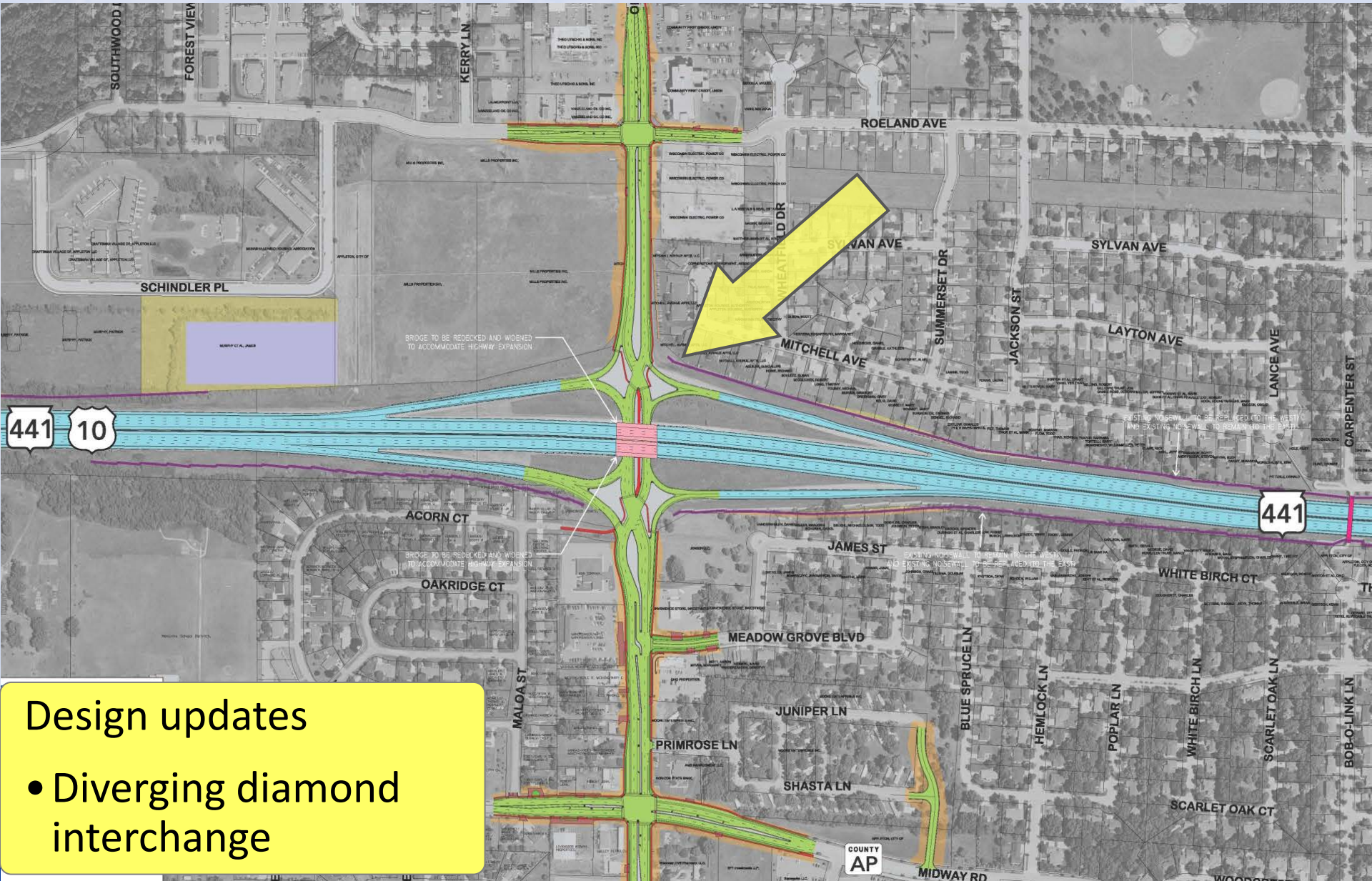
441
TRI-COUNTY
EXPANSION

U.S. Department of Transportation
Federal Highway Administration

WIS 441 Interchange control



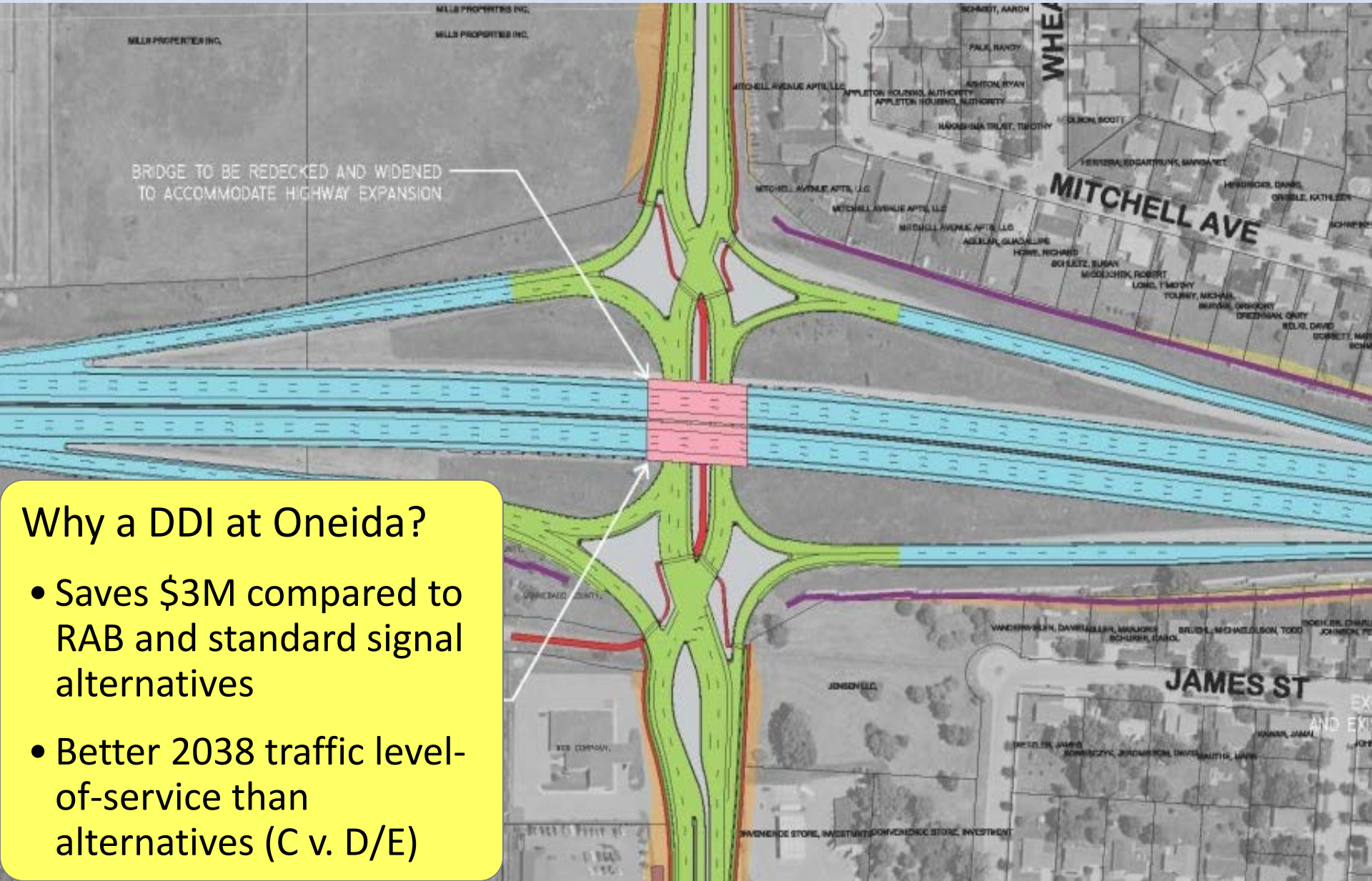
US 10/Oneida St interchange



Design updates

- Diverging diamond interchange

US 10/Oneida St interchange



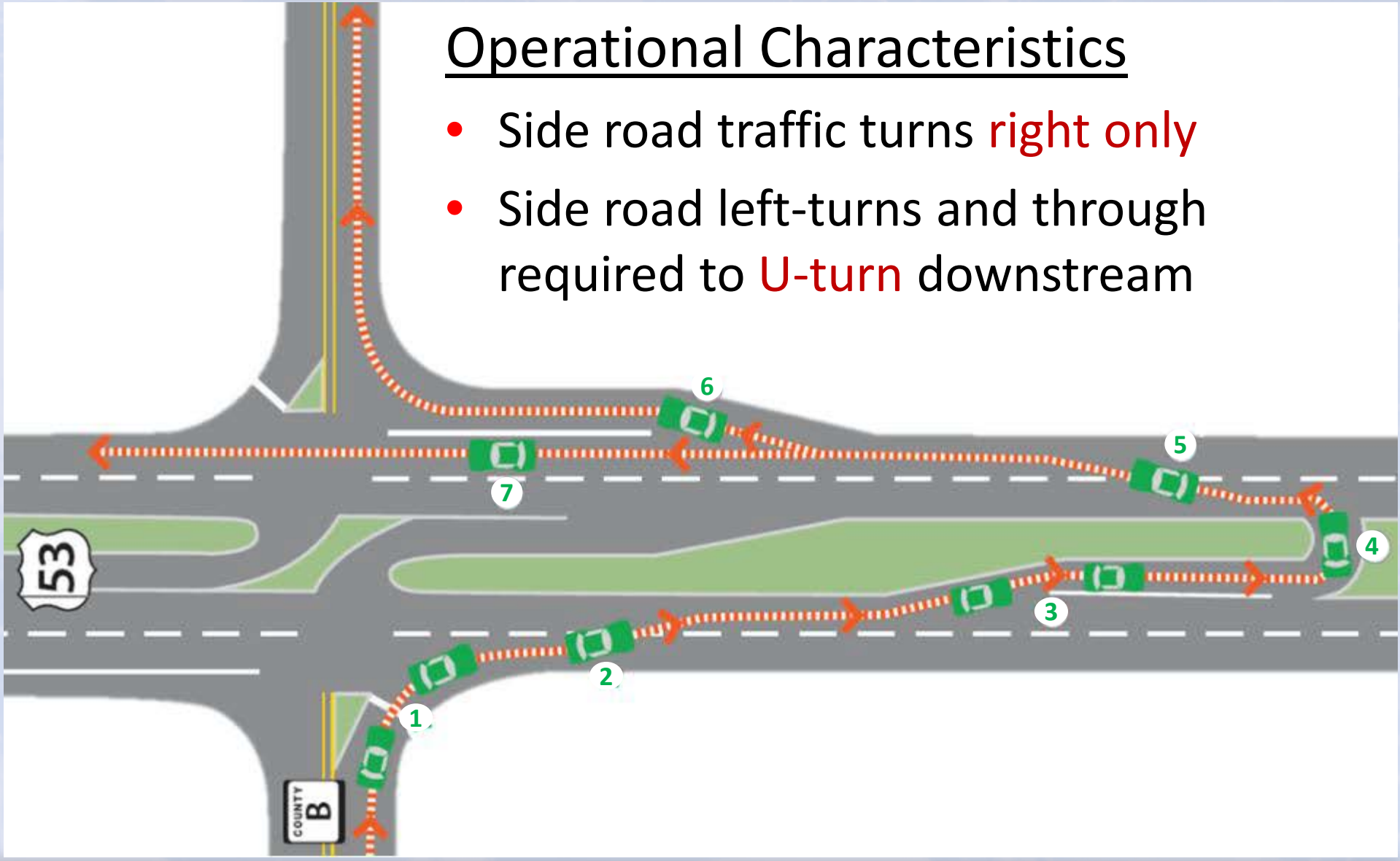
Why a DDI at Oneida?

- Saves $3M compared to RAB and standard signal alternatives
- Better 2038 traffic level-of-service than alternatives (C v. D/E)

J-Turn Intersection

Operational Characteristics

- Side road traffic turns right only
- Side road left-turns and through required to U-turn downstream



J-Turn Intersection

- Where are they applicable?
  - Low to medium side-street Thru/left volume divided expressways
  - Heavy left-turn volume from major road
  - Side road total volume ratio is typically ≤ 20%
  - Side road daily volume between 1,000 – 4,000
  - High number of far-side right angle crashes
  - Side road crossing gap times are insufficient
  - Median width is preferably 50 ft or greater
    - Minimum can be down to 40ft

J-Turn Intersection

Typical Application:

- Low to medium side-street Thru/left volume divided expressways

Advantages

- Reduces crash potential
  - Particularly far side right angle crashes
- Can accommodate up to two times the volume when compared to traditional median crossover type
- Easily retrofitted without purchasing additional R/W
- Low to medium cost
- Non signalized treatment

Disadvantages

- Requires special signage
- Requires public education
- Creates indirect movements
- Creates mainline weaving movements

J-turn Geometric Considerations

- Offset Left-turn lane and ISD
- Offset Right-turn lane and ISD
- Do not offset turn bay for U-turn
- U-turn distance from intersection
- Locate U-turn median openings on or close to a tangent
- U-turn lane length
- ISD for U-turns
- Median width
- Loons for U-turning trucks
- WisDOT has not used right-turn acceleration lanes
- WisDOT has only used STOP control at the side road intersection
- Protect against wrong-way entry
- Bicyclists/ Pedestrians

J-turn Design Guidance

- **FDM 11-25-1.3.2**, "J-turn Intersection",
- **WisDOT recent project plans**
- **NCHRP Report 650**, "Median Intersection Design for Rural High-Speed Divided Highways", http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_650.pdf
- **FHWA-HRT-09-60**, "Alternative Intersections / Interchanges: Informational Report (AIIR), chapter 4, http://www.fhwa.dot.gov/publications/research/safety/09060/
- **Missouri DOT:** 233.2.6 Type 4: Directional Median Opening with Downstream U-Turns, http://epg.modot.mo.gov/index.php?title=233.2_At-Grade_Intersections_with_Stop_and_Yield_Control
- **Mississippi DOT:** *Synthesis of J-Turn Design Standards And Criteria. (Final Draft Report).*, 2010. http://sp.gomdot.com/Roadway%20Design/documents/FINAL%20Synthesis%20of%20J-Turn.pdf

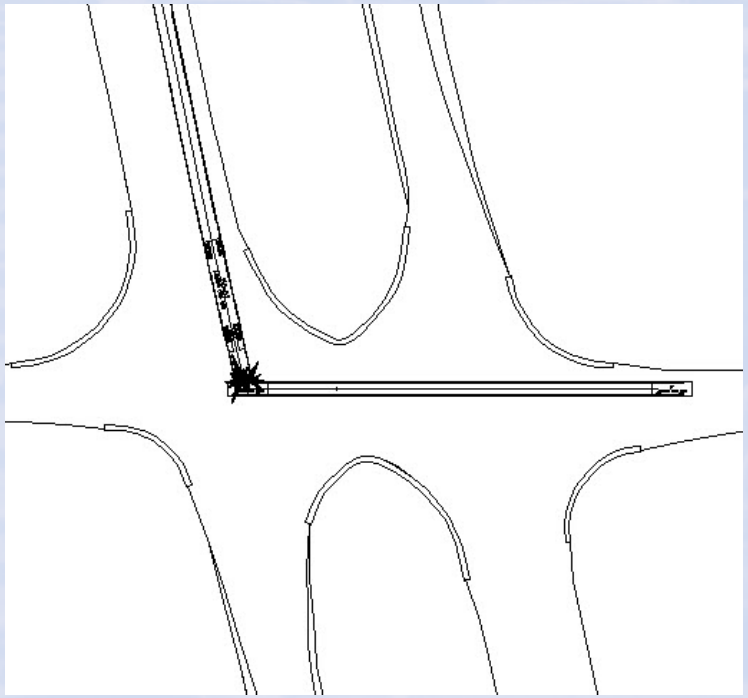
J- Turn
USH 53 & CTH B
Douglas County

By: Greg Helgeson,
Traffic Safety Engineer

J-Turn

Background Info:

- USH 53/CTH B, Douglas County
- USH 53
  - 65 MPH rural expressway
  - AADT about 7000 VPH
- CTH B
  - 55 MPH rural arterial
  - AADT about 1500/2500 VPH
- 95’ median with yield control
- “Far side” right angle crashes



J-Turn – Intersection Alternatives

Road Safety Audit (RSA) was conducted

- Recommended multiple alternatives for further consideration.

Alternative Analysis looked at 5 alternatives:

- Widening median to create STOP
- Offset T intersections
- J-turn intersection
- Overpass with right-in/right-out roadways in two quadrants
- Diamond interchange

J-turn qualified for HSIP funding

J-Turn – Consent Building

- Initial Meeting:
  - County Highway Dept.
  - County Sheriff's Dept.
  - Wisconsin State Patrol
  - Township of Hawthorne
- Support from FHWA Safety engineer
- County Highway Committee endorsement
- County Board presentation (informed consent)

J-Turn – Public Consent

- Strong support from County Board member/school bus driver.
- Primary objector was adjacent business owner.
- PIM was contentious
  - Many wanted an interchange
  - Officials showed support of J-turn
- Packaging with mill/fill project timely decision

J-Turn – Final Design

- Final design added:
  - Positive left turn offset
  - Offset right turns
  - Median curb cuts for pedestrians, bicycles, snowmobiles and ATV's
  - LED lighting of intersection and both J-turns.
- No real estate purchase

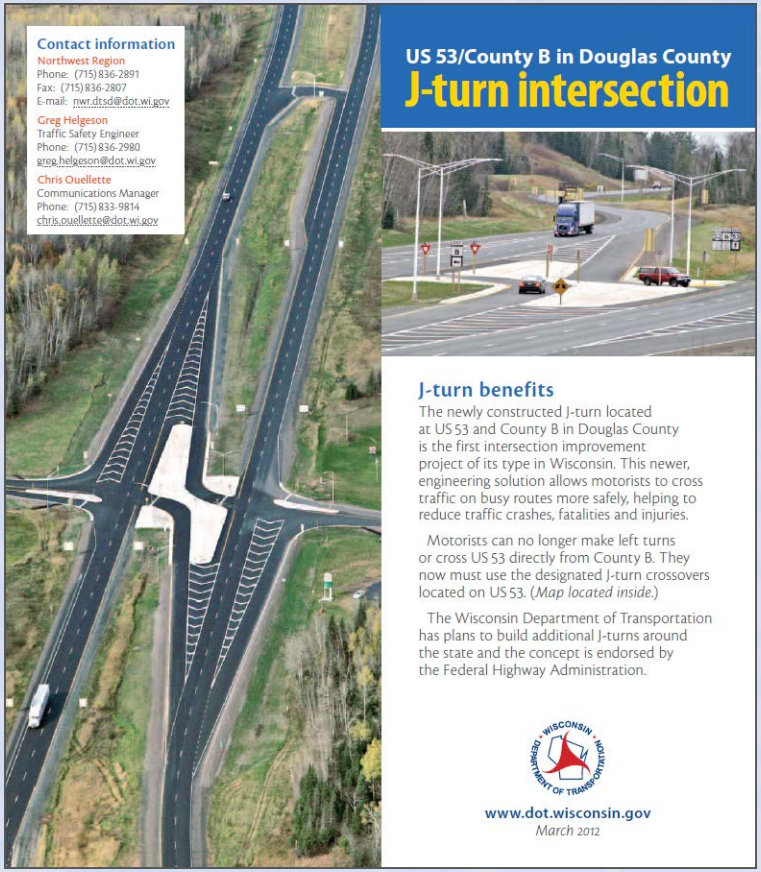
J-Turn Design

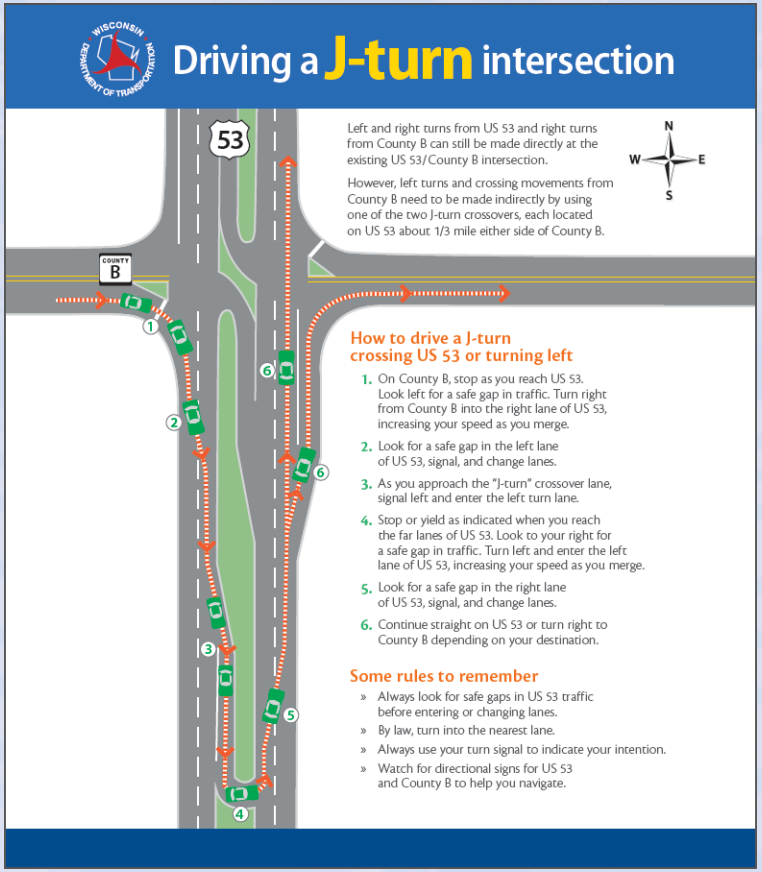
J-Turn Design

J-Turn Design

J-Turn – Public Outreach

- Developed “Driving a J-Turn Intersection” flyer
- Placemats for area restaurants.





J-Turn – Results

- Construction complete 10/8/2011
  - No crashes in two years since
  - Delay – about one minute to traverse
  - Added:
    - Diagrammatic guide signs for CTH B
    - Flex tubes to prevent median cross-cutting

J-Turn – Results

- Less opposition once built
- Emergency responders pleased
- Consent building was key to success

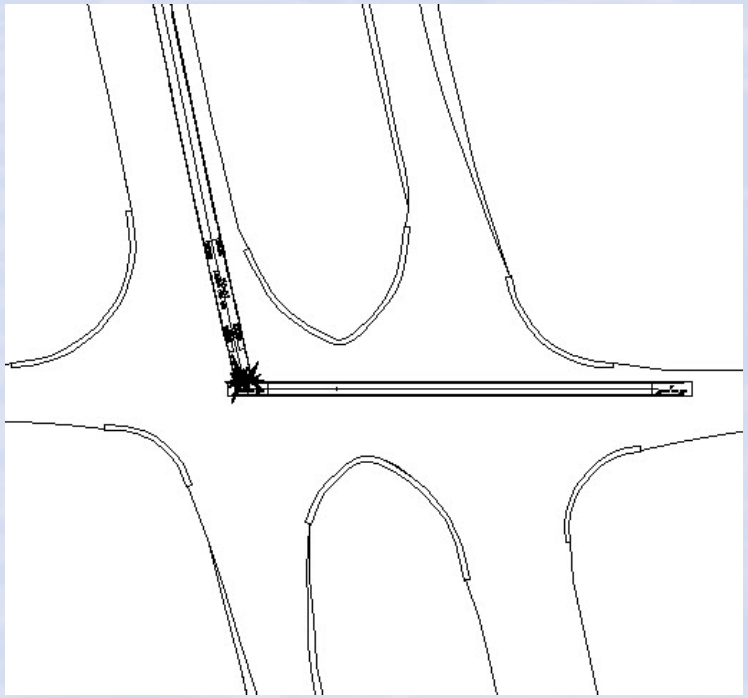
J- Turn
STH 29 & CTH VV
Brown County

Scott Nelson
Traffic Safety Engineer
NE Region

J-Turn

- Background Info:
  - STH 29 & CTH VV, Brown County
  - STH 29
    - 65 MPH rural expressway
    - AADT about 23,000
  - CTH VV
    - 55 MPH rural arterial
    - AADT about 1800/2000
  - 60’ Median
  - HSIP project to correct

    “Far side” right angle crashes



J-Turn – Public Outreach

- Handout following NW Region Template with FAQ

Wisconsin Department of Transportation

WIS 29—County VV J-Turns

Brown County

April 2012

J-turns at WIS 29/County VV Intersection

WisDOT is planning for the construction of J-turns at the existing WIS 29/County VV intersection. This type of intersection is expected to reduce a significant number of the severe, right-angle, "far" side crashes that are occurring at this intersection. Relative to other improvement concepts, J-turns are a low-cost treatment that can be quickly implemented, do not require property acquisition or relocation of homes and businesses, and minimize environmental impact.

J-turns: A safer way to cross a busy highway

A J-turn is an effective way of reducing conflict points – points that lead to crashes – at intersections. It improves safety and mobility and can be quickly implemented. It is generally considered to be an interim traffic control device, implemented to improve safety while a permanent solution (such as an interchange) is designed and constructed.

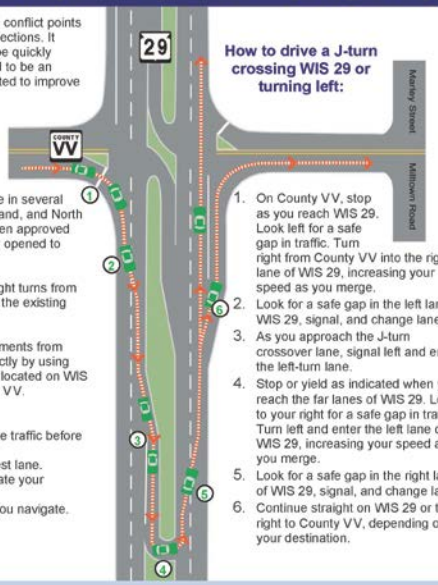
WisDOT has determined J-turns can significantly reduce both the number and severity of crashes. This type of traffic control device is already in use in several other states, including Michigan, Maryland, and North Carolina. In Wisconsin, funding has been approved for 12 J-turn locations with one already opened to traffic in 2011.

Left and right turns from WIS 29 and right turns from County VV will still be made directly at the existing WIS 29/County VV intersection.

However, left turns and crossing movements from County VV will need to be made indirectly by using one of the two J-turn crossovers, each located on WIS 29 about 1/3 mile either side of County VV.

Some rules to remember:

- Always look for safe gaps in mainline traffic before entering or changing lanes.
- By law, you must turn into the nearest lane.
- Always use your turn signal to indicate your intention.
- Watch for directional signs to help you navigate.



How to drive a J-turn crossing WIS 29 or turning left:

1. On County VV, stop as you reach WIS 29. Look left for a safe gap in traffic. Turn right from County VV into the right lane of WIS 29, increasing your speed as you merge.
2. Look for a safe gap in the left lane of WIS 29, signal, and change lanes.
3. As you approach the J-turn crossover lane, signal left and enter the left-turn lane.
4. Stop or yield as indicated when you reach the far lanes of WIS 29. Look to your right for a safe gap in traffic. Turn left and enter the left lane of WIS 29, increasing your speed as you merge.
5. Look for a safe gap in the right lane of WIS 29, signal, and change lanes.
6. Continue straight on WIS 29 or turn right to County VV, depending on your destination.

Wisconsin Department of Transportation – Dedicated people creating transportation solutions through innovation and exceptional service.

Contact information:

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WisDOT Web site:
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Project Web site:
Coming Soon

Daniel Segerstrom, P.E.
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Mission statement:
To provide leadership in the development and operation of a safe and efficient transportation system.

Frequently Asked Questions

What is a J-turn intersection?
This is an intersection that prevents direct crossing and left-turn movements from the side road. These side road movements are made indirectly by making a right turn, traveling about a quarter-mile on the divided main road, and then making a U-turn to proceed in the opposite direction on the main road toward the intended destination. At the original intersection location, left and right turns from the divided main road and right turns from the side road to the main road remain as direct turns. The J-turn does not require mainline through traffic to stop or yield.

Why are J-turns effective in enhancing safety?
J-turns reduce the number of intersection conflict points from 42 to 24 and reduce the right-angle conflict points from 24 to 4. The remaining conflict points are merging, exiting, or lane-changing maneuvers. These are not right angle; if an accident occurs, generally it will be a lower severity crash. Studies done by the National Cooperative Highway Research Program show J-turns provide significant reduction in right-angle, "far" side crashes.

Why isn't a J-turn proposed at WIS 29/County U?
A J-turn was not proposed for safety reasons. A safe U-turn location was not available within approximately a quarter-mile of the intersection. For the U-turn location to the west, the WIS 32 interchange is relatively close to the location where the U-turn would be located, and using the ramps provides a safer route for motorists compared to a U-turn. For the U-turn location to the east, a horizontal curve exists near the intersection. The County VV intersection can be used to make a U-turn. Motorists on County U can also travel west on Glendale Avenue or County VV and access WIS 29 at County VV.

Are there any J-turns in Wisconsin?
There are more than a dozen locations that have funding approved and are being designed for future projects. This J-turn will not be the first constructed in the state. One opened to traffic in 2011.

How much extra travel time is involved in driving a J-turn?
It can be expected to be less than 60 seconds.

Are large vehicles able to use a J-turn?
Yes. The J-turn at WIS 29/County VV will be designed to accommodate the turning widths of large vehicles, including large tractor-trailer combinations and school buses. A weave analysis will also be performed during the design process to ensure that the median crossovers are constructed at an appropriate distance from the side road intersection. The weave analysis will determine this distance by evaluating available gaps in traffic on WIS 29 in combination with the length required for larger vehicles to turn onto WIS 29, accelerate, and merge safely into the median lane so that they can negotiate into the median crossovers.

How long will the J-turn be effective?
It is expected that the proposed J-turn will provide a safer intersection than the existing configuration even as traffic volumes continue to increase on WIS 29. Because of this, the J-turn will continue to be "effective" until an interchange is constructed at the WIS 29/County VV intersection.

J-Turn Design

J-Turn Design

Bulb-Out to J-turns

J-Turn Design

Offset Right Turn

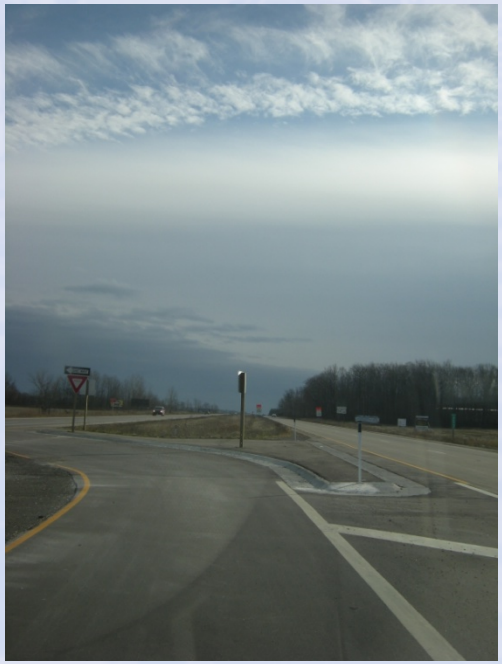
Ped/Bike Median Opening

J-Turn – Results

- Construction complete 7/12/2013
  - Too early to make a conclusions on safety improvement
  - Law enforcement is very supportive of the J-Turn
  - Only reported crash is one property damage rear end at the side-street approach

J-Turn Lessons Learned

- Left turn approach to U-turn should be adjacent to the through lane

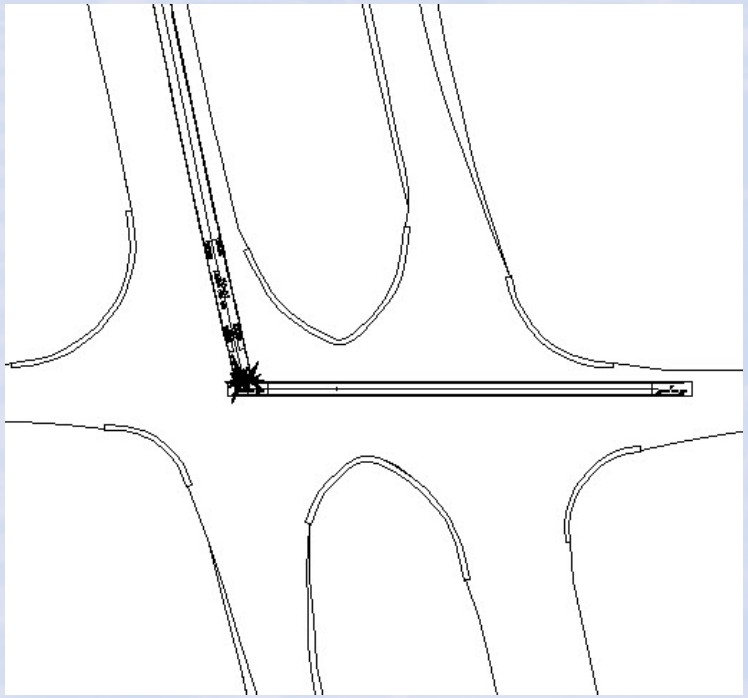


- Intersection and U-turns should be lighted

J- Turn
STH 23 & CTH M
Sheboygan County
Opened: Nov. 15, 2013

J-Turn

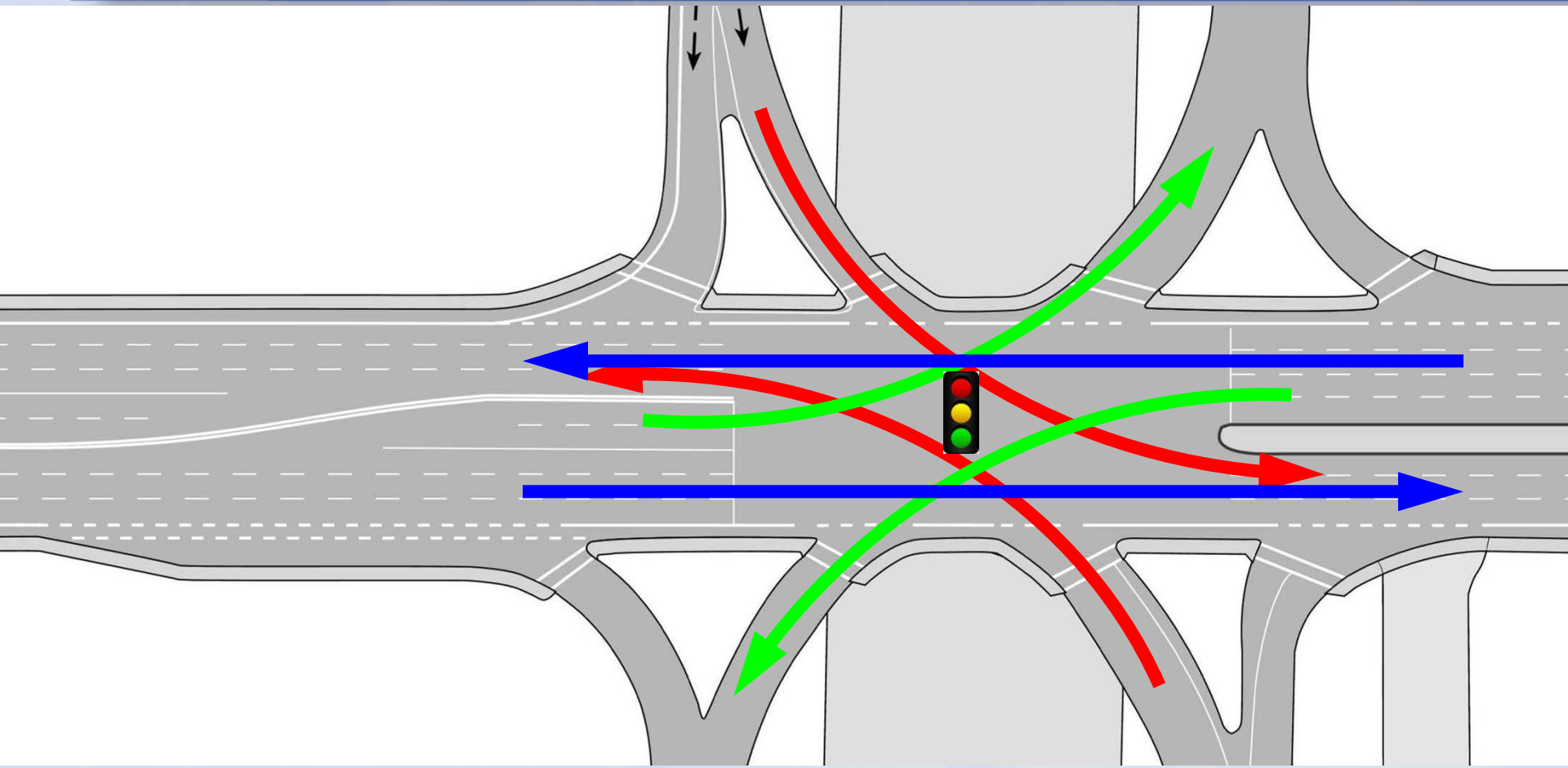
- Background Info:
  - STH 23 & CTH M, Sheboygan County
  - STH 23
    - 65 MPH rural expressway
    - AADT about 19,000
  - CTH M
    - 55 MPH rural arterial
    - AADT about 800/1300
  - 60’ Median
  - HSIP project to correct
    “Far side” right angle crashes



STH 23 & CTH M J-Turn - Site Specific Issues

- Intersection geometrics similar to STH 29 & CTH VV
- Moderate opposition to the J-turn alternative
- Quarry to north of intersection. Several small businesses to the south including some trucking
- Farm machinery utilizes the intersection
- Implemented 3 right-in/right-out, left-in intersections just to the west of this intersection at the same time this intersection was constructed

SPI – Signal Operations



3-Phase Signal Operation

1-Traffic Signal

Single Point Interchange (SPI)

Typical Application:

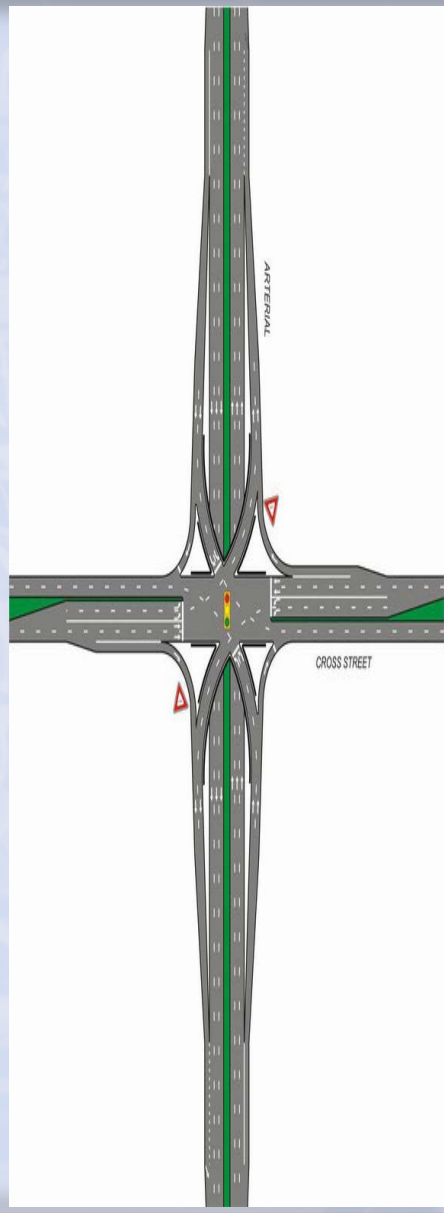
- Service interchange between a freeway and a high-volume arterial with both heavy left turns and through movements

Advantages

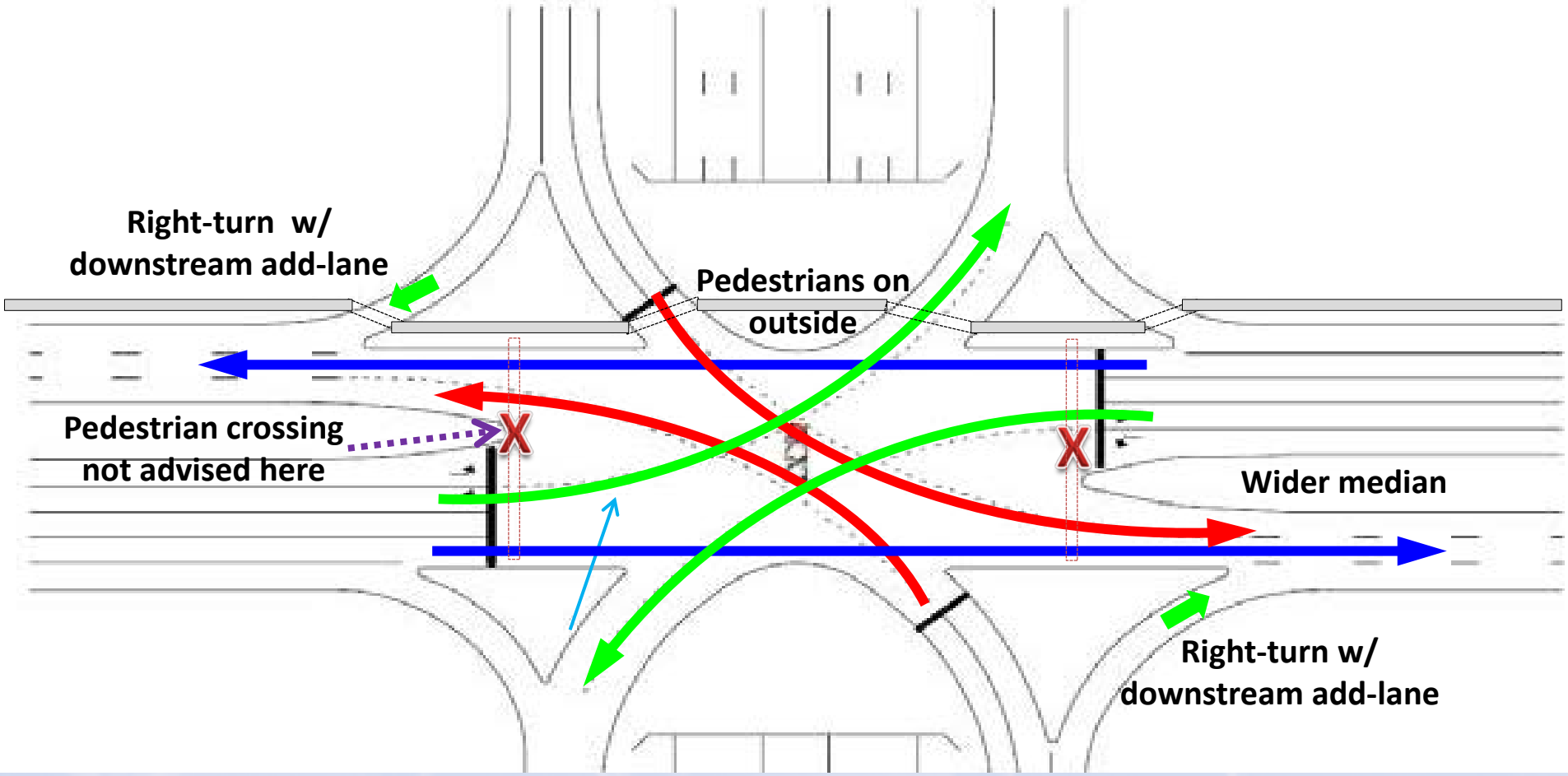
- Simplified signal phasing
- May require less R/W
- Increased capacity for all movements
- Operates well with closely spaced signalized corridor
- Safer design – 24 vehicular conflict points

Disadvantages

- Requires large structure
- Longer clearance times
- Pedestrian traffic must be low
- No ramp off/ramp on movements allowed
- Interchange layout is unfamiliar to drivers



Single Point Interchange (SPI)



- Left turn curves are desirably single radius
- If compound curve is used then smaller curve is at least 0.5 of larger curve
- SSD along curve based on speed rating of curve
- Structure skew is desirably less than 30-degrees

FHWA-HRT-09-060_alt-inters-interch_2010._fig 198,,p284

Single Point Interchange (SPI) – Design Guidance

- **AASHTO GDHS 2004** ("Green Book"), page 785
- **Missouri DOT:** 234.4 Single Point Urban Interchanges (SPUIs), http://epg.modot.org/index.php?title=234.4_Single_Point_Urban_Interchanges_%28SPUIs%29
- **FHWA-HRT-09-60**, "Alternative Intersections / Interchanges: Informational Report (AIIR), chapter 9 http://www.fhwa.dot.gov/publications/research/safety/09060/
- **WisDOT project plans**
  - Eau Claire: USH 53 & USH 12 (SPI is on top)
  - Madison: Beltline & Verona Road (SPI is underneath)

Single Point Interchange
USH 53 & USH 12
Eau Claire County

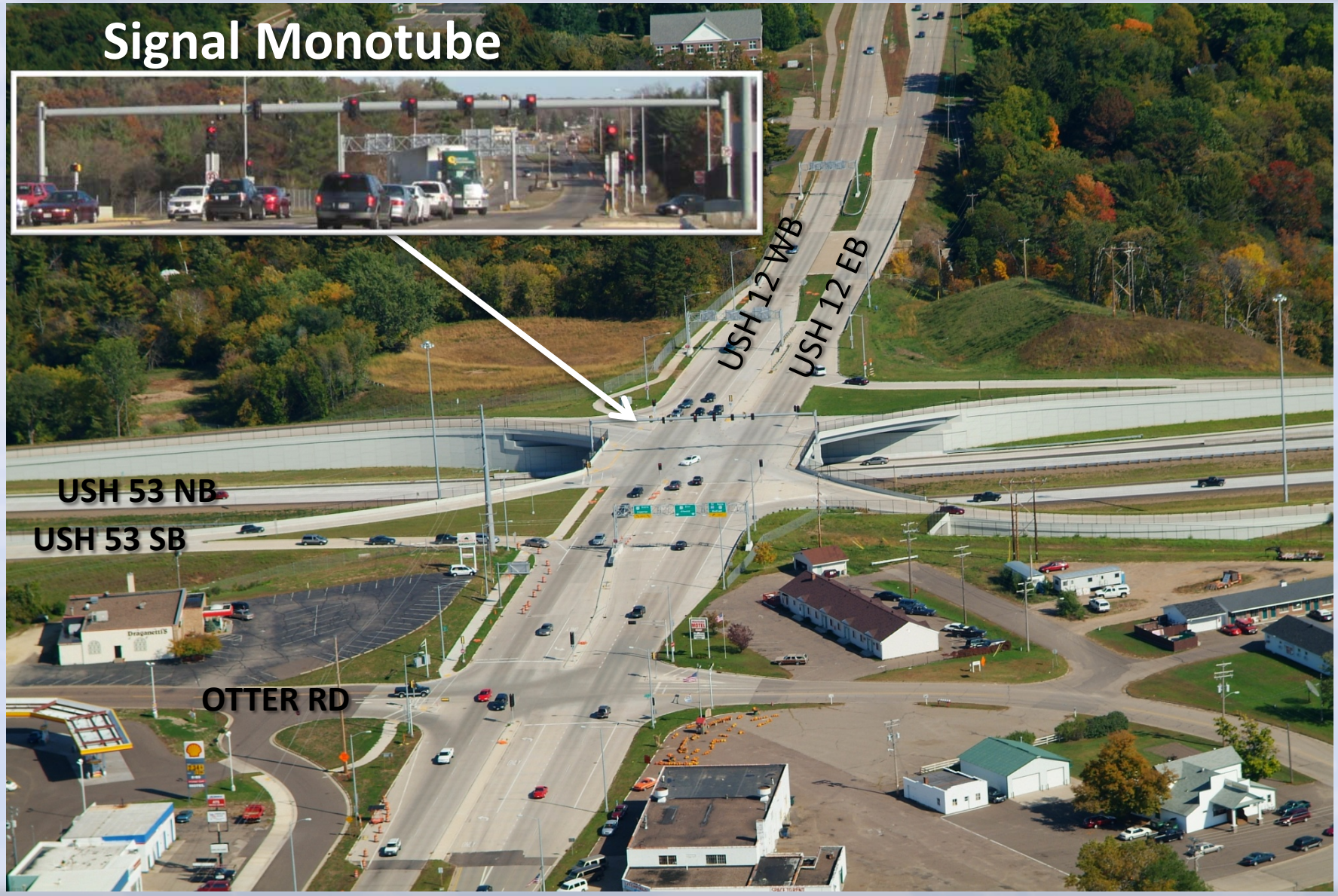
By: Greg Helgeson, Traffic Safety Engineer

Single Point Interchange (SPI)

- Background Information
  - Location
  - USH 53 by-pass project
  - SPI decision late 1990's
  - Opened August 2006
  - Interchange Cost: $11.4 million

SPI - Design

SPI - Design



SPI - Design

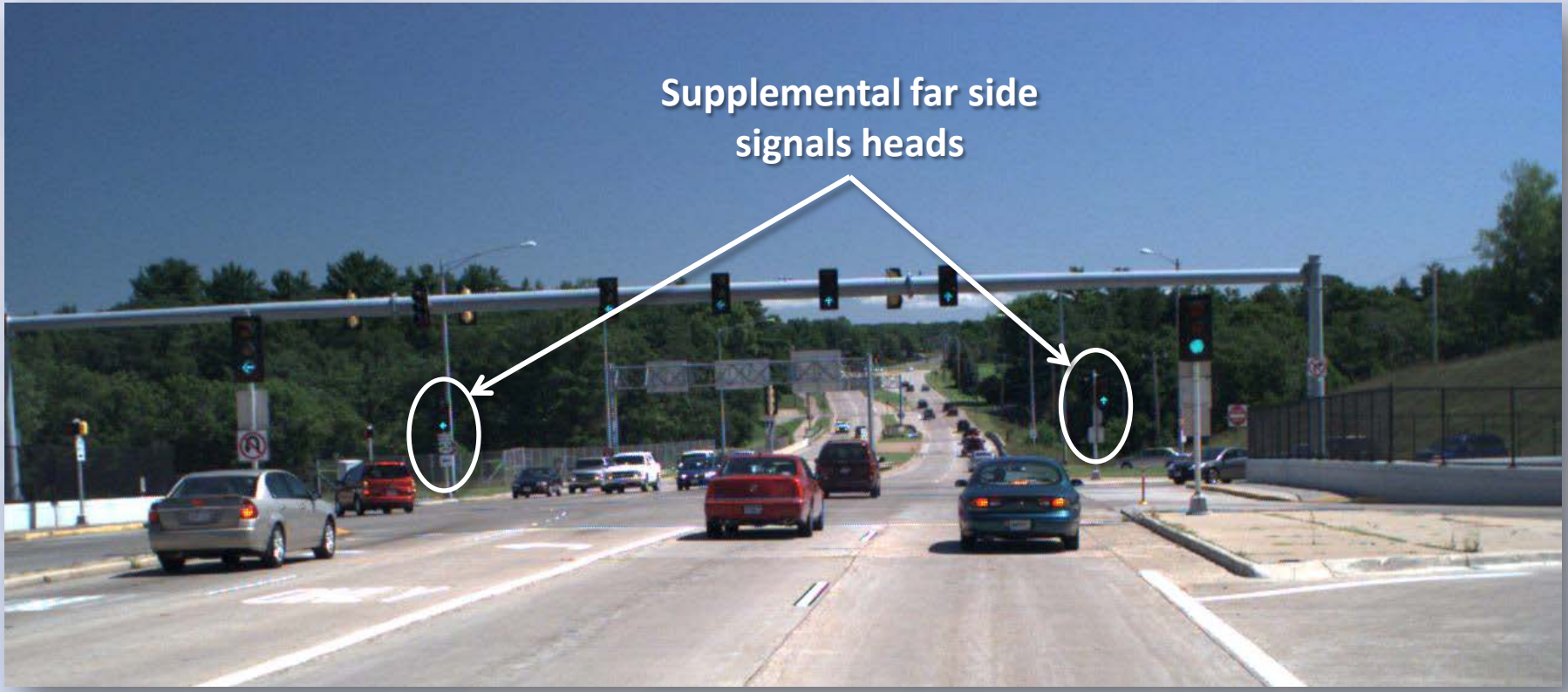
- Opposing left turns allow clear view of conflicting traffic

SPI – Design

- New Interchange
- Otter Road proximity
- Era prior to Roundabouts and Diverging Diamonds
- Ramp right turns not signalized
- Tower Lighting
- Back-up Power Generator
- MnDOT I-494 SPI used as guide

SPI – Field Review

- Field changes prior to opening:



SPI – Field Review

- Field changes prior to opening:

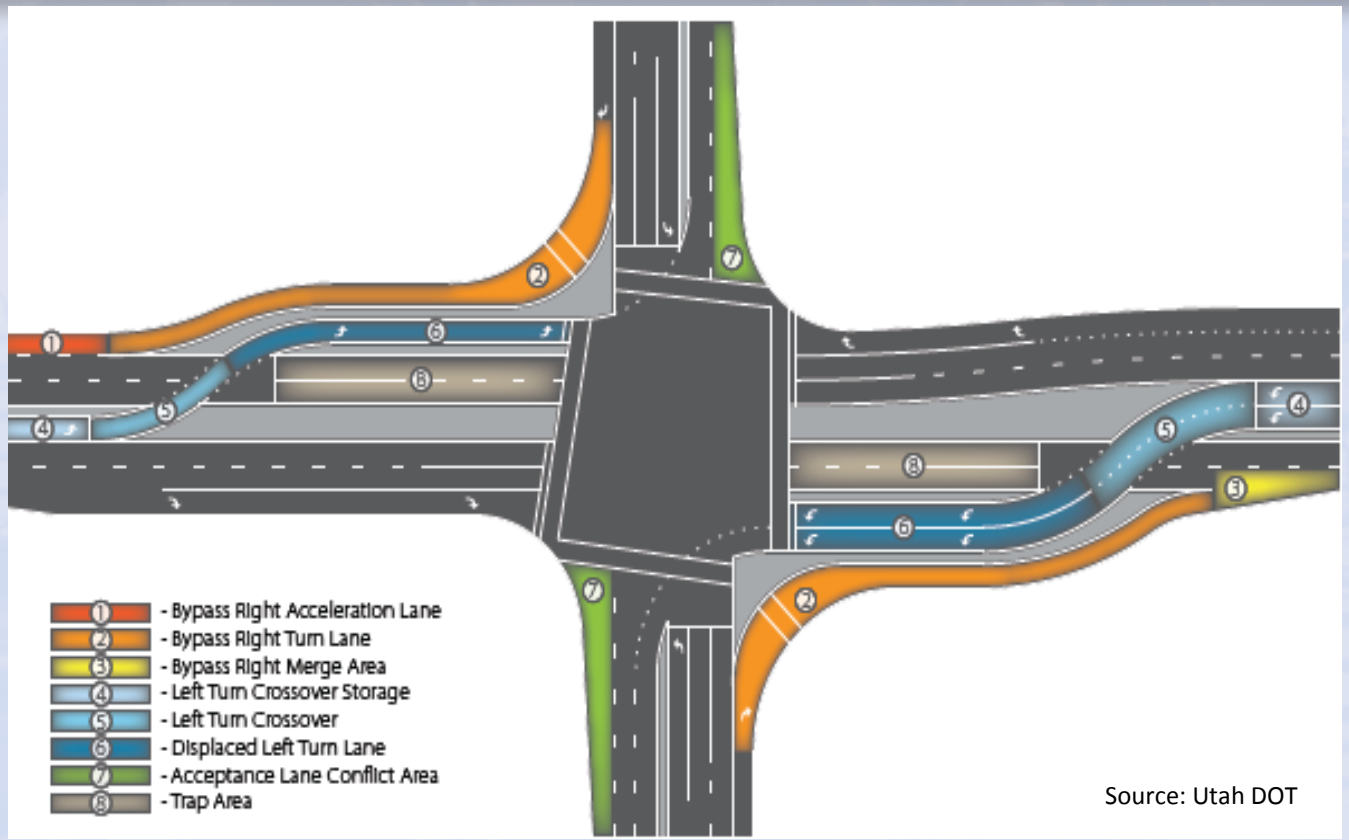
Results

- Has performed well
- No formal operation or safety complaints
- Average Crashes
  - 12 crashes per year
  - 8 rear end crashes per year
  - Low severity
- Current ADT's
  - USH 53: 34,000 VPH
  - USH 12: 20,000 VPH

SPI – Lessons Learned

- Need more spacing to adjacent signals (Otter Road)

Continuous Flow Intersection (CFI)



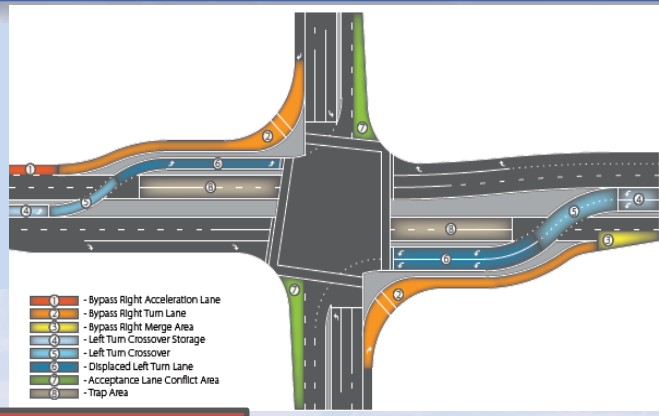
- Best suited for signalized intersections where:
  - Triple lefts are needed
  - Additional thru-lanes are needed

http://www.youtube.com/watch?v=CIUeB3-5dnA

Continuous Flow Intersection (CFI)

Typical Application:

Signalized intersections where a traditional at grade alternative is not sufficient



Advantages

- 2 or 3 Phase signal operation
- Removes left turn traffic from main intersection
- More green time for all movements
- Serves high volume facilities
- Lower cost vs. Interchange

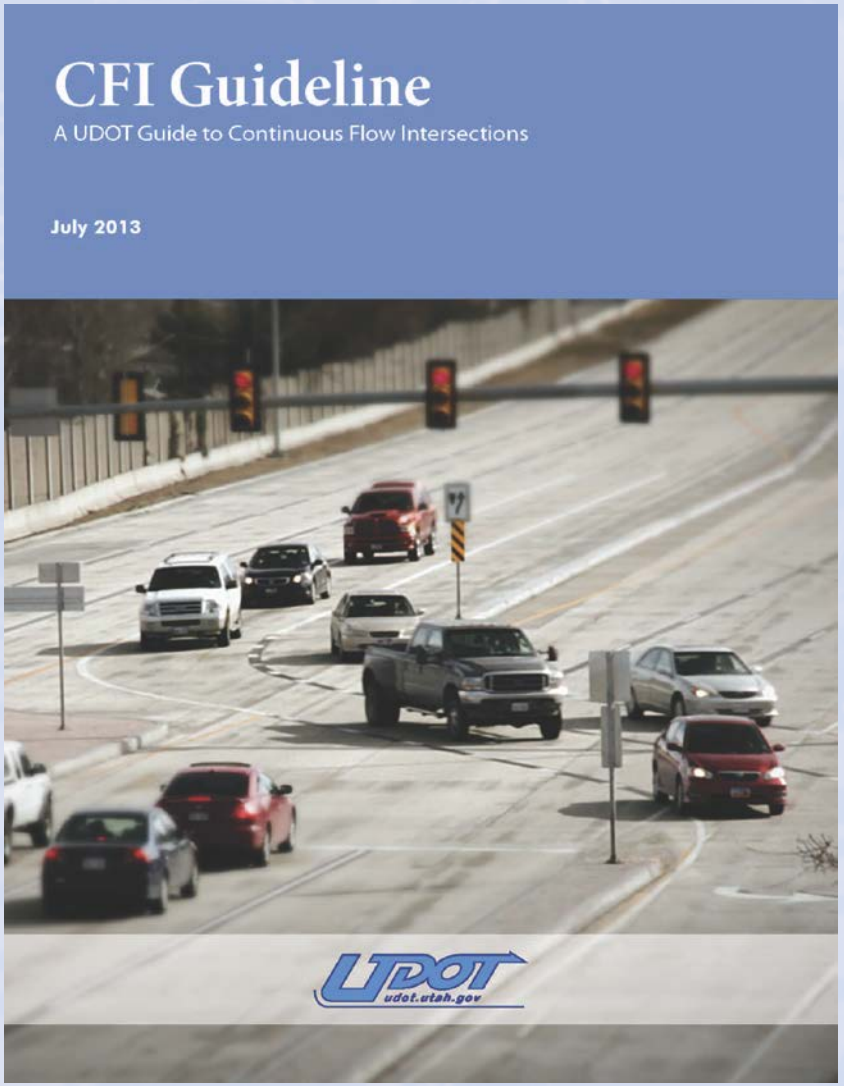
Disadvantages

- Corner business access impact
- May be a larger footprint than traditional
- Potential for wrong way movements
- Potential for right turn and left turn conflicts

UDOT CFI Guidelines

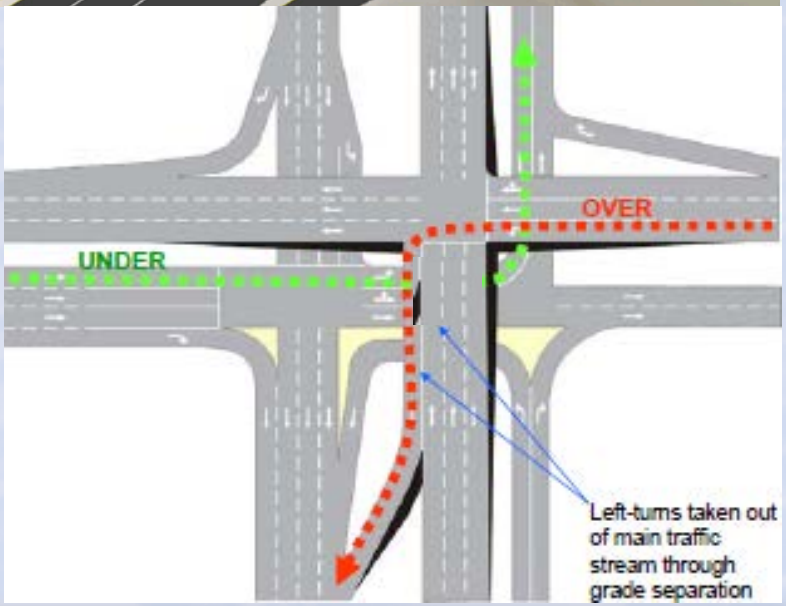
UTAH CFI LOCATIONS

No.	Intersection	City	2-Leg	4-Leg	Bypass Right Turn
1	3500 S & Bangerter Hwy	West Valley City	●		●
2	6200 S & Redwood Rd	Taylorsville	●		●
3	5400 S & Bangerter Hwy	Taylorsville	●		
4	4700 S & Bangerter Hwy	Taylorsville	●		
5	4100 S & Bangerter Hwy	West Valley City		●	
6	5400 S & Redwood Rd	Taylorsville	●		
7	3100 S & Bangerter Hwy	West Valley City	●		
8	Sandy Pkwy & University Pkwy	Orem	●		
9	6200 S & Bangerter Hwy	West Jordan	●		
10	7000 S & Bangerter Hwy	West Jordan	●		
11	13400 S & Bangerter Hwy	Riverton	●		●



Echelon Interchange

- Operation
  - Two independent two-phase signals
    - Preserves progression capabilities on both arterials
  - Unopposed left turns
  - Two left merges



Echelon Interchange

Typical Application:

- Signalized intersections where an at grade alternative is not sufficient

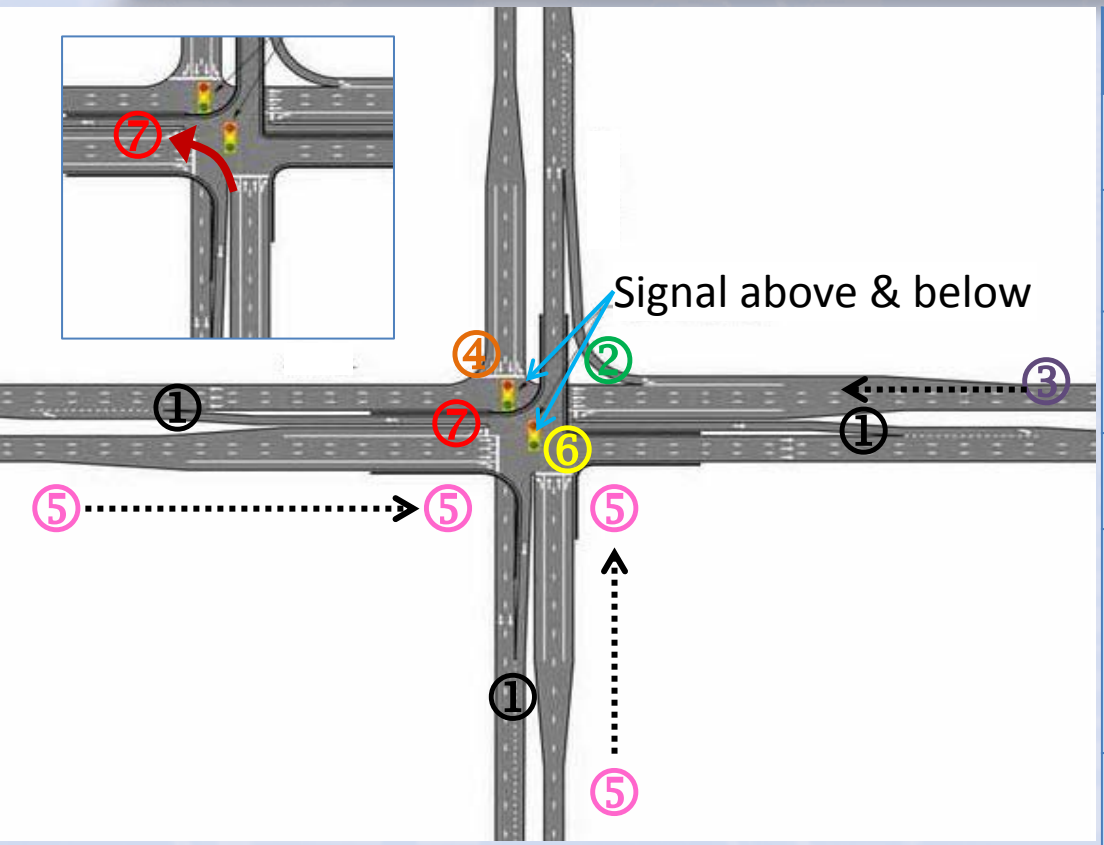
Advantages

- 2 Phase signal operation
- Unopposed left turns
- More green time for all movements
- Serves high volume arterials

Disadvantages

- High structure cost
- Corner business access impact
- No u-turns at or near interchange
- Additional structure maintenance
- Pedestrians must climb grades or cross streets unprotected by signals
- Two left side entrance merge lanes

Echelon Interchange – Geometric Considerations



Structure Issues
Lateral & Vertical Clearances
Pier placement
Barriers and transitions
Retaining wall crash worthiness

Geometric Issues	
①	Left-hand entrances
②	Free-flow right turn - Potential ped conflict
③	Approach Sight Distance to intersection beyond structure
④	ISD to left - thru structure
⑤	Vertical alignment on structure: •Approach grades •Vertical curve and sight distance to and thru intersection
⑥	Intersection geometry – vehicle turning radii
⑦	Wrong-way entry potential

Other

Accommodating other intersection users: pedestrians, bicyclists, transit

Echelon Interchange - Region Experience

Madison Beltline & USH 51 / Broadway (proposed)

Turbine Interchange

I-85/I-485 Interchange in North Carolina

NCDOT, http://www.ncdot.gov/projects/charlotteouterloop/

Turbine Interchange

Typical Application:

A system interchange between two freeways or between a freeway and a high-volume arterial. A turbine interchange is an alternative to a multi-level directional interchange

Advantages

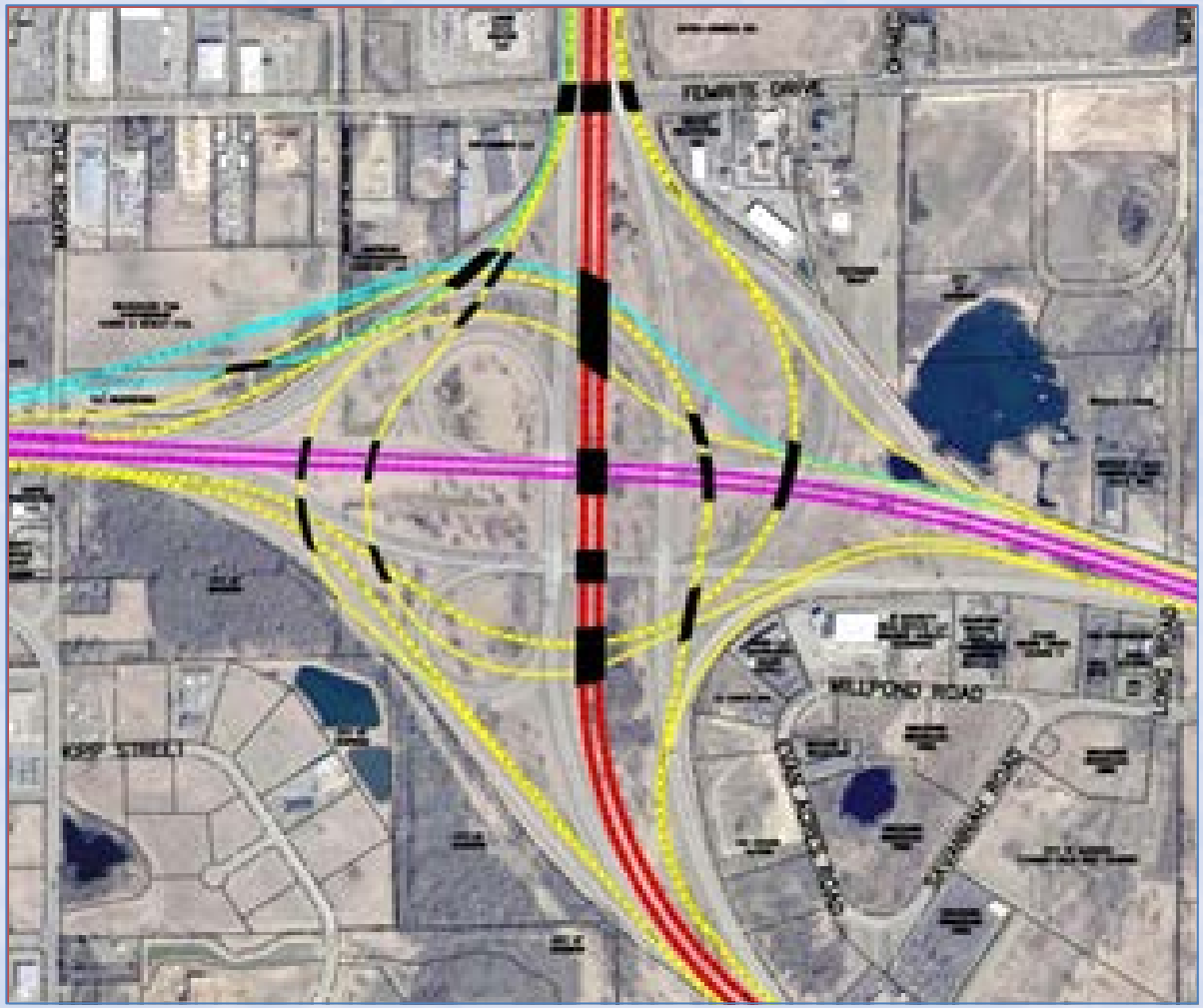
- All movements are free-flow
- Weaving eliminated within interchange
- Very high capacity
- Flexibility in traffic handling and construction phasing
- Compared to a multi-level directional interchange, a turbine interchange has:
  - Smaller bridges with simpler designs, which are less expensive to construct and maintain
  - Flatter ramp grades

Disadvantages

- May require more R/W than a multi-level directional interchange
- Initial public acceptance may be challenging because the interchange layout is unfamiliar
- Curved sections of ramps may have restricted sight lines in segments with roadside barrier (Similar to multi-level directional interchanges)

Turbine Interchange - Region Experience

IH 39/90 & Madison Beltline (proposed)



Grade Separated Quadrant Interchange

Typical Application:

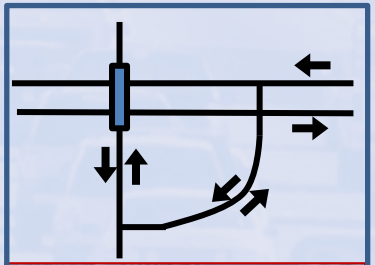
Provide an interim or long term solution at rural expressway intersections instead of a full interchange. Design is similar to at-grade quadrant intersection.

Advantages

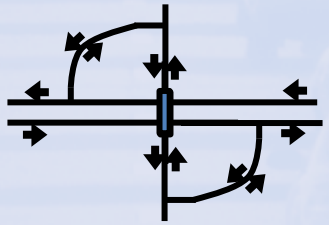
- T-intersections have fewer conflict points
- Less expensive than a full interchange
- No signals on expressway

Disadvantages

- Structure cost
- Structure maintenance



ONE-QUADRANT



TWO-QUADRANT

Hochstein, Joshua L. Potential Rural Expressway Intersection Safety Treatments (Research Conducted in Coordination n with NCHRP 15- 30 , "Median Intersection Design for Rural High- Speed Divided Highways"). (PowerPoint at HEEP Area III / IV Conference). CTRE) , Iowa State University , Ames , IA, 2006 .

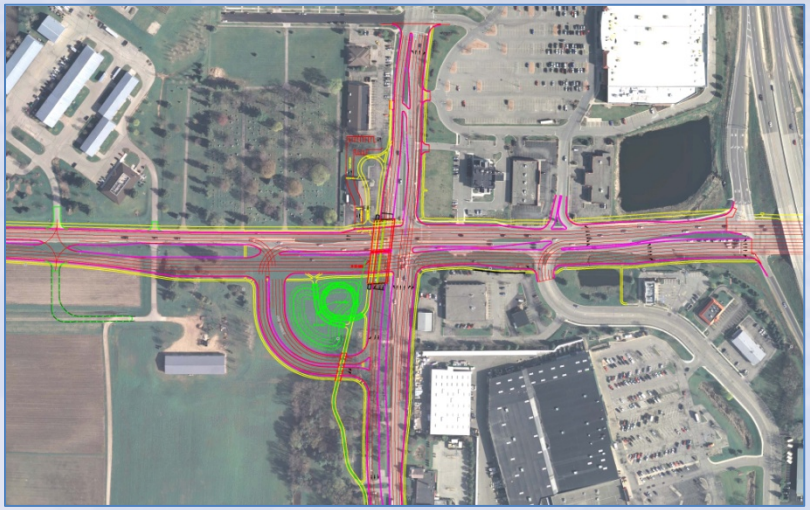
Grade Separated Quadrant Interchange

References

- **NCHRP Report 650**, “Median Intersection Design for Rural High-Speed Divided Highways”, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_650.pdf
- **FHWA-HRT-09-60**, “Alternative Intersections / Interchanges: Informational Report (AIIR), chapter 5, http://www.fhwa.dot.gov/publications/research/safety/09060/

Grade-Separated Quadrant Interchange

Wisconsin Experience



Madison: Junction Road & Mineral Point Road in (under construction)
[Grade separation on SB Junction Rd. only]

Source: http://www.cityofmadison.com/engineering/CTHM/documents/pavt.pdf

Dane County: US 12 and Hwy 73 (proposed)
[Neither road is currently expressway]

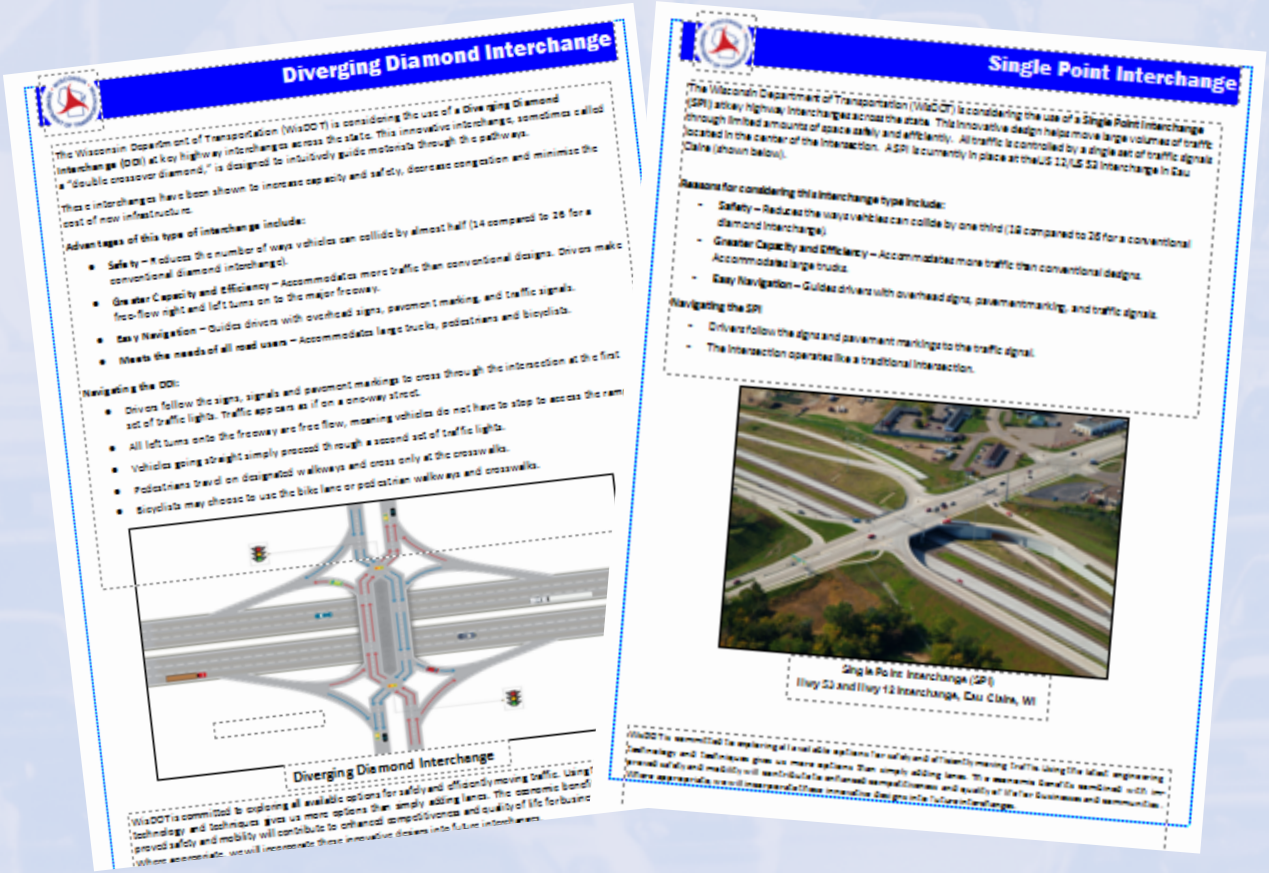
IH 39/90 North Segment - Sep 20, 2013 meeting handout – EMCS/Dane Partners

Fond du Lac:
US 151 at Hwy 175
US 151 at US 45

Google Maps

Public Outreach

Goal: Consistent, understandable messages



Diverging Diamond Interchange

The Wisconsin Department of Transportation (WisDOT) is considering the use of a Diverging Diamond Interchange (DDI) at key highway interchanges across the state. This innovative interchange, sometimes called a "double crossover diamond," is designed to intuitively guide motorists through the pathways.

These interchanges have been shown to increase capacity and safety, decrease congestion and minimize the cost of new infrastructure.

Advantages of this type of interchange include:

- **Safety** – Reduces the number of ways vehicles can collide by almost half (14 compared to 26 for a conventional diamond interchange).
- **Greater Capacity and Efficiency** – Accommodates more traffic than conventional designs. Drivers make free-flow right and left turns on to the major freeway.
- **Easy Navigation** – Guides drivers with overhead signs, pavement marking, and traffic signals.
- **Meets the needs of all road users** – Accommodates large trucks, pedestrians and bicyclists.

Navigating the DDI:

- Drivers follow the signs, signals and pavement markings to cross through the intersection at the first set of traffic lights. Traffic appears as if on a one-way street.
- All left turns onto the freeway are free flow, meaning vehicles do not have to stop to access the ramp.
- Vehicles going straight simply proceed through a second set of traffic lights.
- Pedestrians travel on designated walkways and cross only at the crosswalks.
- Bicyclists may choose to use the bike lane or pedestrian walkways and crosswalks.

Diverging Diamond Interchange

WisDOT is committed to exploring all available options for safely and efficiently moving traffic. Using technology and techniques gives us more options than simply adding lanes. The economic benefit of improved safety and mobility will contribute to enhanced competitiveness and quality of life for business

Single Point Interchange

The Wisconsin Department of Transportation (WisDOT) is considering the use of a Single Point Interchange (SPI) at key highway interchanges across the state. This innovative design helps move large volumes of traffic through limited amounts of space safely and efficiently. All traffic is controlled by a single set of traffic signals located in the center of the intersection. A SPI is currently in place at the US 12/US 53 Interchange in Eau Claire (shown below).

Reasons for considering this interchange type include:

- **Safety** – Reduces the ways vehicles can collide by one third (18 compared to 26 for a conventional diamond interchange).
- **Greater Capacity and Efficiency** – Accommodates more traffic than conventional designs. Accommodates large trucks.
- **Easy Navigation** – Guides drivers with overhead signs, pavement marking, and traffic signals.

Navigating the SPI

- Drivers follow the signs and pavement markings to the traffic signal.
- The intersection operates like a traditional intersection.

Single Point Interchange (SPI)
Hwy 53 and Hwy 12 Interchange, Eau Claire, WI

WisDOT is committed to exploring all available options for safely and efficiently moving traffic. Using technology and techniques gives us more options than simply adding lanes. The economic benefit of improved safety and mobility will contribute to enhanced competitiveness and quality of life for business

- Templates are located in the PIO Toolbox

Consistent Messaging

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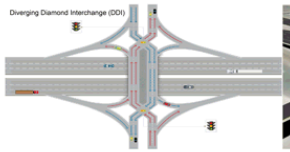
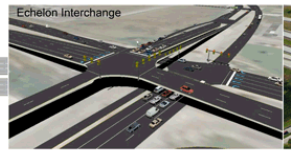
- Road design safety
- Innovative Interchange and Intersection Design
- Diverging Diamond Interchange (DDI)
- Echelon Interchange
- Single Point Interchange (SPI)
- Related info.

Innovative Interchange and Intersection Design





WisDOT is considering the use of a variety of interchange options at key highway interchanges across the state, using innovative design to help move large volumes of traffic through limited amounts of space safely and efficiently.

- Diverging Diamond Interchange (DDI) - This innovative interchange, sometimes called a "double crossover diamond," is designed to intuitively guide motorists through the pathways. These interchanges have been shown to increase capacity and safety, decrease congestion and minimize the cost of new infrastructure.
- Echelon Interchange - This innovative interchange is designed to accommodate two high-volume streets. An echelon introduces a bridge, splitting traffic into two levels, creating two separated intersections of one-way streets. Because there is no opposing traffic for left turns there is more green light time for all movements.
- Single Point Interchange (SPI) - This innovative design helps move large volumes of traffic through limited amounts of space safely and efficiently. All tra controlled by a single set of traffic signals located in the center of the intersection.

Questions about the content of this page, contact:
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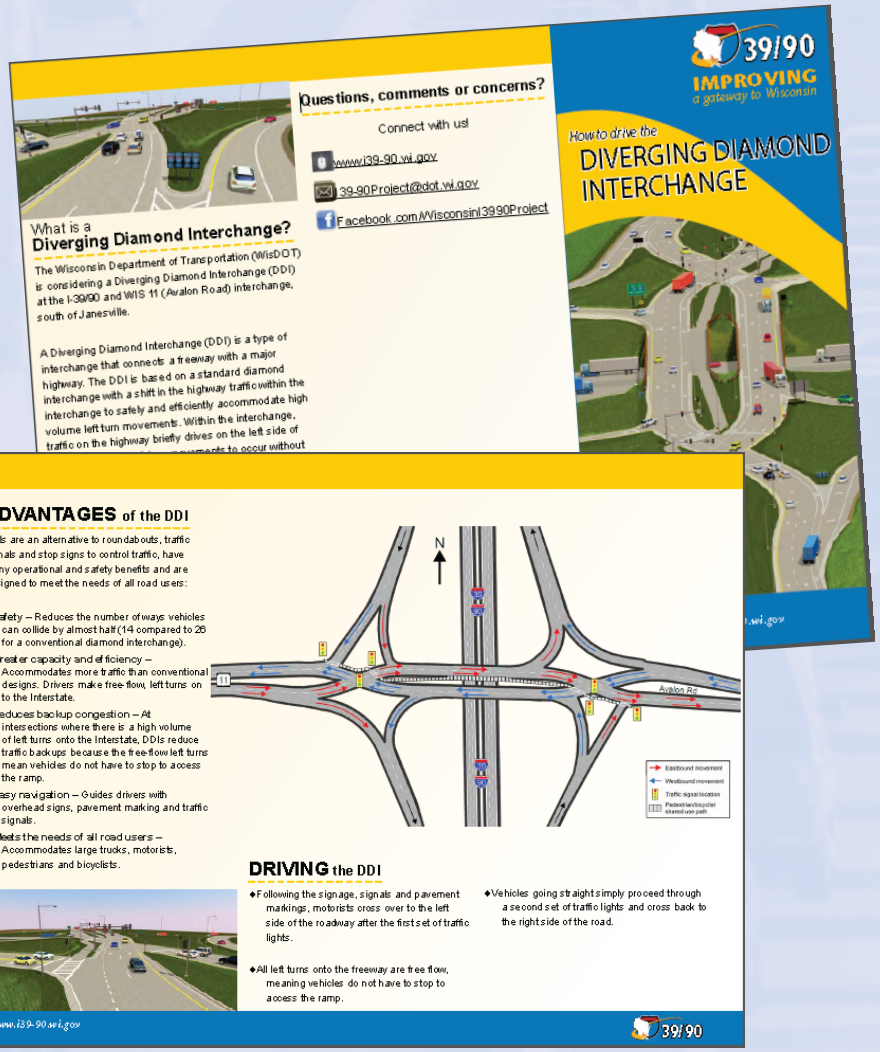
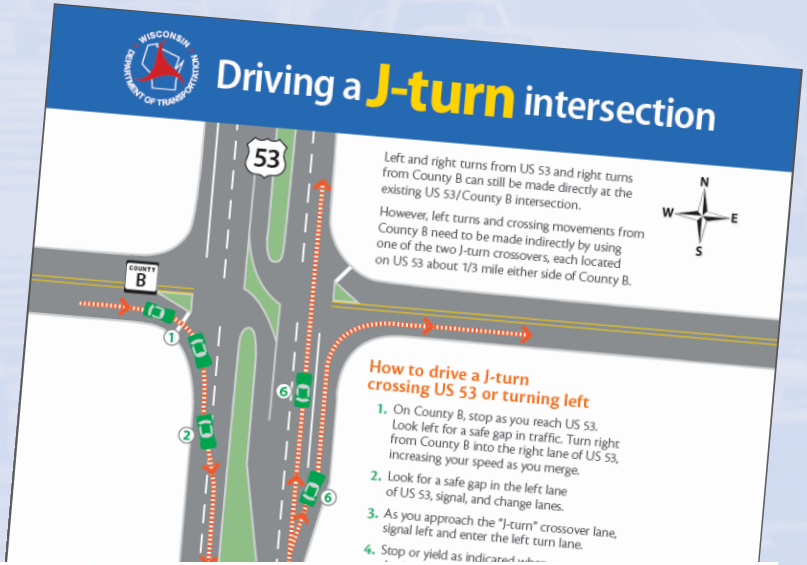
Videos

North Carolina DDI video - Good overview of a DDI interchange.

Missouri DDI video - A driver's experience traveling through a DDI.

Customizing for the Project





Video - How a J-turn intersection works

Next Steps

- Look in the FDM for current guidance, sections
- Follow the ICE process when evaluating alternatives
- Plan for analysis and design training for DDI's
- FDM guidance will be developed for some of this designs
- Contact a task force member with any question

Questions?