



Innovative Intersections

Mark Doctor – Federal Highway Administration
 Wednesday June 10, 2015 / 8am



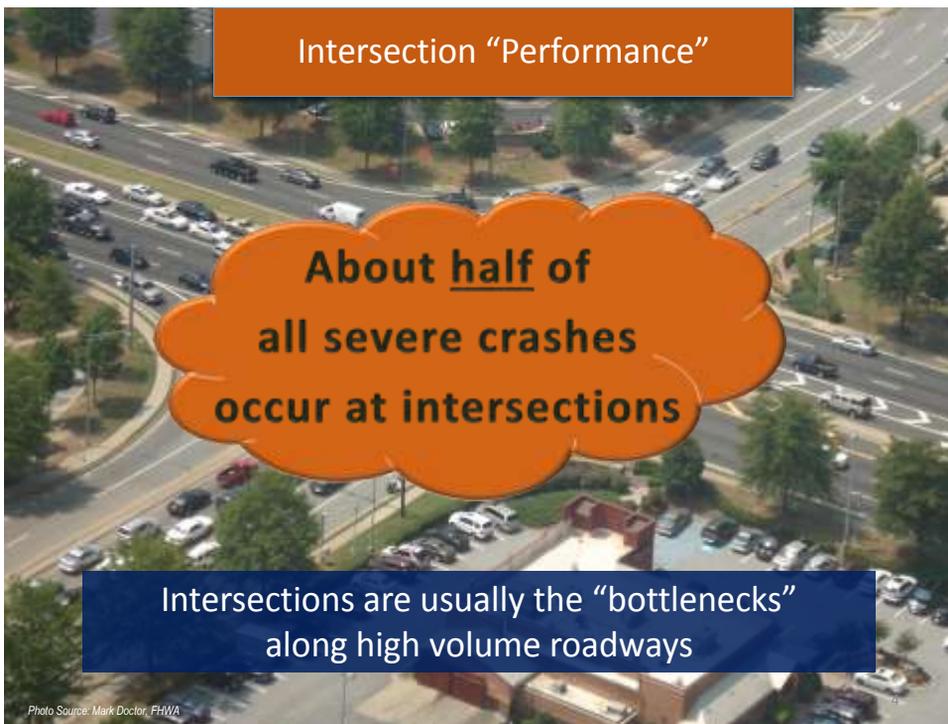
What are the challenges?

- Increasing congestion
- Too many crashes
 - Quantity and severity
- Serving all modes
 - Bicycles, Pedestrians, Transit
- Limited budgets
- Inability for more Right-of-Way
- Reducing impacts

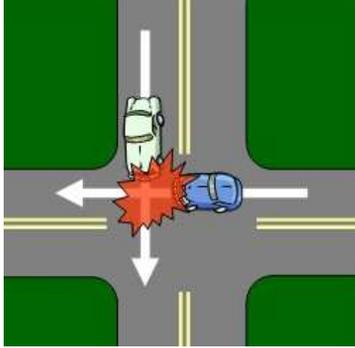


Source: Mark Doctor, FHWA

What are the challenges?



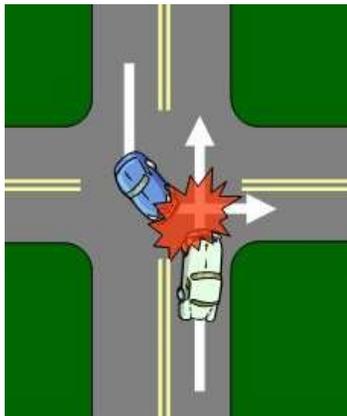
Intersection Safety Facts



Angle crashes account for over 40% of fatal crashes at intersections



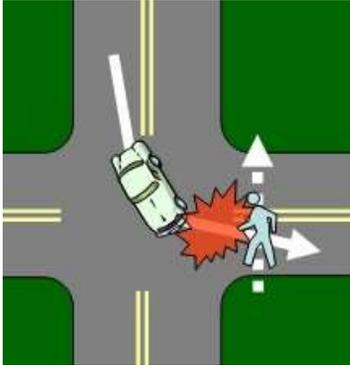
Intersection Safety Facts



Left turn crashes account for over 20% of fatal crashes at intersections



Intersection Safety Facts



**Ped & Bike crashes
account for 25% of fatal
crashes at signalized
intersections**



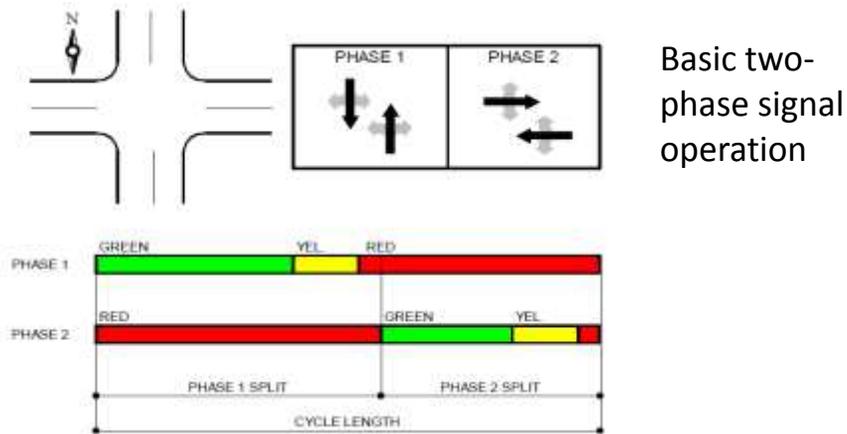
What are Innovative Intersections

Intersection configurations that:

- Improve the way traffic makes certain movements by eliminating, relocating or modifying conflict points; and/or
- Strategically improving the signalization by reducing the number of phases



Signal phasing

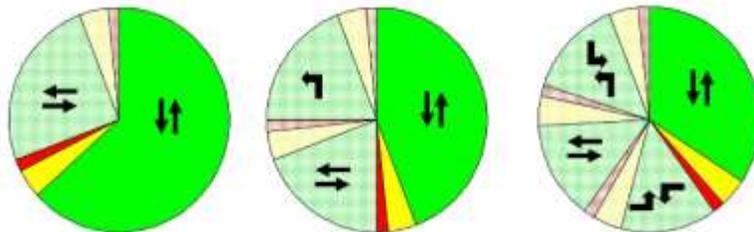


Signal phasing

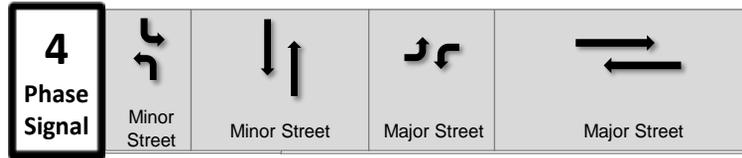
Adding more phases “steals” time away from the major through movement and can increase intersection delays



- More phases also add more “lost time”



Signal phasing



Strategically relocating left turn movements can provide more green time to through traffic



A "Universe" of Innovative Designs

Quadrant



Jughandle



Roundabouts



Median U-Turn



Green-T



Restricted Crossing U-Turn



Diverging Diamond



Displaced Left-Turn



Restricted Crossing U-Turn (RCUT)

(aka J-turn, Superstreet, Reduced Conflict Intersection)



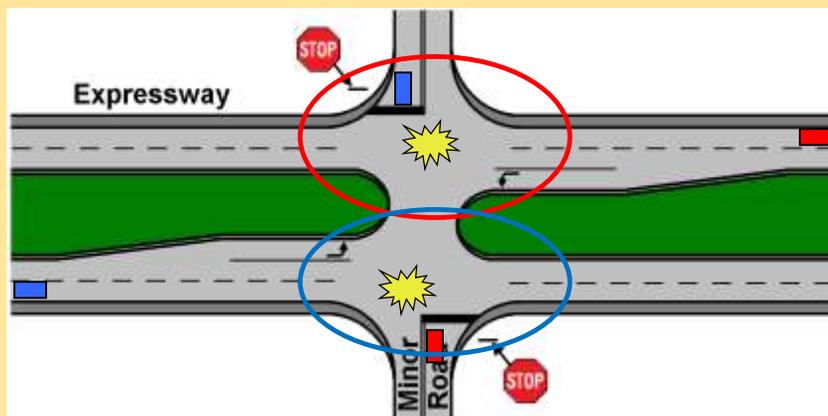
At-grade intersection with directional median such that minor road traffic must turn right and make U-turn for the left-turn or crossing movement.

Major road typically allows all maneuvers (some variations limit left-turns).

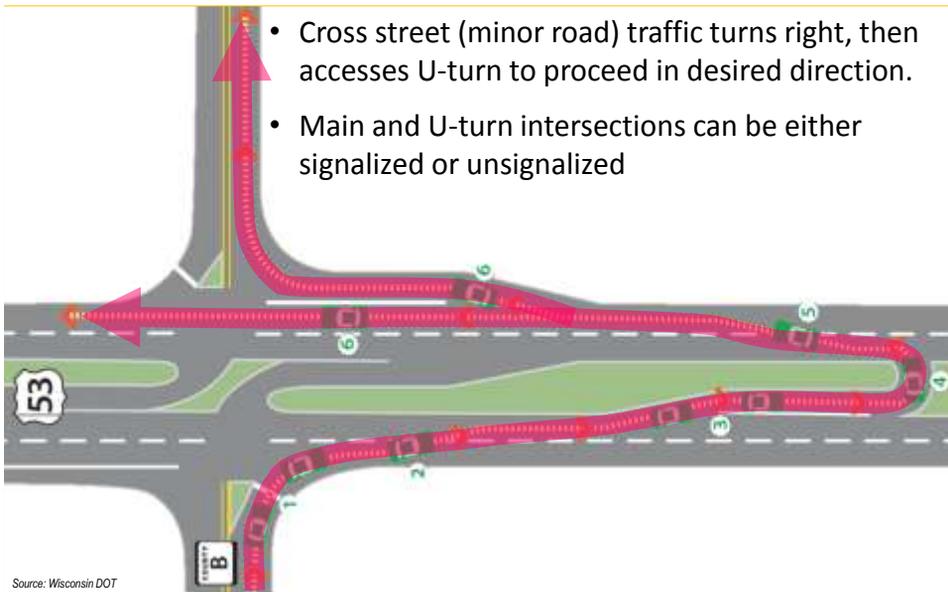


Safety Concerns at Traditional Divided Highway Intersections

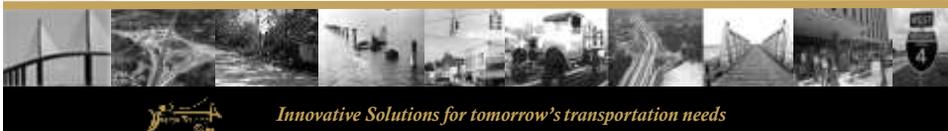
Far-Side Right-Angle Collisions



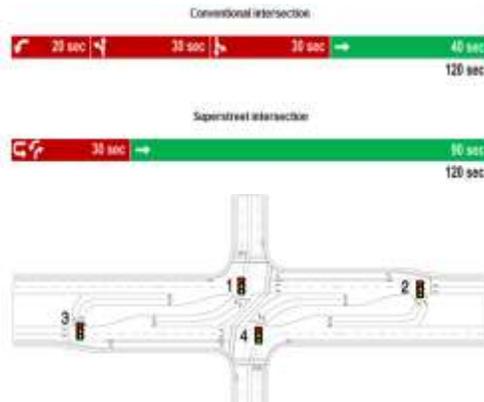
RCUTs reduce the conflicts



Signalized RCUT - “Superstreet”



RCUT signal operations



- RCUTs may operate with shorter cycle lengths than comparable conventional intersections because each signal will typically have only two phases

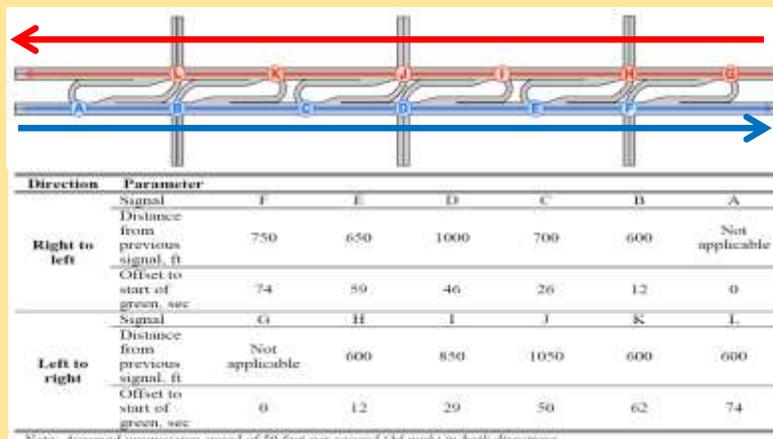
- Shorter cycles reduce delay for most vehicles and for pedestrians

- RCUTs allow different cycle lengths in each direction of the major street

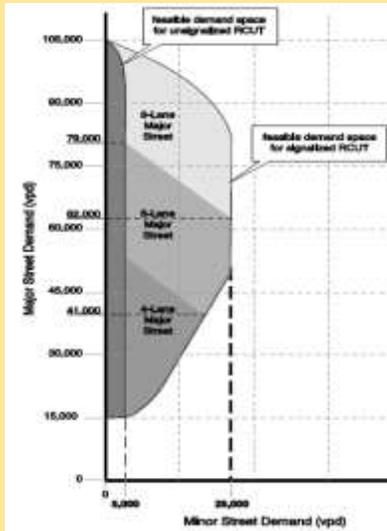


Bi-directional progression

- Each direction may operate independently
- Directions can be progressed at different speeds and/or signal spacing



RCUT feasible demands



- At minor street demands below 5,000 vpd, consider unsignalized RCUTs
- For minor street demands of more than 25,000 vpd, consider other alternative intersections that would generally serve the minor street more efficiently

Source: FHWA Restricted Crossing U-Turn Informational Guide

19

RCUT Intersection – Maryland Field Evaluations

RCUT versus conventional:

- **Crashes decrease between 28% and 44%**¹



Innovative Solutions for tomorrow's transportation needs

20

North Carolina



Fatal & injury, angle, and left-turn crashes decreased by more than half



Percent change in crashes from conventional to RCUT Intersection

Type of crash	Naïve analysis	Comparison group analysis	Naïve empirical Bayes analysis	Empirical Bayes analysis with comparison groups
Total	-34	-46	-27	-74
Fatal and injury	-58	-63	-51	-85
Angle	-86	-74	-86	-78
Left-turn	-75	-59	-76	-66
Sideswipe	15	-13	-12	-36
Rear-end	7	-1	12	-16
Other	15	-15	8	-27

Sample included 13 RCUT intersections across the state where a two-lane rural minor road (STOP control) intersects a four-lane high-speed (55 mph) major road



RCUT Intersections – Tennessee



Implemented RCUT (J-Turn) designs at 4 sites

SR6 at Canyon Rd.
Mount Pleasant, Moory County, TN

**Before: 54 crashes
(2 fatalities, 8 injuries)**

**After: 10 crashes
(0 fatalities, 0 injuries)**

SR6 at Cross Bridges Rd.
Mount Pleasant, Moory County, TN



MODOT Performance Evaluation

Analysis of 5 sites converted to J-turns

Safety Benefits:

35% total crash reduction

54% reduction in fatal & injury crashes

None of the five sites had a fatal crash following J-turn implementation

In a public survey regarding trip time perceptions resulting from the J-turn, the majority said there was no adverse effect

Evaluation of J-Turn Intersection Design Performance in Missouri



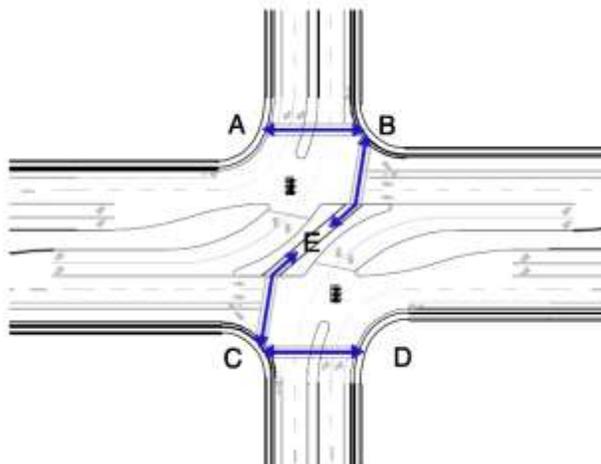
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Missouri Department of Transportation
 2014 Annual Report
 Transportation Planning and Design



RCUT Pedestrian Crosswalks

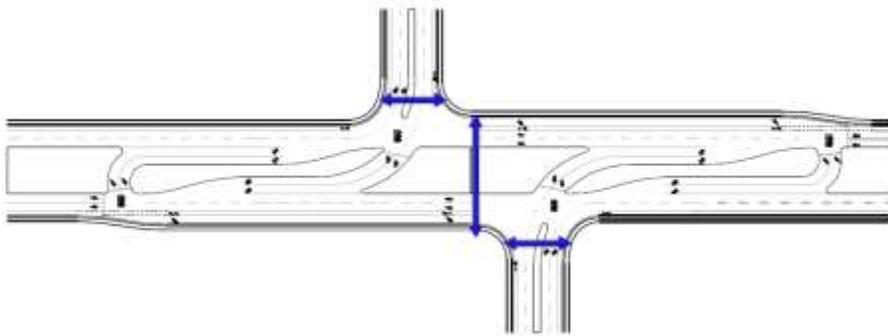
Pedestrian crosswalks and pathways in a signalized RCUT



Pedestrian “Z” Crossing



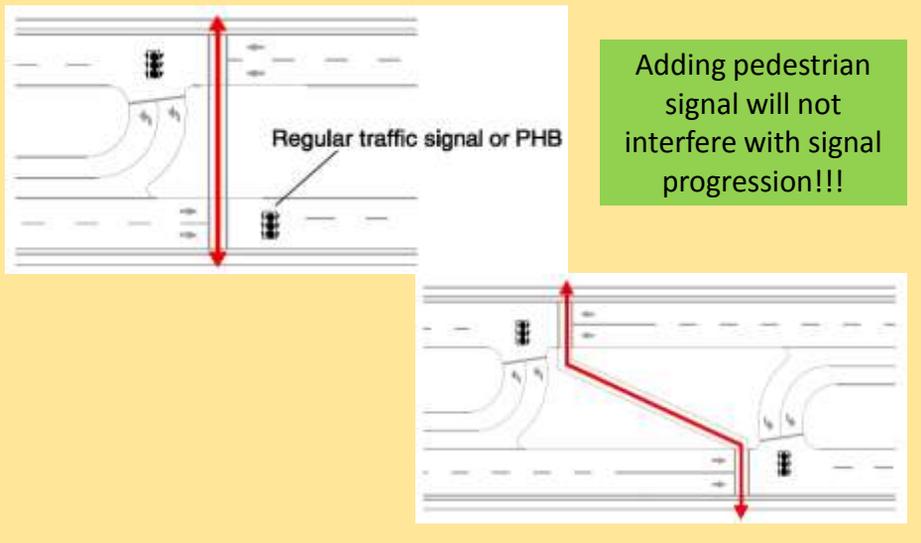
Offset approaches option



This variation should be considered in developing areas where the minor street or driveway locations have not yet been established.



Mid-block ped crossing option



MUT – Median U-Turn

(aka Michigan Left)



- At-grade intersections with *indirect* left turns using a U-turn movement in a wide median and/or loon
- Eliminates direct left turns on both intersecting streets, reducing the number of signal phases and conflict points at the main intersection



MUT – Left turn from major road



Vehicles on the major street (or the street with the median) that want to turn left are directed through the main intersection to a U-turn movement at a downstream directional crossover (usually signalized), and proceed back to the main intersection to then turn right onto the minor street.

MUT – Left turn from minor road



Vehicles on the minor street that wish to turn left at the major street are directed to turn right, make a U-turn movement at the same crossover, and then proceed through the main intersection.

MUT Signal Operations



The MUT removes left-turn phasing, which results in fewer clearance intervals in the intersection cycle and to operate well with a shorter cycle length than a comparable multi-phase cycle



Median U-Turn Corridors

MUT Corridor Performance

Based on comparative traffic operations and simulation studies, MUT intersections had the following operational advantages compared to corridors with TWLTLs and conventional intersections:

- Increase in total throughput from 20% to 40%
- Vehicles stopping were 20% to 40% lower
- Reduced travel times by 17%



MUT Safety Performance

Dataset	Rate Type	Group	Mean Crash Rates (Crashes/MVE)
Corridor	All	MUT (Reduction)	1.554 (14%)
		Conventional	1.806
	All	MUT (Reduction)	1.388 (16%)
		Conventional	1.644
Intersection Related	PDO	MUT (Reduction)	0.982 (9%)
		Conventional	1.077
	Injury	MUT (Reduction)	0.407 (30%)
		Conventional	0.58

In general, MUT intersections show safety performance improvement compared to conventional intersections for most crash types and injury severities.



OK – but ...
 What if I'm dealing with an
 existing arterial that doesn't
 have a median?



MUT Variations: ThrU Turn



- Similar to MUT in that direct left-turns are eliminated from main intersection
- Substitutes a paved bump-out or “loon” beyond the outside lane (or coinciding with a side-street tee intersection or driveway) for the wide median of a MUT



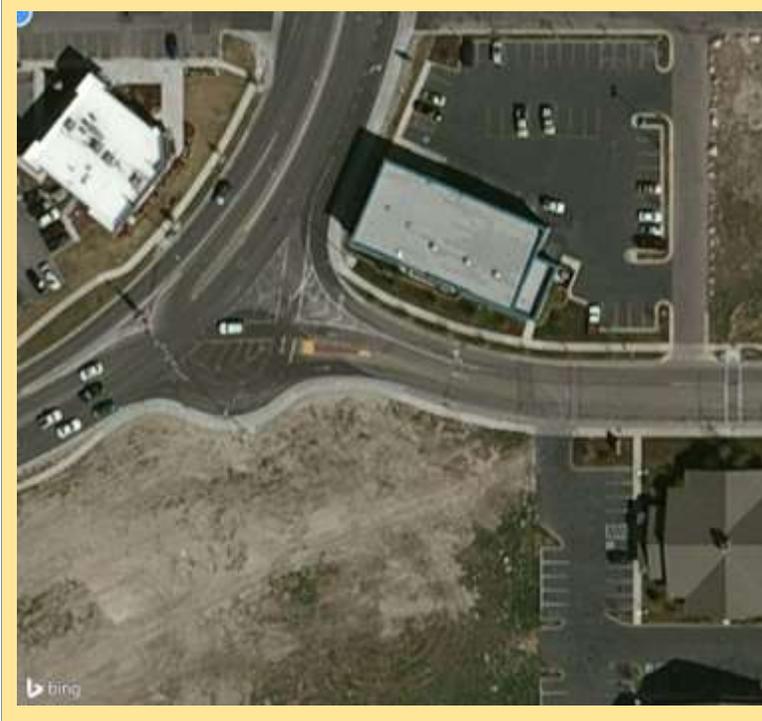
ThrU-Turn

- 12300 South/State Street in Draper, UT
- Adjacent to I-15 Freeway
- Three signalized U-turns 500-600 feet from intersection
- More Green Time for Thru Movements
- Reduce Congestion and Improve Safety



12300
South at
State St.

Draper, UT



U-turn & T intersection



Draper, UT

Advance Signing at ThrU-turn

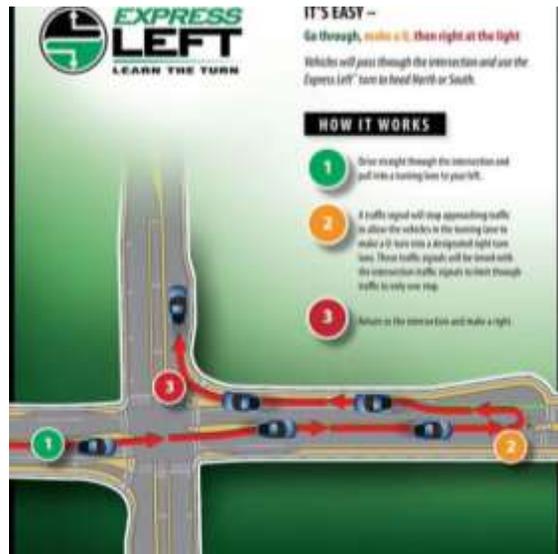


Draper, UT

Signing at U-turn

Tucson, AZ

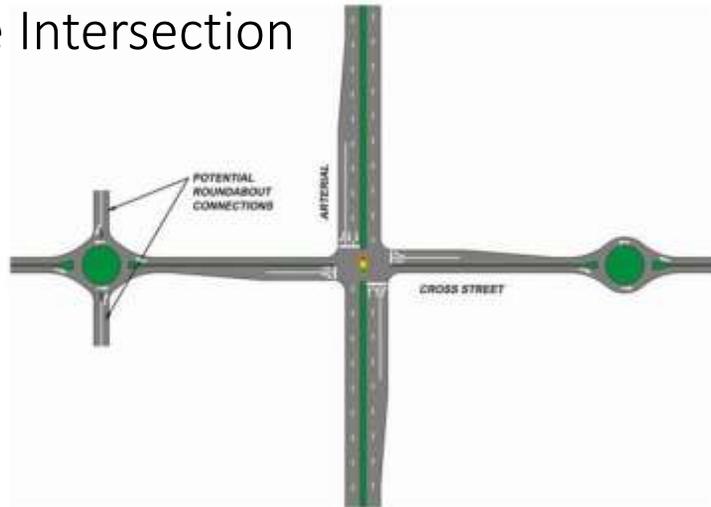
“Express Left”





Tucson, AZ

Bowtie Intersection



Quadrant Roadway Intersection (QRI)



All movements are provided

Four diagrams of a Quadrant Roadway Intersection (QRI) showing different traffic patterns. Each diagram is an aerial view with a central green island and four roadway quadrants. The diagrams illustrate various traffic movements, including through, left-turn, and right-turn movements, with arrows indicating the direction of travel. The diagrams are arranged in a 2x2 grid. The top-right diagram includes a legend titled "SR 4 Bypass Revised Traffic Patterns" and a north arrow.

QRI Adjacent to Interchange



Jughandle Intersections



Displaced Left Turn (DLT) Intersection

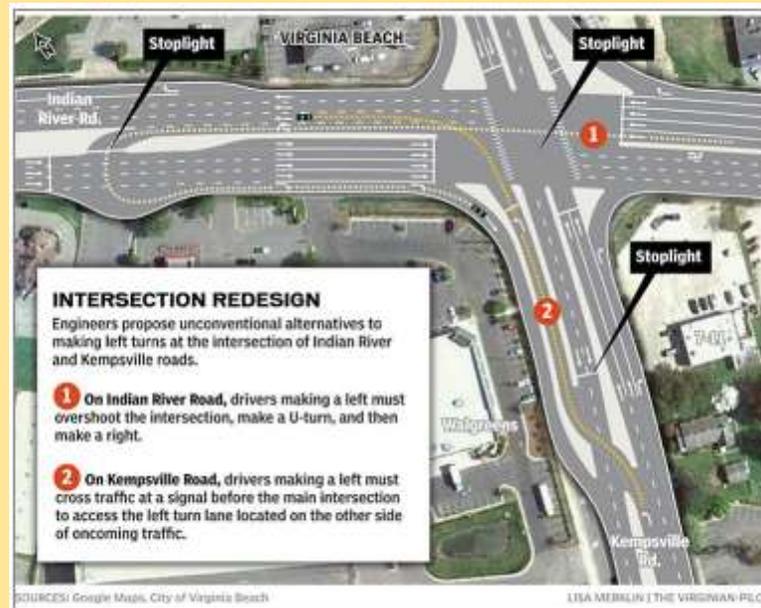
Distinguishing Feature:

Left-turn movement (on one or more approaches) strategically relocated to the far-side of the opposing roadway via interconnected signaled crossover in advance of the main intersection



50

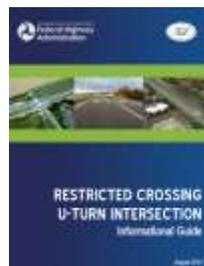
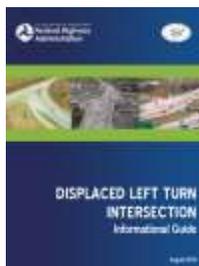
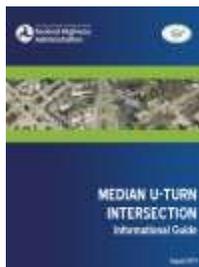
DLT & ThrU Turn Combo



Resources

For easy access ...

safety.fhwa.dot.gov/intersection/



Questions

