ROUNDABOUTS:

A Safe System Intersection Solution
and
The Key to Safer Streets for All Road Users

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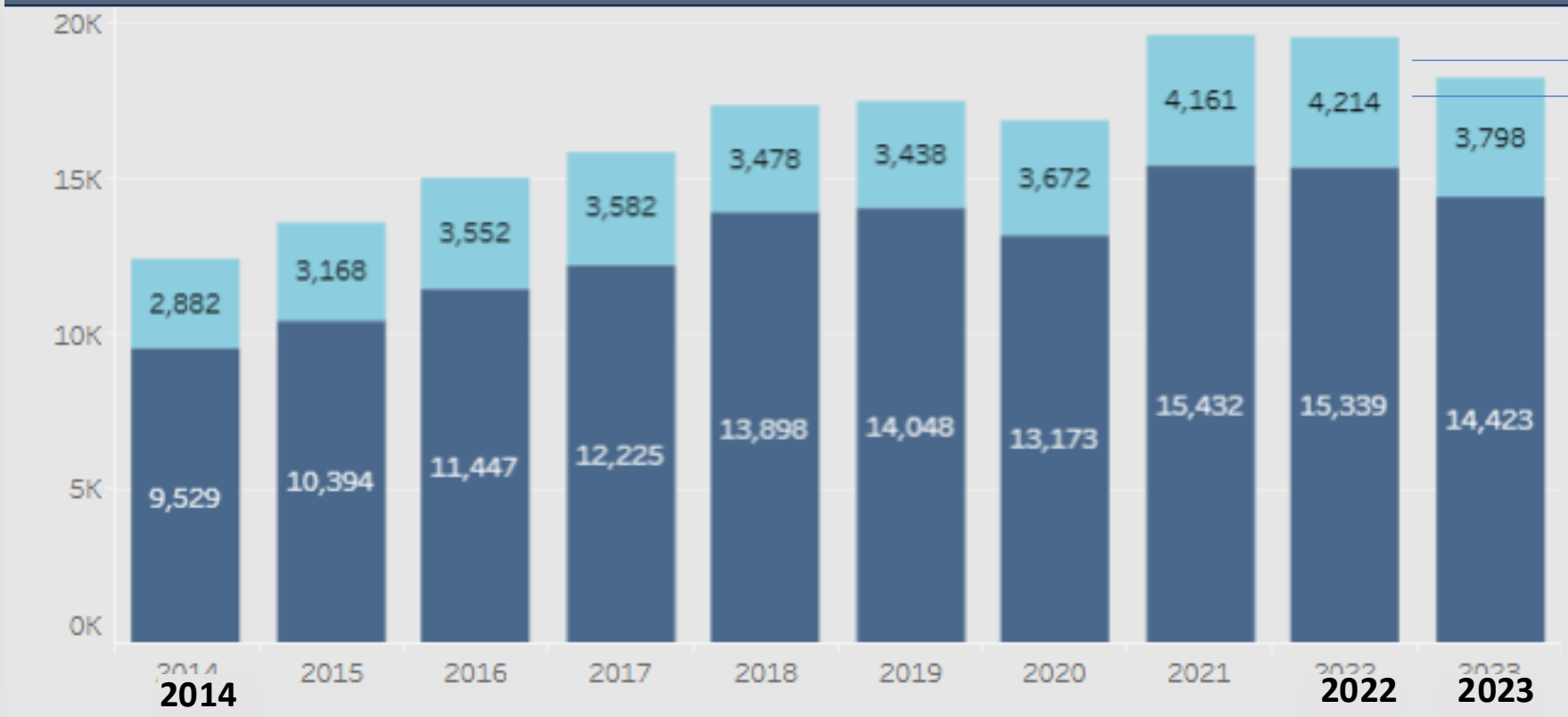
ROUNDABOUTS: A Solution for …

Strategic Highway Safety Plan Crash Data Dashboard—2014-2023 Finalized Data

FATAL AND SERIOUS INJURY VICTIMS & CRASHES OVERVIEW:
ALL CHALLENGE AREAS

from 2014 thru 2022
Fatal Crashes INCREASED 46%

Fatal Crashes DECLINED 8%
2022 vs 2023



416 = 8% drop
across all 16
Challenge Areas

But how did the number of Fatal Intersection crashes change?

FSI Crashes Involving Intersections 2018-2023

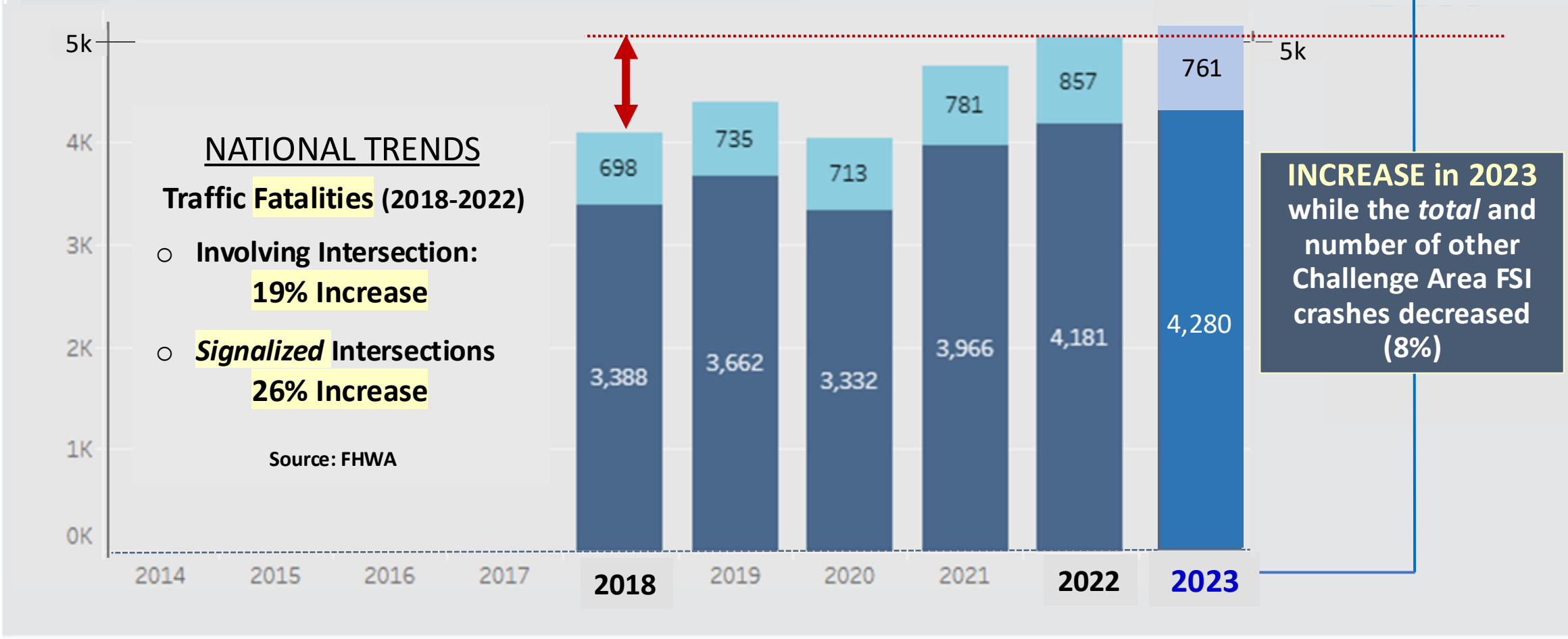
Caltrans Strategic Highway Safety Plan

INCREASE in FATAL CRASHES: 23%

Increase in Serious Injury Crashes: 23%

FATAL AND SERIOUS INJURY VICTIMS & CRASHES OVERVIEW

Intersections (SWITRS)

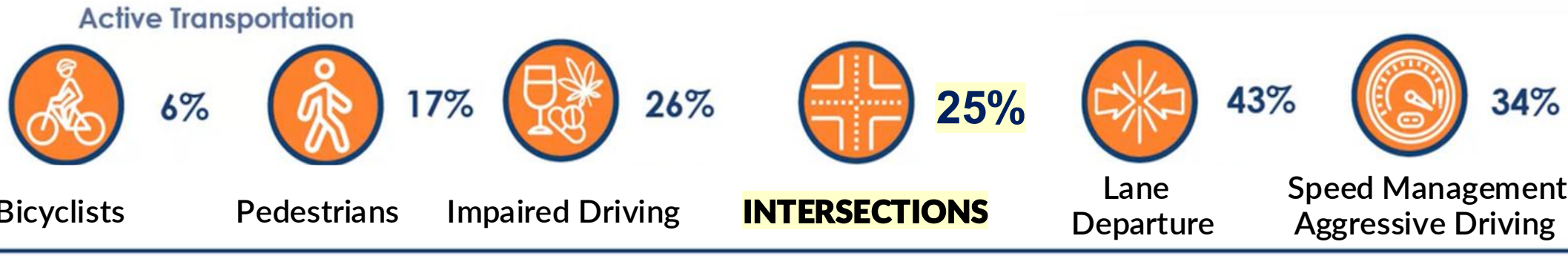


Challenge Area Teams and Statewide Share of Fatalities and Serious Injuries (FSI)

CALIFORNIA SAFE ROADS

High Priority Areas (HPAs)

Share of Statewide Fatal & Serious Injury Crashes (2014 – 2023)

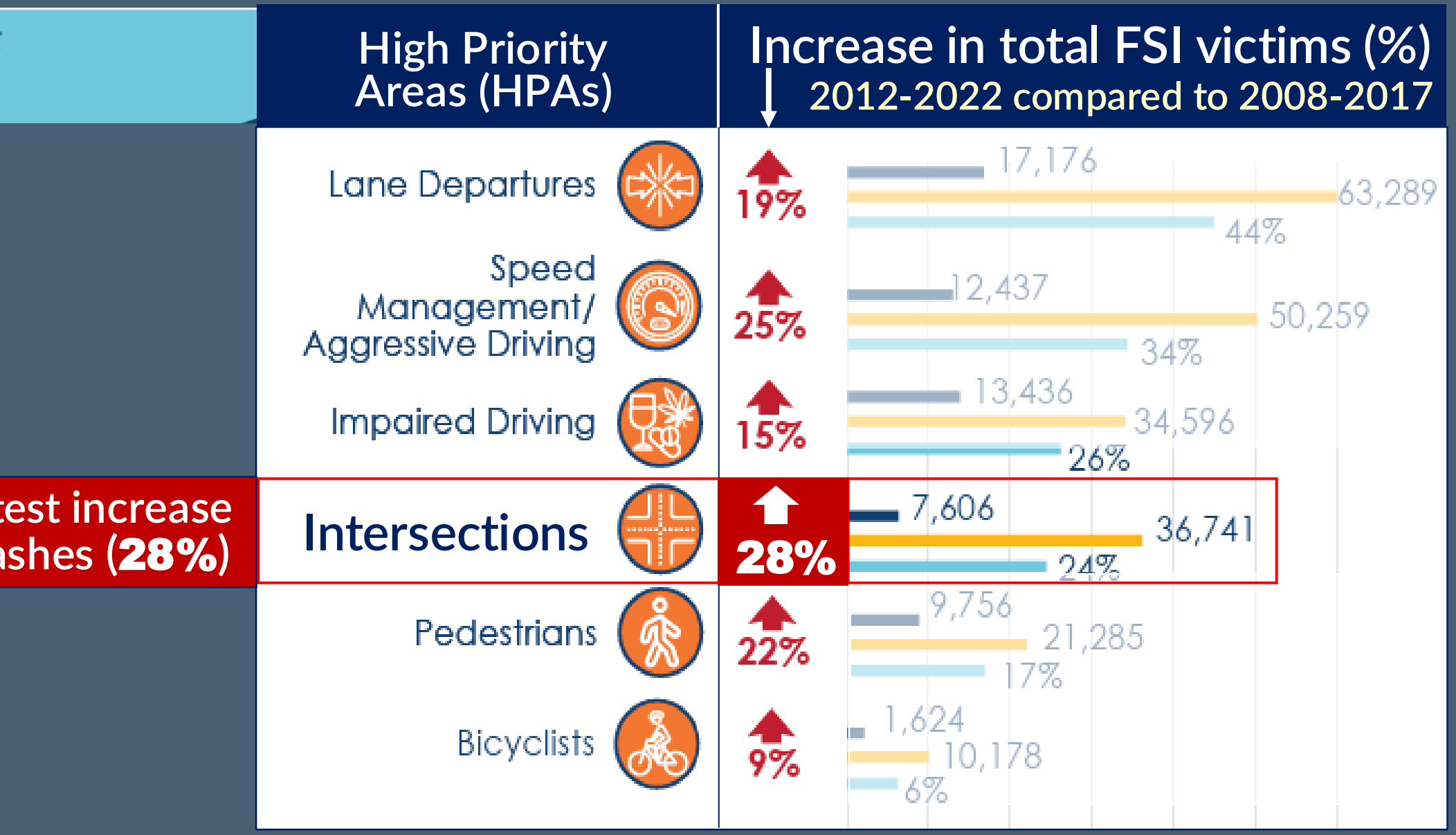


Data Source: *Statewide Integrated Traffic Records System (SWITRS) 2014–2023*
**Fatality Analysis Reporting System (FARS) 2014– 2023, which does not include serious injury data*

***Crash data not associated with these Challenge Areas*

CALIFORNIA SAFE ROADS

Statewide



The greatest increase in FSI crashes (28%)

Where and what type of crashes & conditions are we focused on ?

U.S. Department of Transportation
Federal Highway Administration

Fatal Intersection Crash Trend 2018-2022 (national)

Signalized Intersection Crashes:

Traffic signals are often chosen for operational reasons and may involve trade-offs between safety and mobility. Signalized intersections represent about one-third of ALL intersection fatalities, including a large proportion that involve red-light-running.

Fatalities involving signalized intersections have increased 26%

Year	Total Traffic Fatalities	Traffic Fatalities involving an intersection	Total Traffic Fatalities involving a *Signalized* intersection
2018	36,835	10,148	3347
2019	36,355	10,273	3,296
2020	39,007	10,720	3,577
2021	42,939	11,799	4,047
2022	42,514	12,036 → 19% INCREASE	4204 → 26% INCREASE

Note: table values include records coded as Intersections, Intersection-Related, Driveway Access, and Driveway Access Related

ROUNDABOUTS:

How are they a Safe System Intersection?

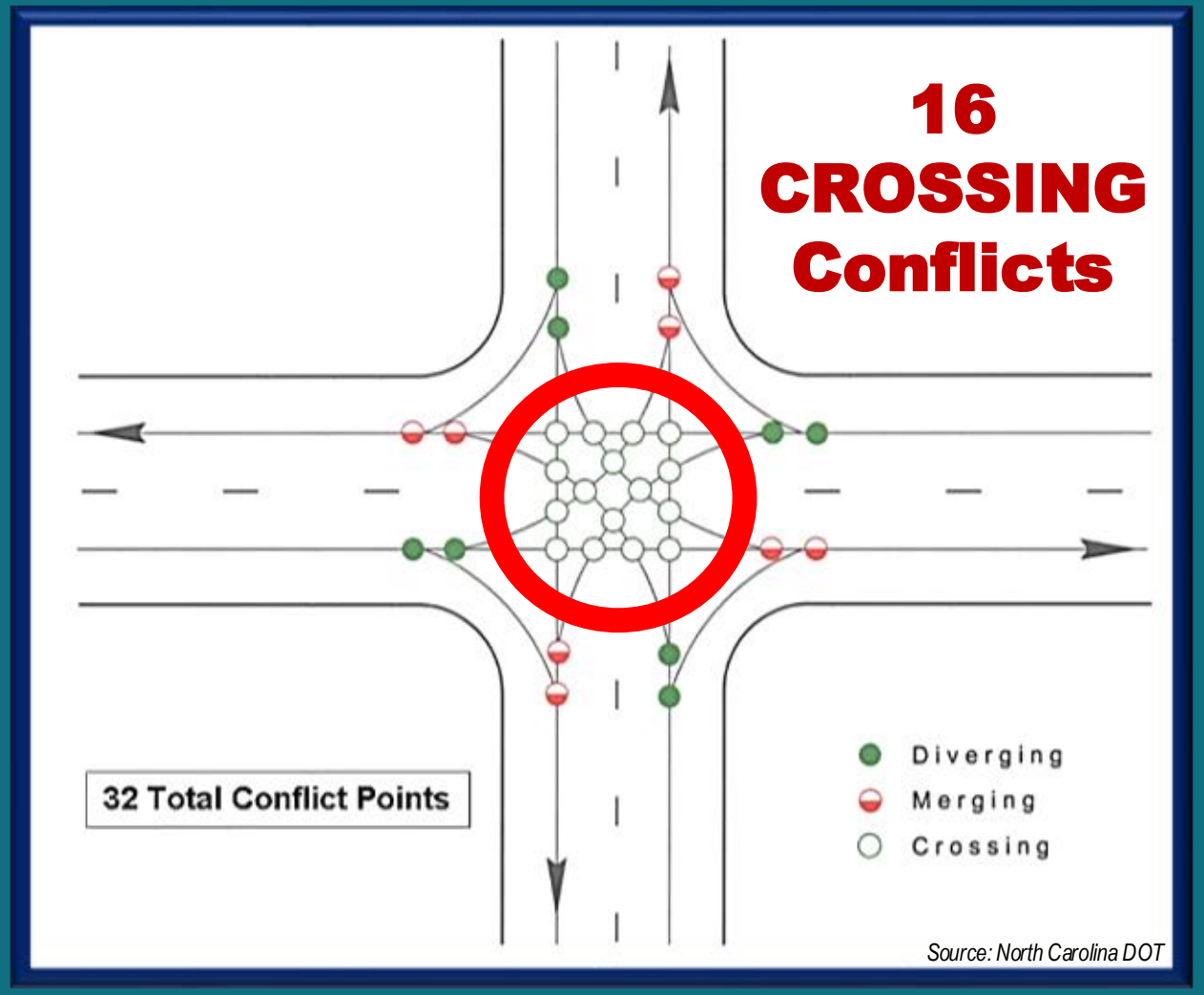
What can produce a severe intersection crash?

Three Factors

conflict points
vehicle speed
collision angle

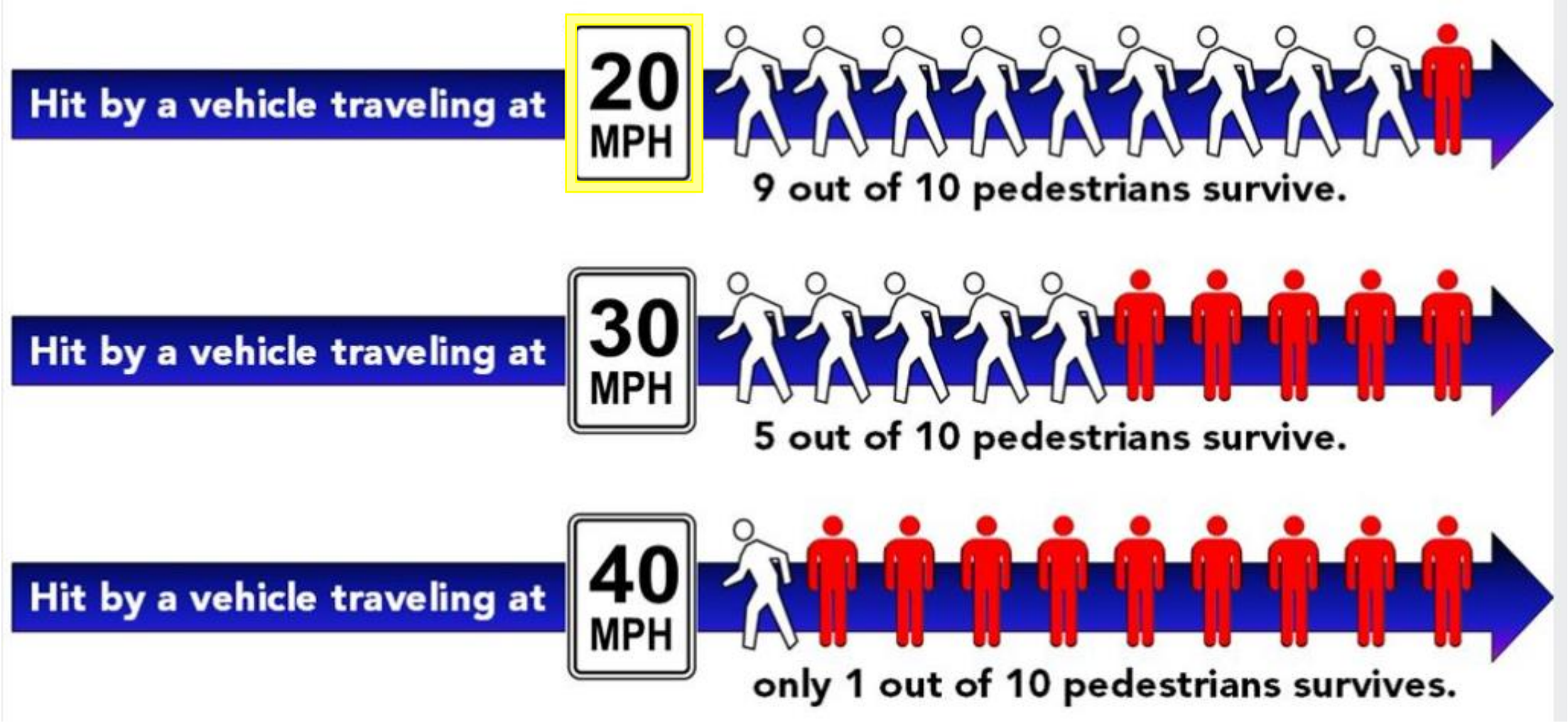
Intersection Conflicts

32 conflict points at a typical crossing-type intersection



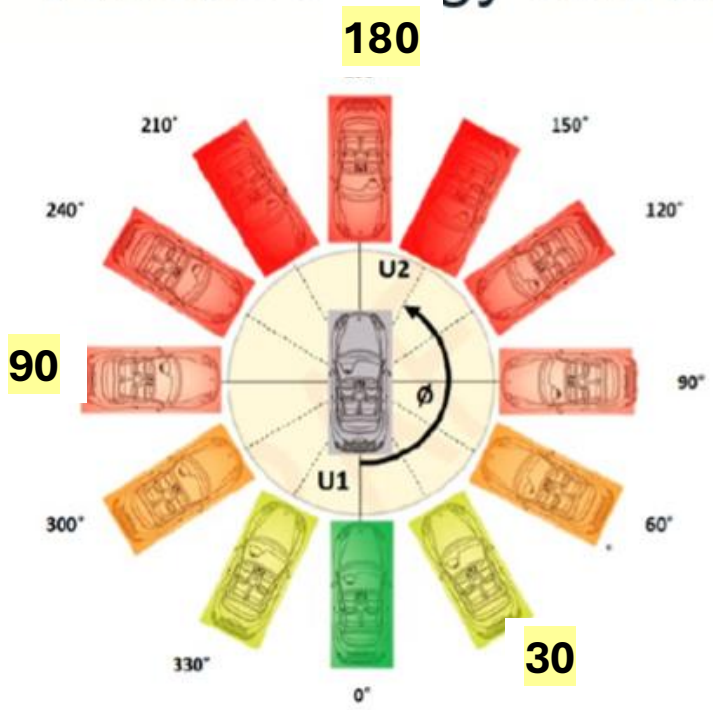
Estimated Laterally Transferred Energy During a Crash

Impact Speed and a Pedestrians Risk of Death

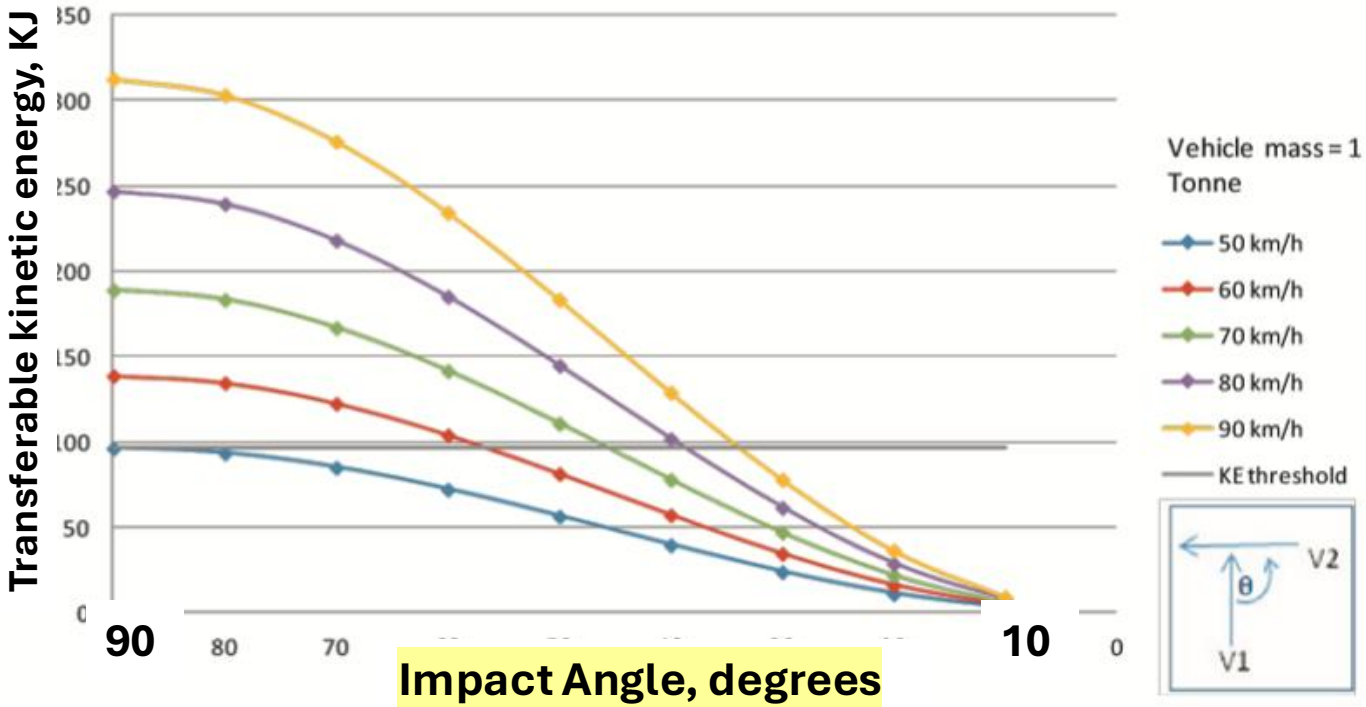


Intersection Crash Angle

- Humans have a physiological threshold for kinetic energy.
- Kinetic energy can also depend on the angle of collision.



Jurewicz et al., 2017

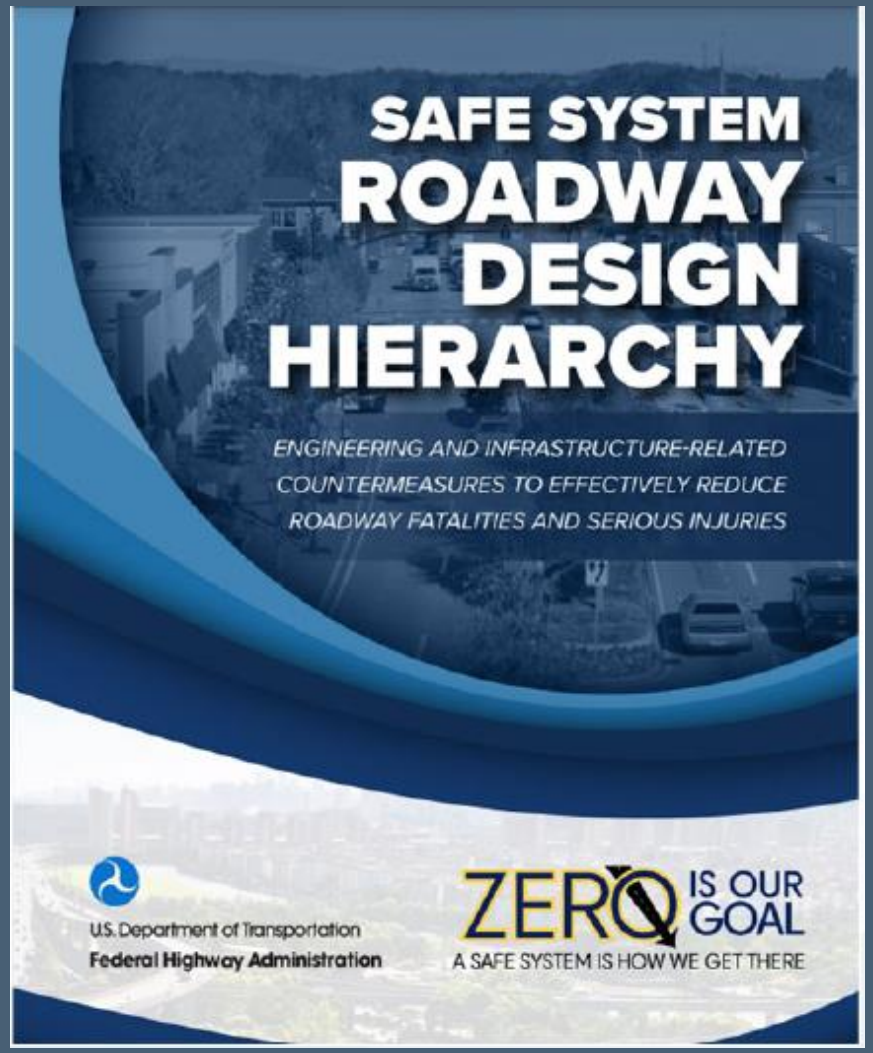


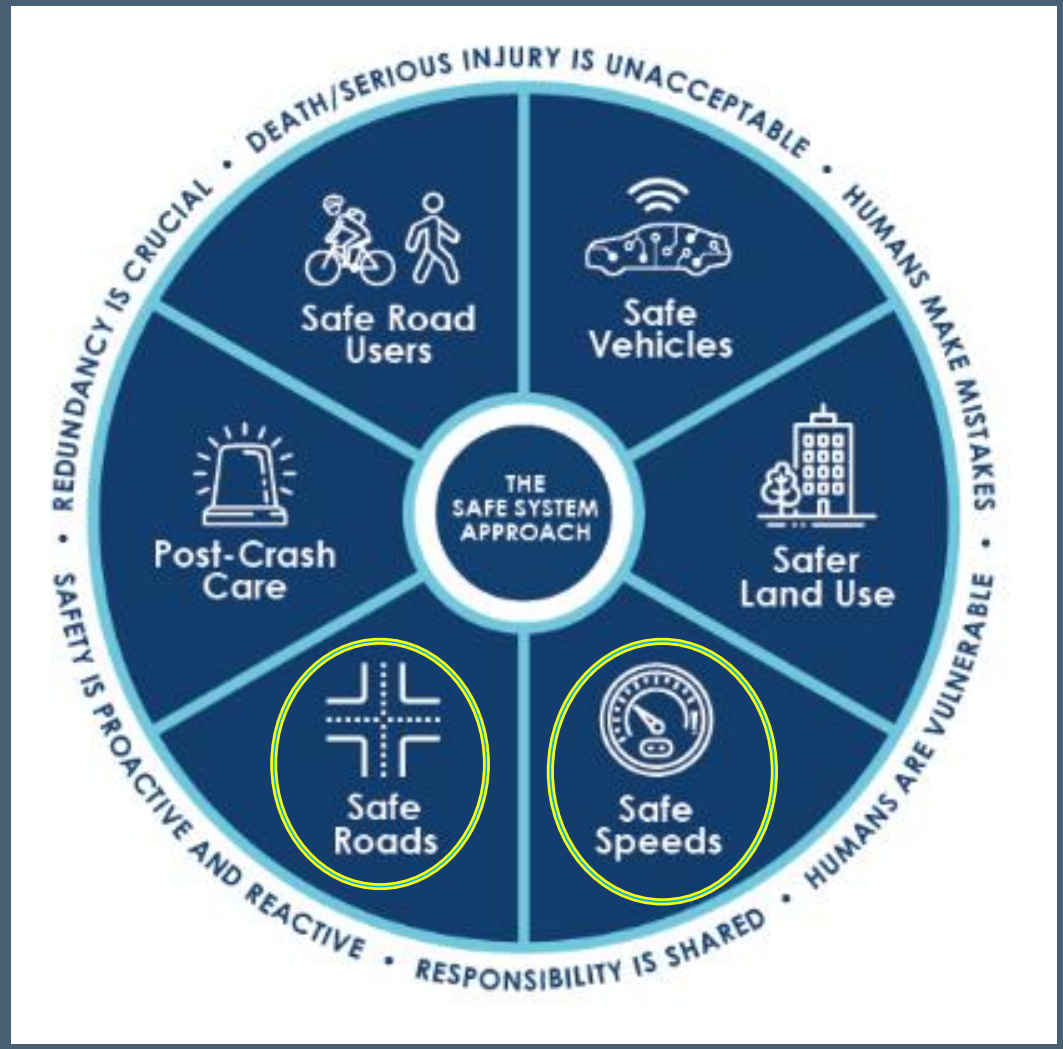
Candappa et al., 2015

How can we Manage Kinetic Energy? (Reduce it)

- Speed management is a major component of kinetic energy management. Speed management practices compliant with the Safe System Approach may include:
  - Altering the roadway cross section
  - → **Intersection Design and Reconfiguration = *SOLUTIONS***
  - Traffic calming
  - Speed limits
  - Speed safety cameras

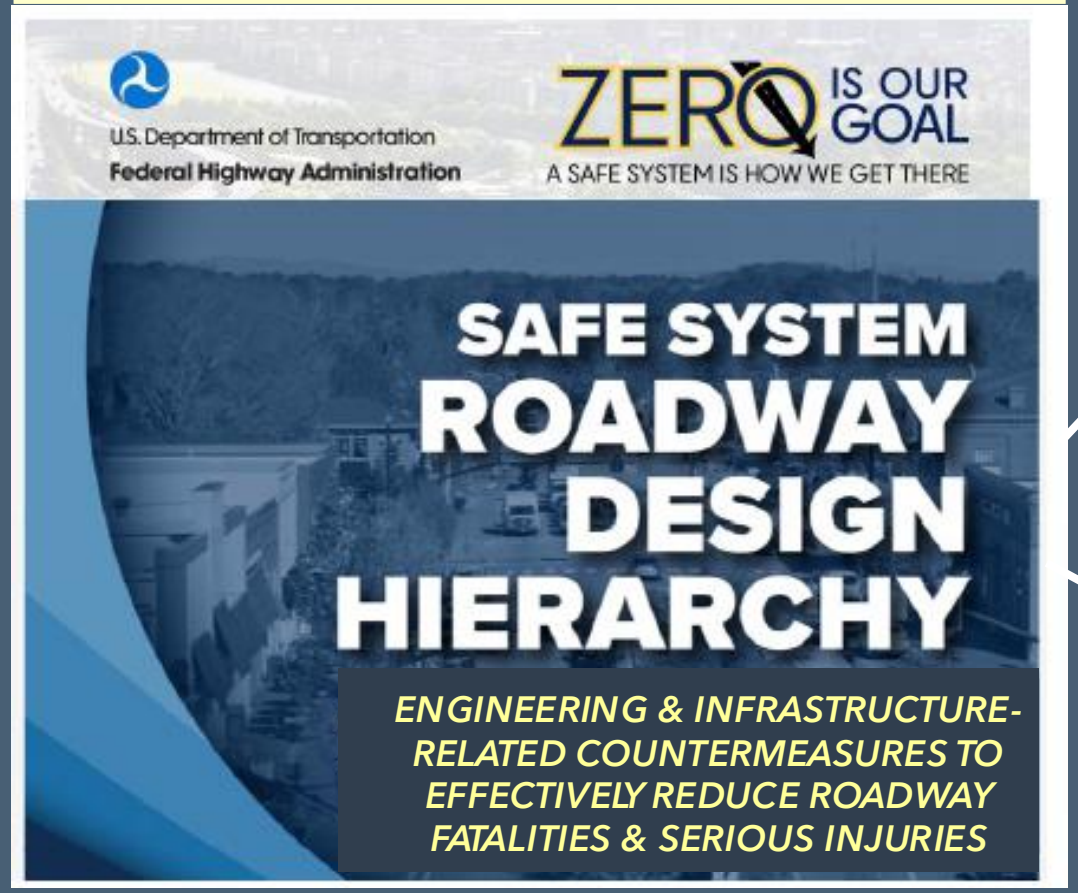
Advancing the Safe Roads *ELEMENT* in the SSA



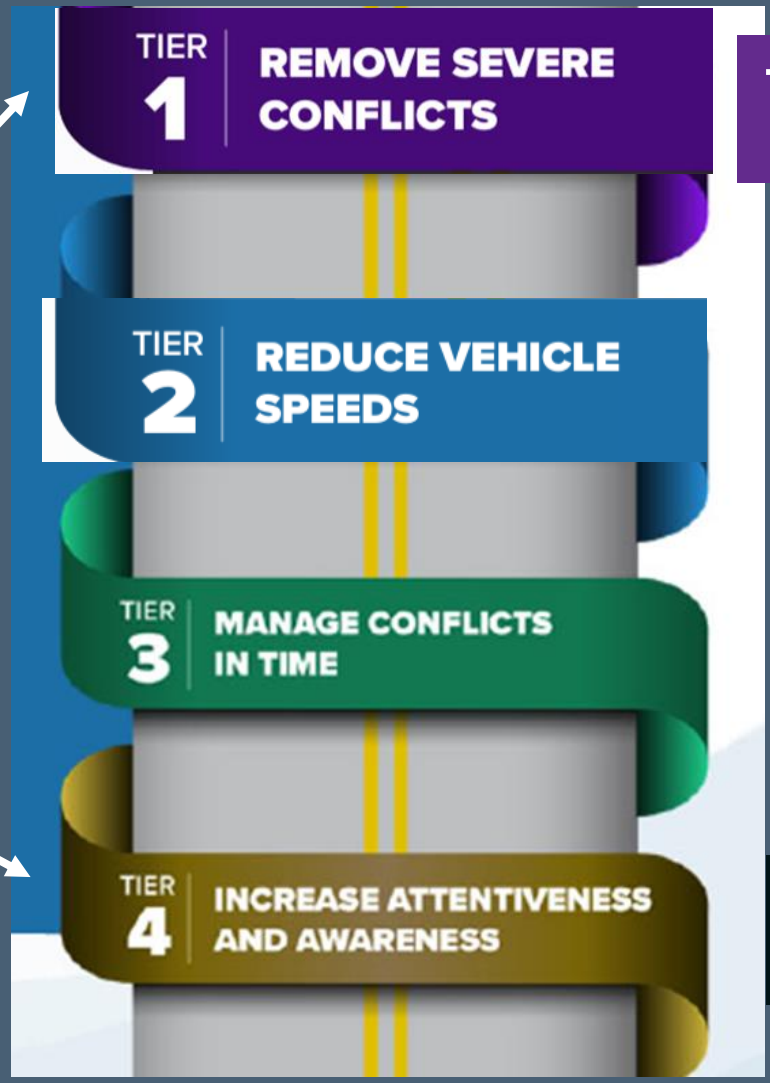


Source: CA 2025-2029 SHSP Interim SSA Wheel

28 Proven Safety Countermeasures & Safe System Solutions



Hierarchy of PSCs & Solutions



from most effective

to least effective

Excerpt from the *SAFE SYSTEM Road Design Hierarchy*, Page 8, FHWA (2024)

Proven Safety Countermeasures for PEDS & BIKES

Ped / Bike	Tier 1	Tier 2	Tier 3	Tier 4
Bicycle Lanes	✓			
Crosswalk Visibility Enhancements				✓
Leading Pedestrian Interval			✓	
★ Medians and Pedestrian Refuge Islands	✓	✓		
Pedestrian Hybrid Beacons			✓	
Rectangular Flashing Beacons (RRFB)				✓
★ Road Diets	✓	✓		
Walkways	✓			
	REMOVE SEVERE CONFLICTS	REDUCE VEHICLE SPEEDS		

Source: FHWA

SAFE SYSTEM ROADWAY DESIGN HIERARCHY

PURPOSE:

To help transportation agencies and practitioners *identify and prioritize* countermeasures & strategies when developing transportation projects

HOW TO USE THE HIERARCHY

Agencies and practitioners should consider Tier 1 countermeasures first, then Tier 2 and …

Consult Tables in the FHWA's Hierarchy publication

https://highways.dot.gov/safety/zero-deaths/safe-system-roadway-design-hierarchy

Excerpt from the *SAFE SYSTEM Road Design Hierarchy*, Page 9, FHWA (2024)

Proven Safety Countermeasures for INTERSECTIONS

Proven Safety Countermeasures	*Tier 1 Remove Severe Conflicts*	*Tier 2 Reduce Vehicle Speeds*	*Tier 3 Manage Conflicts in Time*	*Tier 4 Increase Attentiveness and Awareness*
INTERSECTIONS				
Is anything missing?				✓
	✓			
	✓			
	✓			
	✓	✓	✓	✓
				✓

Excerpt from the *SAFE SYSTEM Road Design Hierarchy*, Page 9, FHWA (2024)

Proven Safety Countermeasures for INTERSECTIONS

Proven Safety Countermeasures	*Tier 1 Remove Severe Conflicts*	*Tier 2 Reduce Vehicle Speeds*	*Tier 3 Manage Conflicts in Time*	*Tier 4 Increase Attentiveness and Awareness*
INTERSECTIONS				
Backplates with Reflective Borders				✓
Corridor Access Management	✓			
Dedicated Left and Right Turn Lanes at Intersections	✓			
Reduced Left Turn Conflict Intersections	✓			
Roundabouts	✓	✓	✓	✓
Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections				✓

Is any other Proven Safety Counter-measure missing?

Use chat box if you know the answer.

Roundabouts

U.S. Department of Transportation
Federal Highway Administration

The modern roundabout is an intersection with a circular configuration that safely and efficiently moves traffic. Roundabouts feature channelized, curved approaches that reduce vehicle speed, entry yield control that gives right-of-way to circulating traffic, and counterclockwise flow around a central island that minimizes conflict points. The net result of lower speeds and reduced conflicts at roundabouts is an environment where crashes that cause injury or fatality are substantially reduced.

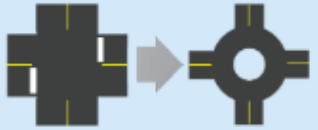
Illustration of a multi-lane roundabout. Source: FHWA

Example of a single-lane roundabout. Source: FHWA

Roundabouts can be implemented in both urban and rural areas under a wide range of traffic conditions. They can replace signals, two-way stop controls, and all-way stop controls. Roundabouts are an effective option for managing speed and transitioning traffic from high-speed to low-speed environments, such as freeway interchange ramp terminals, and rural intersections along high-speed roads.

Golden Hill and Union Road (Paso Robles)

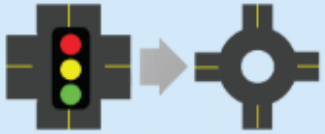
Two-Way Stop-Controlled Intersection to a Roundabout



82%

Reduction in fatal and injury crashes[1]

Signalized Intersection to a Roundabout



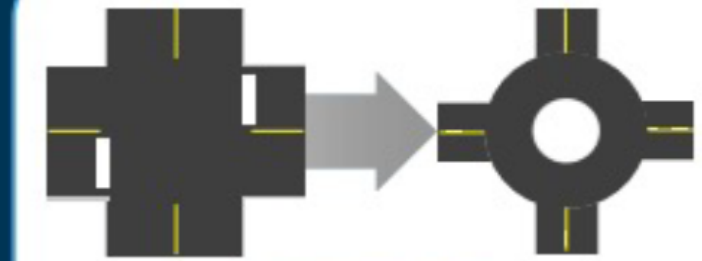
78%

Reduction in fatal and injury crashes[1]

(Souce: FHWA PSC Booklet)

Crash Reduction Factors for Roundabouts

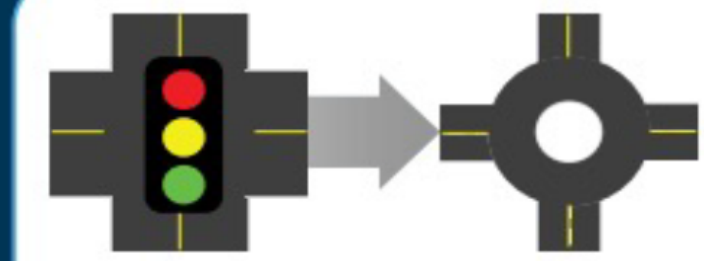
Convert TWO-WAY STOP to Roundabout Intersection



82%

Before-After Project Study RESULTS

Convert SIGNALIZED intersection to Roundabout



78%

% Reduction in Fatal and Injury Crashes [1]

But are roundabouts also safer for Peds & Cyclists?

[1] SOURCE: *Making our Roads Safer, One Countermeasure at a Time; see page 18, FHWA Publication*

- https://safety.fhwa.dot.gov/provencountermeasures/pdf/FHWA-SA-21-071_PSC%20Booklet_508.pdf

Can a traffic signal prevent *ALL* severe crashes?

Single Lane Roundabout

Yield signs at each entry

Counterclockwise Circulation

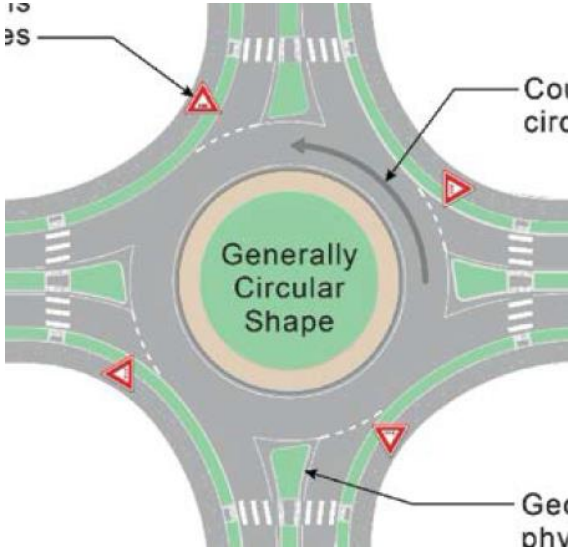
Deflected approach

Generally Circular Shape

Splitter Island

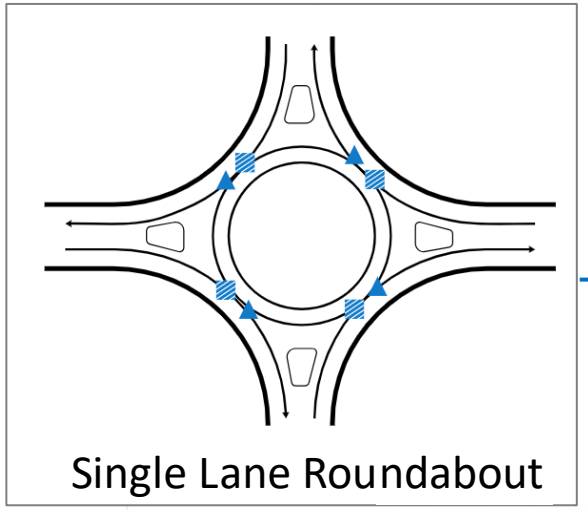
★ *Complete* Pedestrian Crossing

← Note location: about 20’ prior to the entry or yield line



Four Complete pedestrian crossings at each roundabout

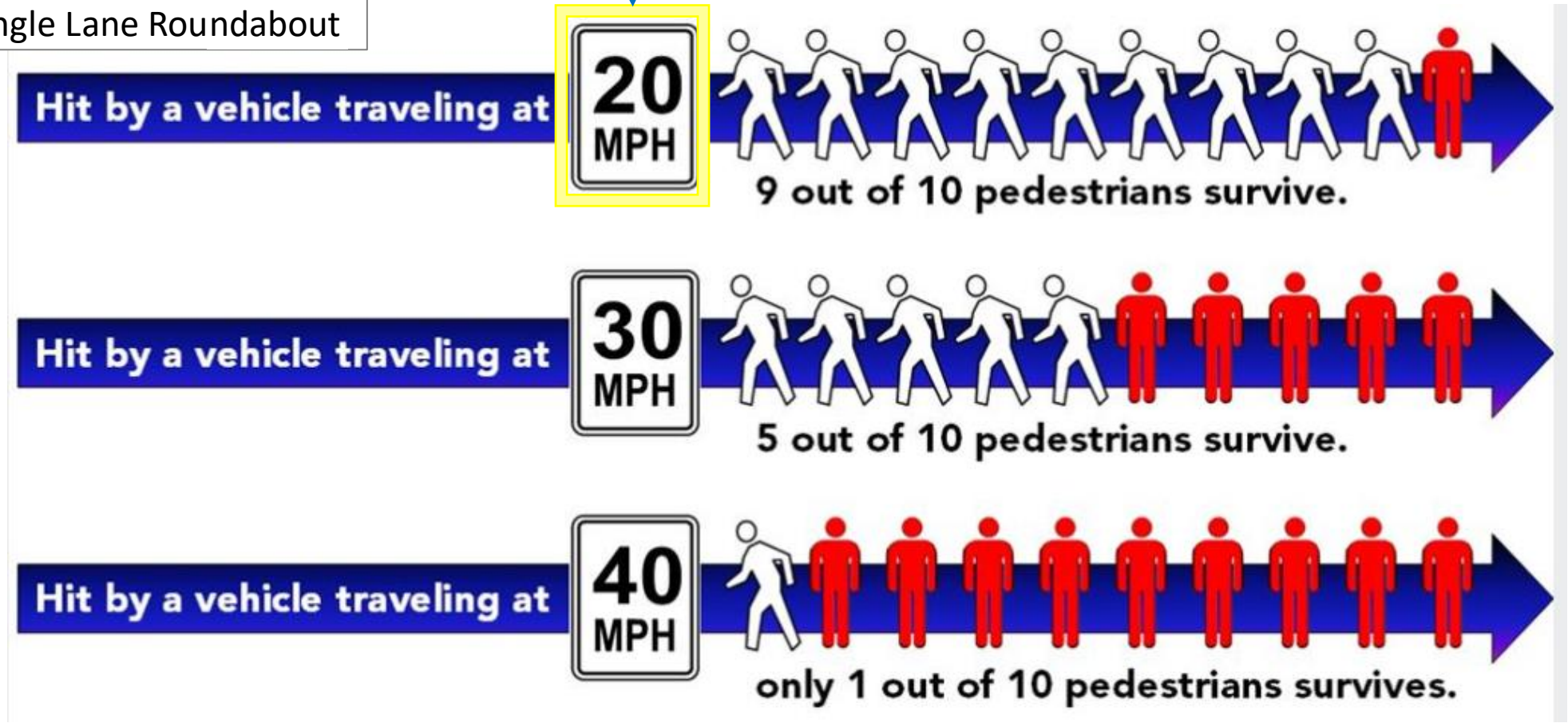
- Raised median *splitter* islands:
  - provide refuge for pedestrians
  - allow for crossing of one direction of traffic at a time
  - very short crossing distance
- Crossings located to facilitate:
  - Focus on peds while slowing
  - One driver decision at a time
  - stopping is easy because drivers are already braking or slowing



Single Lane Roundabout

Why Roundabouts are Safer: *Speed*

- 8 low speed Veh-Veh Conflict Points (with shallow angles)
- 8 low-speed Pedestrian Crossing Conflict Points



ROUNDABOUTS: Slower & Safer for all Road Users

"since the early 1990's … there have been only 10 vulnerable road user fatalities …"

STREETSBLOG USA

BICYCLE INFRASTRUCTURE

Opinion: America Should 'Think Round' For Safety for Vulnerable Road Users

By Kea Wilson Sept 19, 2022 (Excerpt)

The actual safety record for roundabouts for vulnerable road users, though, speaks for itself — regardless of any conjecture otherwise.

Although there is no known, official collection of crash data for roundabouts nationwide, Scott Batson, a traffic engineer from the Portland Bureau of Transportation, has been unofficially tracking fatalities at roundabouts since the early 2000s from publicly known crashes. From that data, there have been only 10 vulnerable road user fatalities at roundabouts — six pedestrians and four cyclists — since they were first installed in the US in the early 1990s. None of those fatalities are known to have occurred in a marked crosswalk located along one of those roundabouts, either.

https://usa.streetsblog.org/2022/09/19/opinion-america-should-think-round-for-vulnerable-road-user-safety

Mini-roundabout - 62' Diameter, Source: FHWA

ROUNDABOUTS

Roundabouts eliminate severe conflicts

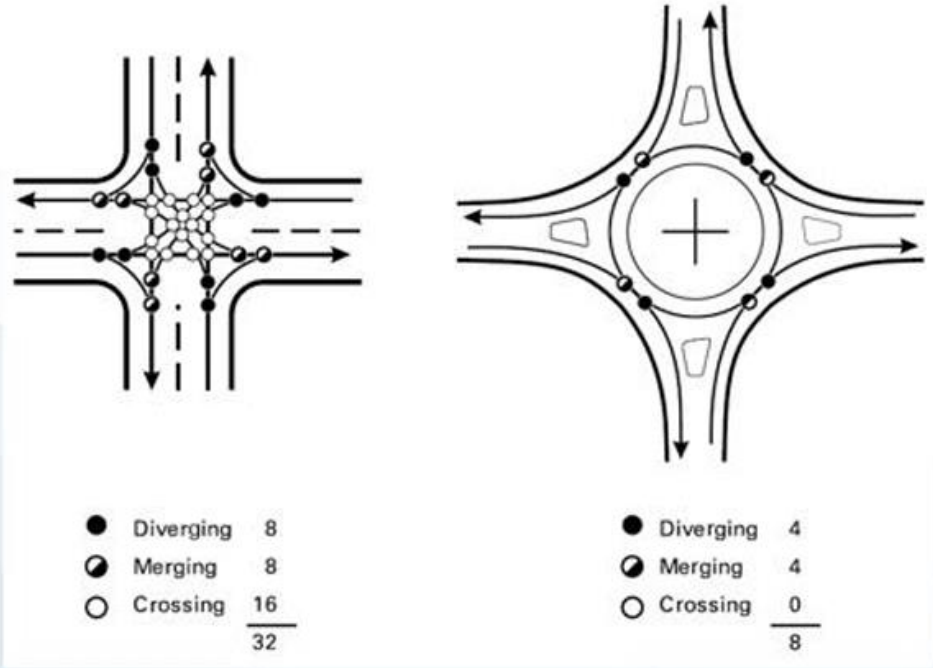


Image derived from: https://dublinohiousa.gov/roundabouts

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

Excerpt from the *SAFE SYSTEM Road Design Hierarchy*, Page 9, FHWA (2024)

Proven Safety Countermeasures for INTERSECTIONS

Proven Safety Countermeasures	*Tier 1 Remove Severe Conflicts*	*Tier 2 Reduce Vehicle Speeds*	*Tier 3 Manage Conflicts in Time*	*Tier 4 Increase Attentiveness and Awareness*	CRF (F+I)
INTERSECTIONS					
Backplates with Reflective Borders				✓	NA
Corridor Access Management	✓				< 25%
Dedicated Left and Right Turn Lanes at Intersections	✓				< 30%
Reduced Left Turn Conflict Intersections	✓				< 50%
Roundabouts	✓	✓	✓	✓	80 - 90%
Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections				✓	

Roundabout APPLICATIONS

INNOVATIVE INTERCHANGES

Single Roundabout

Double Roundabout Interchange Small Footprint

Intersections along High-speed Corridors

DESIGN TREATMENTS AND PRINCIPLES FOR: *High-Speed Approaches to Roundabouts*

OVERVIEW:

As an extension of TxDOT's Roadway Design Manual Chapter 14, this aid provides designers with guidance for roundabouts on roadways where posted speeds are 45 mph or higher.

SAFETY BENEFITS OF ROUNDABOUTS ON HIGH-SPEED FACILITIES

(Based on National Statistics) … nearly 40% of rural non-interstate road fatalities occur at intersections (Isebrands et al).

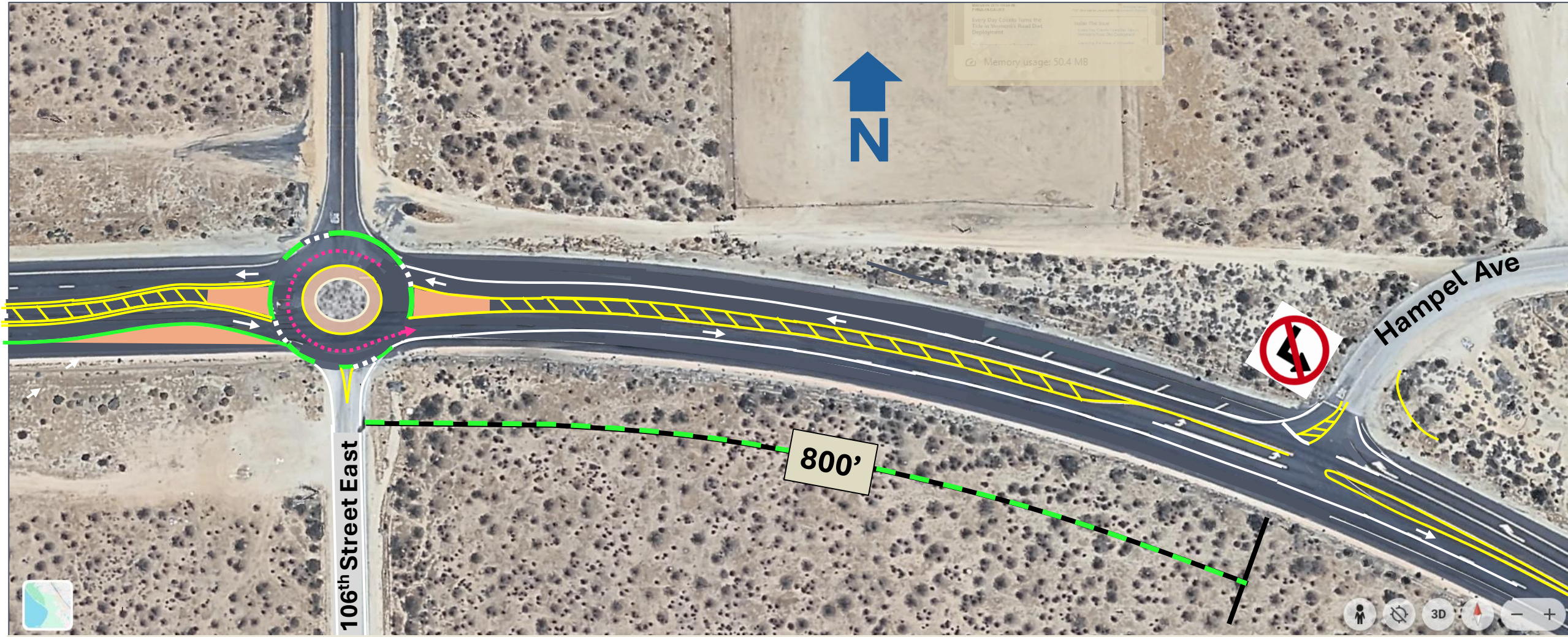
At 17 rural roundabout installations with high-speed approaches:

The average injury crash frequency was reduced by 84%

- **Angle crashes were reduced by 86%**
- **Fatal crashes were eliminated.** (Isebrands, 2009)

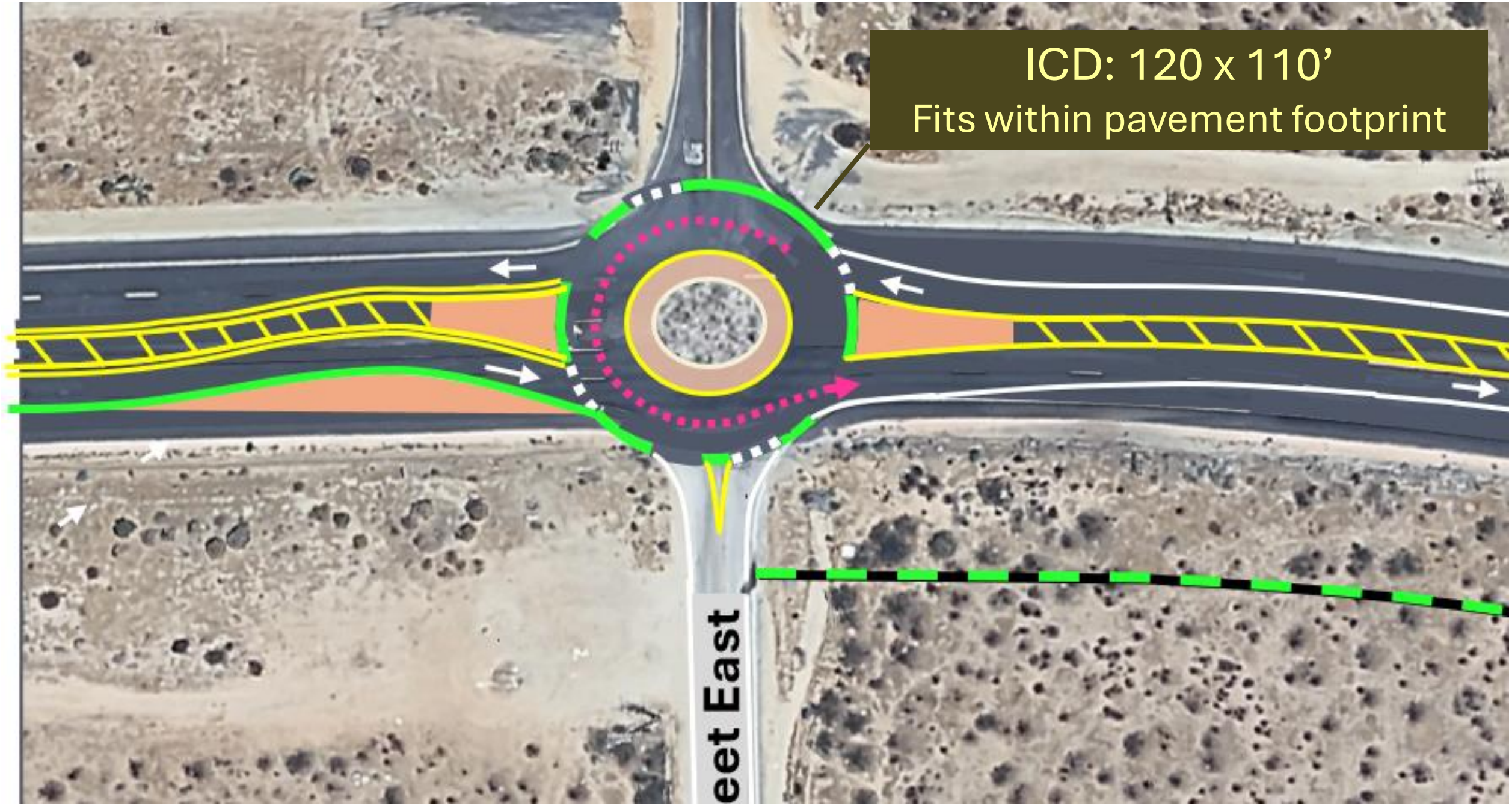
The number of successful roundabout installations on high-speed highways has reached a critical mass of evidence supporting conversion of high-speed stop control intersections to roundabouts

Alternative Concept for Intersection of County Route Q and 106th Street



IMPROVEMENTS:

- **Convert Hampel Ave to RCUT by eliminating left-turn from Hampel to EB Route Q**
  - **the roundabout provides a U-Turn f**or drivers wanting to head easterly on SR 138
  - the roundabout shown has an ICD of 105 to 115’
    - Therefore, design vehicles would be directed to use 106th St. (where speeds will be

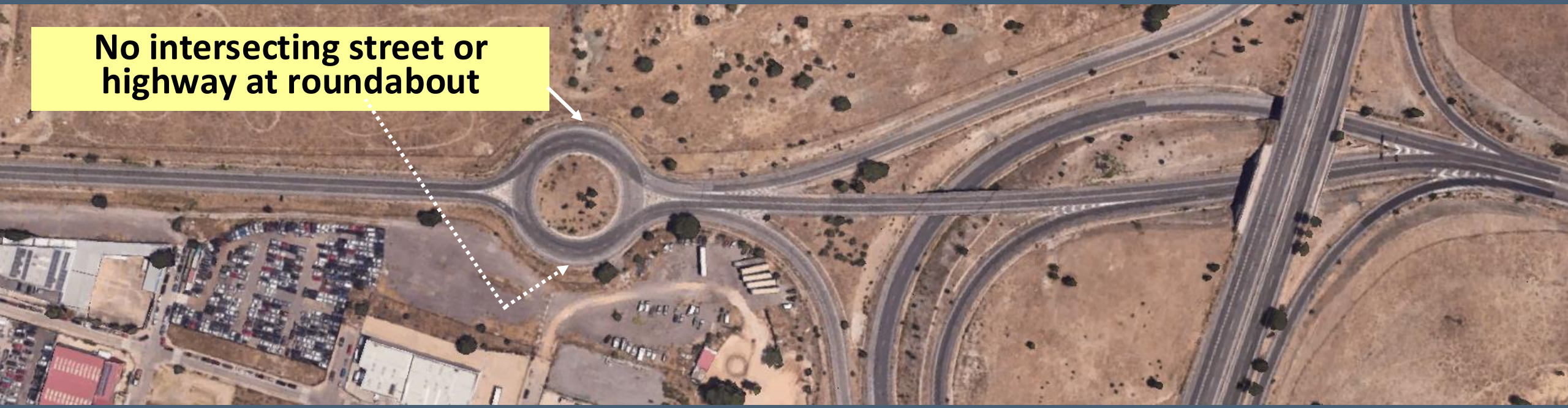

ICD: 120 x 110’
Fits within pavement footprint
eet East

School Safety

(speed control aided by small roundabouts)

ROUNDABOUT APPLICATIONS

- Traffic Calming / Speed Reduction
- Improve Circulation: Provide U-Turns



Slows vehicles prior to entering:

- a community (Main Street along a rural corridor)
- a complex (high-risk) intersection / interchange:
  - speed differential prevails, and
  - multiple decisions are required

ROAD and Intersection DIETS

Greater Operational Efficiency → Higher Capacity →
Fewer lanes required at entry → facilitates implementation of Road Diets

Case Study: College Street in Ashville, NC
An *Intersection* Diet within RD Corridor
6 lanes (one leg) to 2 lanes

District 6 Roundabout Costs (ROW+Const)

Rural roundabouts with extensive ROW

1. Ker-184 and Sunset Blvd near Arvin (2022), 160’ ICD, $4.4 M
2. Ker-184/223 and Wheeler Ridge Road near Arvin (2022) 150’ ICD, $7.0M
3. Tul-190 and Rockford Rd near Porterville (2025), 180’ ICD, $5.2 M

Urban roundabouts with minimal ROW

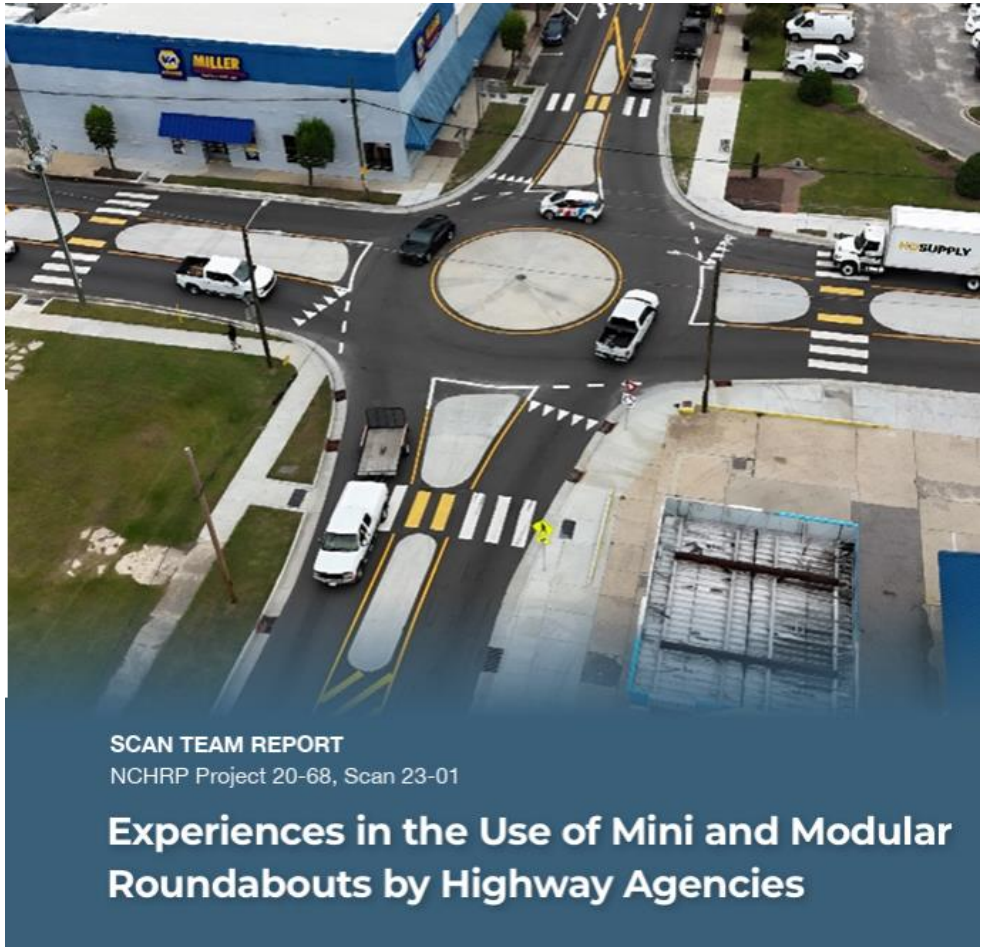
1. Tul-137 and Morrison Street in Tulare (2024), 95’ ICD, $1.6 M
2. Fre-33/180 in Mendota (2025), 140’ ICD, $3.1 M

UPDATE: *SAFE SYSTEM SOLUTIONS* & INNOVATION

- **NCHRP Domestic Scan Study on Mini, Compact & Modular Roundabouts**
  - **Findings presented to statewide audience during Peer Exchange Training (Dec 1-3)**
  - **Small (Affordable) Roundabout Alts:**
    - **Mini and Traversable ompact**
    - **Modular Design / Construction**

KEY FINDING:

They all work under a broad range of conditions when design performance objectives are met



Mini-roundabout

The mini-roundabout is typically characterized by a smaller inscribed outer diameter than a roundabout (typically 45 – 90 feet), **a traversable center island over which trucks, buses, and other heavy vehicles may drive** and (sometimes) a splitter island on one or more of the approaches. Mini-roundabouts are generally used on lower-volume streets and where space is inadequate for a full-size roundabout. Each approach of mini-roundabouts operates under the control of a YIELD sign.

Mini-roundabouts function and perform similarly to roundabouts with larger circulatory roadways but require less right-of-way with a smaller footprint.

Small Roundabout (1 of 2 with D = 105') in Kings Beach

Kings Beach, CA along North Shore of Lake Tahoe | SR 28

Kings Beach Road Diet along SR 28

Compact Roundabouts included as integral component of Road Diet thru Kings Beach

All paved 5-lane section reduced to two-lanes (one in each direction)

Vehicle speeds reduced (roundabout spacing: 775')

Complete Ped Crossings installed (2 at each roundabout)

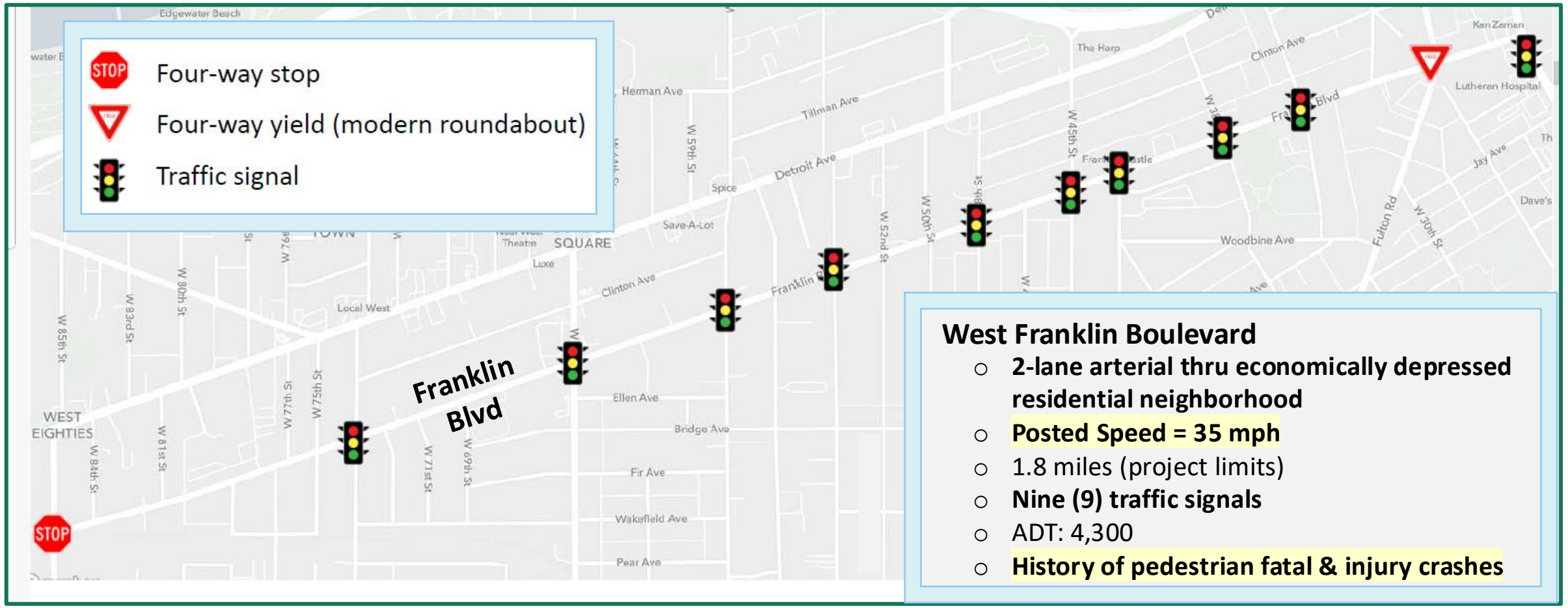
Improved pedestrian safety, mobility & access To/from Lake Tahoe

West Franklin Blvd MINI-ROUNDABOUT CORRIDOR Project

City of Cleveland, Ohio

PRE-Project Conditions

Purpose & Need → Traffic Calming / Safety



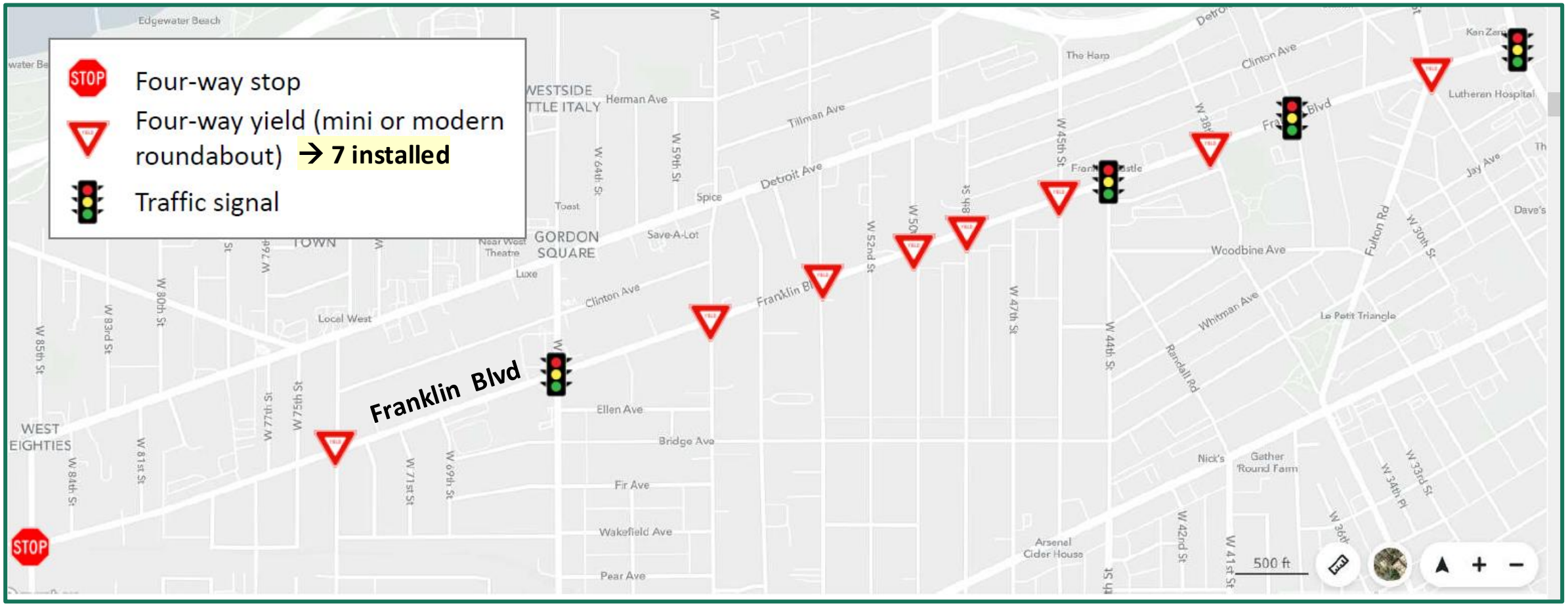
West Franklin Boulevard

- **2-lane arterial thru economically depressed residential neighborhood**
- **Posted Speed = 35 mph**
- 1.8 miles (project limits)
- **Nine (9) traffic signals**
- ADT: 4,300
- **History of pedestrian fatal & injury crashes**

West Franklin Blvd MINI-ROUNDABOUT CORRIDOR Project

City of Cleveland, Ohio

POST-Project Intersection Control



West Franklin Blvd MINI-ROUNDABOUT CORRIDOR Project

Observations and Evaluation: Traffic Calming and Safety Findings

Pre-Project

Location	Direction	85th Percentile Speed (mph)
8205 Franklin Blvd.	Eastbound	32
	Westbound	36
6016 Franklin Blvd.	Eastbound	34
	Westbound	34
4610 Franklin Blvd.	Eastbound	34
	Westbound	32
3600 Franklin Blvd.	Eastbound	34
	Westbound	34
Corridor Average		**34**

Table 4: Measured Speeds, 2016 Speed Study

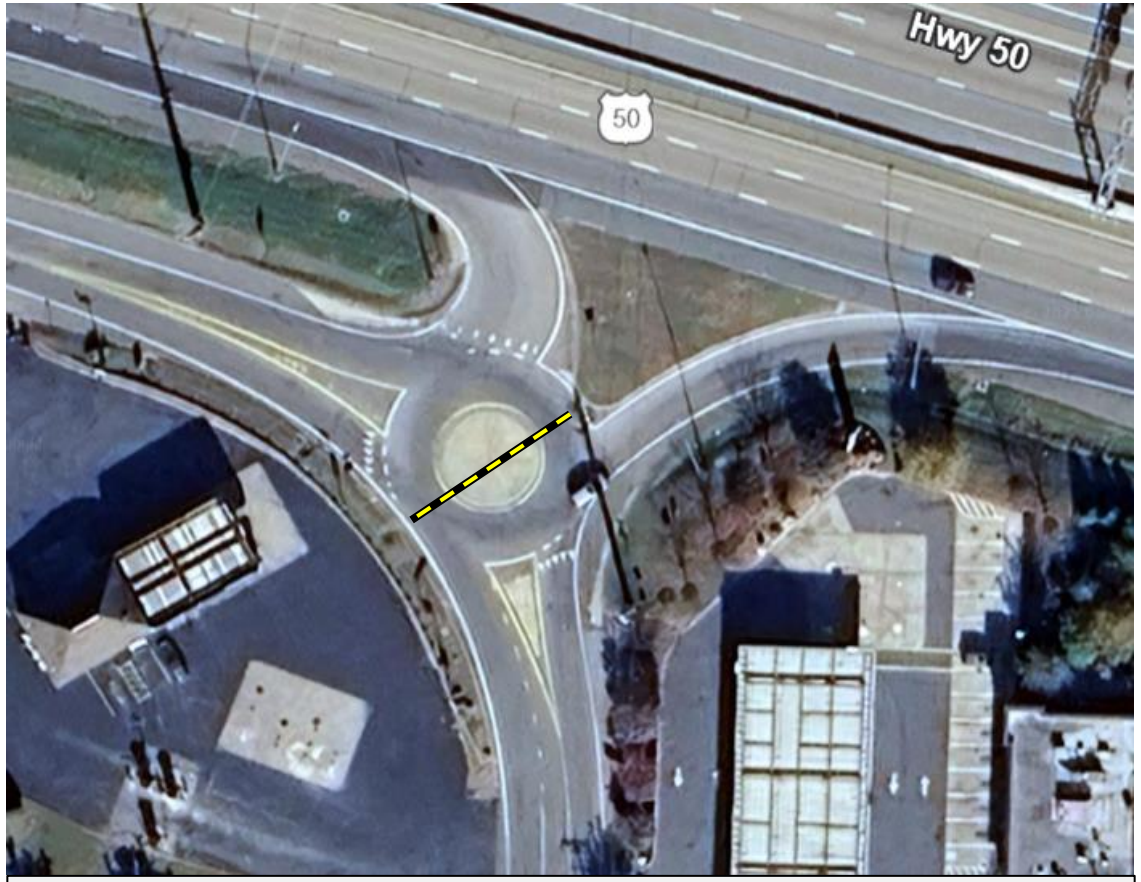
Post-Project

- Speeds slowed: 50th percentile ~22.5 mph; 85th percentile ~27
- Speed limit signage changed to 25 mph
- Crash records: too soon to say, but only 1 recorded roundabout-involved crash (PDO)

Opportunities to Accelerate Implementation of a Safe System Intersection
CONVENTIONAL VS MINI ROUNDABOUTS AT INTERCHANGES

Conventional Roundabout at NB I-5 "hook" ramp terminal
La Novia Road Interchange | San Juan Capistrano (D12)

Circulatory Roadway "footprint": 150-foot diameter
Construction Cost: $7 Million



Mini Roundabout at US 50 "hook" ramp terminal
Thompson Creek Rd Interchange | Stevensville, Maryland

Circulatory Roadway "footprint": 75-foot diameter
Construction Cost: < $1.5 Million

Roundabout Sizes …

… Design Vehicles can be accommodated over entire range of sizes and shapes, including Minis (because of traversable center island)

Principles of a Safe System Approach

A Safe System Approach incorporates the following principles:

4. Responsibility is Shared

All stakeholders – including government at all levels, industry, non-profit / advocacy, researchers, and the general public are vital to preventing fatalities and serious injuries on our roadways.

5. Safety is Proactive and Reactive

Proactive tools and investments must supplement reactive investments. Every activity and project presents an opportunity to identify and address safety issues in the transportation system.

6. Redundancy is Critical

If one part of the system fails, overlapping parts are in place and work as designed to protect people. **Double-down on investment in strategies that have built-in redundancy.**

Proven Safety Countermeasures for INTERSECTIONS

Proven Safety Countermeasures	Tier 1 Remove Severe Conflicts	Tier 2 Reduce Vehicle Speeds	Tier 3 Manage Conflicts in Time	Tier 4 Increase Attentiveness and Awareness	CRF (F+I)	COST ($) L-M-H	CRF per $
INTERSECTIONS							
Backplates with Reflective Borders				✓	NA		
Corridor Access Management	✓				< 25%		
Dedicated Left and Right Turn Lanes at Intersections	✓				< 30%		
Reduced Left Turn Conflict Intersections	✓				< 50%		
Roundabouts	✓	✓	✓	✓	80-90%		
Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections				✓			

Roundabouts are a 4-Tier Solution and include other PSCs

Questions?

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Thank You