The Expanding Role of *ROUNDABOUT INTERSECTIONS*

Jerry Champa
HQ Division of Traffic Operations

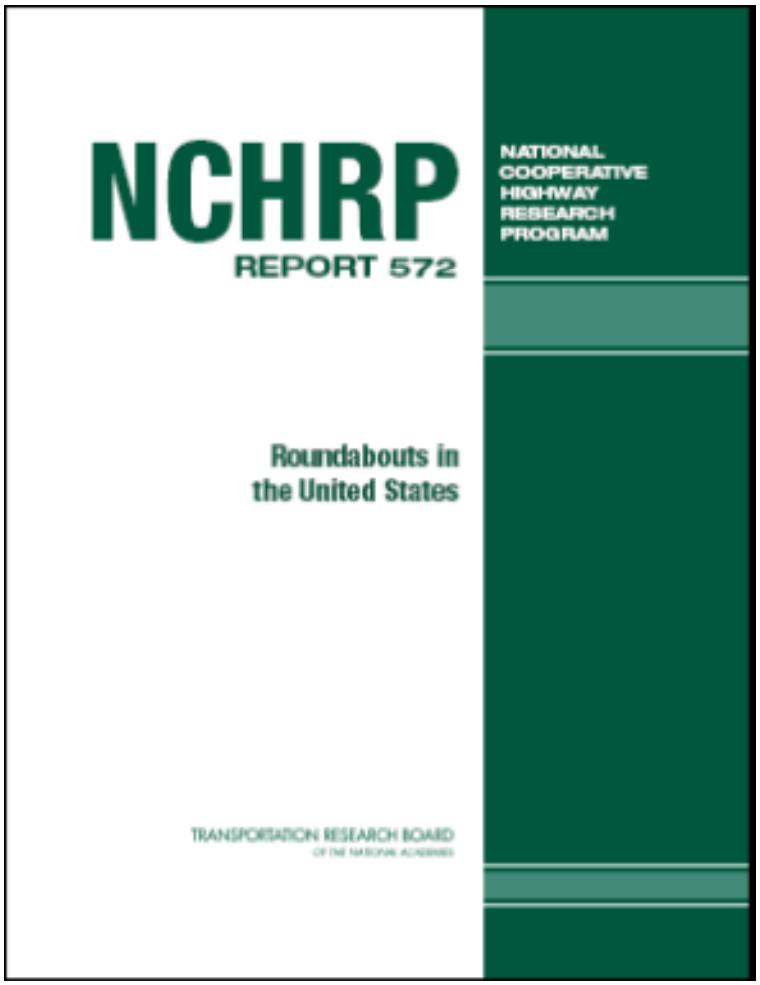
The Expanding Role of *ROUNDABOUT INTERSECTIONS*

How we can improve travel times, safety & the environment …

***…while* reducing speed, speed differential, congestion, vehicle emissions & energy consumption**

NCHRP 3-65 / NCHRP Report 572

- **Most comprehensive study of U.S. roundabout performance to date**



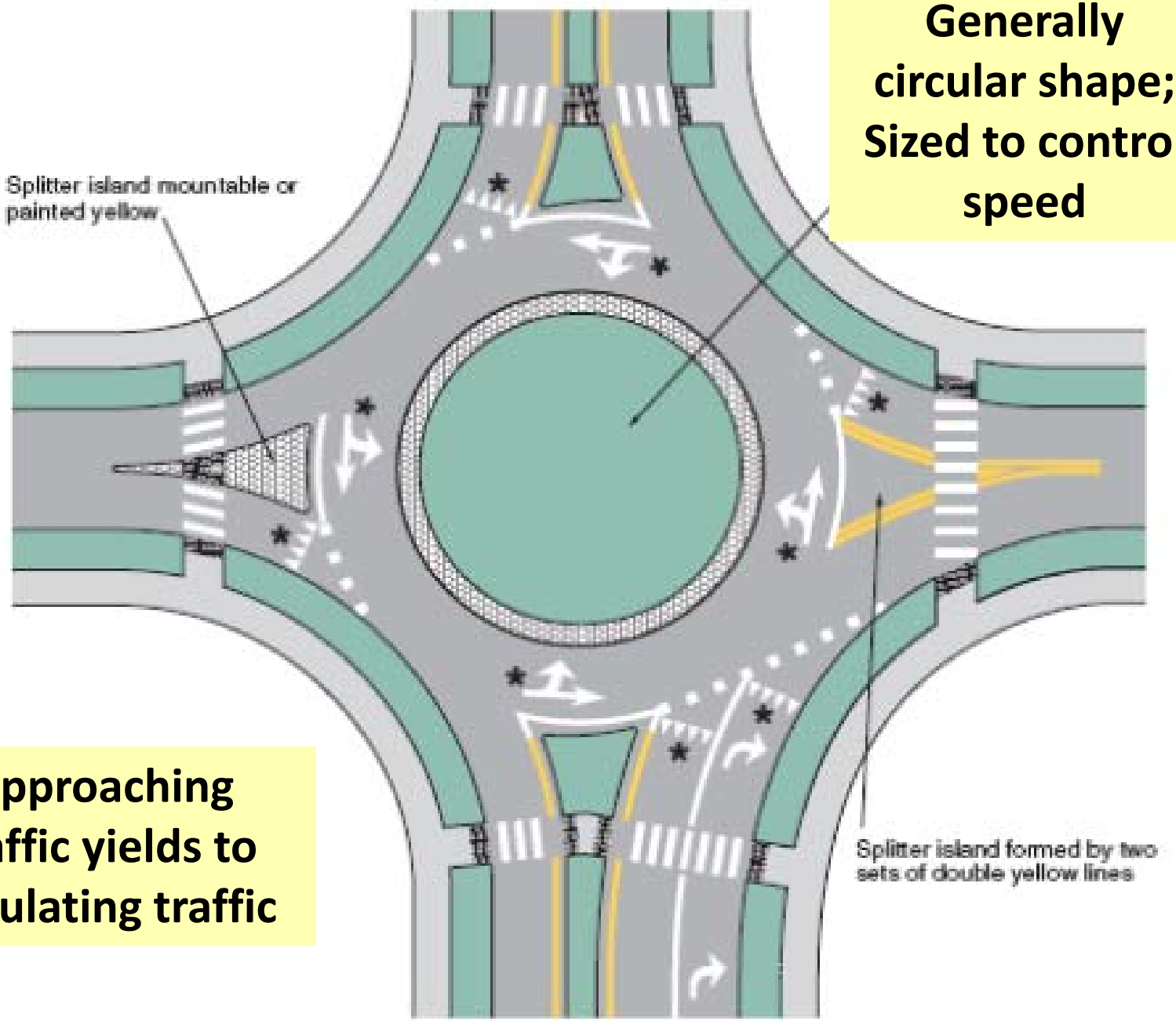
BASICS: What?

DEFINITION of Roundabout:

- **Type of circular intersection**
- **A form of intersection "control"**

What makes a roundabout a roundabout?
(i.e. different from other circular intersections)

- **Yield control** (applies to entering traffic**)**
- **Geometric features that control speed**
  - **Size** (diameter)
  - **Deflection** (at entries)



Generally circular shape; Sized to control speed

Approaching traffic yields to circulating traffic

North Pole, Alaska

10

BASICS: Why?

Why all the attention? And focus on intersections?

Purely from the perspective of *system performance*:

- **Access is a necessary evil!**
- **Access is a threat to both safety & mobility**
- **Access decisions significantly affect performance**
  - **location, spacing, frequency, type, "control," etc.**

BASICS: Why?

Why all the attention? And focus on intersections?

Roundabouts are not just a form of I/S control …

- **RBTs are often the most efficient & safest form of intersection "control" over a broad range of operating conditions**

Note: site specific engineering analysis is always necessary

- **RBTs can produce multiple performance benefits in a broad range of situations**
  - **that is: multiple roles & applications**

MYTHS & MISPERCEPTIONS
that Affect Consideration & Decision-Making

Is the Glass Half *Empty* or Half *Full*?

MYTHS & MISPERCEPTIONS

Is the Glass Half *Empty* or Half *Full*?

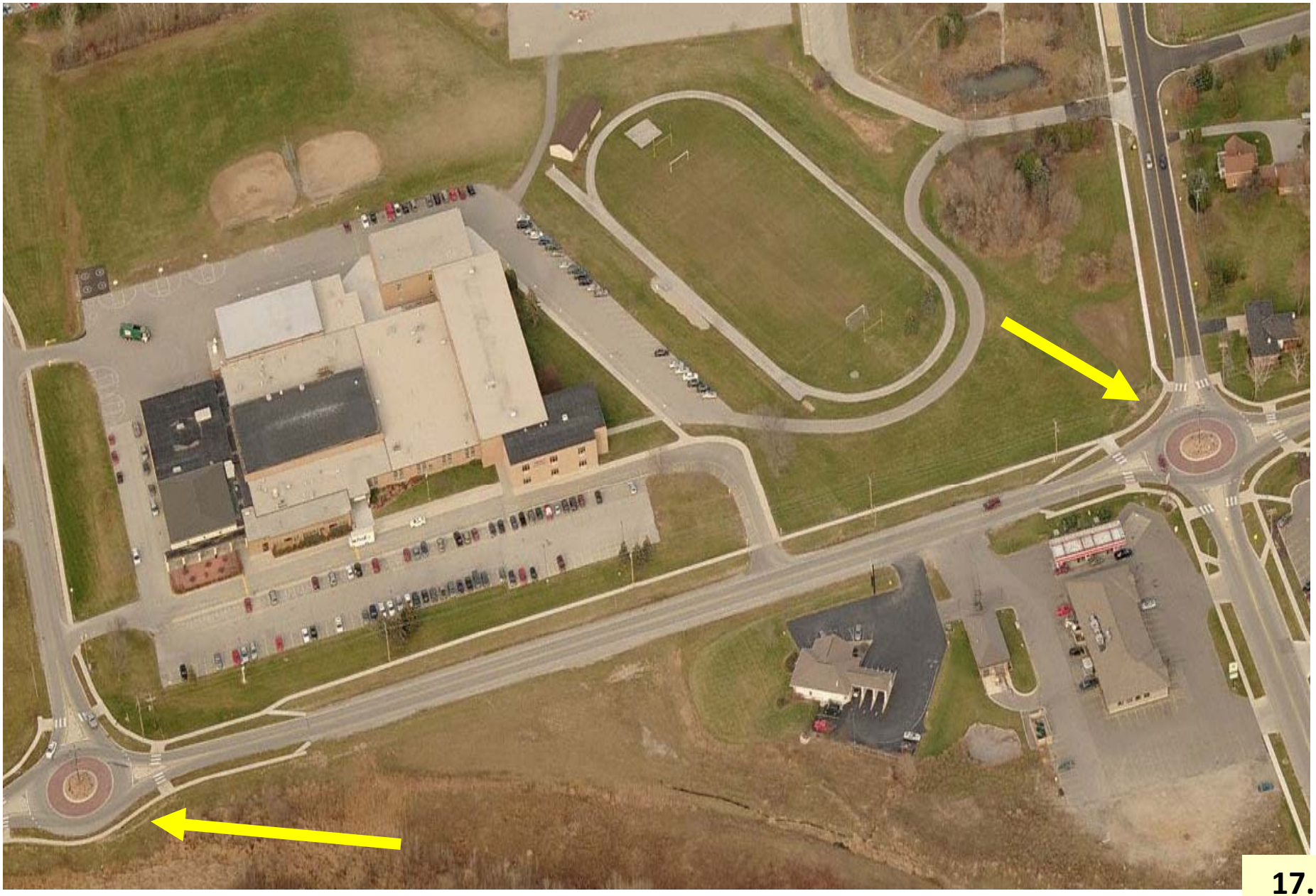
The "Half Empty" Syndrome

- Typical or common concerns regarding
  - "Minority" Users
    - older drivers,
    - bicyclists,
    - pedestrians,
    - disabled pedestrians,
    - School-age children
    - trucks

Large Trucks (and Emergency Responders)**?**

PHOTOGRAPHY SOURCE: Lee Rodegerdts

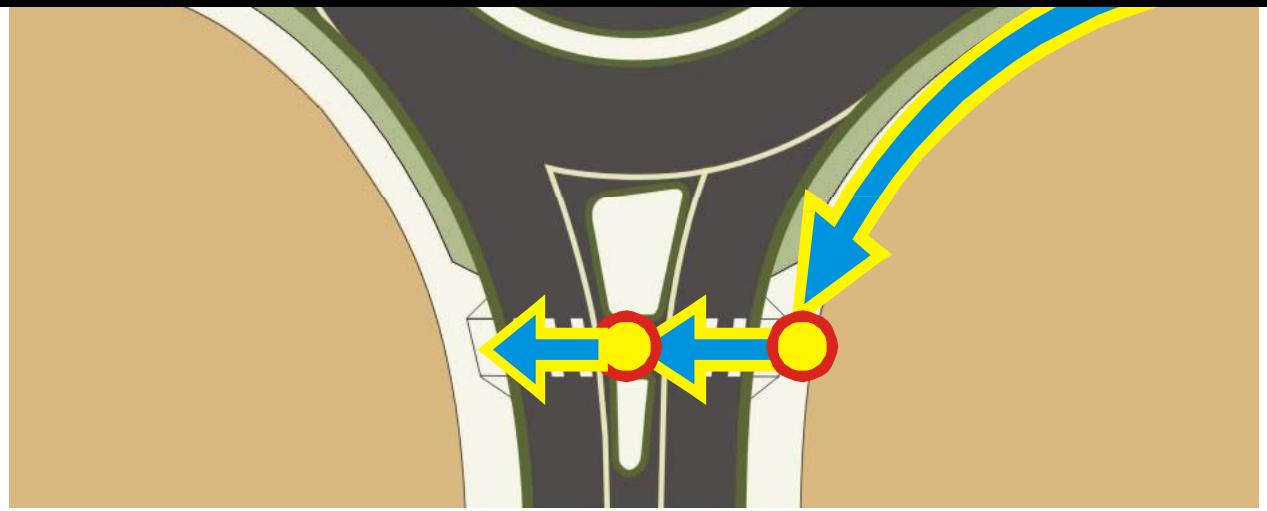
School Zones?



Pedestrians in the Roundabout

"Personally, I love them, and I'll tell you why". Haltom said, "you only have to stop one lane of traffic, then go to the middle and wait. The cars can't go much faster than 20 mph through the roundabout so the crossing aspect is great"

Excerpt from the Howard-Suamico, Denise Haltom, School Crossing Guard, Suamico, Wisconsin



MYTHS & MISPERCEPTIONS

Regarding *SAFETY* ….

See FHWA's Nine Proven Safety Measures (strategies)

MYTHS & MISPERCEPTIONS

<u>The "Half Empty" Syndrome</u>

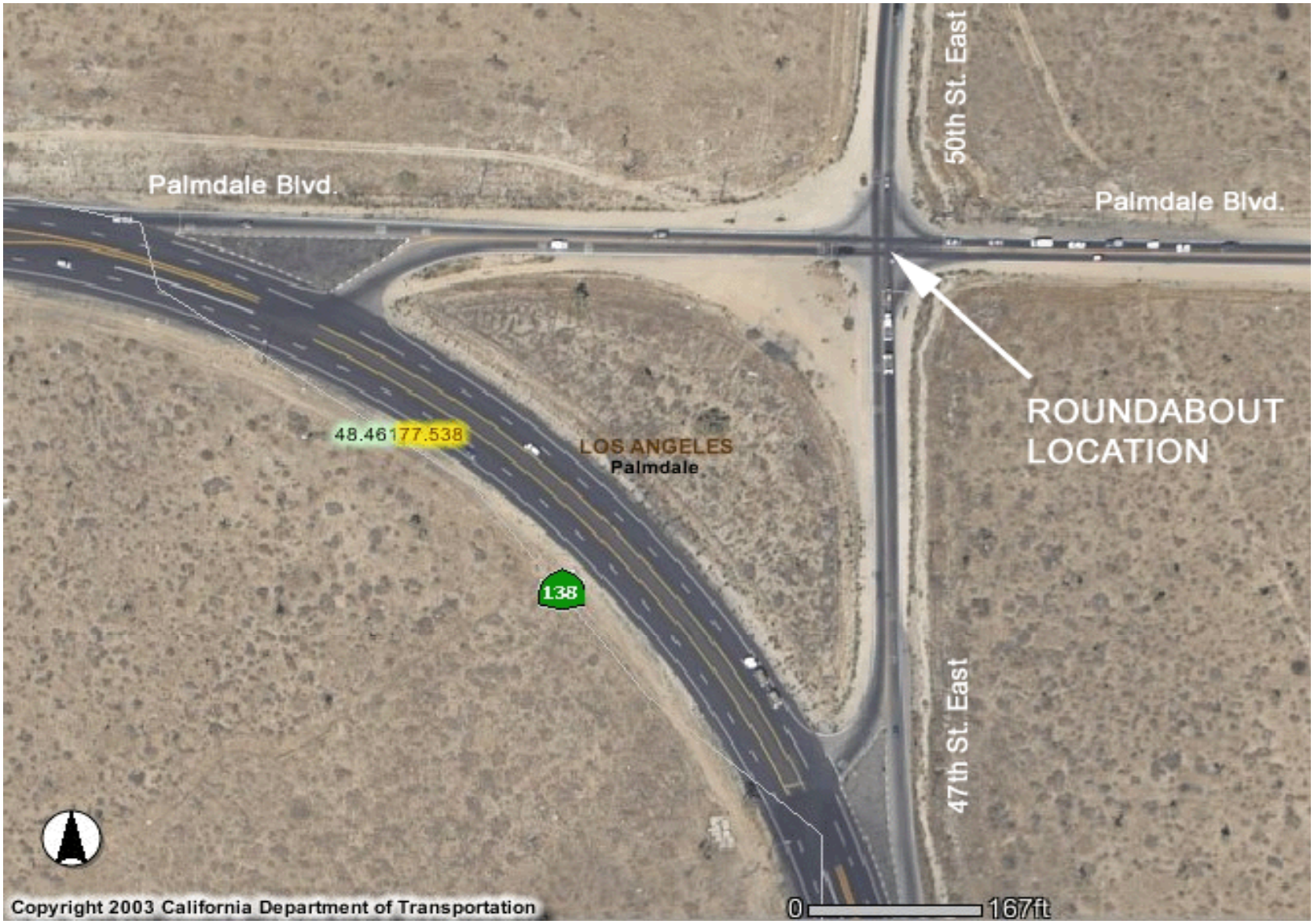
- Typical or common concerns regarding**:**
  - ***CAPACITY* / volume threshold**

MYTHS & MISPERCEPTIONS

The "Half Empty" Syndrome

- **Typical or common concerns regarding**
  → *HIGH-SPEED* environments

Palmdale Blvd. (Rte. 138)/47th St. East/50th St. East Before Roundabout Project in Palmdale



MYTHS & MISPERCEPTIONS

The "Half Empty" Syndrome

- **Typical or common concerns regarding:**
    - **Special treatment / solution status**
    - **Expansion of RBTs**
    - **Weather Conditions** (picture from North Pole)

MYTHS & MISPERCEPTIONS

The "Half FULL" Syndrome

RBTs are always an ideal (& practical) solution?

MULTIPLE BENEFITS

- **System Performance** (key "measures")
  - ***SAFETY performance***
    - ***Traveler (ALL)***
    - ***Worker***
  - ***OPERATIONAL performance (mobility)***
    - ***Intersection control delay***
    - **Congestion**
    - **Access to, and across "mainline" (for peds)**
- **Environmental / Sustainability**
  - **Air Quality**
  - **Energy Consumption**
  - **Operational & Maintenance Support Costs**
- **Community Values:** Aesthetics, Calming, etc

Reduce Congestion and Pollution

Efficient during peak <u>and</u> off-peak

Stops

Idling

Delay

Basic Comparison of Roundabout Categories

Design Element	Single-Lane Roundabout	Multilane Roundabout
Desirable maximum entry design speed	20 to 25 mph (30 to 40 km/h)	25 to 30 mph (40 to 50 km/h)
Maximum number of entering lanes per approach	1	2+
Typical inscribed circle diameter	90 to 180 ft (27 to 55 m)	150 to 300 ft (46 to 91 m)
Central island treatment	Raised*	Raised*
Typical maximum service volume	**≤25,000 veh/day**	**≤45,000 veh/day**

* (may have traversable apron)

NCHRP Report 672, Exhibit 1-9

U.S. Experience
NCHRP Report 572 Results (May 2006)

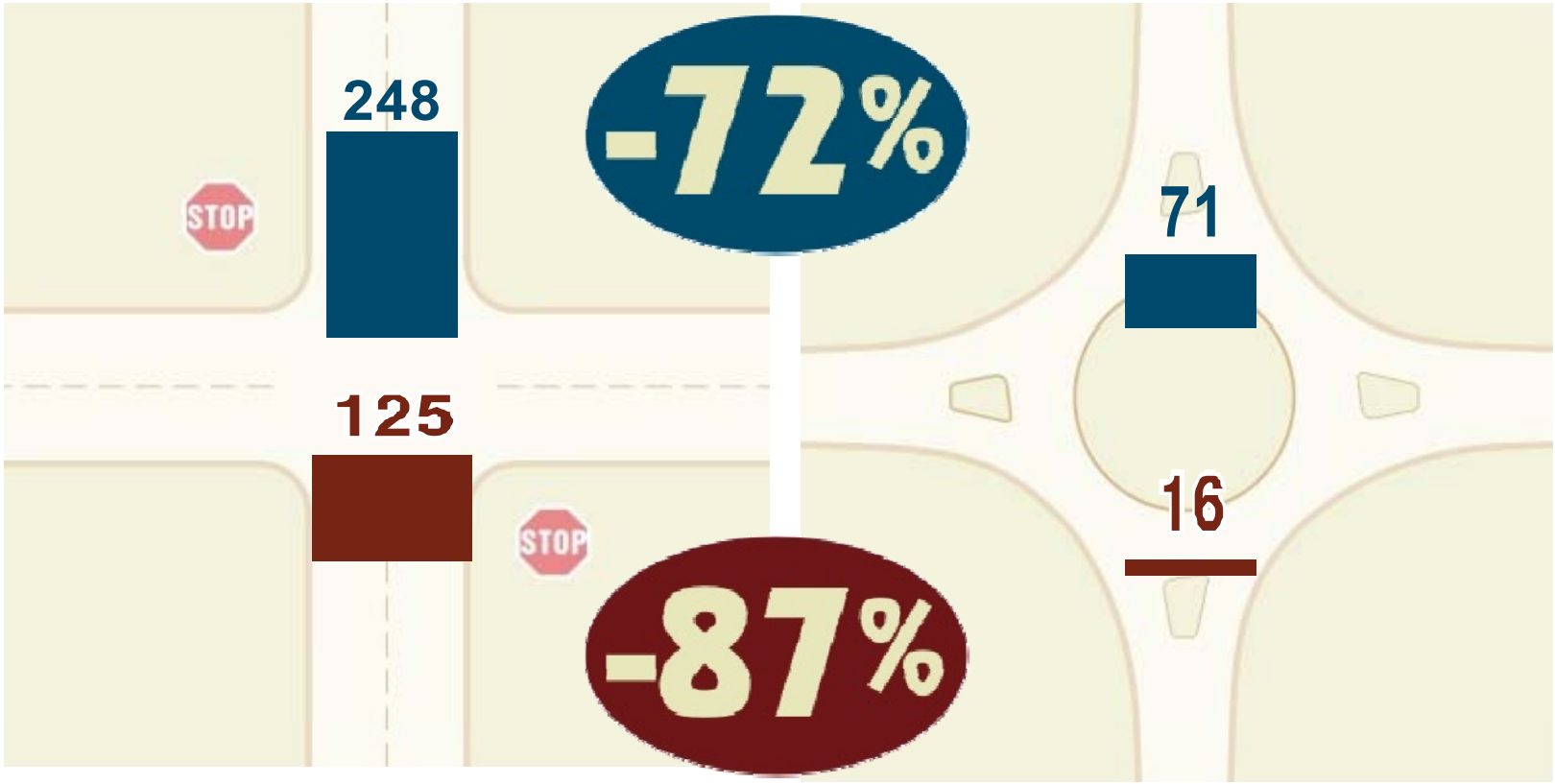
Group Characteristic before Conversion (sample size)	% Reduction in All Crashes	% Reduction in Injury Crashes
All sites (55)	35	76
Signalized (9)	48	78
All-way stop (10)	No significant change	No significant change
Two-way stop (36)	44	82

NCHRP Report 572, Table 28

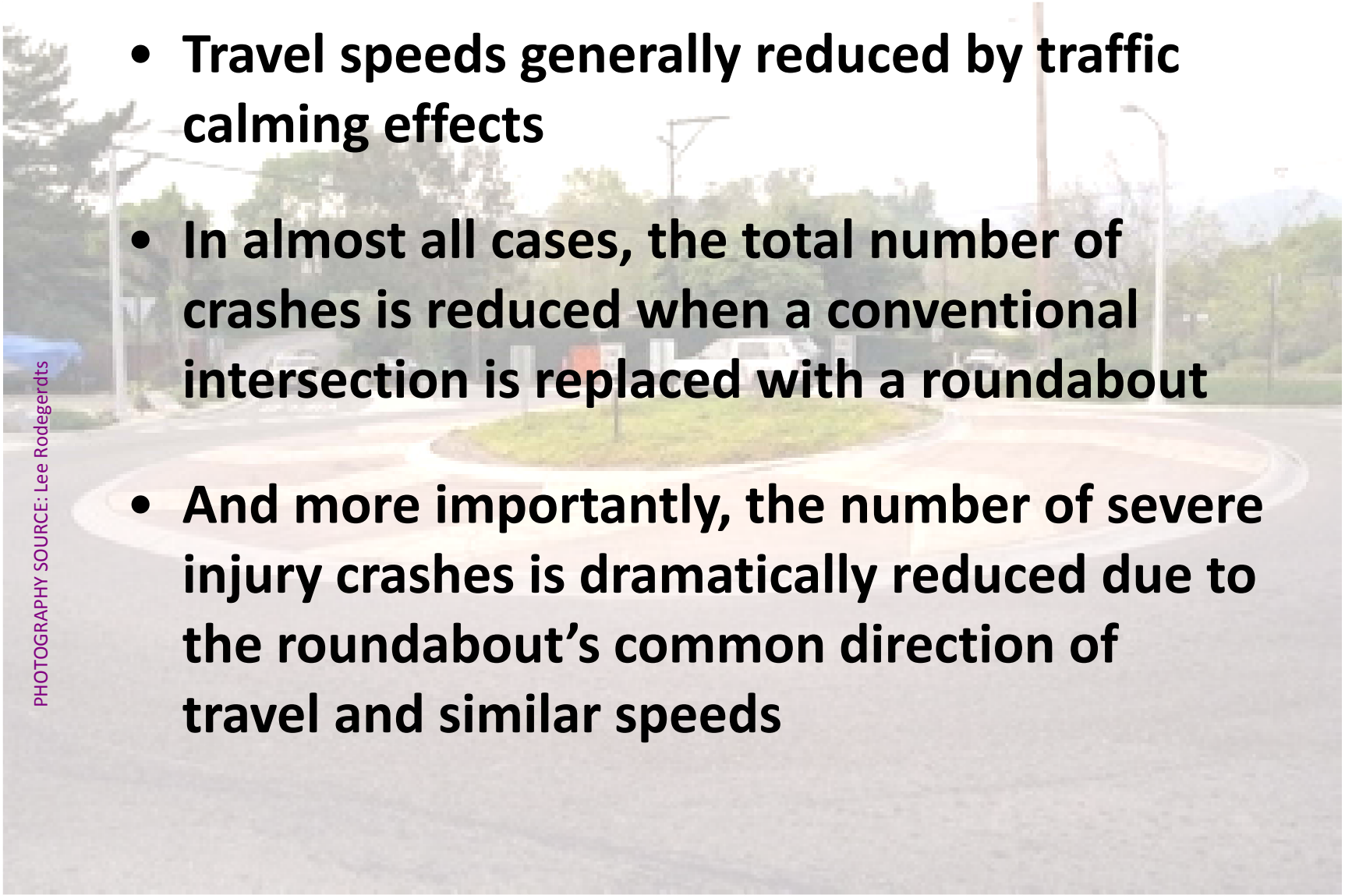
How do typical types of crashes compare between conventional intersections and roundabouts?

In rural high-speed corridors

Rural TWSC intersection	Roundabout



Summary of the Roundabout Safety Features



PHOTOGRAPHY SOURCE: Lee Rodegerdts

- Travel speeds generally reduced by traffic calming effects
- In almost all cases, the total number of crashes is reduced when a conventional intersection is replaced with a roundabout
- And more importantly, the number of severe injury crashes is dramatically reduced due to the roundabout's common direction of travel and similar speeds

MULTIPLE ROLES

To Address *Performance Deficiencies / Needs*

- **HOT SPOTS (at intersections)**
  - **Safety**
  - **Operational bottlenecks**
  - **challenging Access points**
- **CORRIDORS**
  - **Main Streets, School Zones**
  - **Small towns in rural areas**

MULTIPLE ***ROLES***

As a standard or "best" (traffic control) practice

- **During the planning / scoping of capital projects**
  - **New intersections or interchanges**
  - **Capacity expansion**
    - **Intersection / Interchange / Mainline**
  - **High-speed environments**
  - **Interchange Ramp Terminals** (transition points)
- **To provide a "Complete Street"**
  - **Infrastructure for all users**
- **As a best CSS strategy**
  - **traffic calming**
  - **part of *Road Diet plan***

questions

Bicycle Considerations (options)

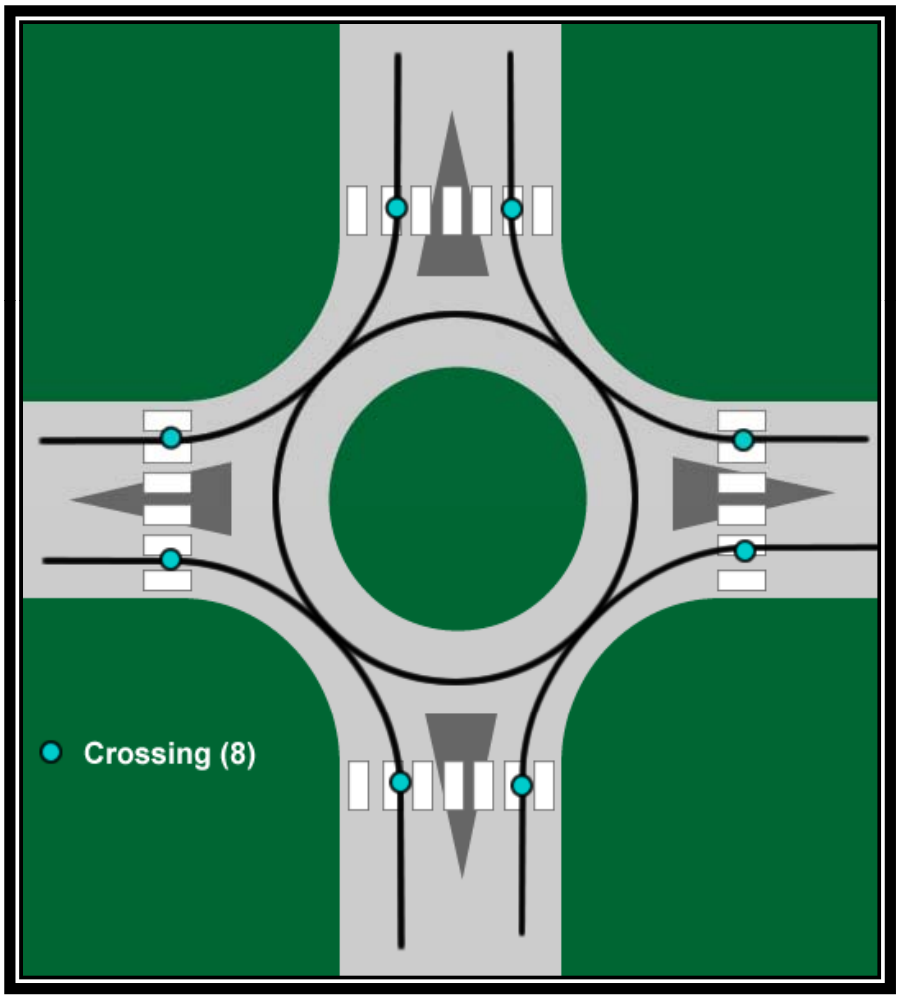
PHOTOGRAPHY SOURCE: Lee Rodegerdts

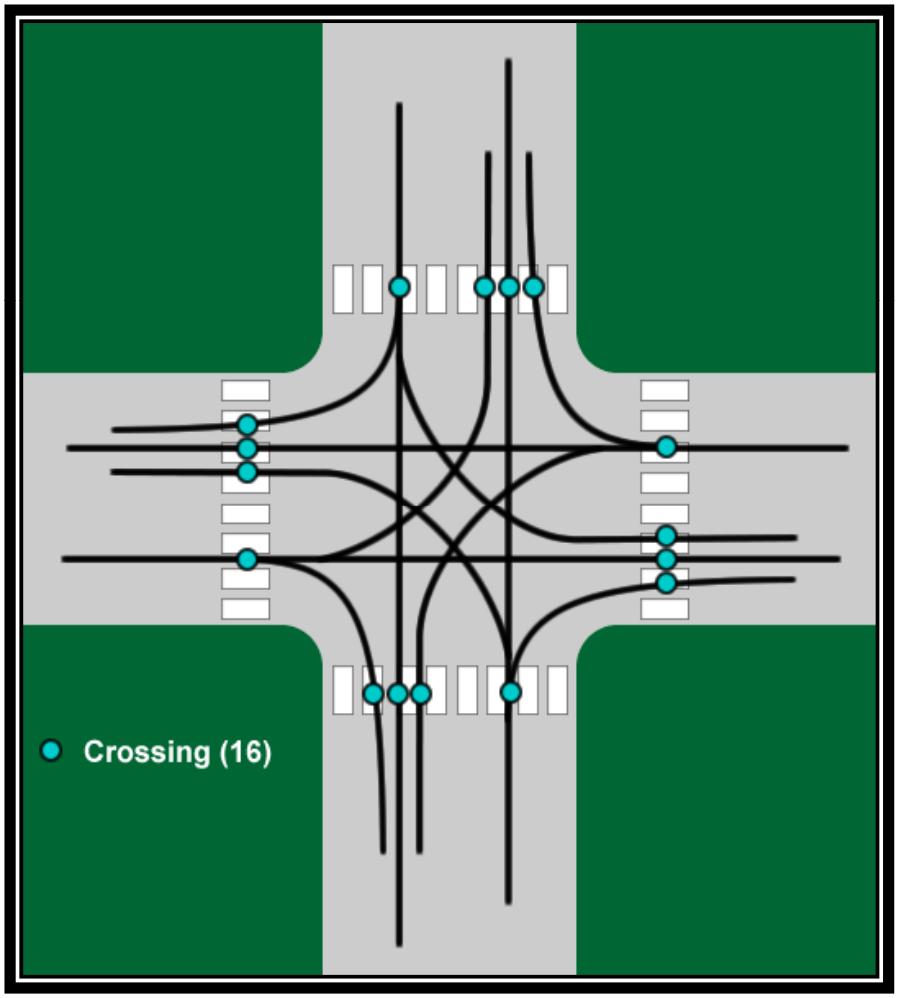
Excerpt from Caltrans 2010 Publication:
"COMPLETE INTERSECTIONS:
A Guide ... for Bicyclists and Pedestrians"

"Numerous studies have shown that single-lane roundabouts have the potential to increase both motor vehicle capacity and motor vehicle capacity safety."

" … (roundabouts) should be considered at locations where signalization is warranted; where they could effectively address safety issues; or where new roads create new intersections."

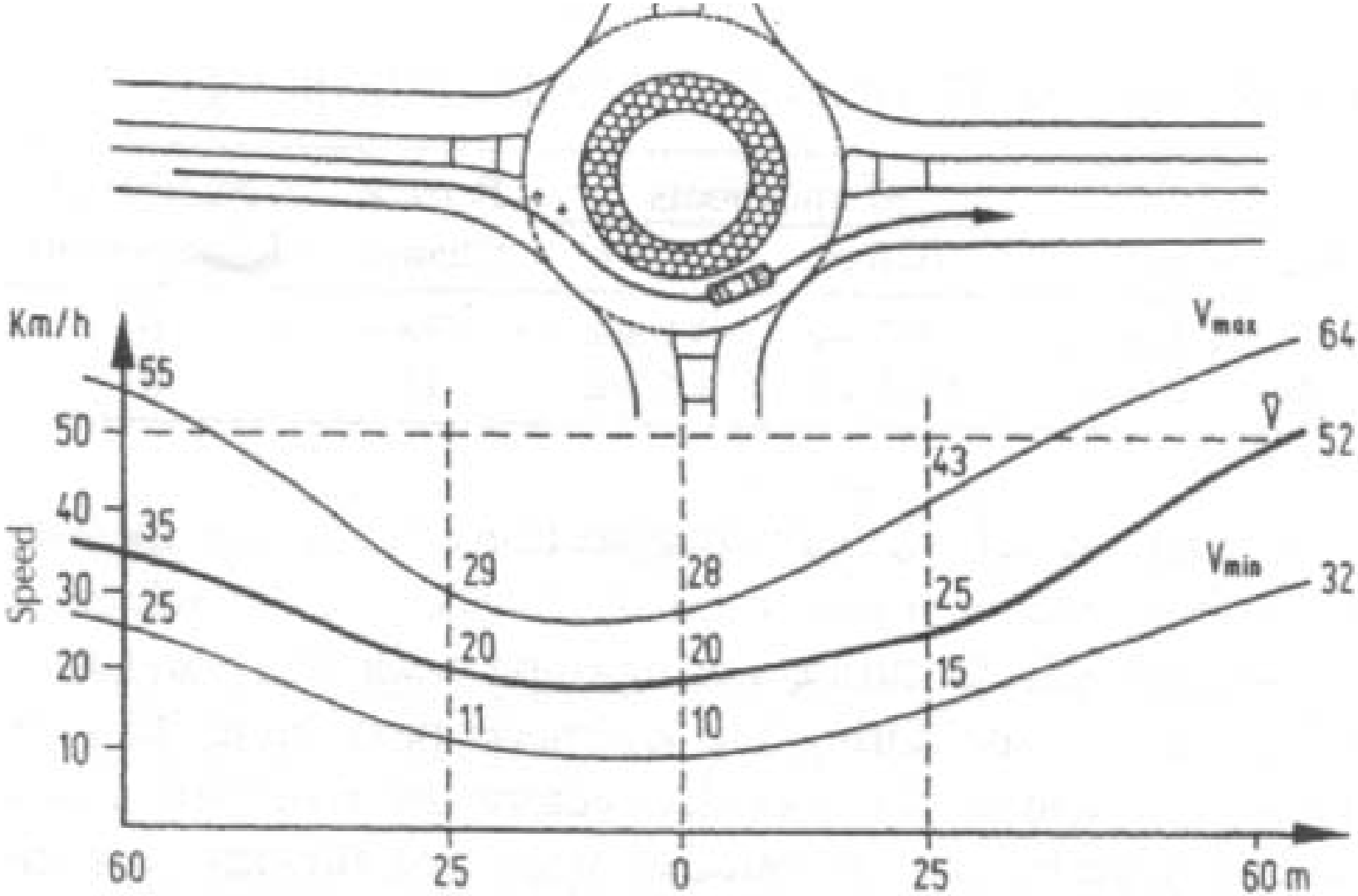
Vehicle-Pedestrian Conflict Points





Slide 12 - JC

Vehicle Speeds: REDUCED

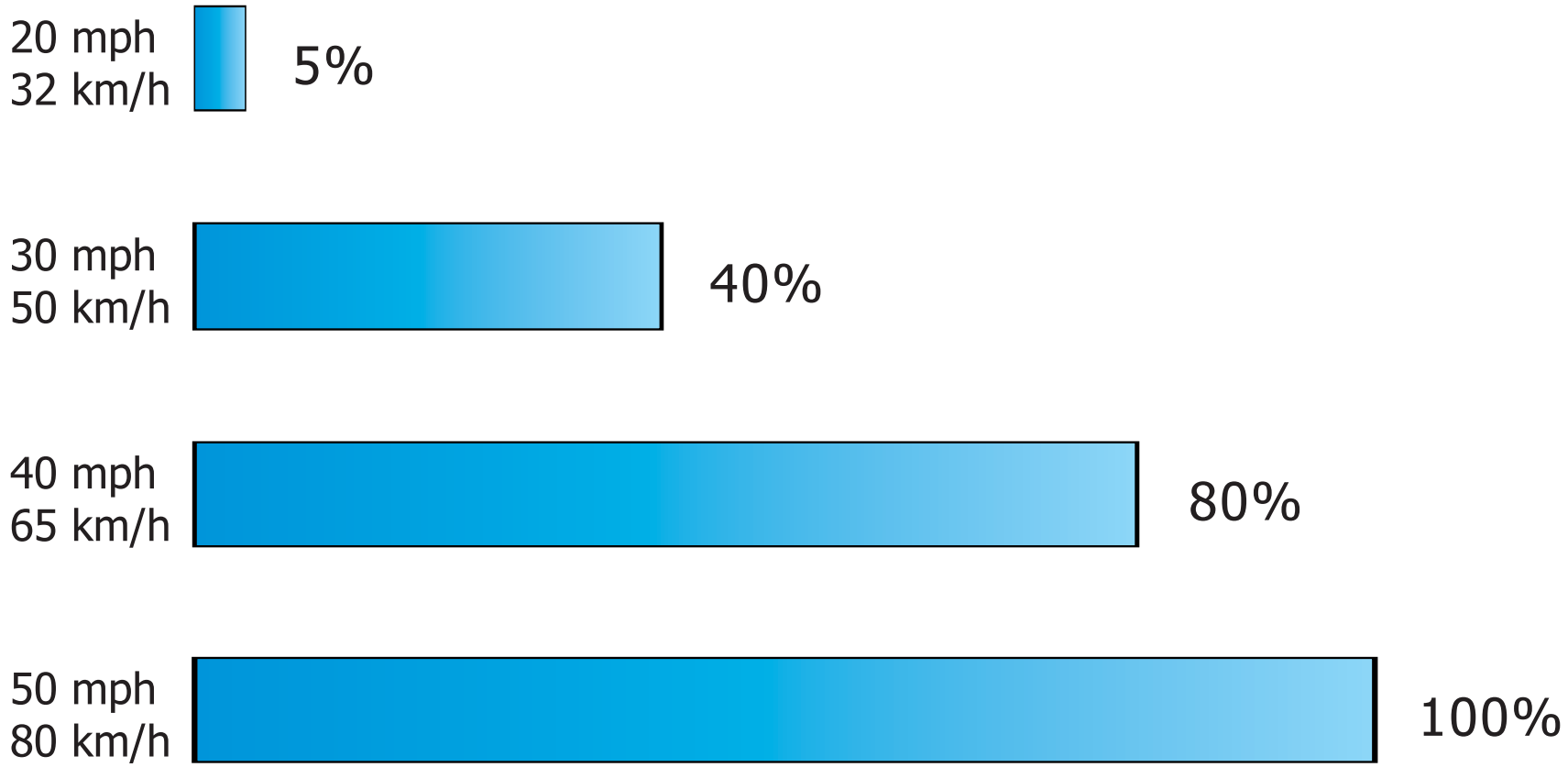


Source: Werner Brilon

PHOTOGRAPHY SOURCE: Lee Rodegerdts

Lower speed is safer for pedestrians

Chance of pedestrian death if hit by a motor vehicle



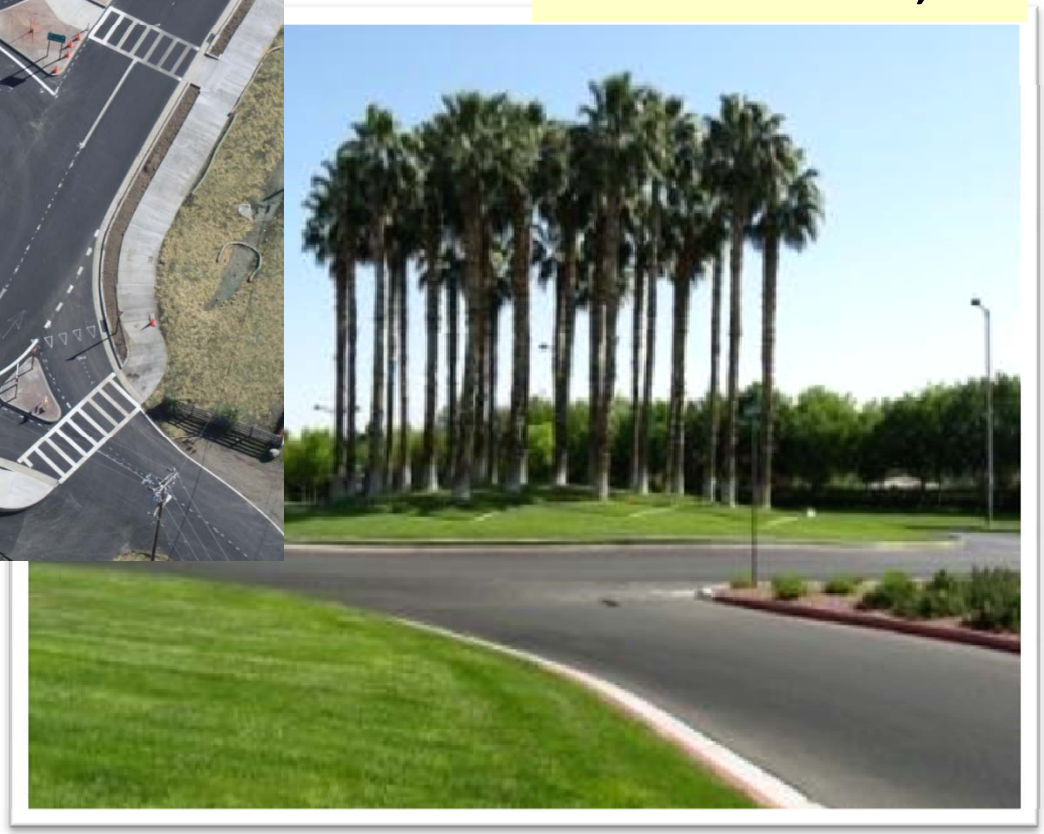
NCHRP Report 672, Exhibit 5-15

Experience Across the U.S.

From zero to more than 2,000 since 1990

Ft. Bragg, CA

Summerlin, NV



Vail, Colorado

Experience Across the U.S.

From zero to more than 2,000 since 1990

- **What Next?**
  - **Lead States:**
    - **Systematic Approach to Consideration**
    - **Corridor Approach**
  - **FHWA**
    - **Technology Transfer**
    - **Technical Assistance**
  - **Caltrans?**

Caltrans Experience (to date)

At intersections with California State Highways

- **16 roundabouts are operational**
  - **One is in a high-speed environment**

Palmdale (L.A. County) – SR 138

Caltrans Experience

At intersections with California State Highways

- 16 roundabouts are operational
  - One is in a high-speed environment
  - 10 at interchange ramp terminal intersections
  - Five of 16 are in District 3 (Four in Truckee)

City of Truckee 2-Lane Roundabouts

I-80 Interchange with SR 89 (S)

Caltrans Experience

At intersections with California State Highways

- **16 roundabouts are operational**
  - One is in a high-speed environment
  - 10 at interchange ramp terminal intersections
  - Five in District 3 (Four in Truckee)
  - **Most are multi-lane (or hybrid)**

Pacific Coast Highway (SR 1)
Lakewood Blvd / Los Coyotes Diagonal in Long Beach

Caltrans Experience

At intersections with California State Highways

- 16 roundabouts are operational
  - One is in a high-speed environment
  - 10 at interchange ramp terminal intersections
  - Five in District 3 (Four in Truckee)
  - Most are multi-lane (or hybrid)
  - Three have 5 or more approach "legs"
  - "5 Points" was relinquished to Santa Barbara
  - At least 2 others were "approved," then rejected
- Dozens in planning & project "pipeline"
  - Seven projects in District 6 project "pipeline"
- Lots of starts, stops, unique situations & successes!

MULTIPLE APPLICATIONS

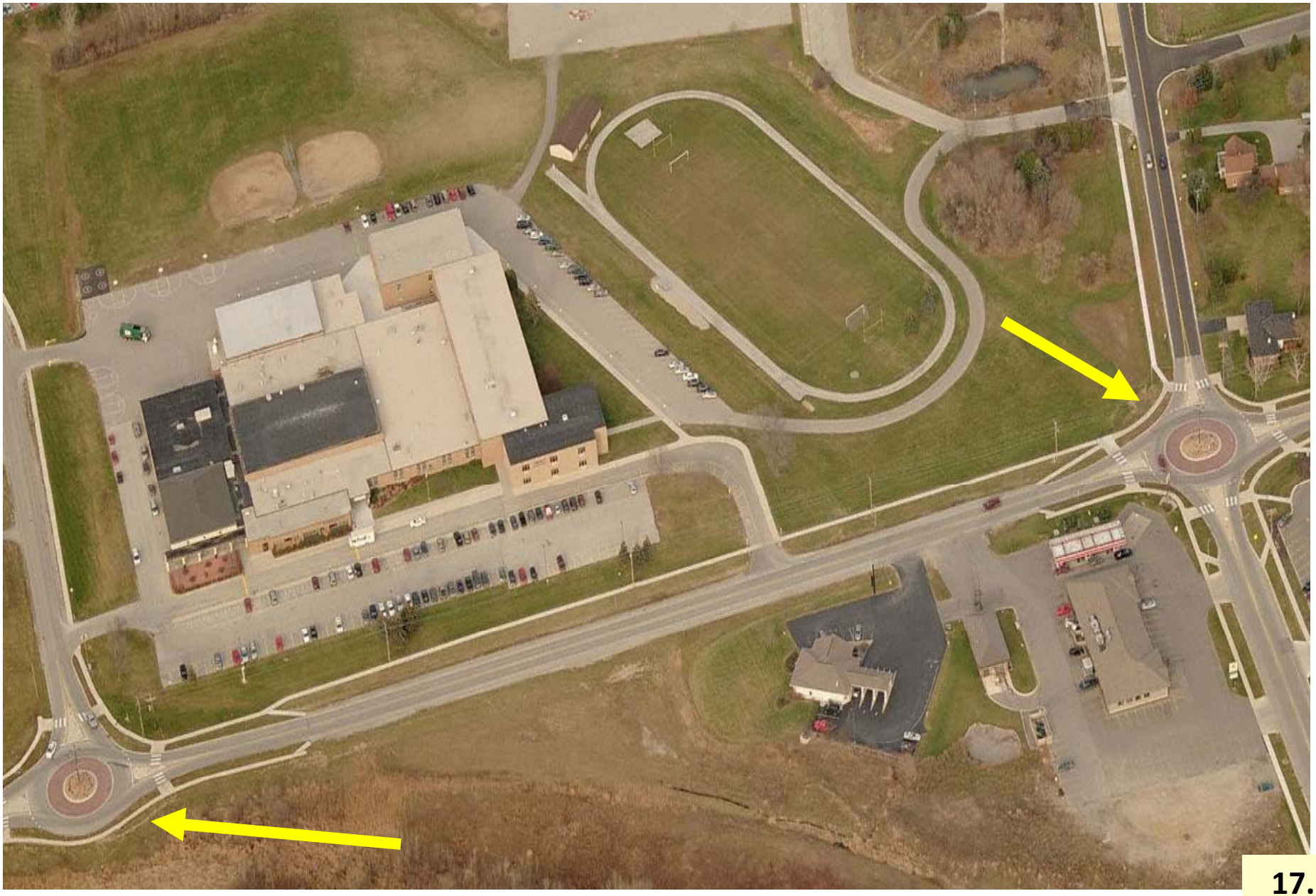
Large Developments - South Jordan, Utah

Applications: *MOBILITY*

To Reduce "Control" Delay & Queuing

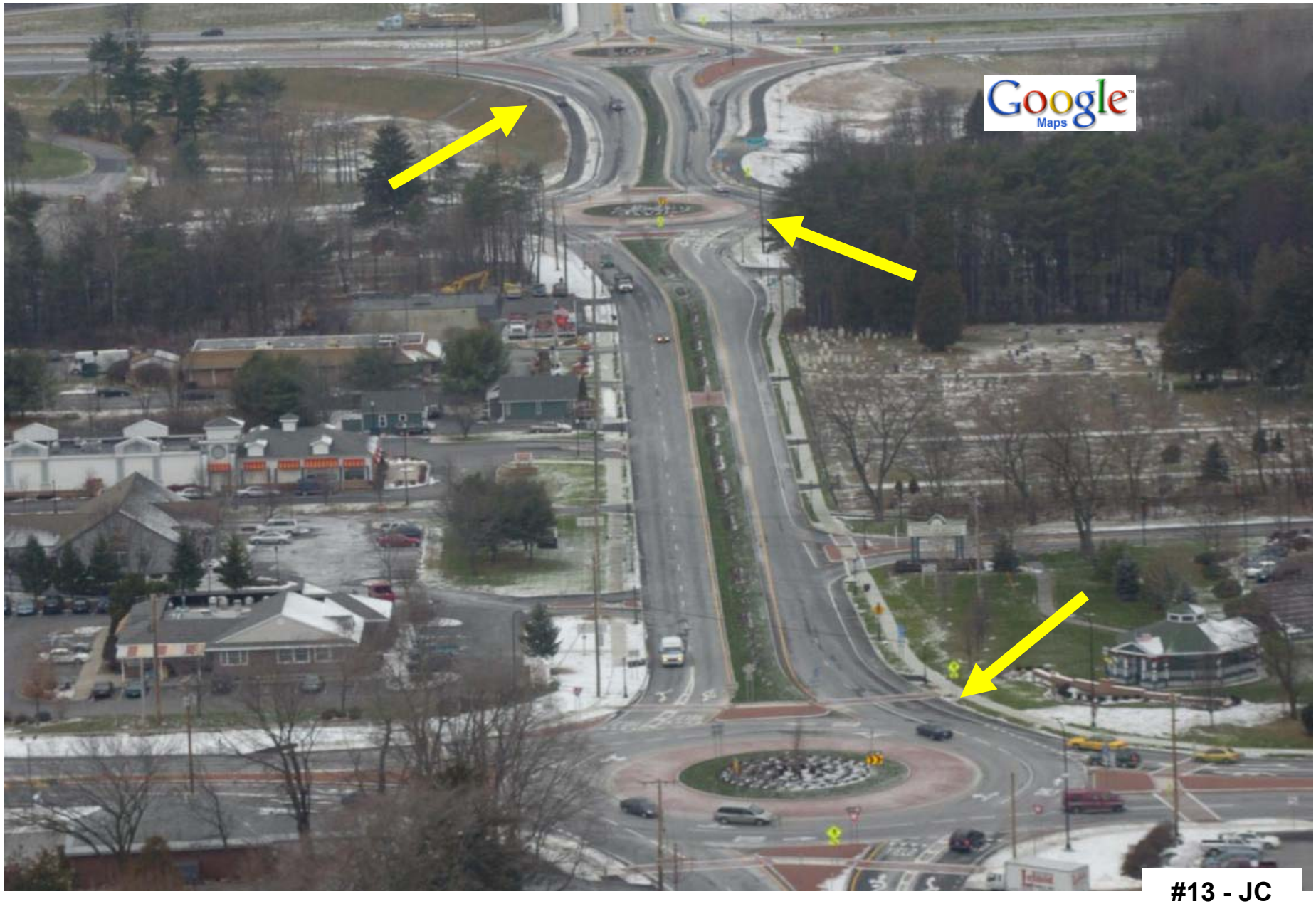
Alternative to Stop and Signal Control

Speed Management (school zone)



Rural (High Speed) Corridors

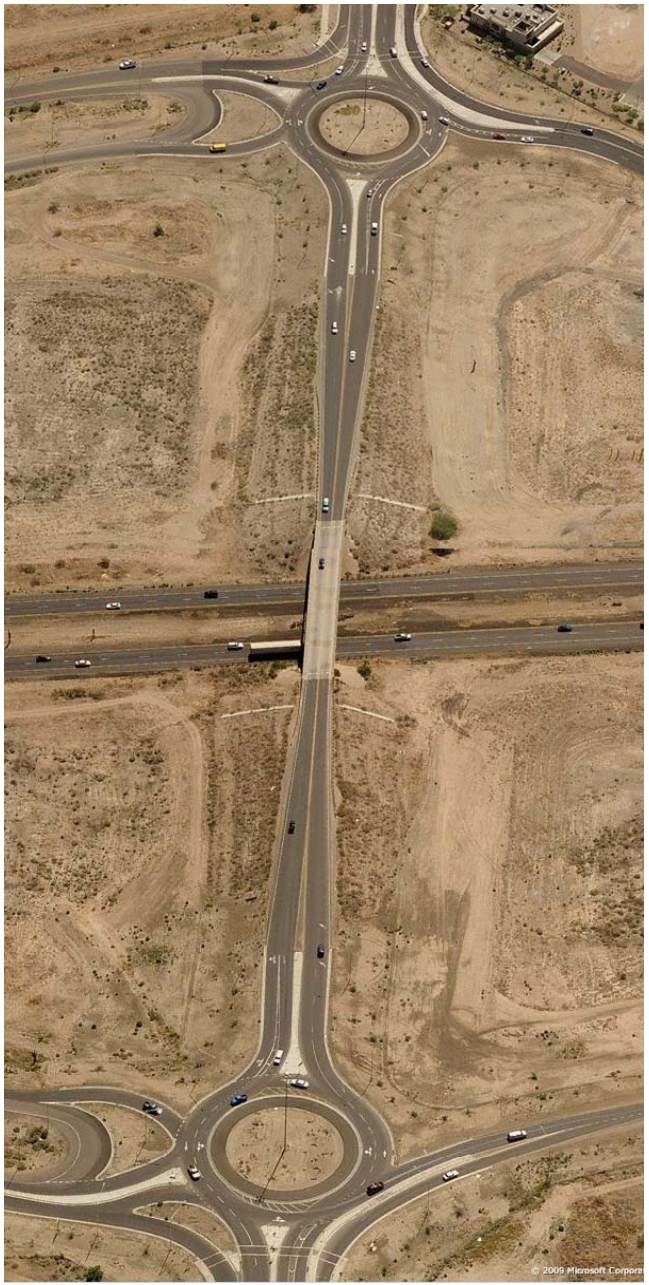
Roundabouts & Access Management



#13 - JC

Roundabouts at Interchanges

- **Less queuing (ramp storage)**
- **Scope / Cost (e.g. bridge width)**



Gateway / Speed Transition (Traffic Calming)

TOWN OF
TRUCKEE
Established 1863
Incorporated 1993
N
Feet
0
50
100
200

Aesthetics

The Expanding Role of *ROUNDABOUT INTERSECTIONS*

What is the Department's "plan" for expanding the role of roundabouts to meet the mobility, safety, environmental and resource challenges facing the State Highway System?

The Expanding Role of *ROUNDABOUT INTERSECTIONS*

What is the Department's *PLAN* for expanding the role of roundabouts to meet the mobility, safety, environmental & resource challenges facing the SHS?

There is a Plan, but it's not the Department's

- ***COALITION***
  - ***M*ulti-state DOT, Agency & disciplinary partnership *via* Strategic Safety Plan & FHWA**
- **Intersection <u>Performance</u> Initiative**
  - ***Intersection Control Evaluation Policy***
- **Executive & Partner Support (Nov 9th)**

PLAN for Expanding the Role of *Roundabouts in CA*

- ***Focus on State Highway System*** (first)
- ***Adopt approach, and use resources, guidance, tools and expertise developed by Lead States and FHWA***
  - **Policy, Process & Guidance Updates**
    - *Divisions of Planning and Design*
    - Division of **Traffic Operations**

- **Performance-based approach to the evaluation & selection of Intersection Control**

Intersection Control Evaluation
A POLICY PROJECT

TARGET:

- Premature selection of Intersection Control
- Core Business Functions
  - Transportation Planning processes
  - Traffic Operations & Safety Programs
    - Signal and Stop Control policy/warrants
    - Traffic Operational & Safety Analysis
  - Project Planning

Intersection Control Evaluation
A POLICY PROJECT

END-PRODUCTS:

- ***PROCESS** that will increase consideration, assessment or analysis of yield-control when a new intersection or change in "control" at existing intersection is contemplated*
- ***RESOURCES & TOOLS***
- ***SERVICES:***
  - ***TECHNICAL SUPPORT (FHWA model)***

Until 2013 ….

ADVICE / TIPS
to Facilitate Decision-Making

- **Be *OBJECTIVE***
  - **Rely upon engineering analysis**
    - **estimated performance outcomes (benefits)**
  - **Rely upon Benefit / Cost analysis**
    - **"apples – apples" comparison among alts**

- **Respect** (don't neglect) **Design *PRINCIPLES***
- **Focus on providing adequate "Footprint"**
  - **This will facilitate "substantial compliance"**
  - **This will produce desired speed environment**
    - **For all users (e.g. trucks)**

ADVICE / TIPS
to Facilitate Decision-Making

- Be OBJECTIVE
- Respect Design PRINCIPLES

- **CONSULT with:**
  - **Partners**
  - **Experienced / knowledgeable practitioners**
  - **Independent experts (peer review)**
  - **Those who <u>analyze</u> & <u>operate</u> highway systems**

- **Focus on Purpose & Need** (for Investment)
  - **Includes Value and/or Benefits to Community**
    - **e.g. Lower speeds; facilitates "road diet"**

Getting Used to Roundabouts

National studies show that communities usually oppose the idea (roundabouts) at first, Washington State DOT engineer Brian Walsh said, *"our experience here in Washington have mirrored that; we have had a lot of people not very happy about the idea of roundabouts, but after they are constructed, those fears mostly go away."*

Washington State DOT built its first state-highway roundabout in 1998 in Port Orchard, where a triangular intersection on Highway 160 had produced 39 crashes in three years. In the first 18 months after the roundabout opened, only two accidents occurred.

The Seattle Times June 5, 2002

PHOTOGRAPHY SOURCE: Lee Rodegerdts

RESOURCES

- **FHWA Website (comprehensive)**
  - **Peer-to-Peer Program (P2P)**

How to get Peer Assistance

The first step to using the P2P Program is to let us know you need assistance. There are several ways to reach us; you can call, send an email, or apply online. Whichever method you use, the FHWA Safety P2P Coordinator will be ready to assist. The coordinator will determine your specific questions or issues and match you with the best Peer for your case.

CONTACT: P2P Hotline: (866) P2P-FHWA

email: RoundaboutsP2P@dot.gov

Roadway Safety Peer-to-Peer Program

RESOURCES

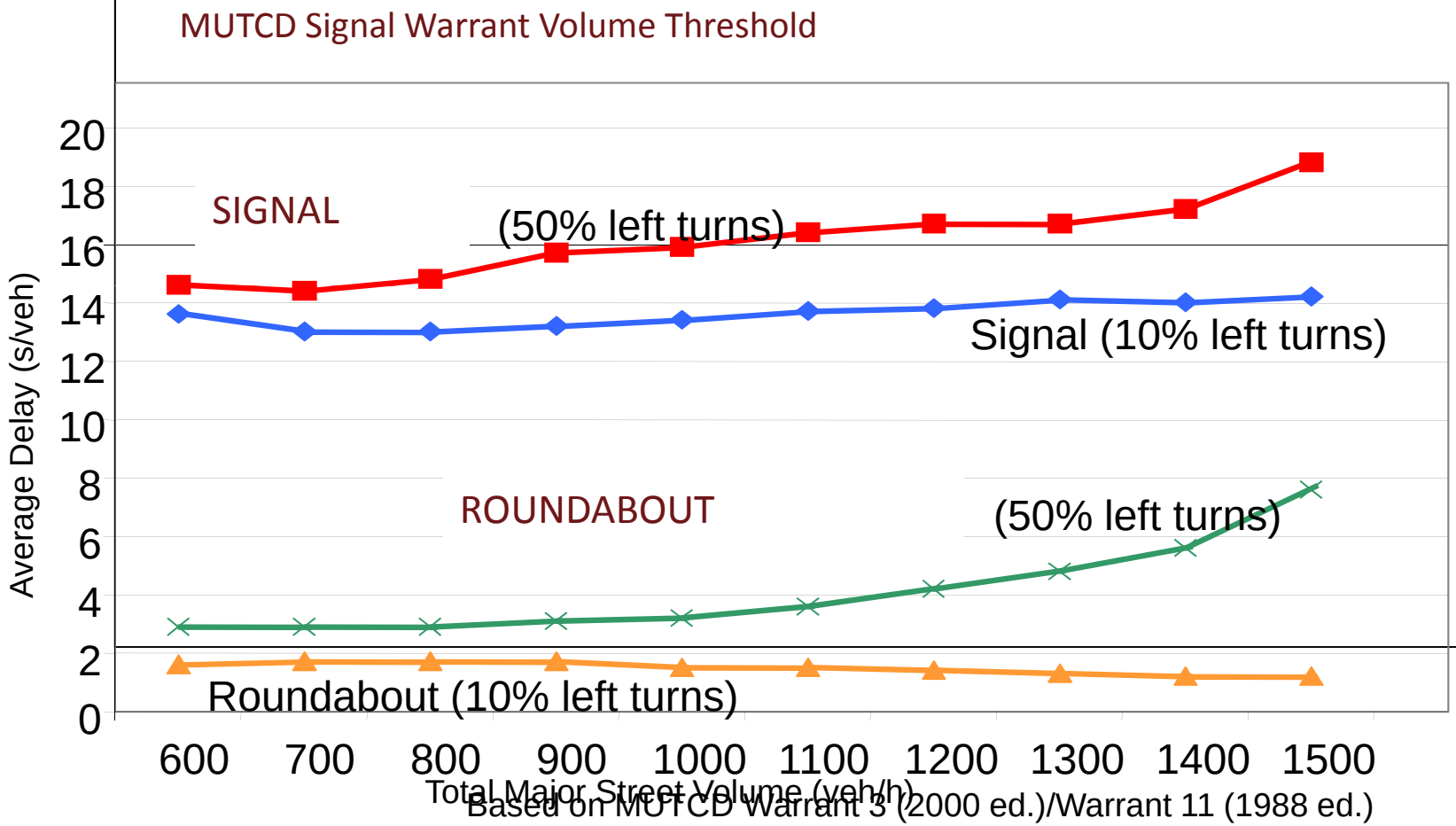
- **FHWA Website (comprehensive)**
  - **Peer-to-Peer Program (P2P)**

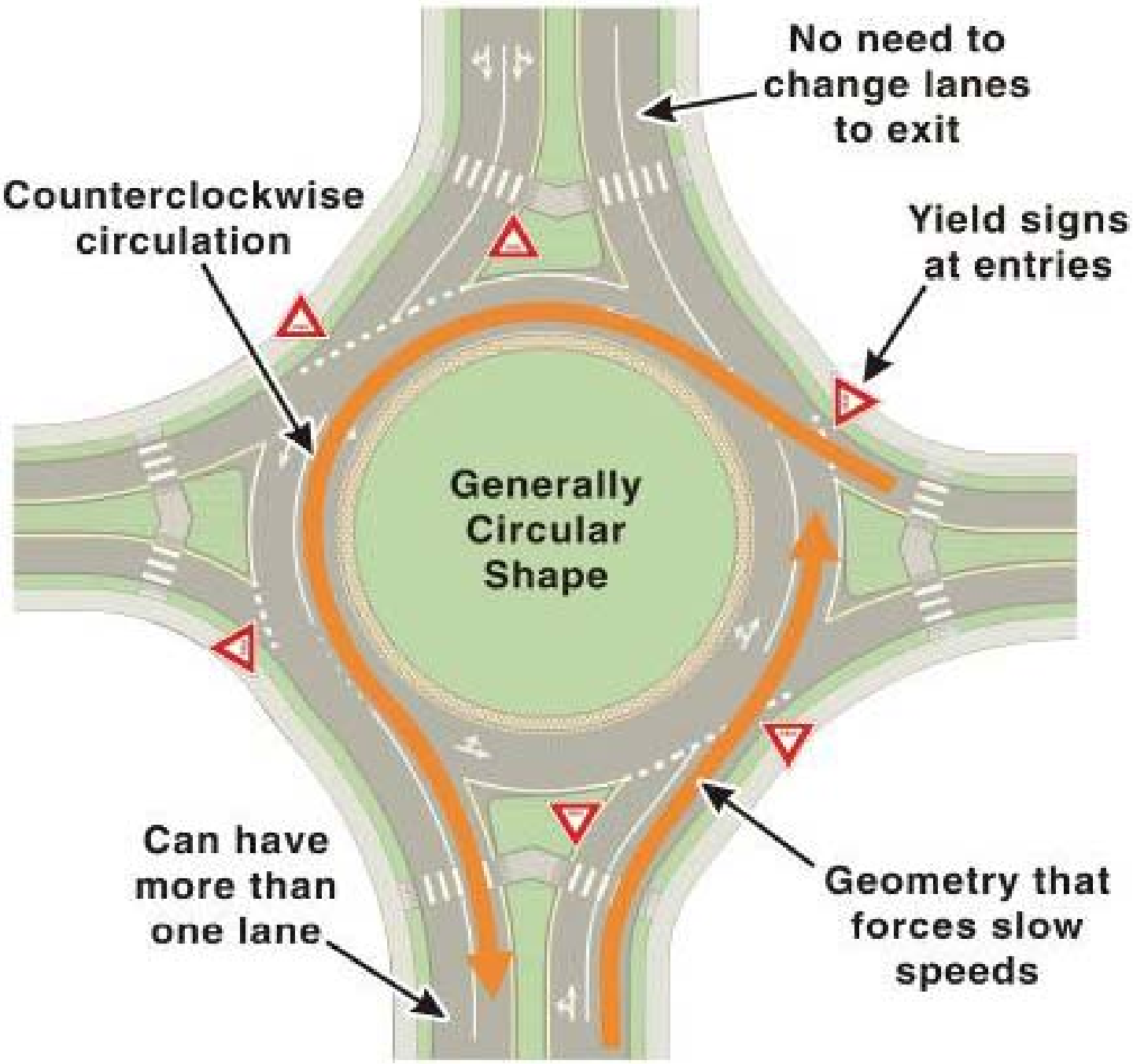
- **Caltrans Websites**
  - Design: ***Design Information Bulletin 80.1***
  - Traffic Operations: ***CA MUTCD***
  - Planning**: Inventory / Resource** document
    - **Practitioners**
    - **PMK's or SME's** (for technical assistance)
      - **Geometric Design**
      - **Traffic Operational & Safety Analysis**
      - **Conceptual Approval**

QUESTIONS

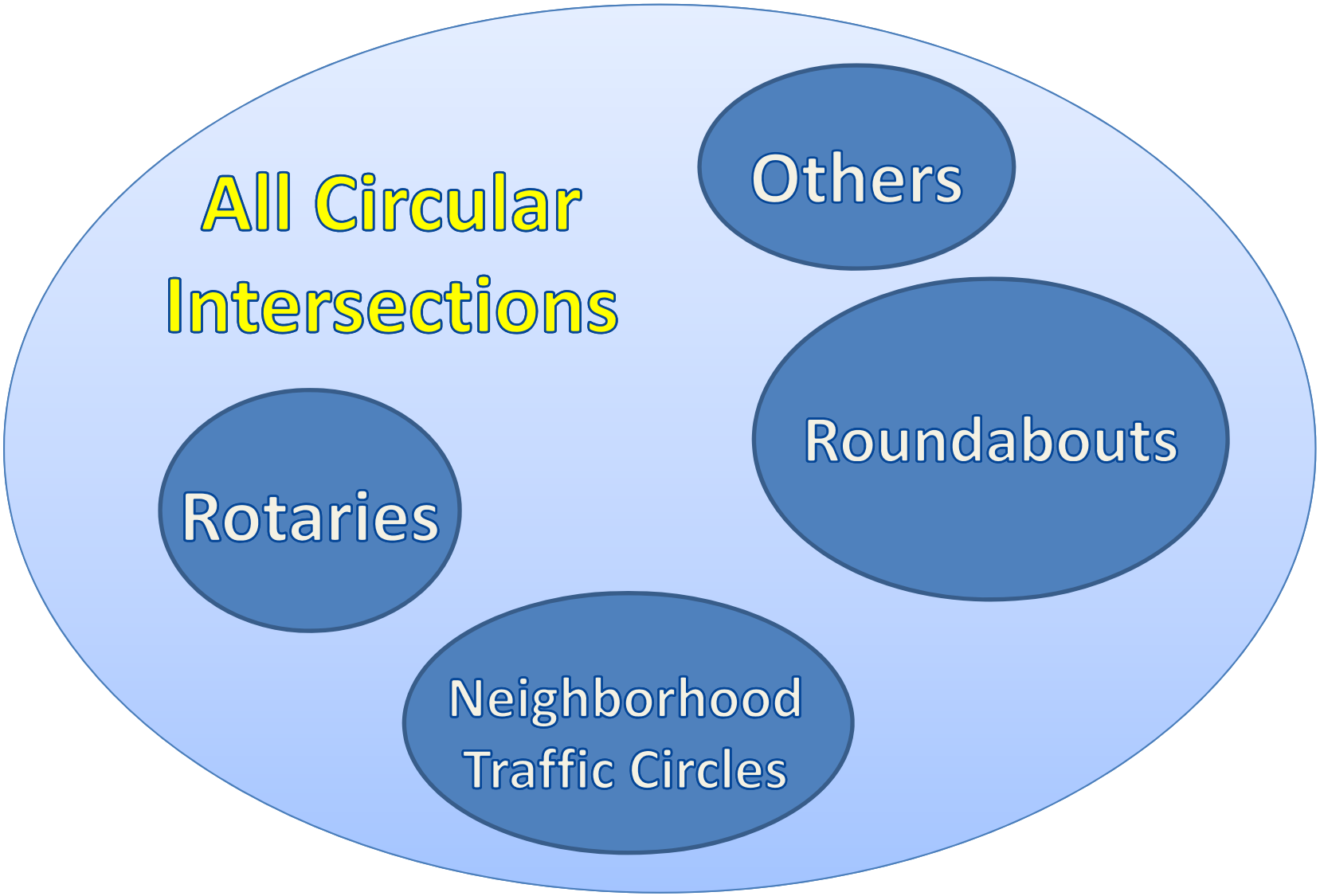
Roundabouts at Interchanges

Roundabouts Often Have Less Delay Than Signals




No need to change lanes to exit
Counterclockwise circulation
Yield signs at entries
Generally Circular Shape
Can have more than one lane
Geometry that forces slow speeds

Terminology



Why a Roundabout?

Improve safety

Reduce congestion and pollution

Save money

Complement other common community values

Safety Aspects of Roundabouts

- **C**
- **F**
- **A**
  p

Intersection Crash Statistics (nationally)

- 27.3 % of all reported crashes
- Almost 25% of all traffic fatalities
- Almost 50% of all traffic injuries
- About 55% of all crashes are related to Access
- Traffic Signals increase crash frequency

NEW YORK STATE

Department Of Transportation

- NYDOT- "Signal Policy"
- "When the analysis shows that a roundabout is feasible, it should be considered the Department's preferred alternative due to the proven substantial safety benefits and other operational benefits."

Keys to Success

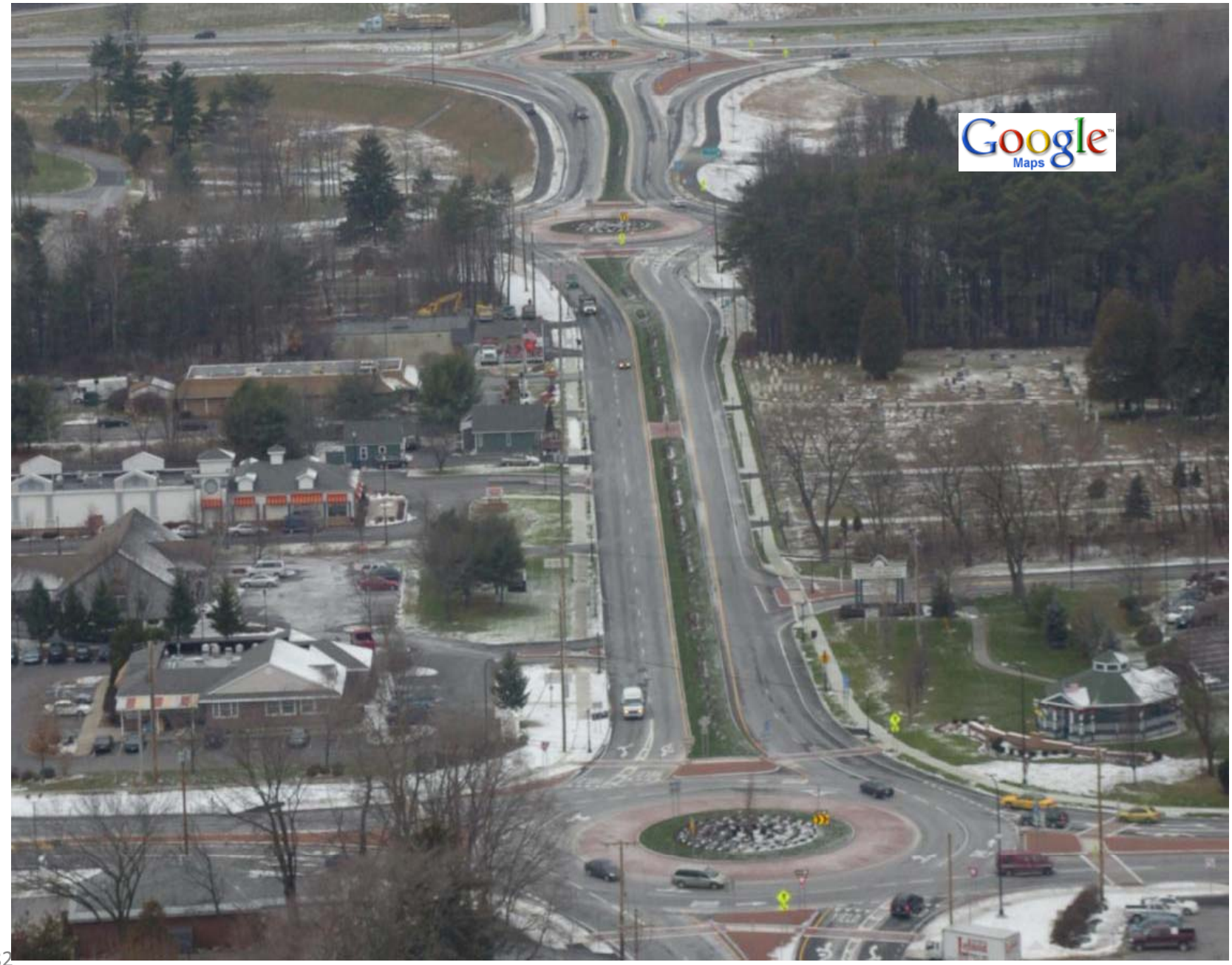
- Proper design
- Public involvement
- Stakeholder support

Why Roundabouts?

- Roundabouts are being considered as viable or even preferred alternatives due to a number of potential benefits:
  - Safety performance
  - Operational performance
  - Environmental benefits
  - Land use
  - Access management
  - Operations and maintenance costs
  - Aesthetics

- Roundabouts are often, but not always, the best choice – make a case-by-case evaluation

Right-of-Way Requirements


Google
Maps

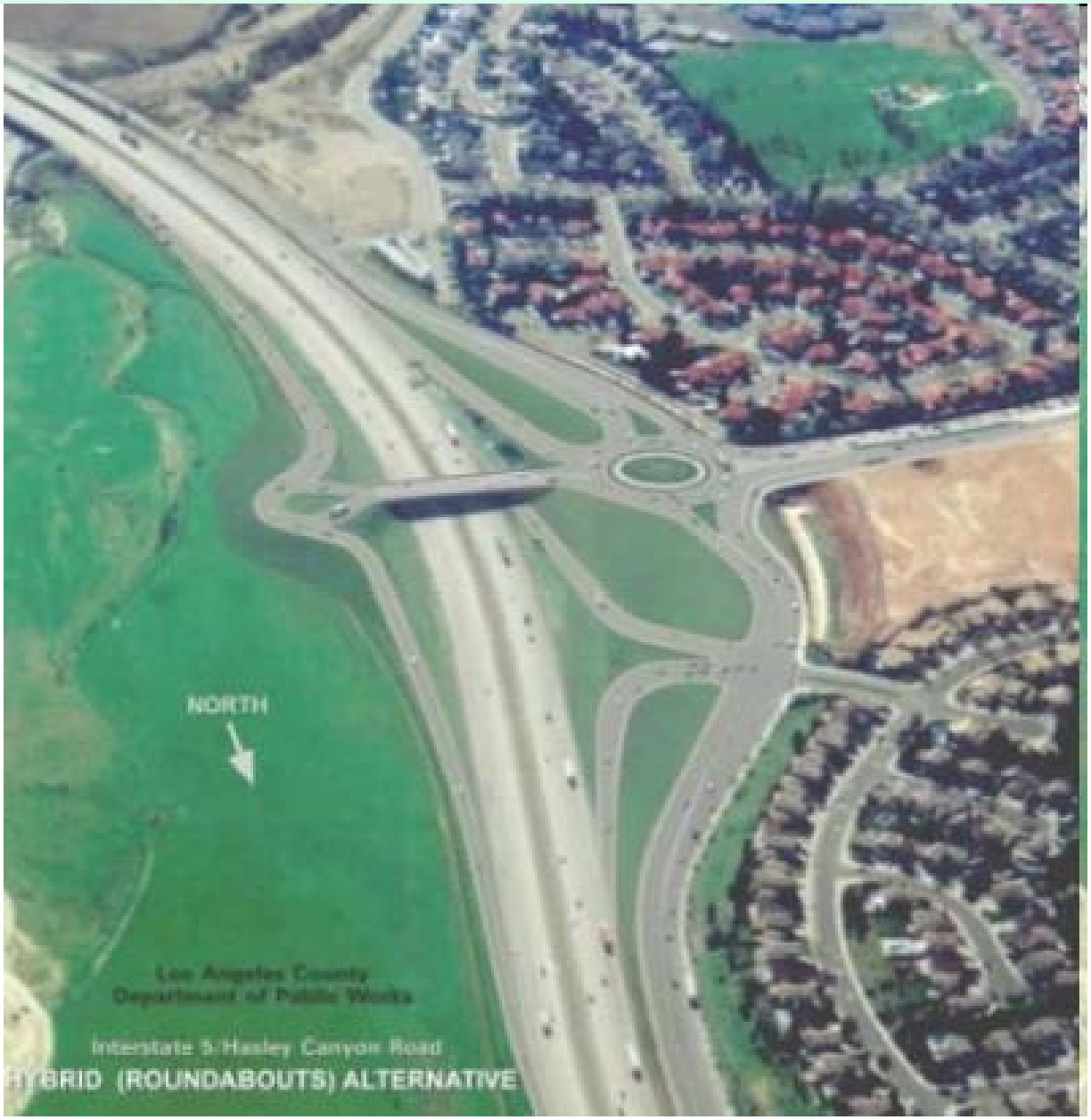
Safety is a major consideration on

In the year 2003 there were an average of 6,850 motor vehicle crashes per day at intersections in the United States.

PHOTOGRAPHY SOURCE: Fred Ranck

For transportation professionals, safety is a major concern.

Route 5/ Hasley Canyon Rd./The Old Road Near Castaic



Pacific Coast Highway (Route 1) /Lakewood Blvd / Los Coyotes Diagonal in Long Beach

Residential Subdivision: Modesto, CA

Small Towns: Howard, Wisconsin

Urban Centers: Towson, Maryland

High-Speed Rural Hwy: Paola, KS

Photos: Lee Rodegerdts

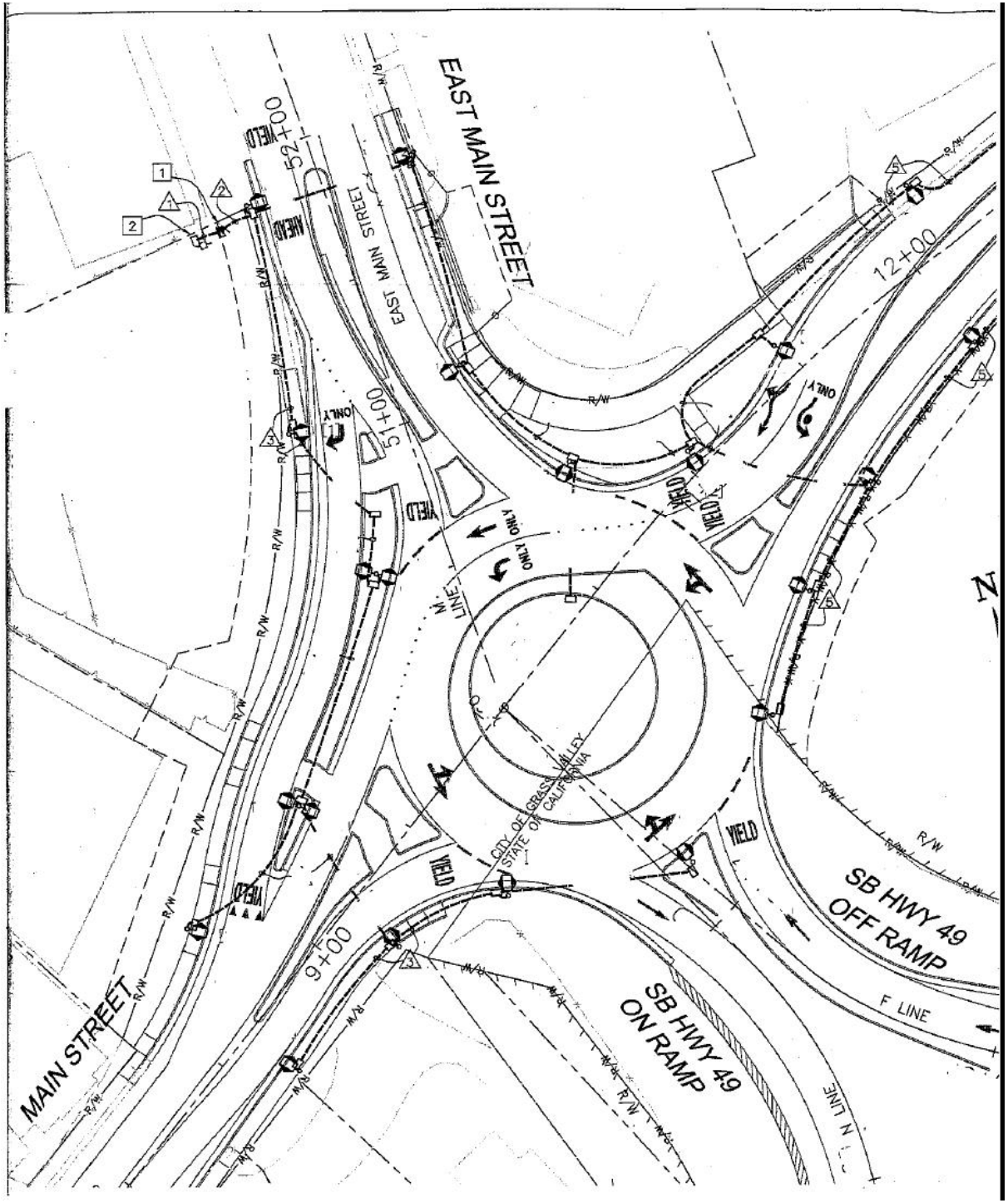
Tourist Routes - Astoria, Oregon

Large Developments – S. Jordan, UT

Northern Climates – North Pole, Alaska

Near Schools - Clearwater, Florida

Photos: Lee Rodegerdts



Grass Valley

E. Main St./ Idaho Maryland Road

EMIM

Roundabouts Informational Webinar

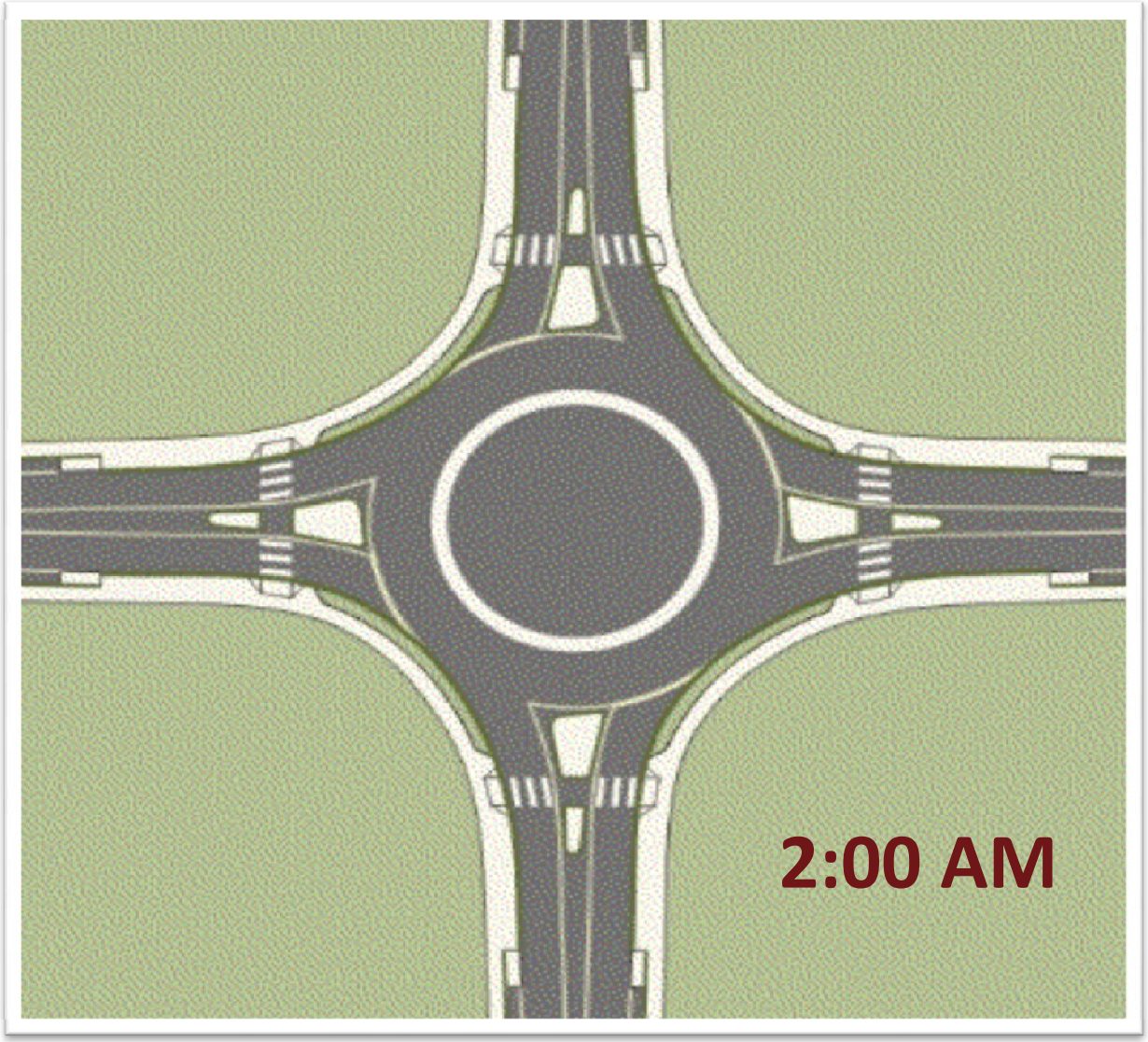
Hosted by Caltrans and FHWA

November 9, 2011

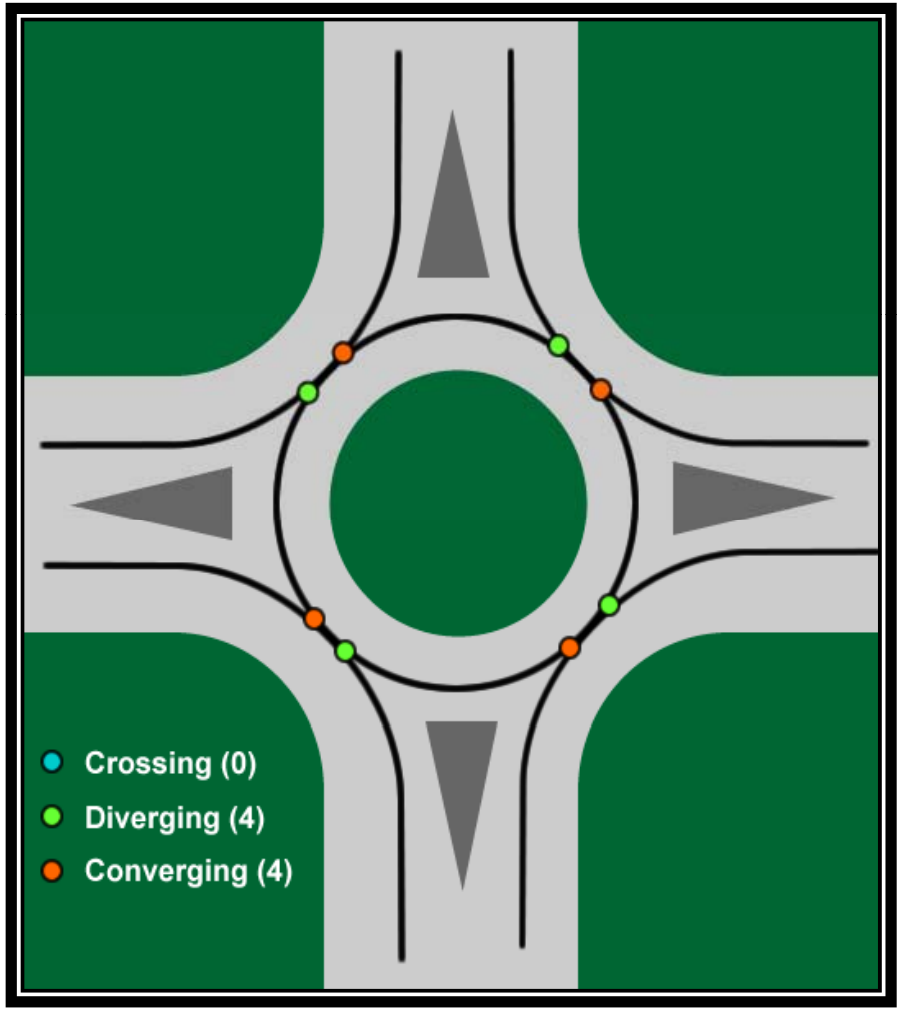
Safety Performance

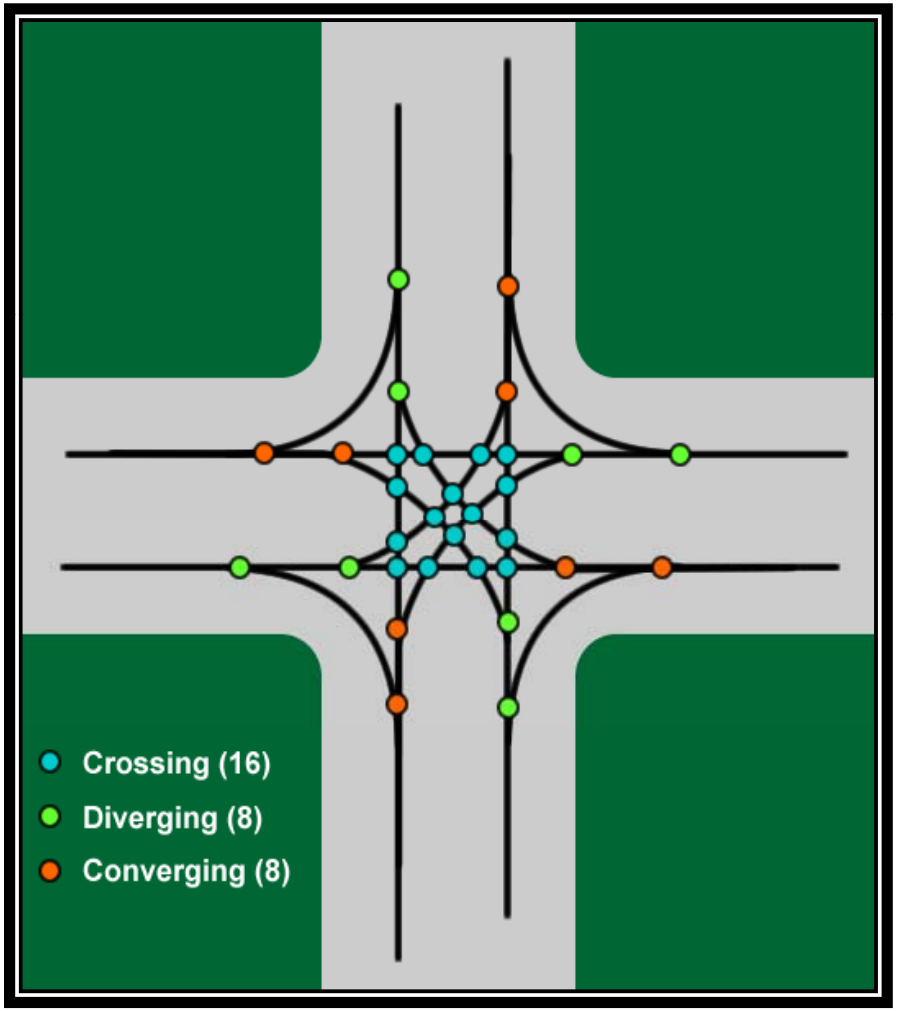
- Roundabouts have a proven safety record for reducing motor vehicle crashes, particularly injury crashes
- Experience is due to basic contributing factors:
  - Reduced vehicle speeds
  - Reduced driver decisions
  - Reduced conflict points
  - Reduced conflict severity

Operations – Roundabouts are Self-regulating



Vehicle Conflict Points





- <u>Overview</u>
- Planning (Roundabout Guide)
- Operations (2010 HCM, Rbt Guide)
- Geometric Design (Roundabout Guide)
- Traffic Control Devices (MUTCD, Rbt Guide)

- Resources

Testimonials (quotes)

The Second Edition of Roundabouts: An Informational Guide is now available! Please visit http://safety.fhwa.dot.gov/intersection/roundabouts/ for more information.

School crossing guard

Brian Walks

Roundabouts Peer-to-Peer Assistance

http://safety.fhwa.dot.gov/intersection/roundabouts/

For More Information

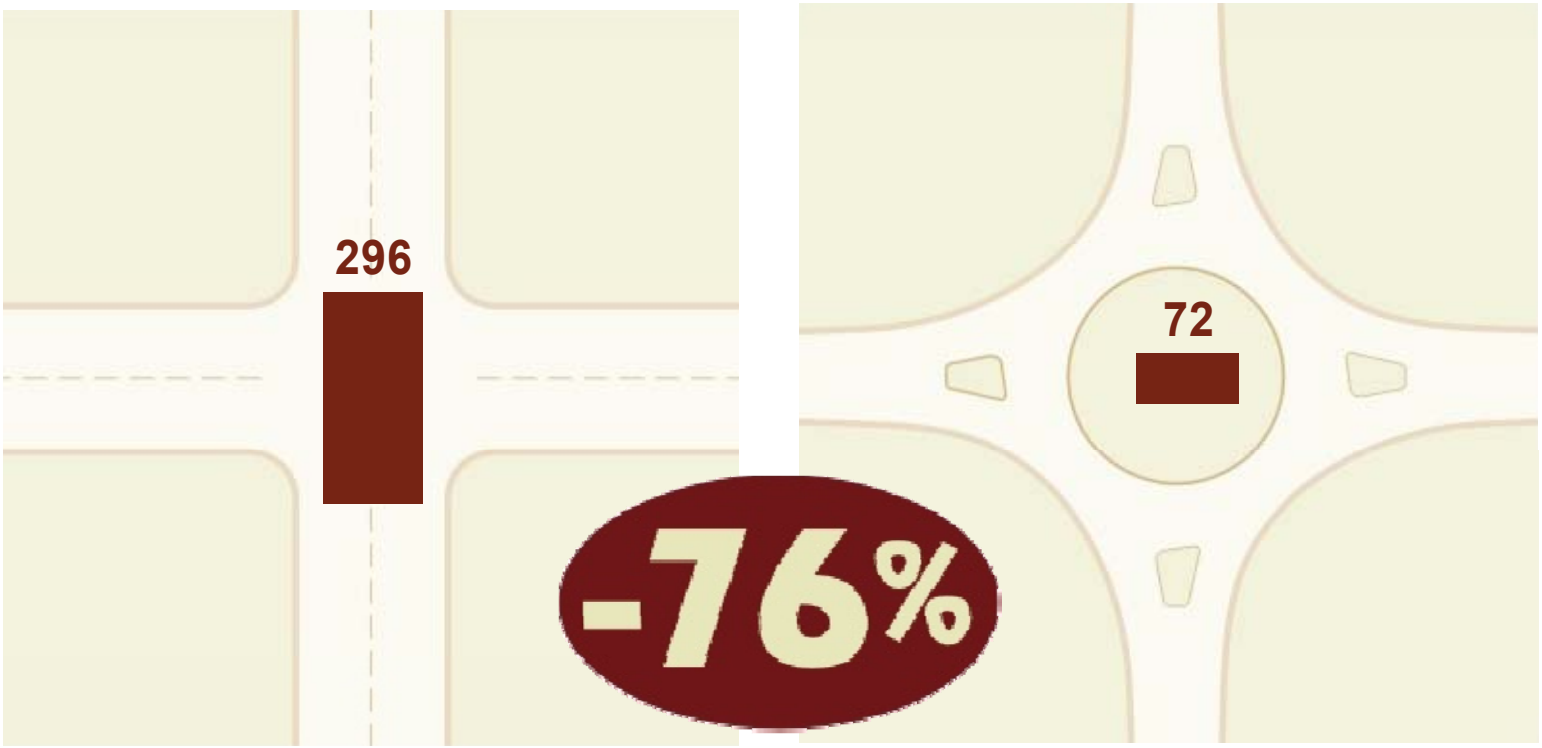
- FHWA Office of Safety
  - http://safety.fhwa.dot.gov/
- Institute of Transportation Engineers
  - http://www.ite.org/
- U.S. Access Board
  - http://www.access-board.org/
- National Cooperative Highway Research Program
  - http://www.trb.org/

How can we *cost-effectively* ***improve*** **mobility** (*travel times*) ***& safety*****,** while ***reducing speeds*** **& impacts** on the **environment?**

Isn't this what Californians *expect* from transportation policy makers?

What is the effect on severe injury rates after an intersection is converted to a roundabout?

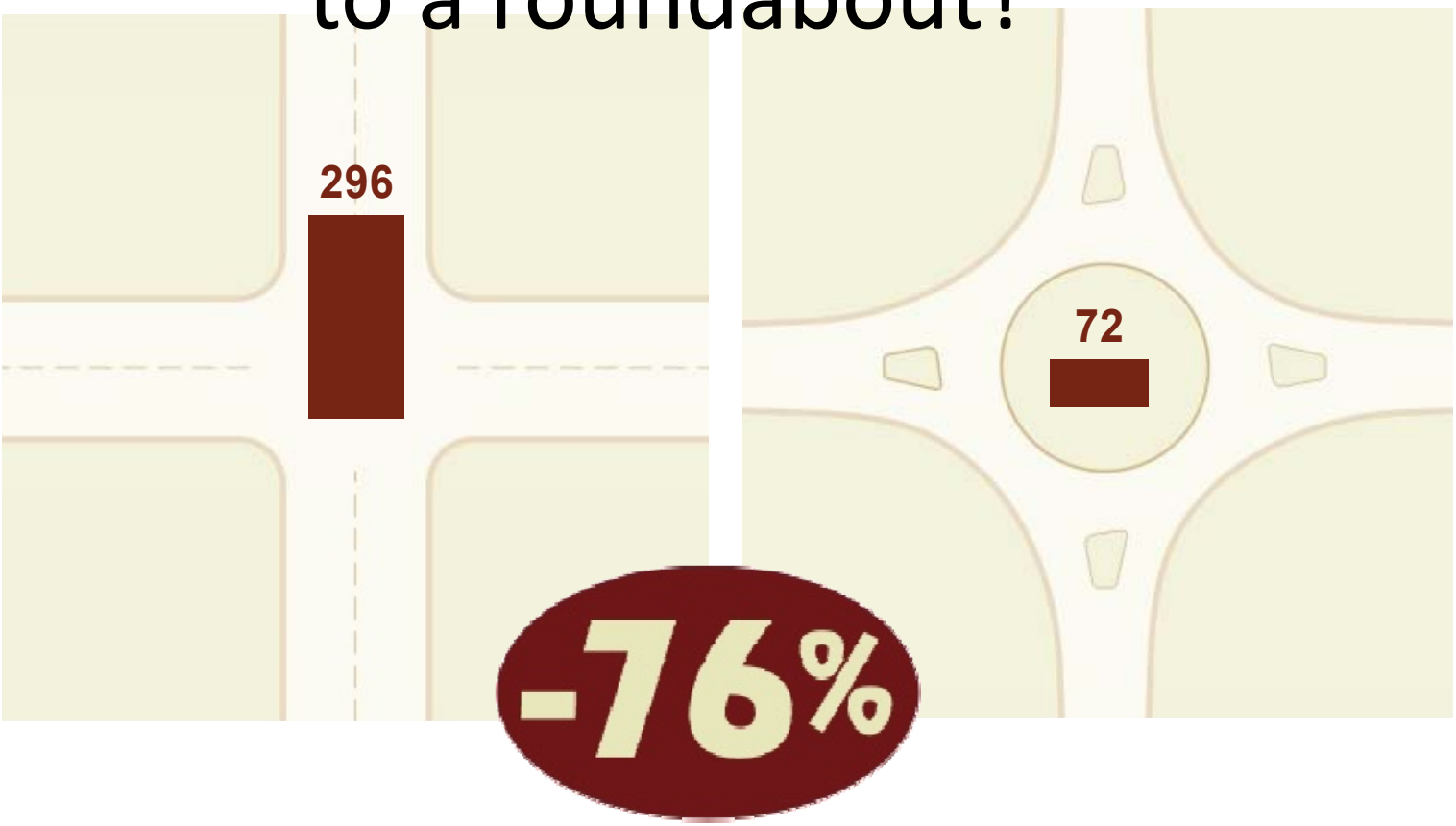
Conventional 4-way Intersection | **Roundabout**



Data from 55 intersections with at least 2 years of crash data before and after conversion of the intersection to a roundabout.

DHIPP - Nevada County

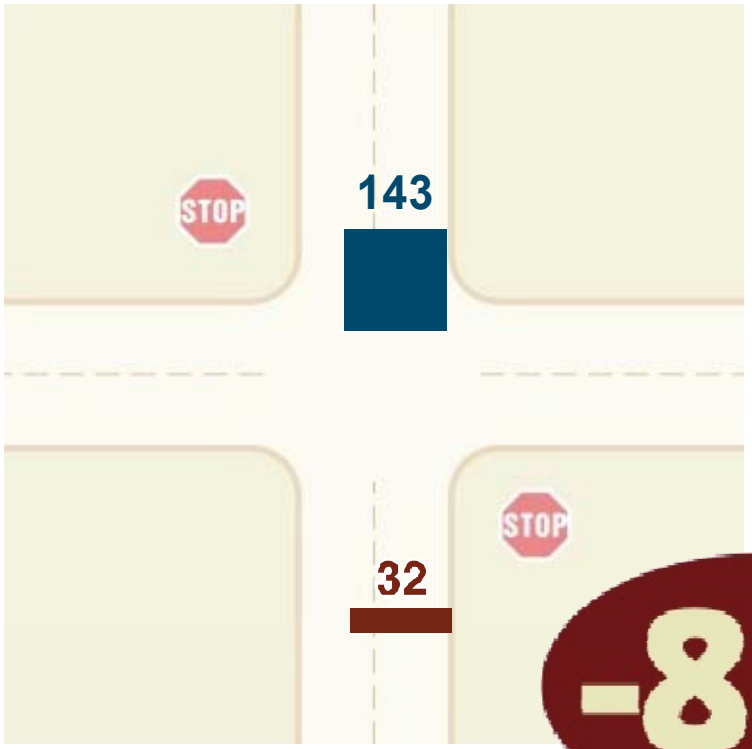
What is the effect on severe injury rates after an intersection is converted to a roundabout?

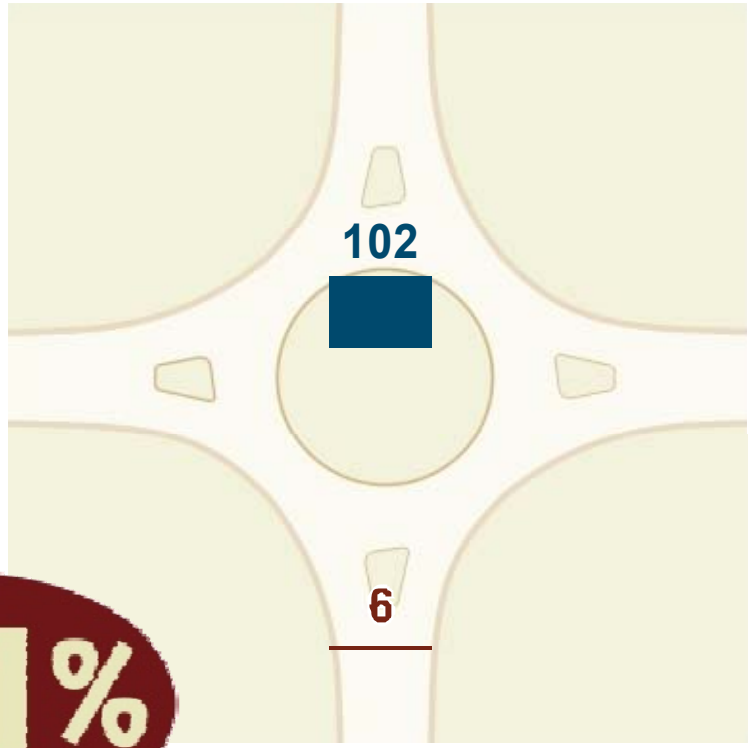


How do typical types of crashes compare between conventional intersections and roundabouts?

[redacted]

[redacted]





-81%

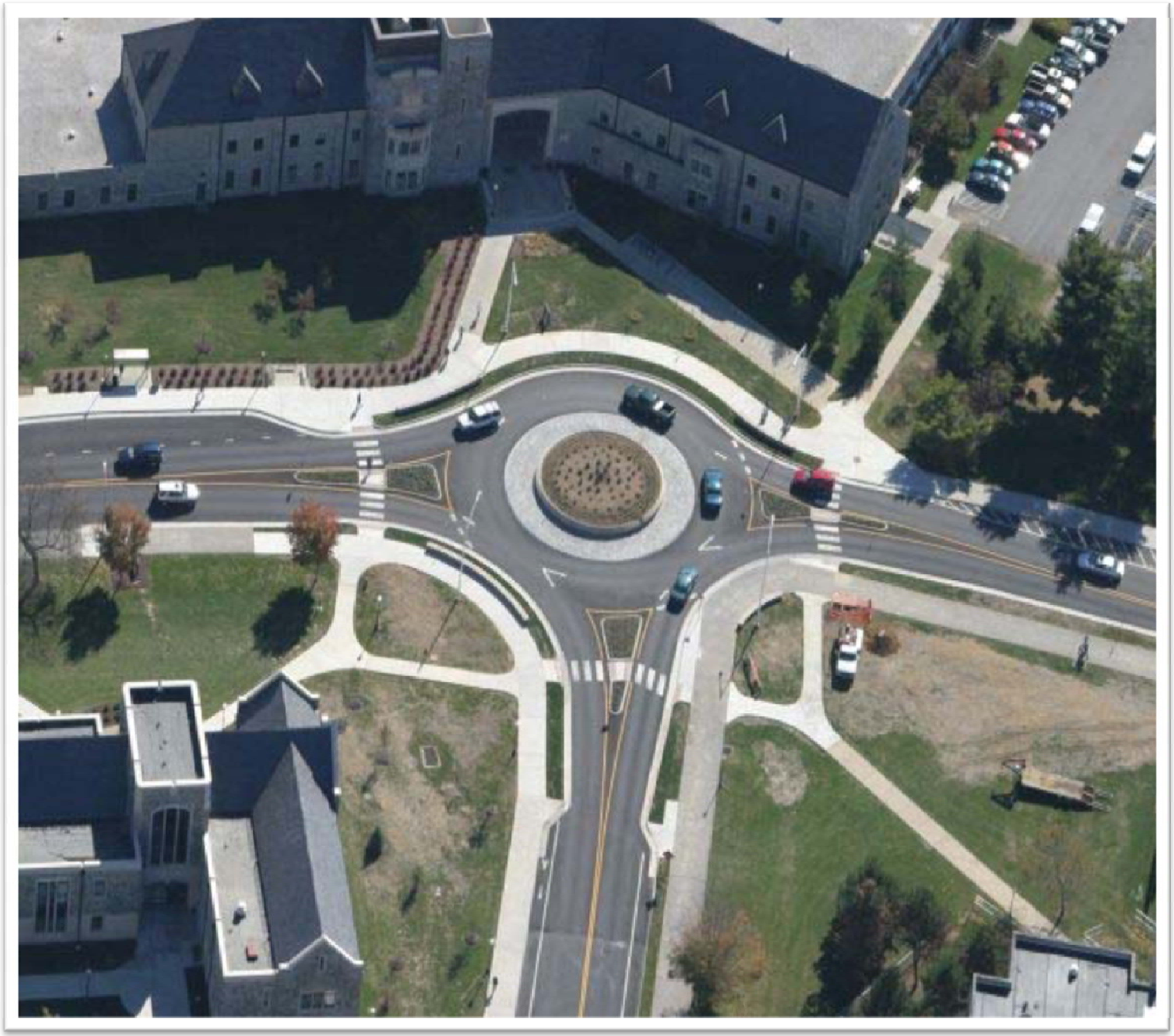
Where to Consider Roundabouts

- Intersections with high crash rates/high severity rates
- Intersections with complex geometry, skewed approaches, >4 approaches
- Rural intersections with high-speed approaches
- Freeway interchange ramp terminals
- Closely spaced intersections
- Replacement of all-way stops
- Replacement of signalized intersections
- At intersections with high left turn volumes
- Replacement of 2-way stops with high side-street delay
- Intersections with high U-turn movements
- Transitions from higher-speed to lower-speed areas
- Where aesthetics are important
- Where accommodating older drivers is an objective

Typical types of crashes at roundabouts

Intersection Type	Change in Total Crashes after Conversion	Change in Severe Injury after Conversion
All Four-Way Intersections	-35%	-76%
Signalized urban	TOO FEW	-60%
Signalized Suburban	-67%	TOO FEW
All-Way Stop Controlled	SIMILAR	SIMILAR
Two-Way Stop Controlled Urban	-72%	-87%
Two-Way Stop Controlled Suburban	-32%	-71%
Two-Way Stop Controlled Rural	-29%	-81%

Multi-Lane Roundabouts



Why Focus on *Access* & *Roundabouts*?

From the perspective of *system performance*:

- **Access is a necessary evil!**
- **Access is a threat to both safety and mobility**
- **Access decisions have major affect on performance**
  - **location, spacing, frequency, type, "control," etc.**

- **Roundabouts are often the most efficient safest form of intersection *control***
  - over a broad range of operating conditions
  - however, site specific engineering analysis is necessary