

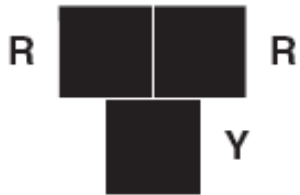


Safety and Operations of Pedestrian Hybrid Beacons (also known as HAWKs)

Sequence for Pedestrian Hybrid Beacon

Legend

SY Steady yellow
FY Flashing yellow
SR Steady red
FR Flashing red



1. Dark Until Activated



2. Flashing Yellow Upon Activation



3. Steady Yellow



4. Steady Red During Pedestrian Walk Interval



5. Alternating Flashing Red During Pedestrian Clearance Interval



6. Dark Again Until Activated



BACKGROUND AND CONCERNS WITH HAWK



James W. Sparks is deputy street transportation director in charge of the Traffic Operations Division of the City of Phoenix

Pedestrian Warning Flashers in an Urban Environment: Do They Help?

ITE JOURNAL - JANUARY 1990

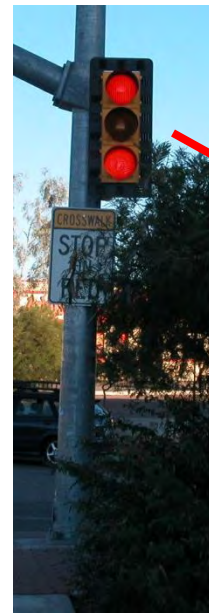
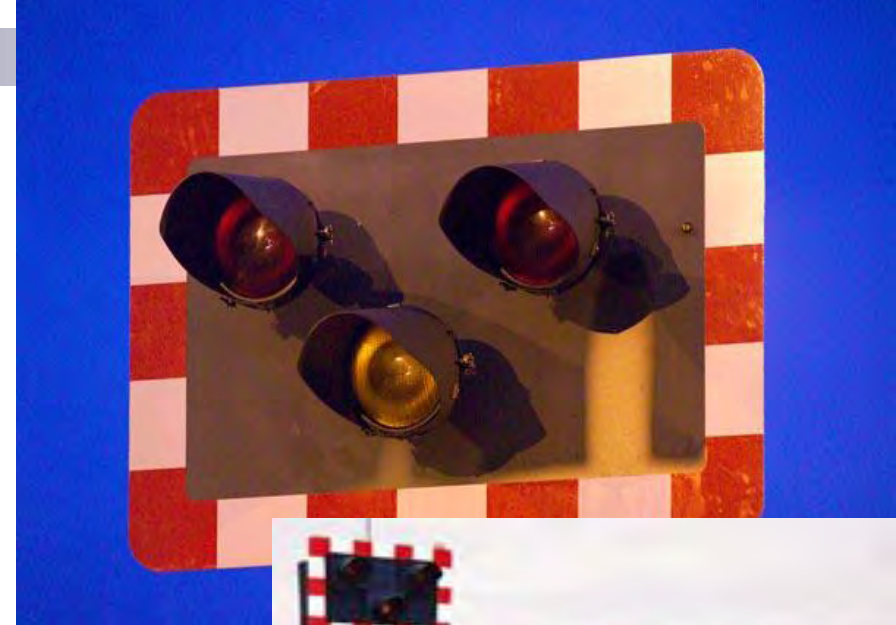
BY JAMES W. SPARKS AND MICHAEL J. CYNECKI

“In summary, national literature and local experience in Phoenix, Arizona, show that flashers offer no benefit for intermittent pedestrian crossings in an urban environment. In addition, the longer the flasher operates, the more it becomes part of the scenery and eventually loses any effectiveness.”



History

- Better pedestrian treatment needed
- Inspiration (European beacon Newcastle)
- Modification made over years to address concerns





Common Questions/Concerns During Development

1. Dark beacon may be confusing
2. Side street drivers may be confused
3. Will cause proliferation of devices
4. Creates non-uniformity
5. Driver understanding of alternating flashing red

1. Dark Beacon Confuses Drivers

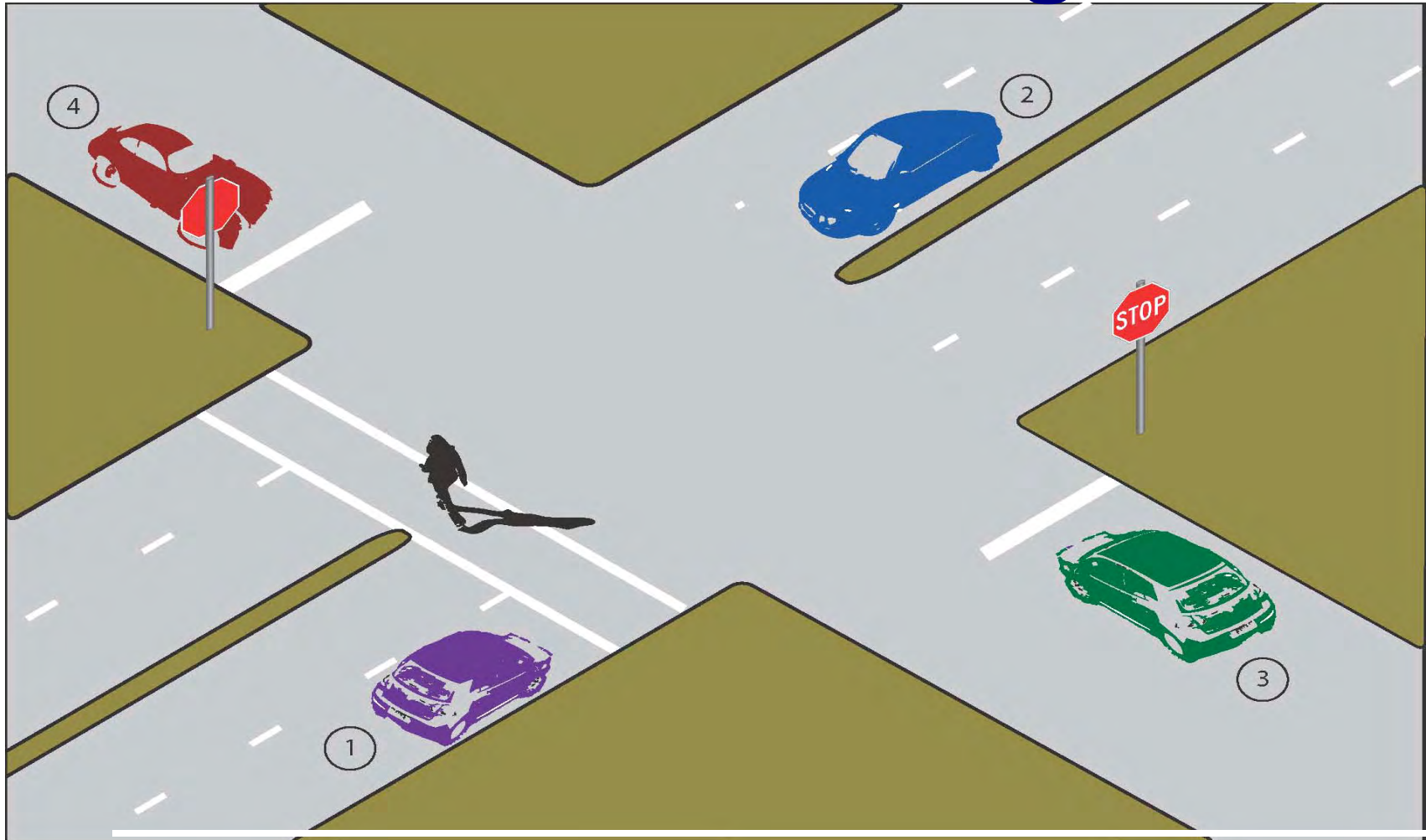
- Has not been observed during scientific studies by UNC & TTI
- Tucson experience shows that vehicles do not stop at a dark beacon
- Dark beacon critical to overcome 1/2 signal concerns
- Similar device used in Europe for last 60 years



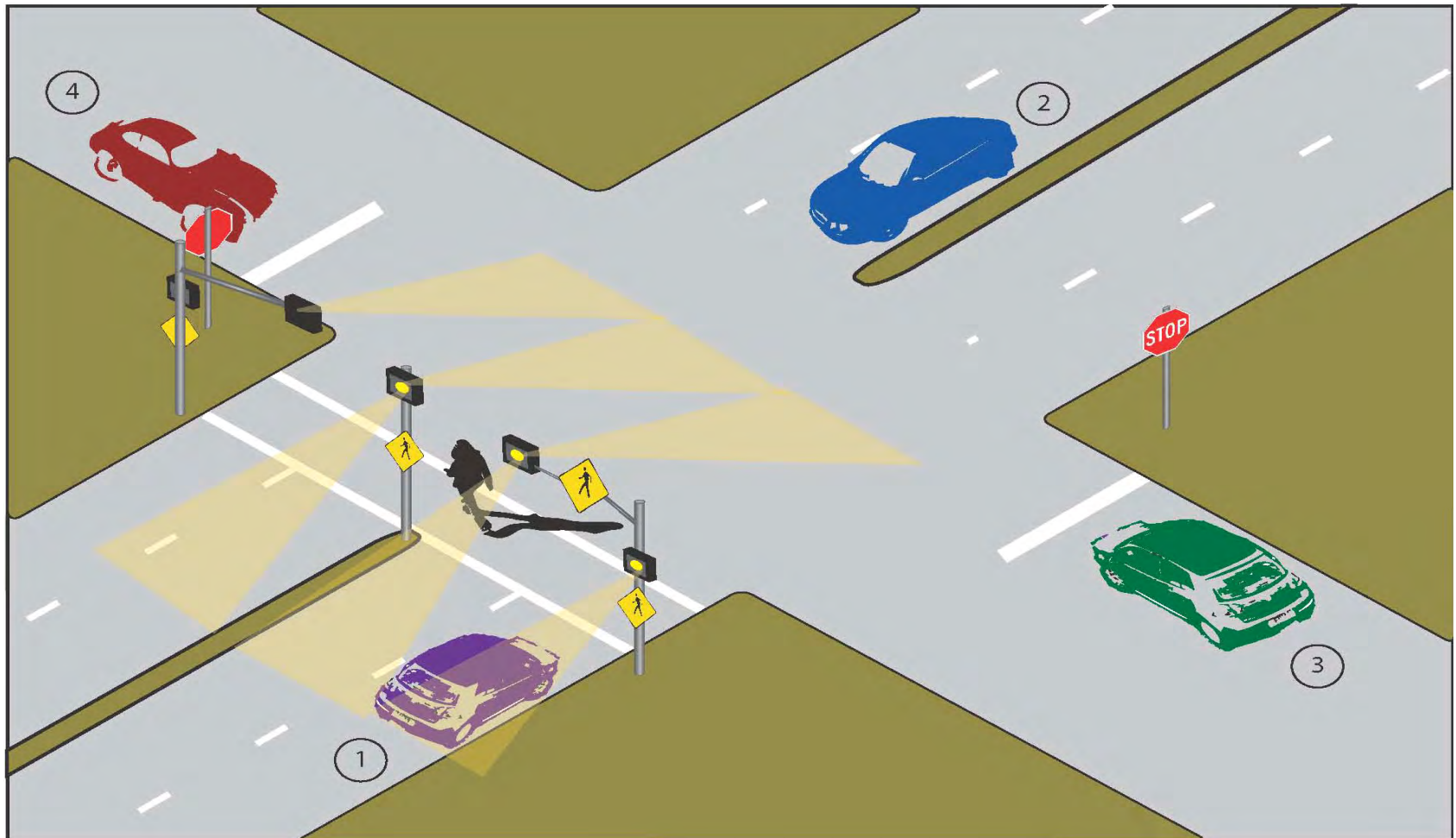
2. Drivers on Side Street May be Confused

- Drivers on side street do not know who has the right-of-way

Uniform Vehicle Code: Normal Crosswalk Right of Way

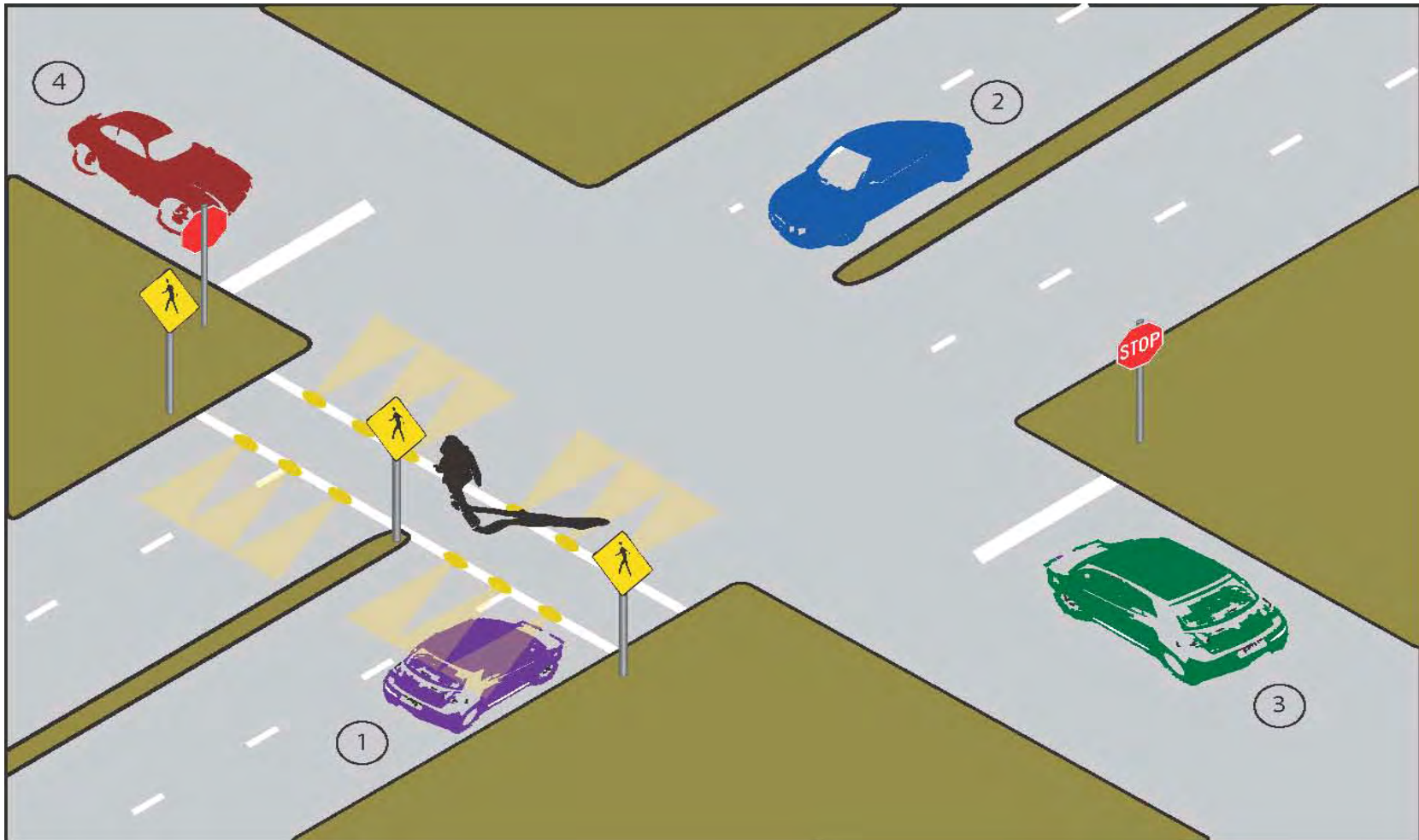


Flashing Beacon Crossing Right of Way: NO CHANGE



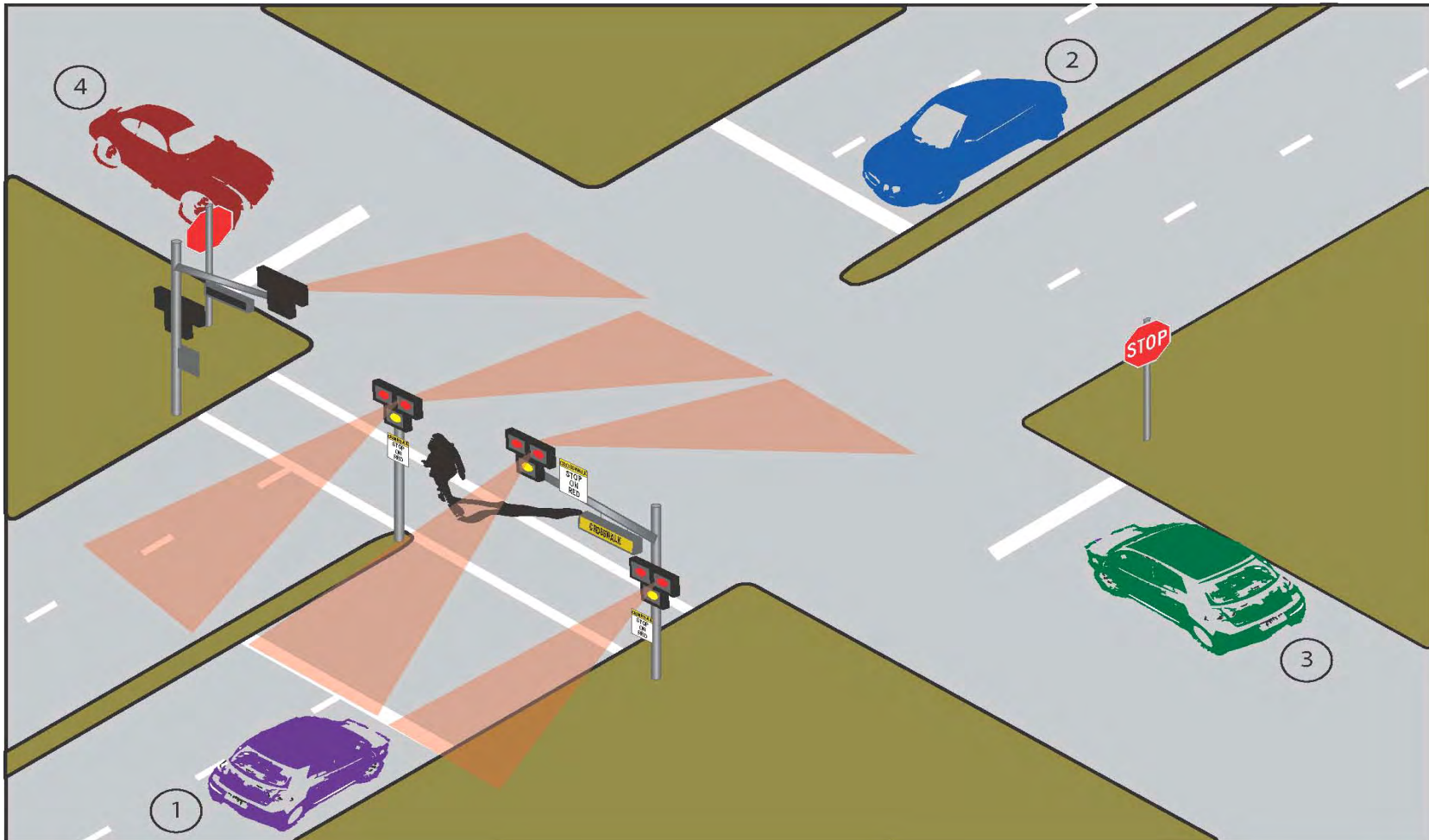
Flashing In-Road Lights

Right of Way: NO CHANGE



Pedestrian Hybrid Beacon

Right of Way: NO CHANGE



Confusion with Right-of-Way?

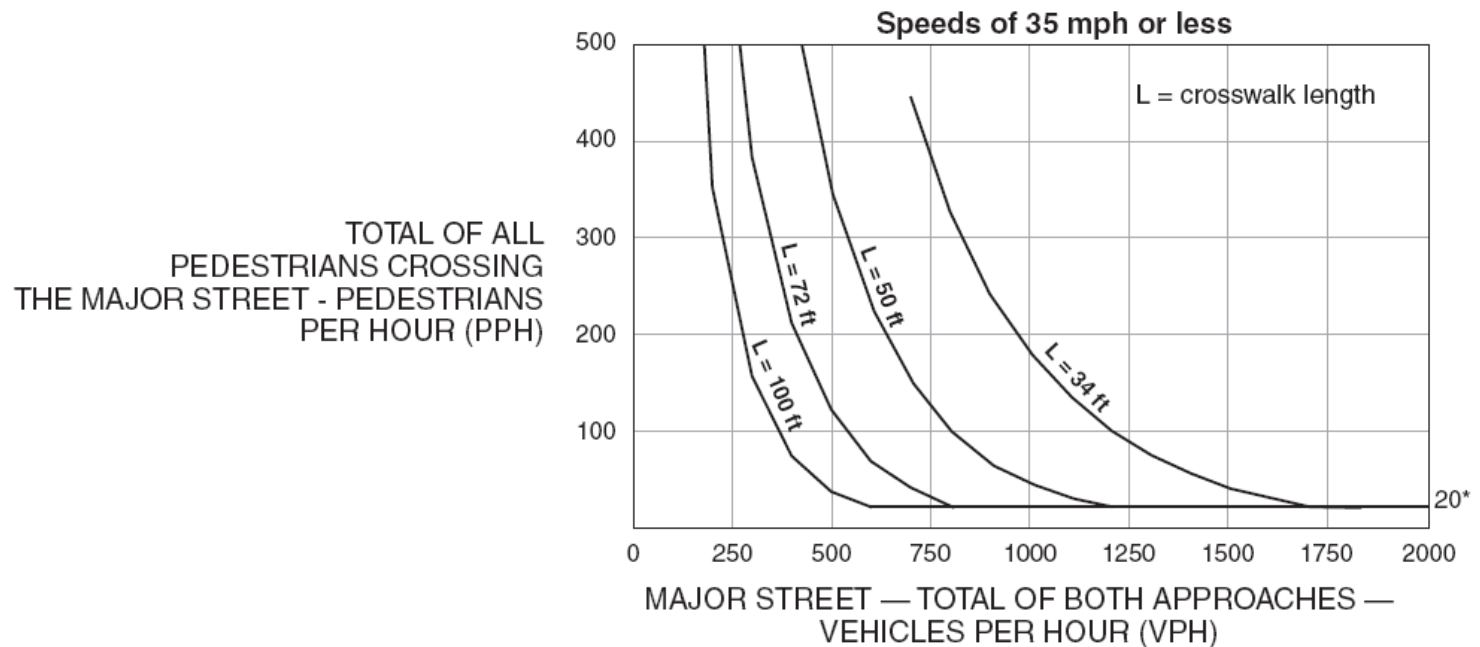
■ The HAWK...

- Is a supplement to the crosswalk
- Does not change the right-of-way rules, therefore acts more as a beacon than as a signal

3. Proliferation of Devices

- Beacons normally do not have a numeric warrant, but warrants are in the MUTCD for the Pedestrian Hybrid Beacon

Figure 4F-1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways



* Note: 20 pph applies as the lower threshold volume

Proliferation of Devices (cont)

- There is a need for a device at crosswalks that is more than a yellow flasher, but a full signal is not warranted or appropriate
 - Avoid side street “defacto arterial”
 - Allows for main street progression
 - Reduces delay via ½ cycle operations, flashing red, split phase operations
- Pedestrian hybrid beacon can reduce the political and community pressures to install unwarranted full traffic signals

4. Creates Non-Uniformity

- Concern that the HAWK will further proliferate non-uniform designs and installations
- Already have non-uniformity → there are numerous variations in use throughout the nation currently now



Florida Crossing Eyes



King County Flashing Beacon



Utah Flashing Double Beacon



Ohio Flashing Yield Sign



Ohio Yield Sign



California Flashing Beacon



In-Pavement Lights



Portland: 1/2 Signals



Seattle: 1/2 Signals



L.A. Midblock Signals

(Signal rests in GREEN UPWARD ARROW, Changes to Flashing RED)



5. Alternating Flashing Red

- Drivers not proceeding in a stop-and-go format during alternating flashing red and crosswalk is clear
 - Sign
 - Education
- Drivers not stopping during alternating flashing red phase
 - Targeted enforcement
 - Education



Ongoing Debate

- 2009 MUTCD included following “Guidance” (Section 4F.02, page 509) not previously seen by NCUTCD:
 - “...should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs.”
- Recommended by NCUTCD (June 2011)
 - Remove above language and replace under STANDARDS” with:
 - E. If a pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a side road, vehicular traffic on the side road shall be controlled by STOP sign.



OPERATIONS

Regional Transportation Authority



- Half-cent sales tax
- City has installed 17 HAWK crossings in 2+ years, many at schools
- No school district contribution required

Tucson Criteria

- School crossing?
- Crossing activity
- Traffic speeds
- Gaps
- Crash experience
- Number of travel lanes and traffic volumes
- Spacing

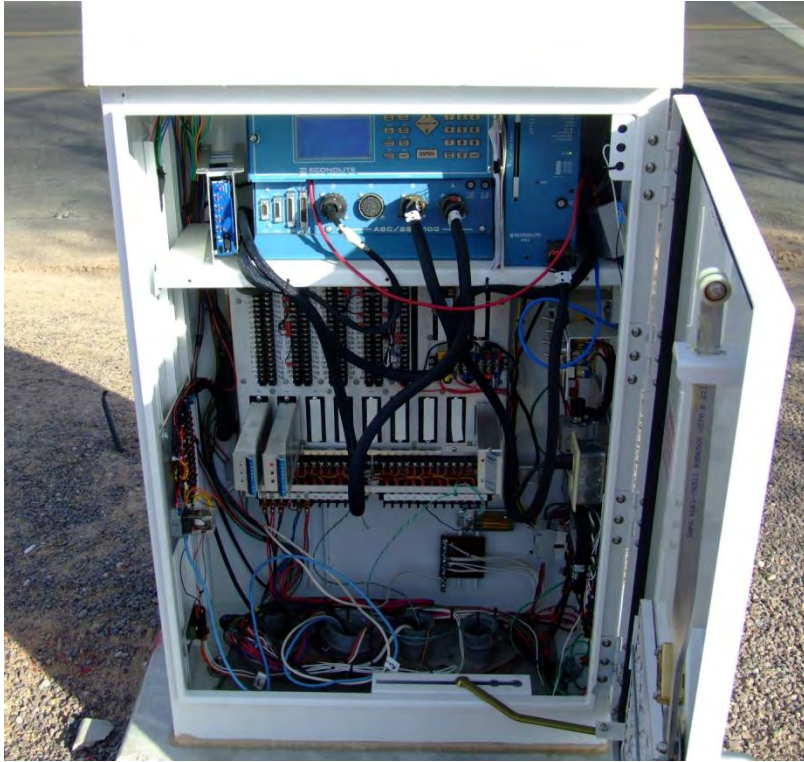


Equipment



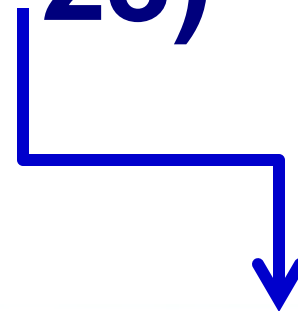
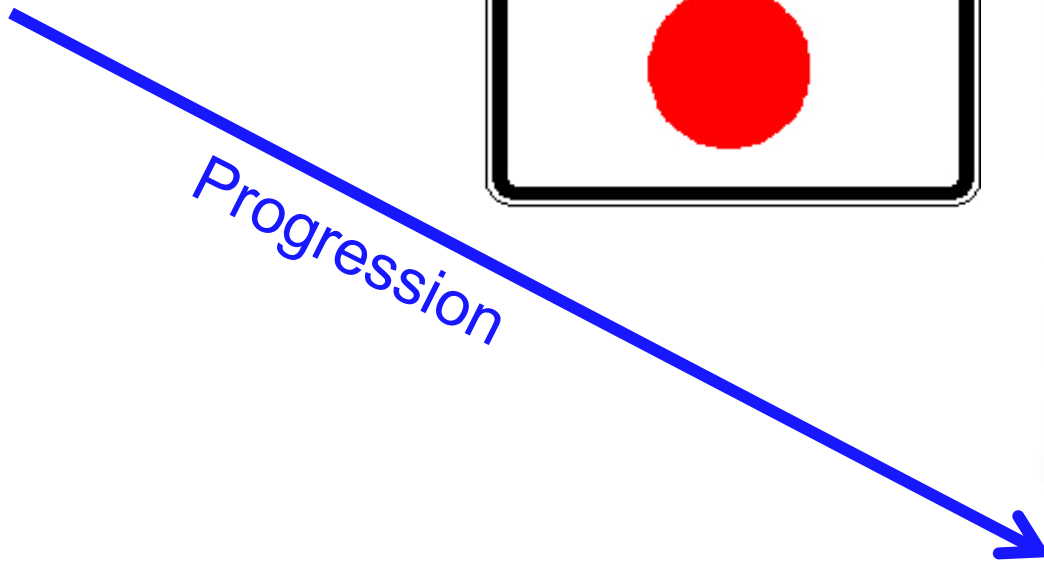
- Standard equipment
- Total cost \$100,000 - \$150,000
- Street lighting recommended
- Commercial power
- Use of on-call contractor

Controller



- Standard controllers
- Econolite ASC-2 controllers require special firmware, remapping of functions, and changes to write-protected memory
- ASC-3 controllers accommodate HAWK timing right out of the box

STOP ON RED (R10-23)





Signing

- Use R10-23 except in school zones
- Advance warning signs in fluorescent yellow, with Diamond Grade sheeting (DG³)
- Illuminated CROSSWALK sign
- Special push button sign
- Signs prohibiting pedestrians crossing leg w/o beacon (optional)



School Signing



Crosswalk
Signing



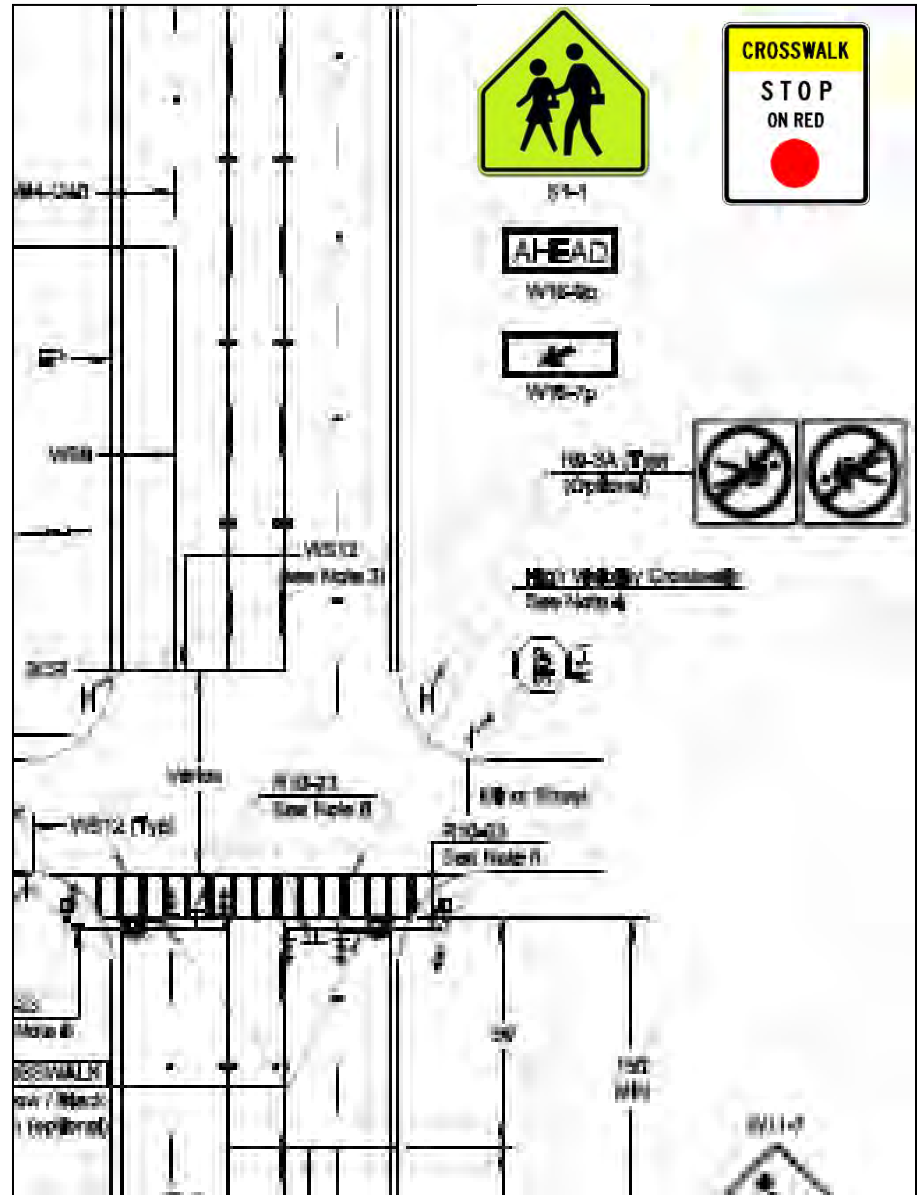
Mounting Detail



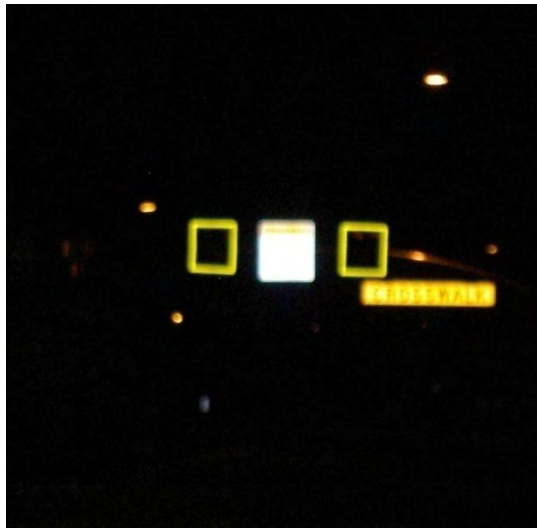
Advance
Signing

Striping

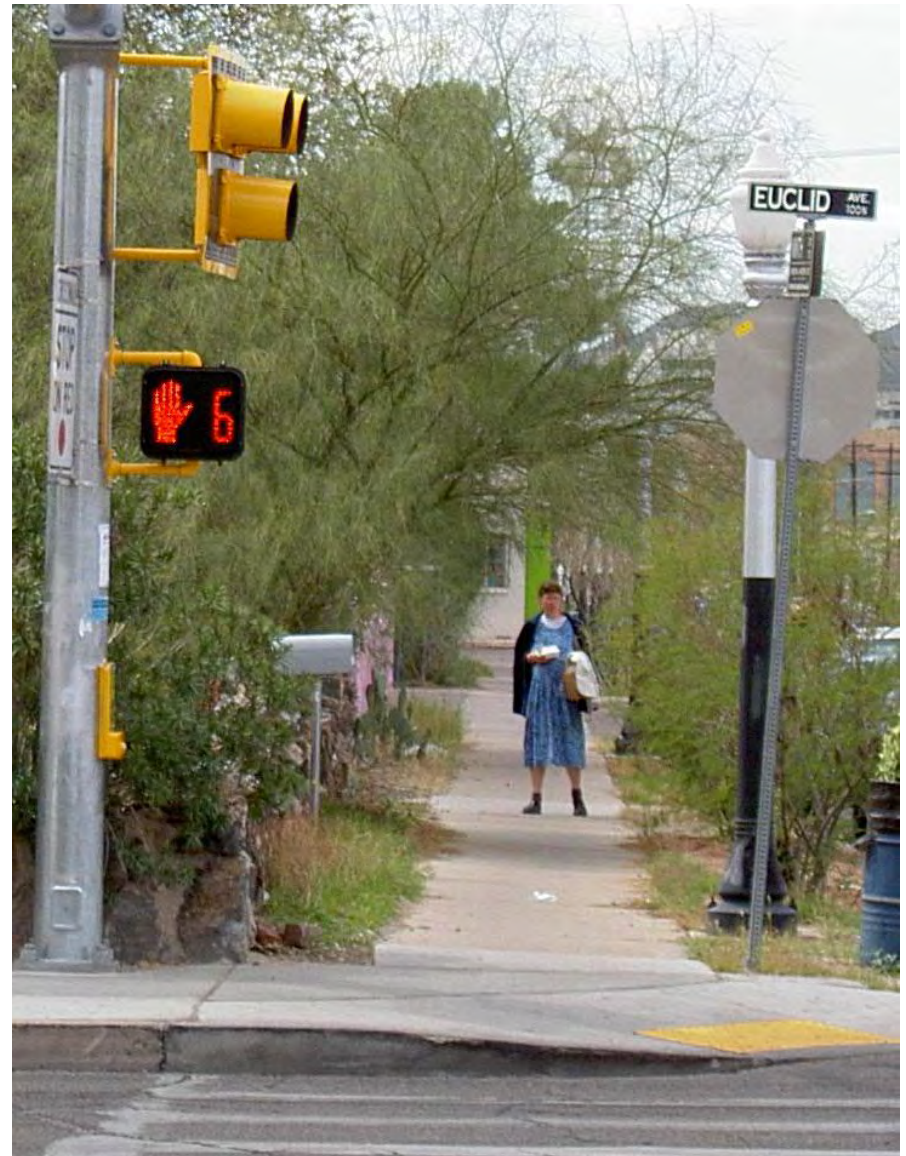
- High visibility crosswalk
- Stop bar 50 ft back
- Solid white 8-inch lane line between approach travel lanes (distance is a function of posted speed limit)



Retroreflective Strip



Countdown Pedestrian Indication



Education

Children's Safety Program

Through TDCOT's Traffic Safe Kids Program, the department is teaching children about staying safe on Tucson's streets. A short presentation and magical puppet show is being presented to our young students through the local elementary schools. Whether they're walking or taking the bus to school, riding their bike or scooter, or playing ball in their own neighborhood, we want to help children remember their safety tips when the time comes to act. There is also a safety activity book for children. The book's characters teach life-saving rules in ways that appeal to young children. The messages featured throughout the book are geared for children in elementary school with the hope that the messages learned will be remembered all their lives.

Zack Rabbit, a trusty fellow with a floppy ear, and Lenny Lizard, Zack's mischievous partner, are TDCOT's "honorary safety messengers." Some of the safety messages included in the activity book are:

- Look both ways before and while crossing the street and watch for turning cars
- Obey the school crossing guard
- Ask an adult to show you a safe route to walk to school
- Wear safety protective gear when riding your bike or scooter
- Don't play in or near the street
- Buckle up for safety - and remind everyone else to buckle up too!



Special Pedestrian/Bicycle Beacon Signals

Every corner is a crosswalk, marked or not, where the driver must yield. Some have beacon signals for special circumstances. Remember to act responsibly and look out for children.

"If you have people engaging in activities that put lives at risk, engineering countermeasures can only go so far. Convincing people to change their behavior will have the most lasting effects. However, this may be the most difficult thing to do in order to ensure pedestrian safety."

Federal Highway Administration

To learn more about how bicyclists and motorists can **SHARE The ROAD** legally and safely in Pima County, a free guide is available to the public by contacting 791-4372.

You may obtain additional information by calling the Tucson Department of Transportation Public Information Officer at 791-4371

Si usted necesita ayuda para entender esta folleto, llame a Public Information Officer, 791-4371. Alguien le ayudará con sus preguntas.



A community service of the Tucson Department of Transportation Bringing Life to Transportation

CROSSINGS

Special Pedestrian/Bicycle Beacon Signals



PELICAN Crossing: Pedestrians Activate

The PELICAN Light Control Activation crossing is activated by pushing a button. The Pelican then signals pedestrians to cross to the decorative median island and then along the median to the second signalized crossing point a short distance away.

The technique incorporates a standard RED-YELLOW-GREEN signal that rests in main street GREEN for vehicular traffic until a pedestrian wishes to cross. The signal then changes to RED and shows the pedestrian a WALK signal to go to the median.

The pedestrian then activates a second button and crosses the second portion of the main street. This two stage crossing only delays the pedestrian minimally and allows the main street signal operation to maintain the signal synchronization system. The system provides for a safe pedestrian crossing and minimizes the potential for stops, delays, accidents, neighborhood and environmental issues.

Pelicans are quite effective in providing a safe crossing of major streets for pedestrians mid-block. An extension of the PELICAN system is the TOCAN signal system for both bicycles and pedestrian crossings.



TOCAN Crossing: "Two groups CAN cross," Bicycle and Pedestrian

The Two groups CAN cross signaling system was designed to provide a safer crossing for "two" groups - PEDESTRIANS and BICYCLISTS. A traditional signal crossing system would normally be inappropriate at locations where both pedestrian and bicycle crossing is needed. In many cases the bike route is along a residential street where the crossing of the major street is

at an irregular spacing creating serious signal synchronization and potential safety problems. A traditional signal would encourage additional vehicle traffic to cut through on the residential street, negatively impacting the "livability" of the neighborhood. The TOCAN crossing signal may be activated by either riding up to the stop bar or pressing the button. Please do not ride across the street when the RED bicycle symbol is lit. These signal units, along with the HAWK unit help find a community transportation balance for mobility and safety and encourage citizens to "share the road."



HAWK Crossing: "Watching over the Pedestrian like a Hawk"

The High intensity Activated crossWALK is one of the newest crossing systems in use. It's based on a European design and is similar to the current American school bus warning flasher system.

The HAWK consists of a standard traffic signal RED-YELLOW-RED format. The unit is off until activated by a pedestrian. When a pedestrian wishes to cross the street, they

press a button which activates a warning FLASHING YELLOW light on the main street. The indication then changes to a SOLID YELLOW advising drivers to prepare to stop. The signal then displays a SOLID RED and shows the pedestrian a WALK symbol. The beacon then displays an ALTERNATING FLASHING RED and the pedestrian is shown a FLASHING DON'T WALK with a "countdown" signal advising them of the time left to cross. Drivers are allowed to proceed during the flashing red after coming to a full stop and making sure there is no danger to a pedestrian. At school crossings, drivers must wait until the children and crossing guard are completely out of the crossing.



Split-Phase



Split-Phase



Split-Phase

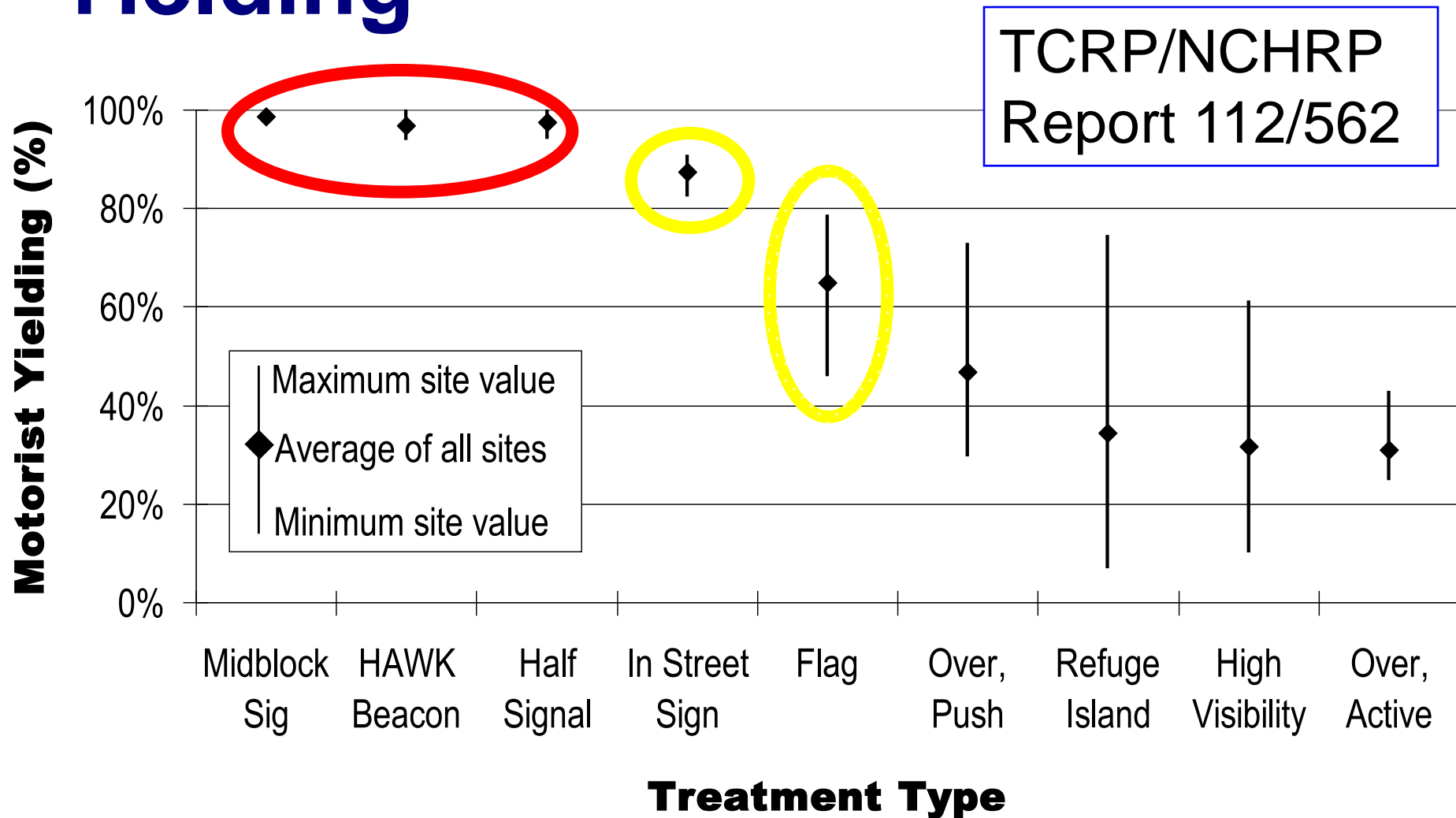




EFFECTIVENESS

Effectiveness

Yielding



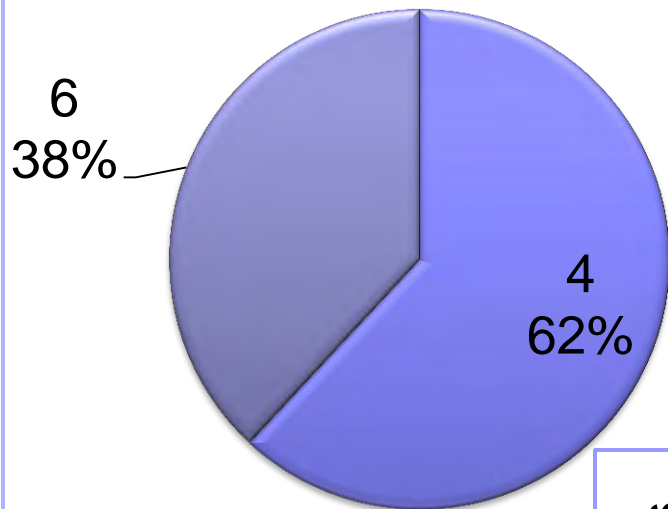
Effectiveness Safety



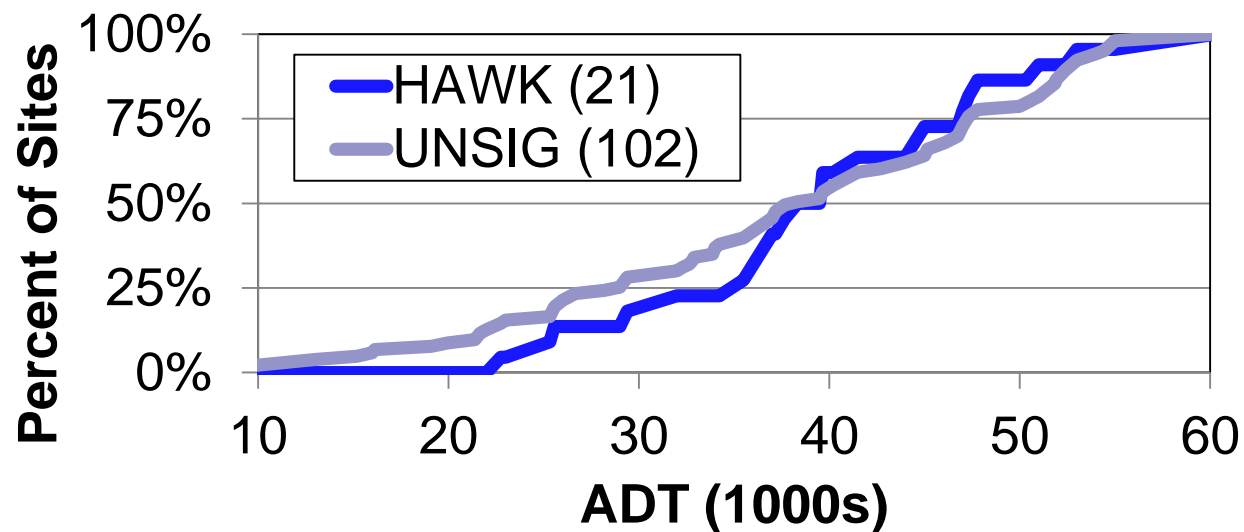
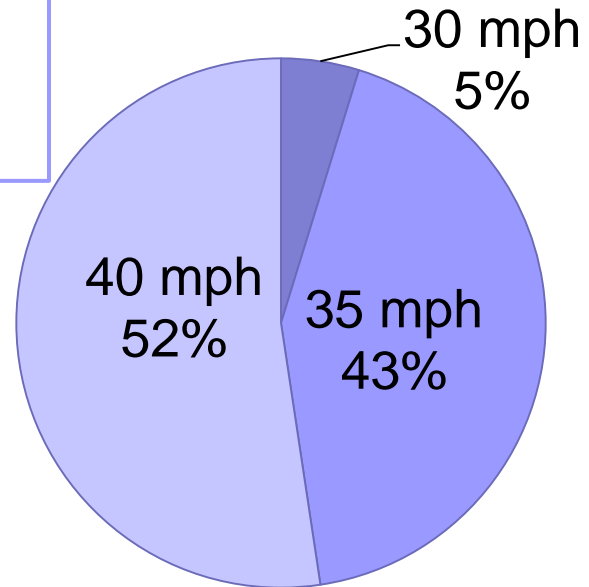
- Anecdotal evidence = yes
- FHWA sponsored research
 - Comprehensive, before-after safety evaluation using Empirical Bayes
 - Study started fall 2007
 - 21 treated sites, 103 reference sites
 - 36 months before period
 - 80% of sites had 24 months or more of after period

HAWK Site Characteristics

Number of Lanes



Posted Speed Limit



Median

HAWK

Yes

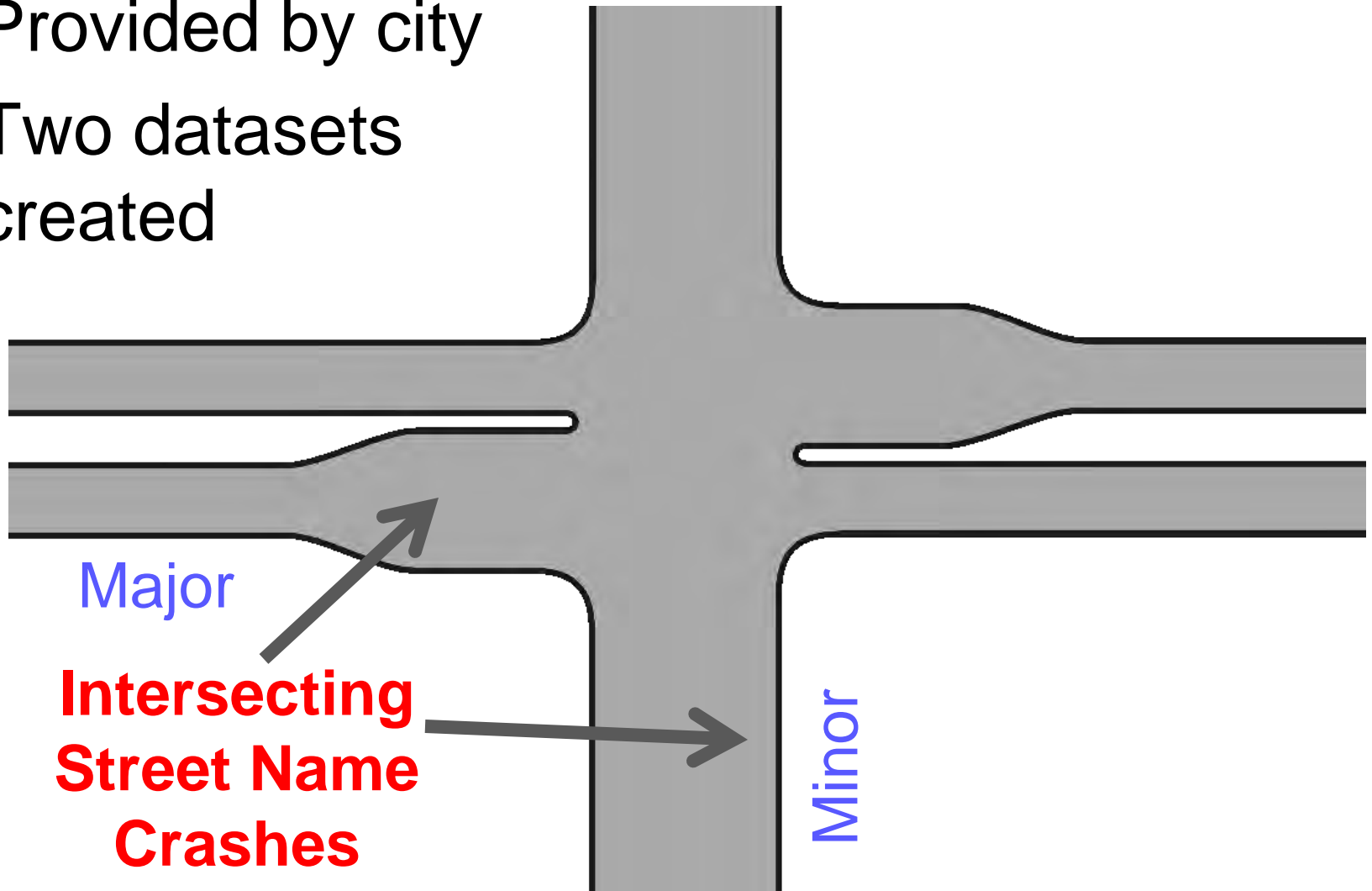
57%

No

43%

Crash Data

- Provided by city
- Two datasets created

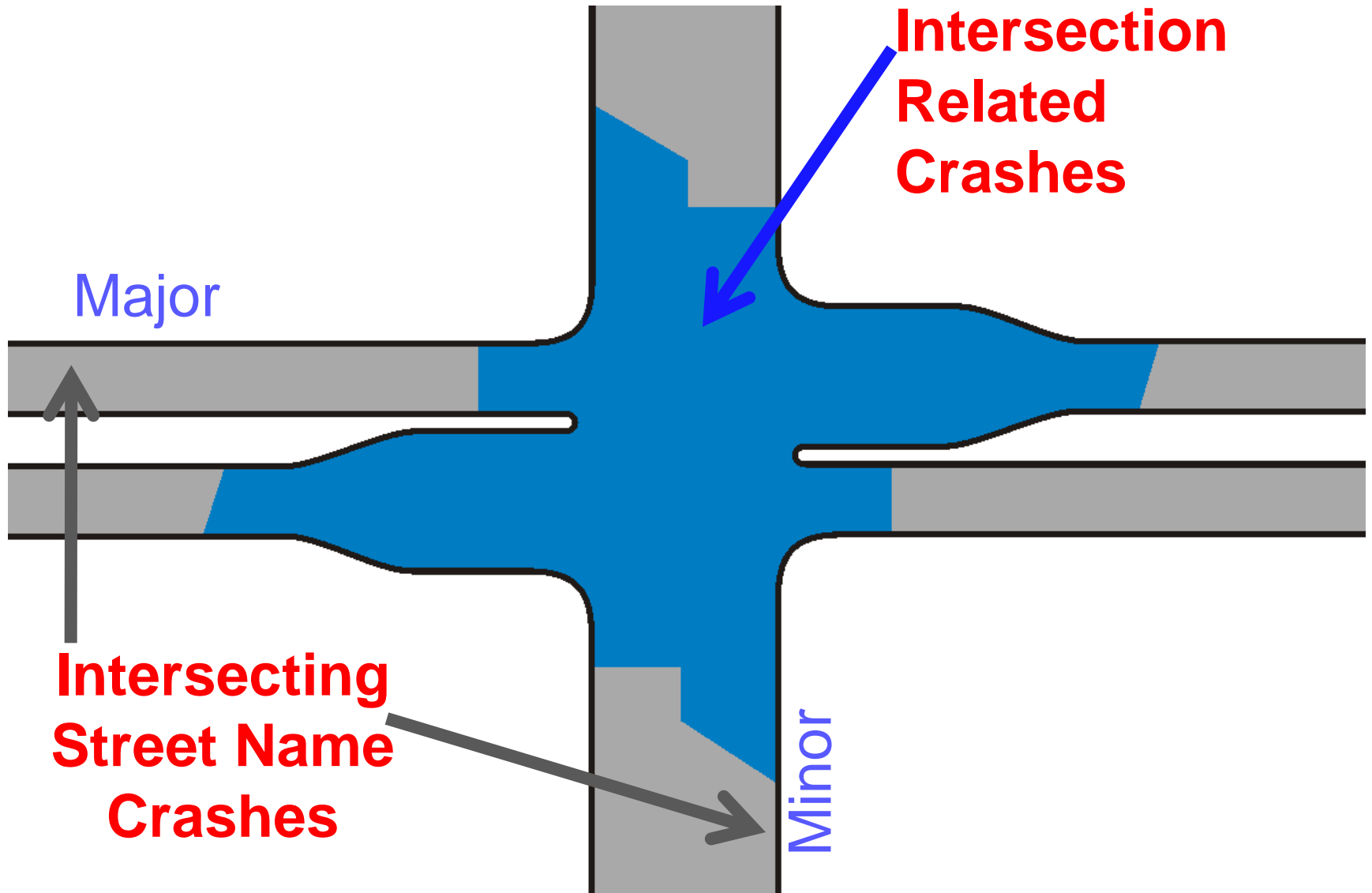


Intersecting Street Name Crashes

Empirical Bayes Results

HAWK SITES	103 Unsig		
	Total	Severe	Ped
After Crashes	508	173	4
Crashes Predicted	624.5	198.1	12.8
% Reduction	19	13	69
Statistically significant?	Yes	No	Yes

Crash Data



Intersection-Related Crashes

Empirical Bayes Results

HAWK SITES	103 Unsig		
	Total	Severe	Ped
After Crashes	183	77	2
Crashes Predicted	256.4	90.1	5.5
% Reduction	29	15	65
Statistically significant?	Yes	No	Yes

Summary



- Safety evaluation of HAWK beacon using Empirical Bayes method
- Before-After
 - 21 treatment sites
 - All at stop-controlled intersections/major driveways
 - Reference sites groups:
 - 103 unsignalized intersections
- Statistical significant changes:
 - 29% reduction in total crashes
 - 69% reduction in pedestrian crashes

References

- *Safety Effectiveness of the HAWK Pedestrian Crossing Treatment*
 - TechBrief, FHWA-HRT-10-045
 - <http://www.fhwa.dot.gov/publications/research/safety/10045/10045.pdf>
 - Research Report, FHWA-HRT-10-042
 - <http://www.fhwa.dot.gov/publications/research/safety/10042/10042.pdf>
- *Improving Pedestrian Safety at Unsignalized Crossings* (TCRP/NCHRP 112/562)
 - http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf



RRFB SLIDES

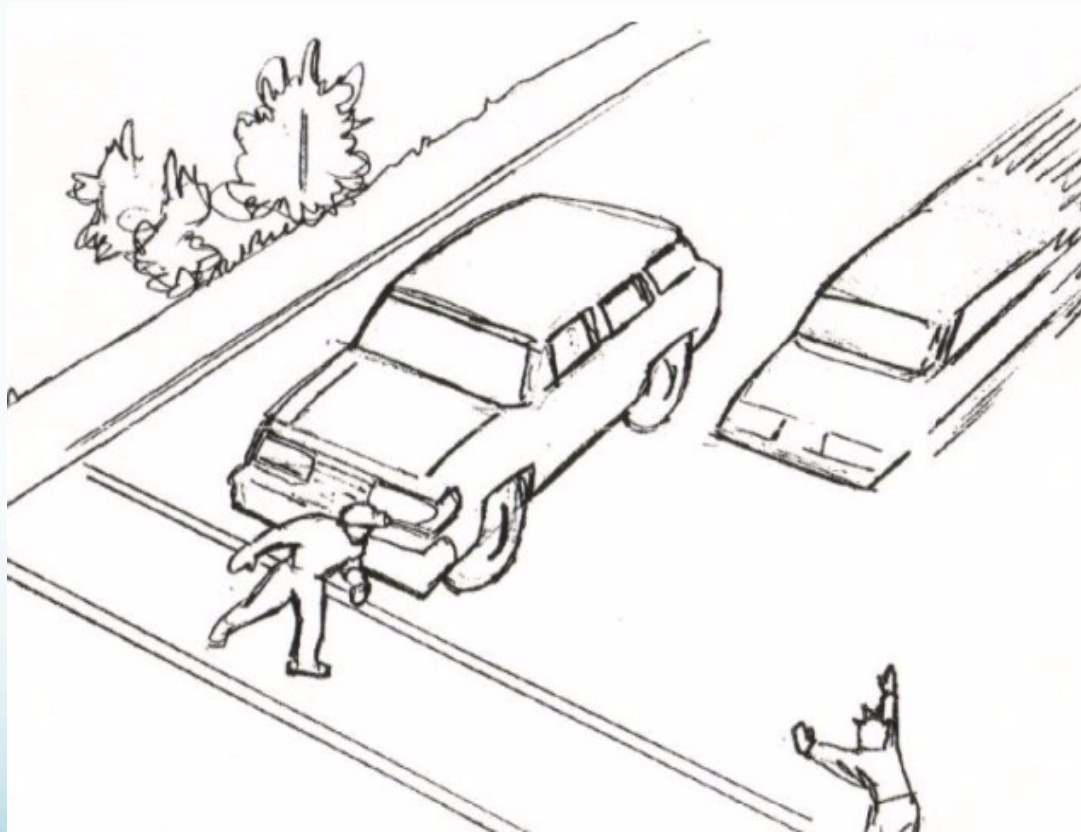
QUESTIONS?



Variables Influencing the Efficacy of the RRFB

Ron Van Houten, Ph.D.
Western Michigan University

Multiple Threat Crashes/ 12,000/15000 ADT

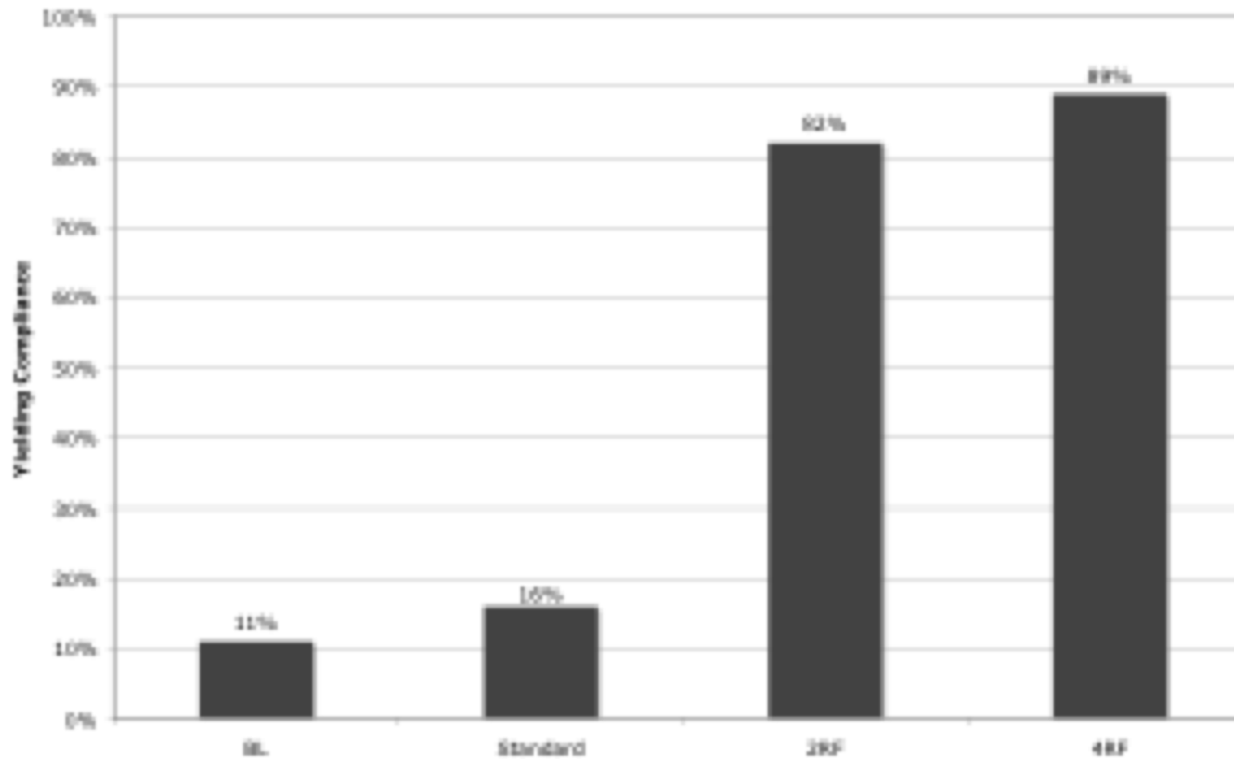


RRFB

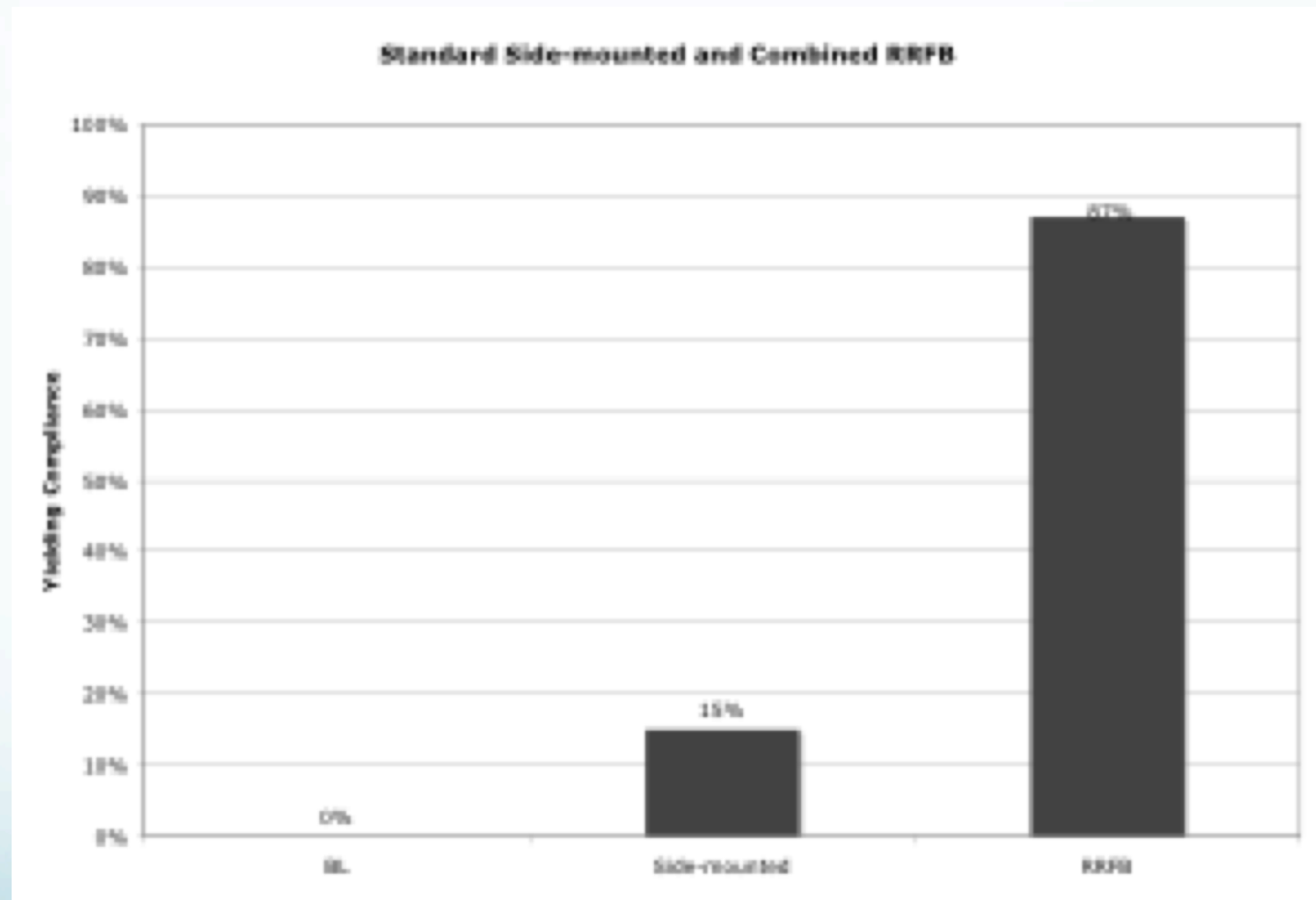


RRFB vs. Traditional Overhead Beacon

58th St. & 3rd Ave. M Day



RRFB vs. Traditional Side Mounted Beacon



Results from 22 Sites in Three Regions of US

- Baseline yielding averaged 4% ranging from 0% to 26%
- After one week yielding averaged 79% ranging from 64% to 97%
- After one month yielding averaged 84% ranging from 62% to 96%
- After **two years** yielding averaged 84% ranging from 72% to 96% with a mean of

Location of Crosswalk	Number of Lanes	Median Present	Traffic Flow	ADT	Posted Speed Limit
31 st St. south of 54 th Ave. S.	4	YES	Two-way	9,600	35 mph
4 th St. @ 18 th Ave S.	4	YES	Two-way	17,657	35 mph
22 nd Avenue N east of 7 th S	4	YES	Two-way	13,524	35 mph
9 th Avenue N east of 26 th St	4	NO	Two-way	12,723	35 mph
22 nd Avenue N west of 5 th St	4	YES	Two-way	18,367	35 mph
M.L.K St. @ 15 th Ave. S.	5	YES	Two-way	12,025	35 mph
M.L.K. St. N of 17 th Avenue N.	5	NO	Two-way	14,336	35 mph
1 st Avenue N west of 13 th St.	3	NO	One-way	9,715	30 mph
9 th Avenue N west of 25 th St.	4	NO	Two-way	12,723	35 mph
1 st St. south of 37 th Ave. N.	4	YES	Two-way	6,216	35 mph
58 th St. south of 3 rd Ave. N.	4	YES	Two-way	13,826	35 mph
Central Avenue d @ 61 st St	4	NO	Two-way	12,742	40 mph
1 st Avenue S @ 61 st St	3	NO	One-way	12,742	35 mph
1 st Avenue N @ 61 st St	4	NO	One-way	9,128	35 mph
83 rd Avenue N @ Macoma Dr	2	NO	Two-way	4,774	35 mph
9 th Avenue N @ 45 th St.	4	NO	Two-way	9,343	35 mph
22 nd Avenue S west of 23 rd St.	4	NO	Two-way	9,343	35 mph
62 nd Avenue S @ 21 st St.,	3	NO	Two-way	5,008	35 mph
9 th Avenue N @ 31 st St.	4	NO	Two-way	11,982	35 mph
Hawley St @ Atwater	2	NO	Two-way		35 mph
Midlothian Rd. @ Idewild Ave.	2	NO	Two-way		35 mph
Midlothian Rd @ Kilarny Pass Rd.	4	NO	Two-way		35 mph
Brentwood Road @ 13 th St	4	NO	Two-way	30,000	30 mph

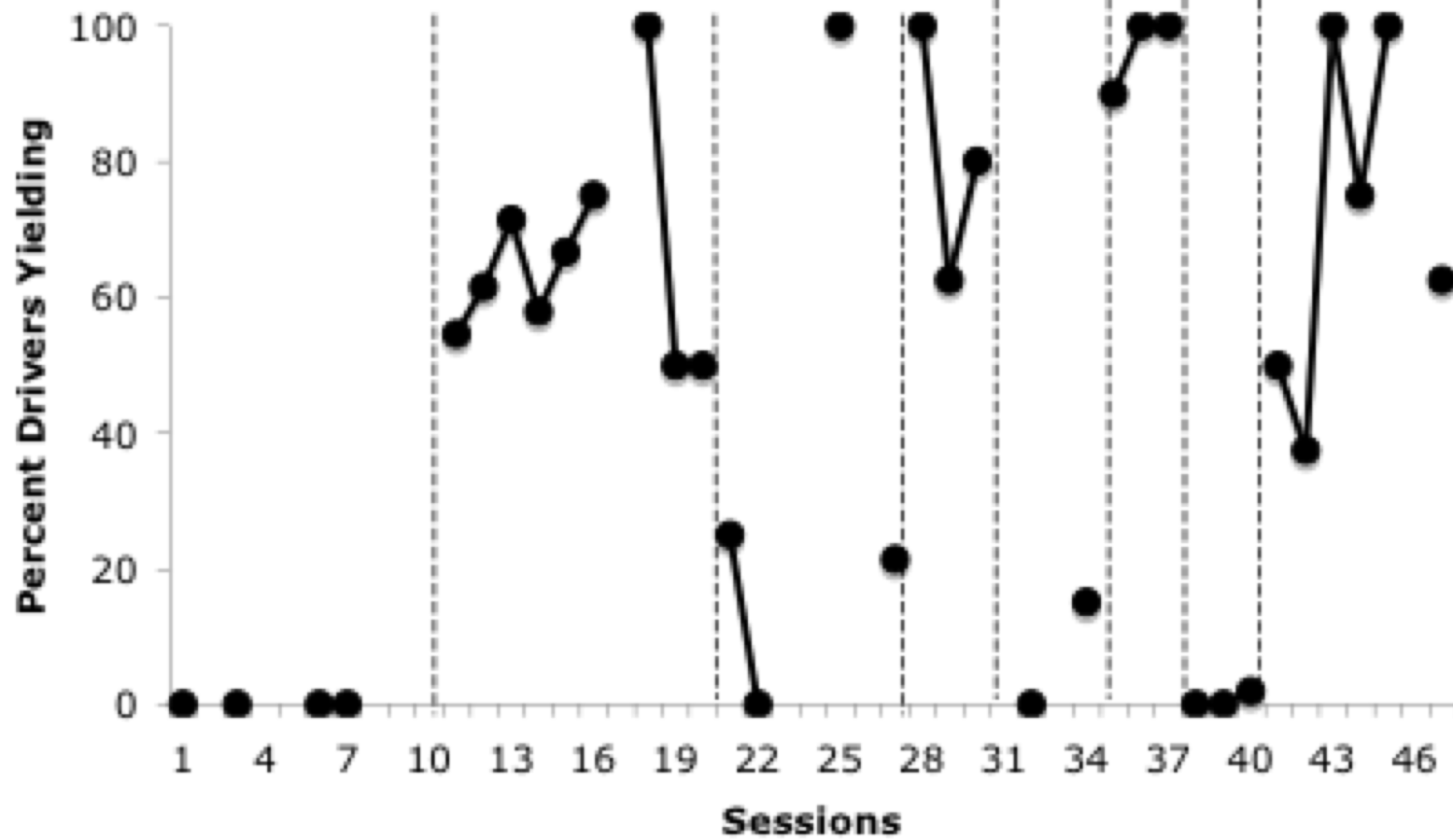
	DAY								
Location	BL	7	30	60	90	180	270	365	730
FLORIDA									
31st St. south of 54 th Ave S	0%	54%	76%	N/A	59%	N/A	91%	75%	83%
4th St. @ 18 th Ave. S.	0%	63%	72%	N/A	69%	N/A	69%	80%	80%
22nd Ave N & 7 th St.	0%	97%	96%	91%	93%	92%	91%	98%	96%
9th Ave N & 26 th St.	0%	80%	82%	85%	95%	81%	88%	77%	78%
22nd Ave N & 5 th St.	8%	87%	89%	92%	92%	87%	96%	92%	95%
M.L.K. & 15 th Ave S.	1%	86%	84%	85%	82%	N/A	89%	88%	88%
M.L.K. & 17 th Ave. N.	0%	96%	94%	80%	82%	83%	88%	82%	83%
1st Ave N & 13 th St.	2%	85%	87%	75%	78%	N/A	91%	88%	N/A
9th Ave N & 25 th St.	0%	86%	90%	83%	90%	N/A	88%	81%	79%
1st St. & 37 th Ave N.	0%	79%	87%	85%	87%	N/A	90%	97%	95%
58th St. & 3 rd Ave N.	0%	85%	84%	85%	85%	79%	92%	82%	88%
Central Ave & 61 St.	0%	94%	95%	77%	73%	72%	79%	67%	72%
1st Ave S & 61 St.	5%	68%	72%	73%	75%	72%	90%	72%	78%
1st Ave N & 61 St.	0%	75%	75%	68%	82%	42%	76%	79%	83%
83rd Ave N & Mac.	0%	86%	93%	91%	73%	88%	84%	80%	90%
9th Ave N & 45 th St	0%	54%	91%	89%	90%	80%	83%	77%	78%
22nd Ave S West of 23 St.	0%	89%	86%	78%	77%	60%	75%	81%	82%
62nd Ave S & 20 St.	0%	77%	76%	77%	53%	78%	81%	84%	80%
9th Ave N & 31 St.	16%	93%	95%	89%	88%	82%	82%	89%	N/A
Average	2%	81%	86%	82%	80%	76%	86%	83%	84%
ILLINOIS									
Midlothian. & Kilarnary	7%	62%	62%	N/A	N/A	N/A	N/A	N/A	N/A
Hawley & Atwater	19%	71%	68%	N/A	N/A	N/A	N/A	N/A	N/A
Average	13%	67%	65%						
D.C.									
Brentwood	26%	62%	74%	N/A	N/A	80%	N/A	N/A	N/A

Miami-Dade Phase II Implementation Results

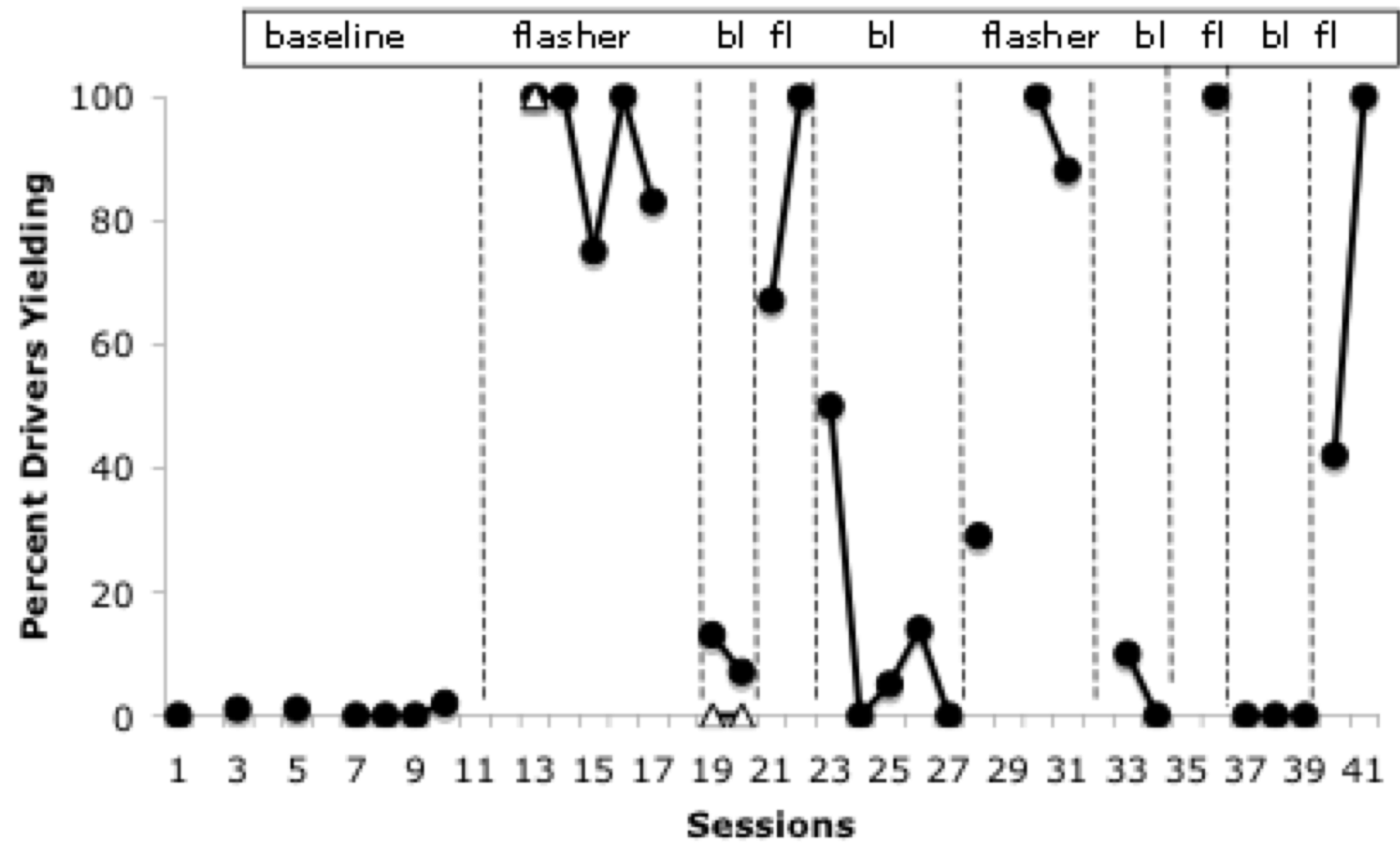


NW 67th @ Main Street (Local Residents)

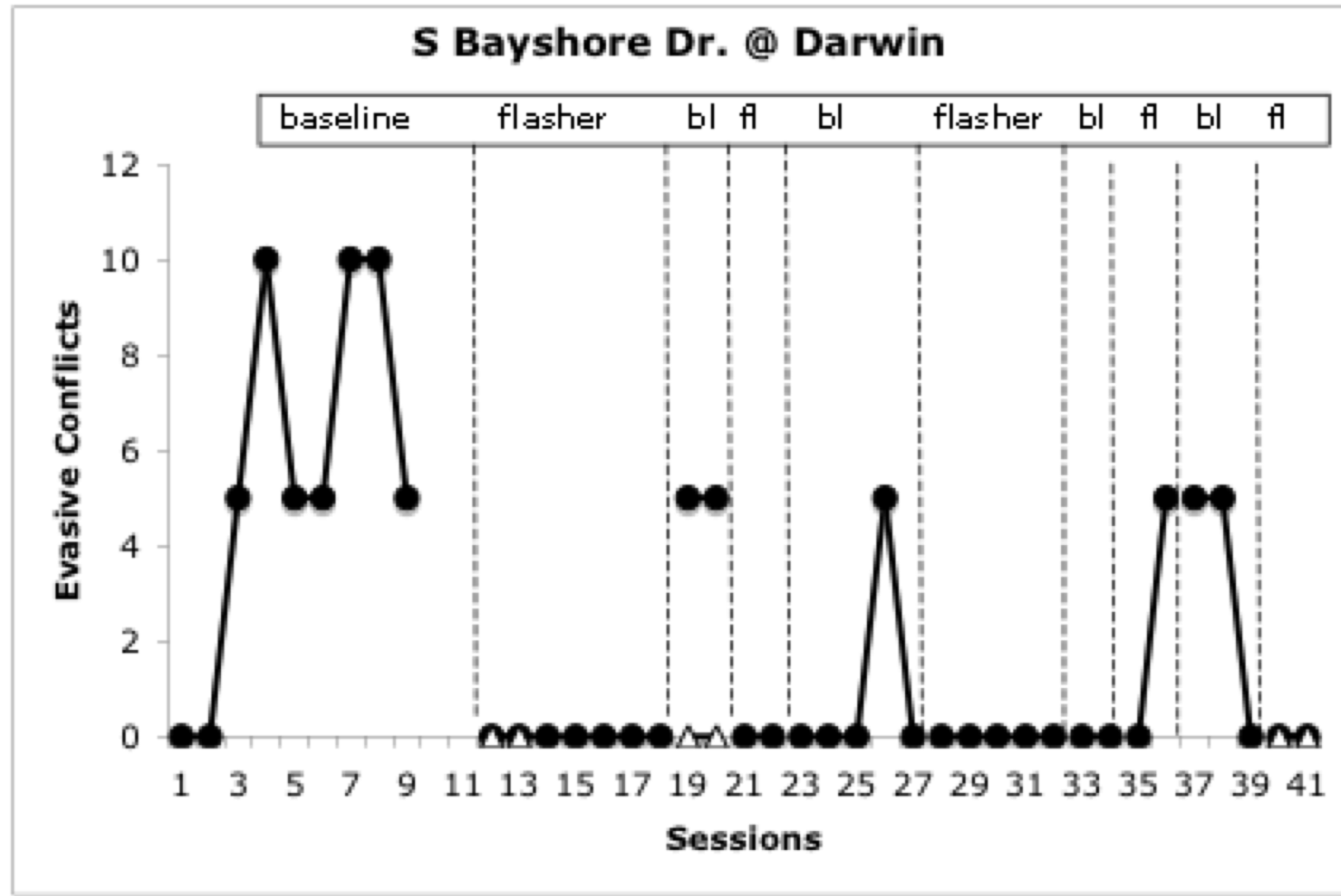
baseline flasher baseline fl bl fl bl flasher



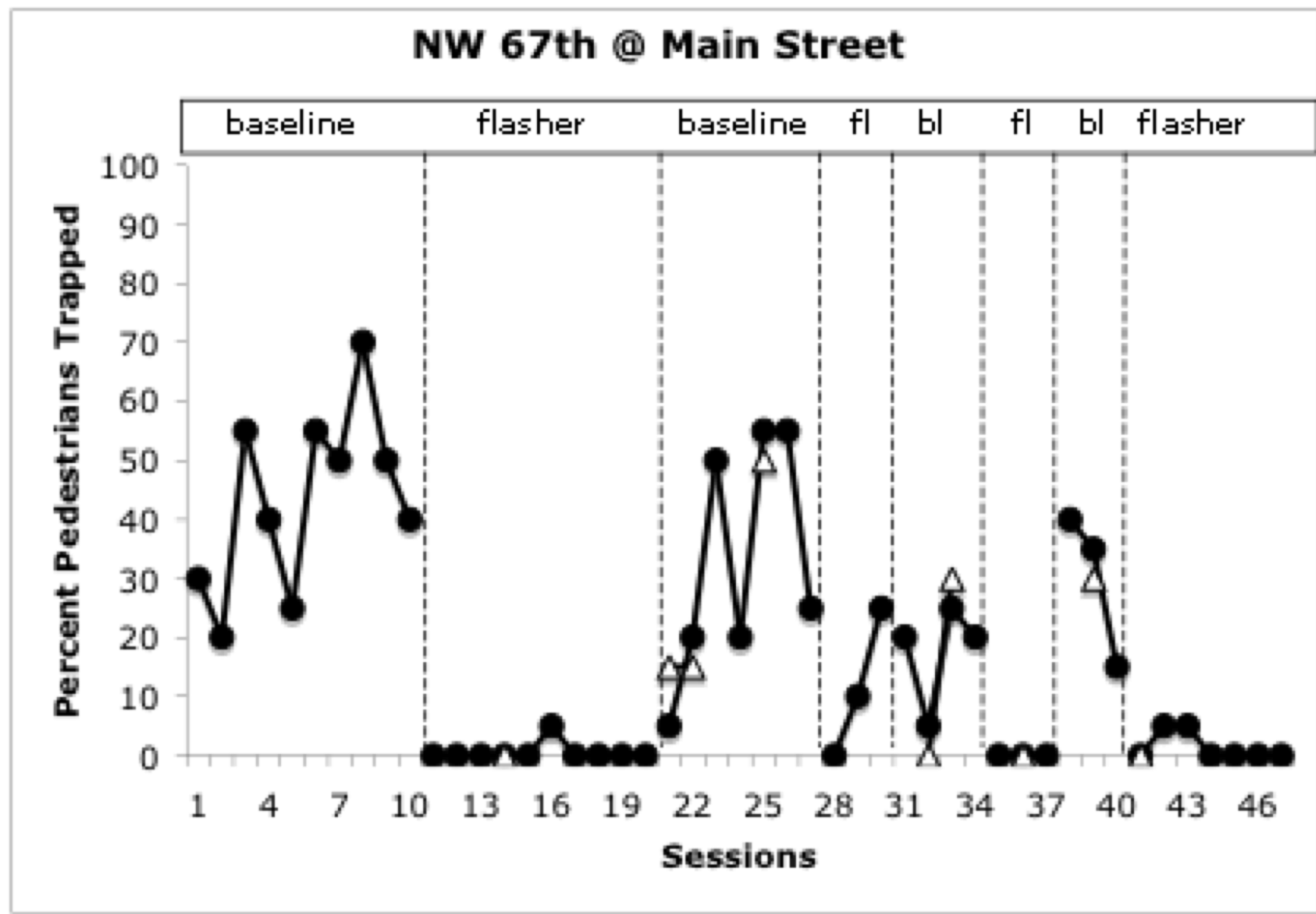
S Bayshore @ Darwin (Local Residents)



Evasive Conflicts



Trapped on yellow line





Results May Vary

Does the Device Meet the Standard?

- Size of Device
- Separation
- Flash Pattern
- Luminosity

Luminosity Standard

- FHWA Interim Approval requires that the RRFB meet the SAE standards for yellow flashing emergency beacons specified in SAE J 595. They should have a certificate of compliance
- I have noted some devices do not seem to meet this standard
- The brightness of the display is likely one of the major factors leading to strong positive results
- Certificate of Compliance should state:

Meets photometry of jurisdictional compliance standard(s)
identical to:

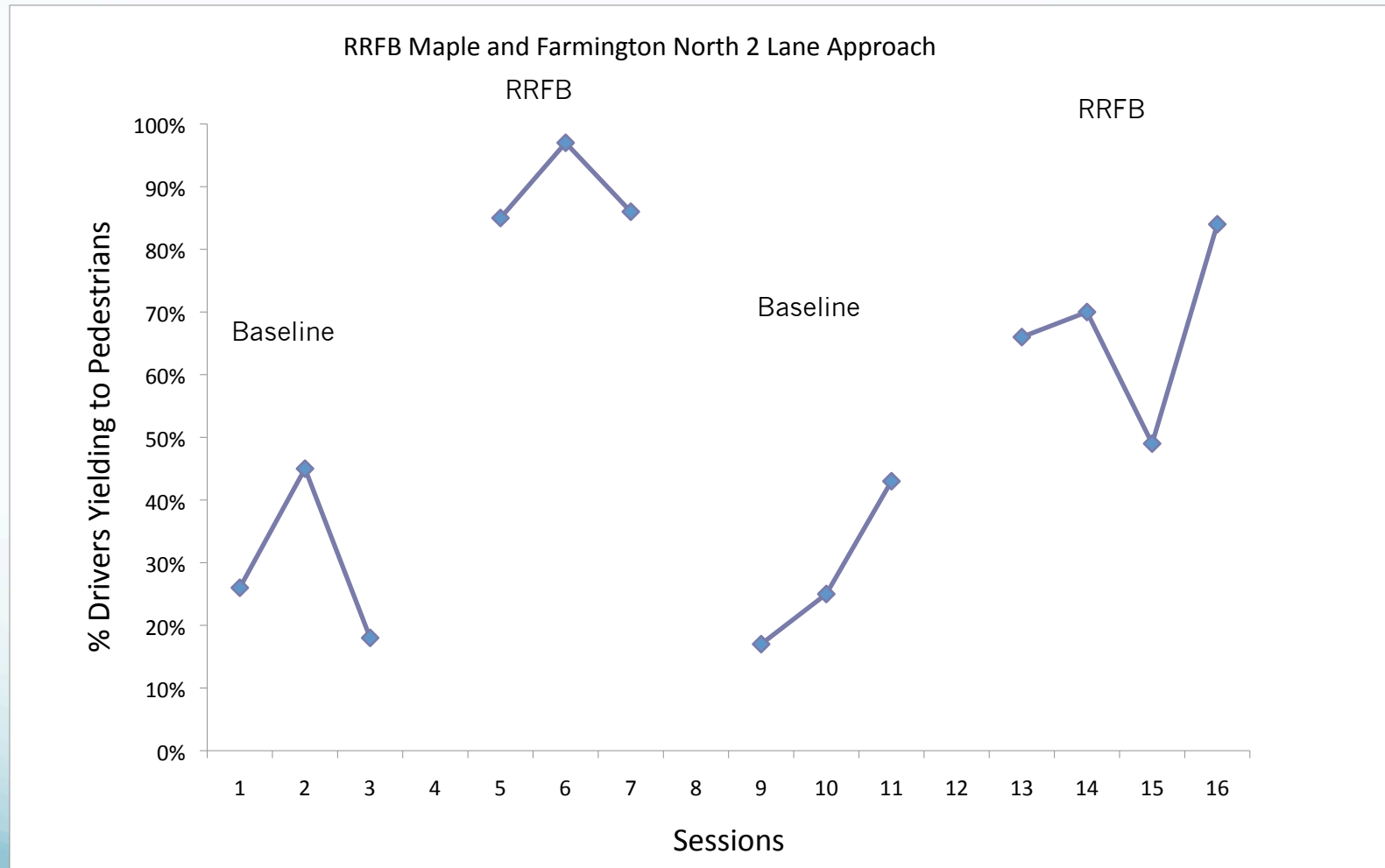
2 J595 Class 2 Nov08 Yellow Peak Cd

2 J595 Class 3 Nov08 Yellow CdS/Min

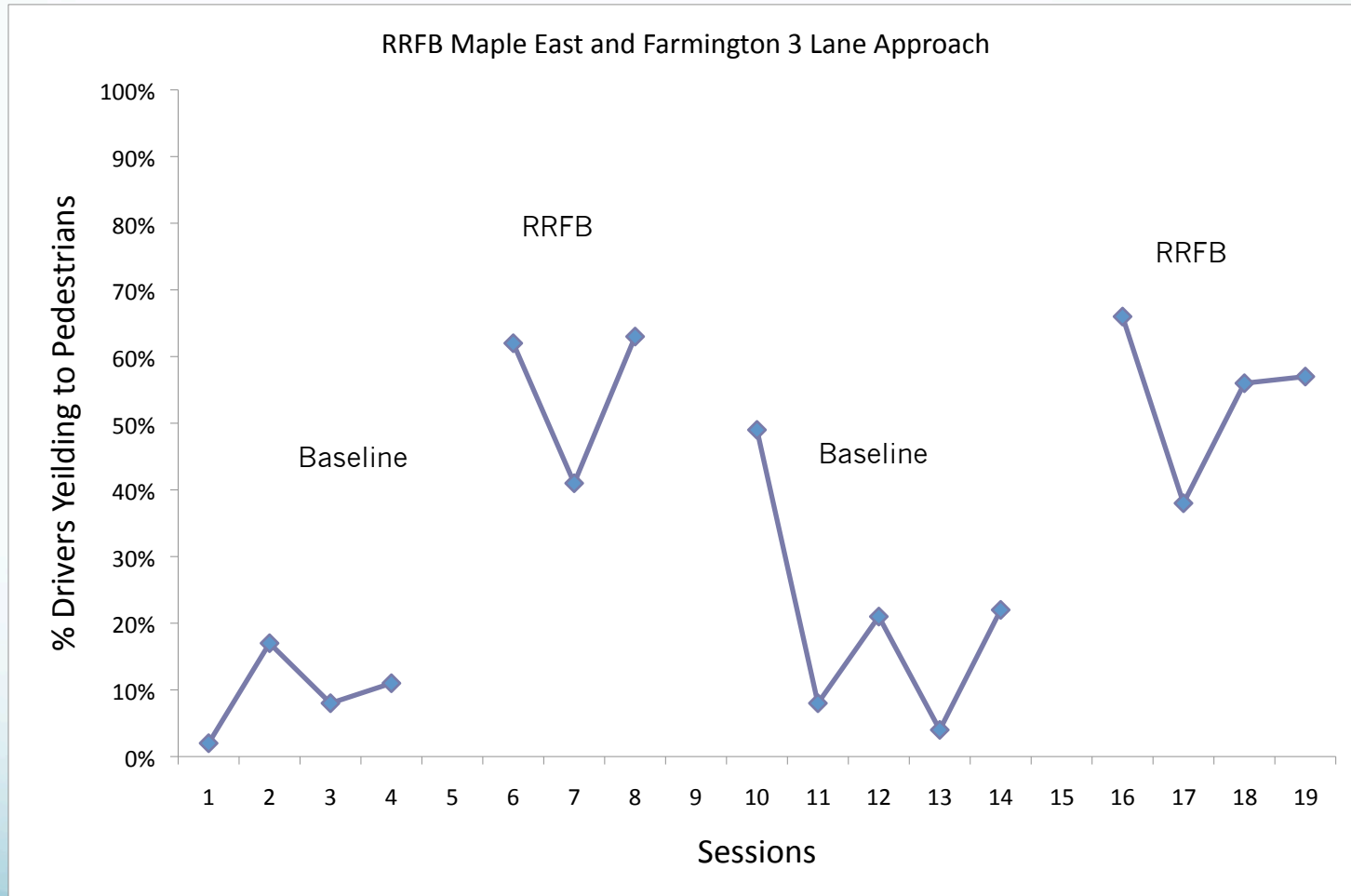
Other Critical Factors

- Other factors may be the number of lanes
- Presence or absence of a history of enforcement
- Cultural factors
- Presence of effective outreach efforts

2 Lane Approach



3 lanes



Other Factors Influencing Safety

- Advance Yield and Advance Stop Bars
- Raised Refuge Islands
- In Street Sign

Advance Yield Markings

- Yielding too close screens view of pedestrian
- Stopping further back fixes problem



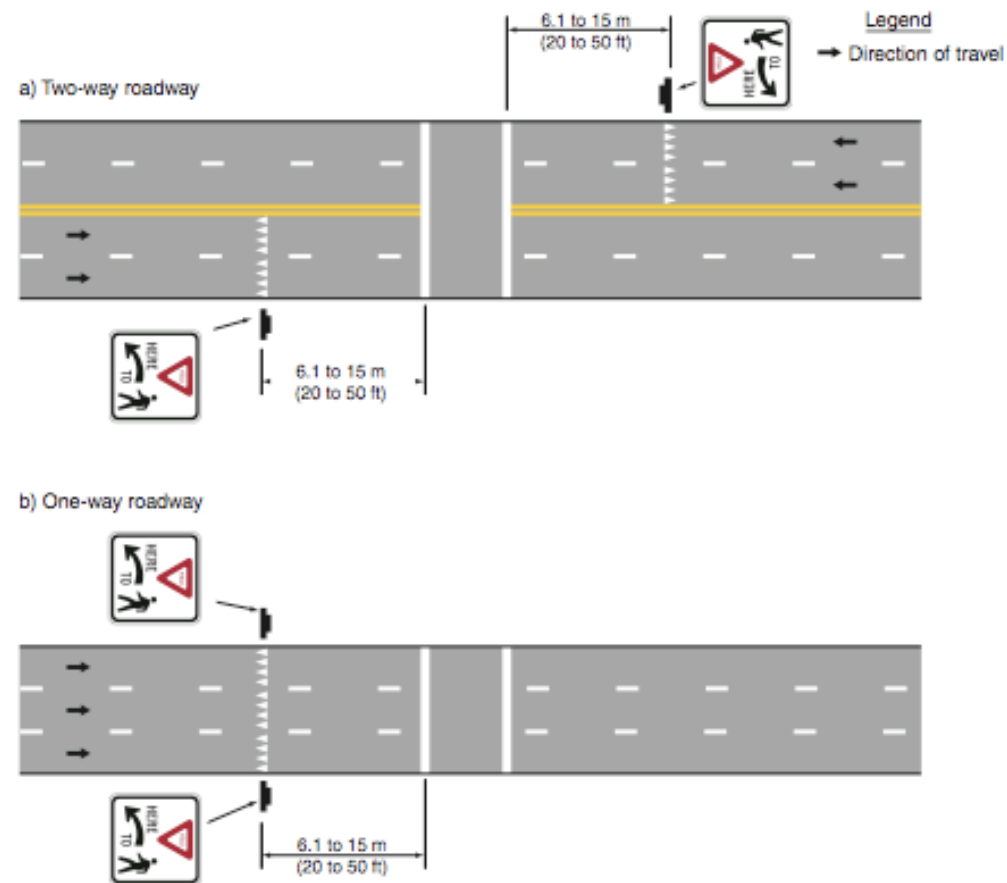


A Page from the MUTCD

2003 Edition

Page 3B-27

Figure 3B-15. Examples of Yield Lines at Unsignalized Midblock Crosswalks





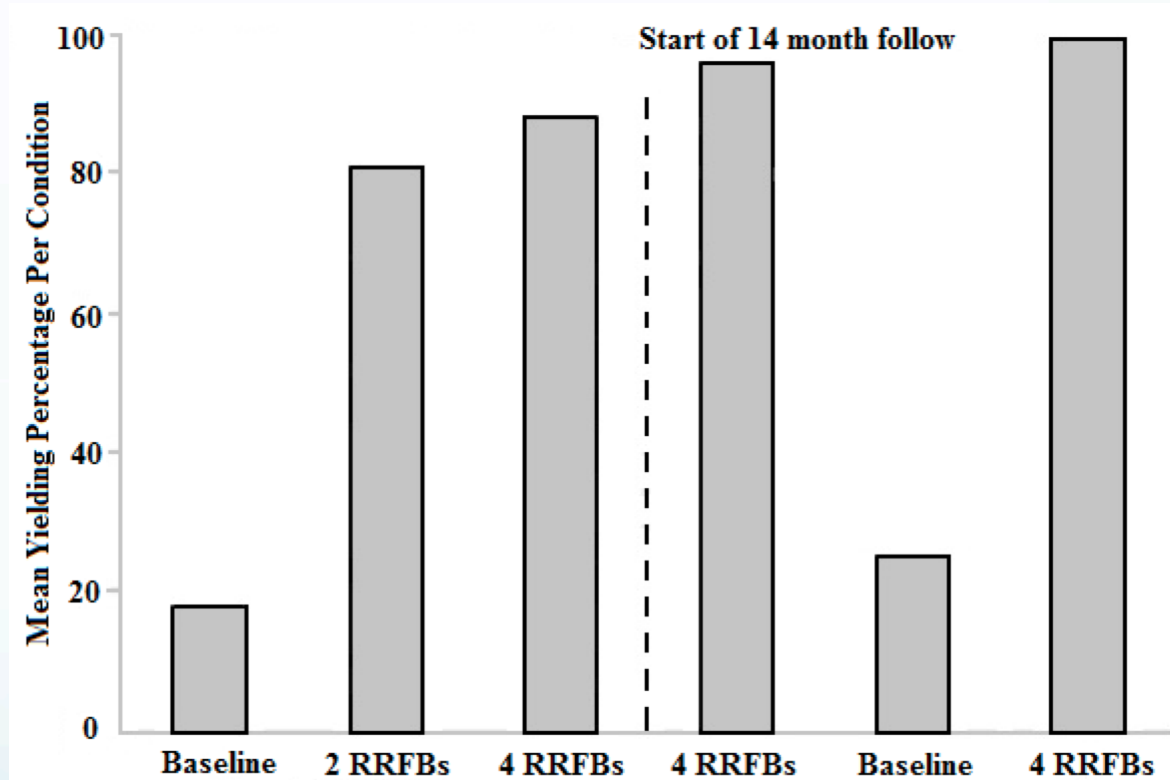
Raised Refuge Islands



4 Beacons vs. 2 Beacons

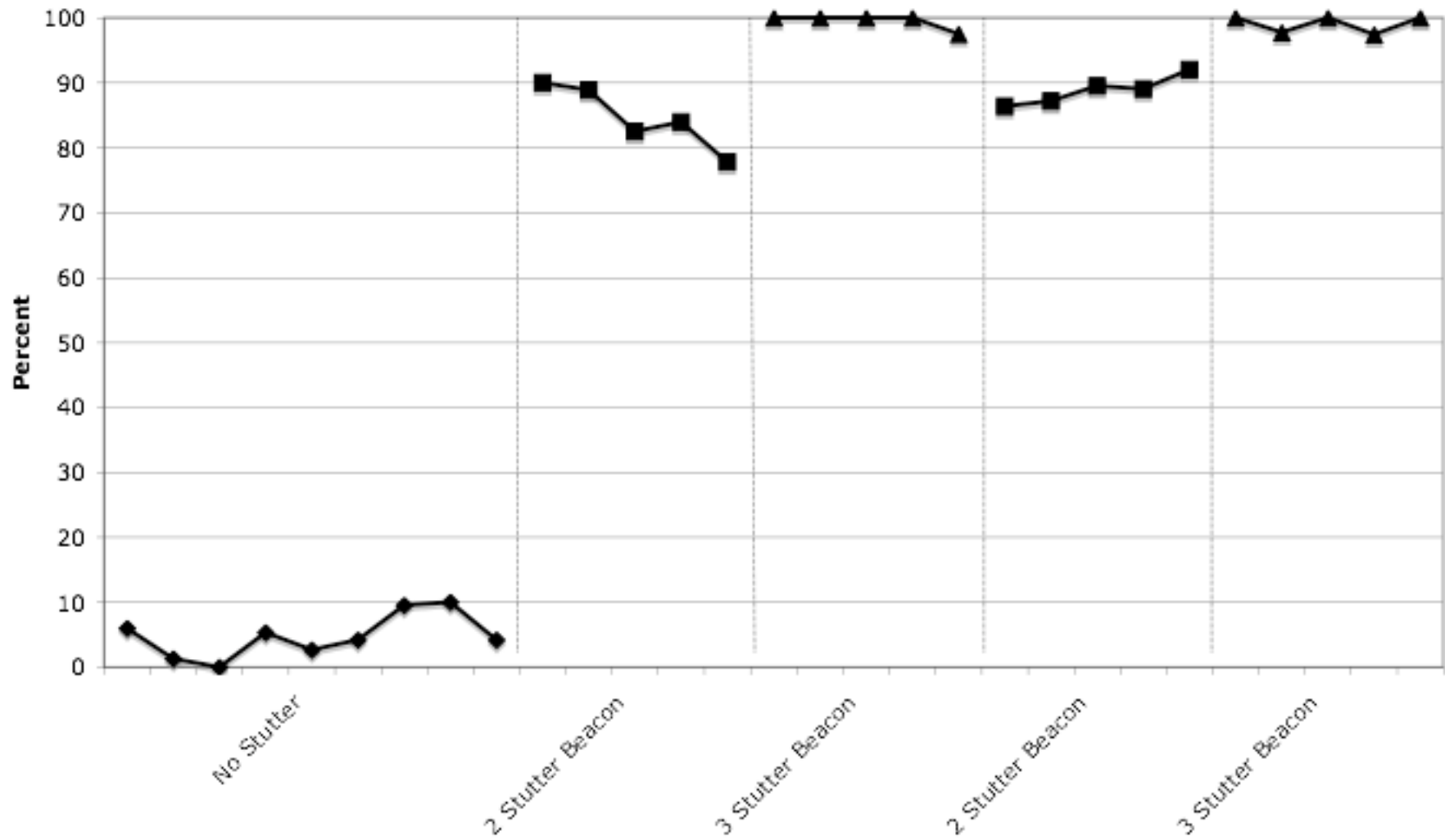


4 Beacon Vs 2 Beacon System



Night Data

1st. St. & 37th Ave. North
Yielding Percentages NIGHT

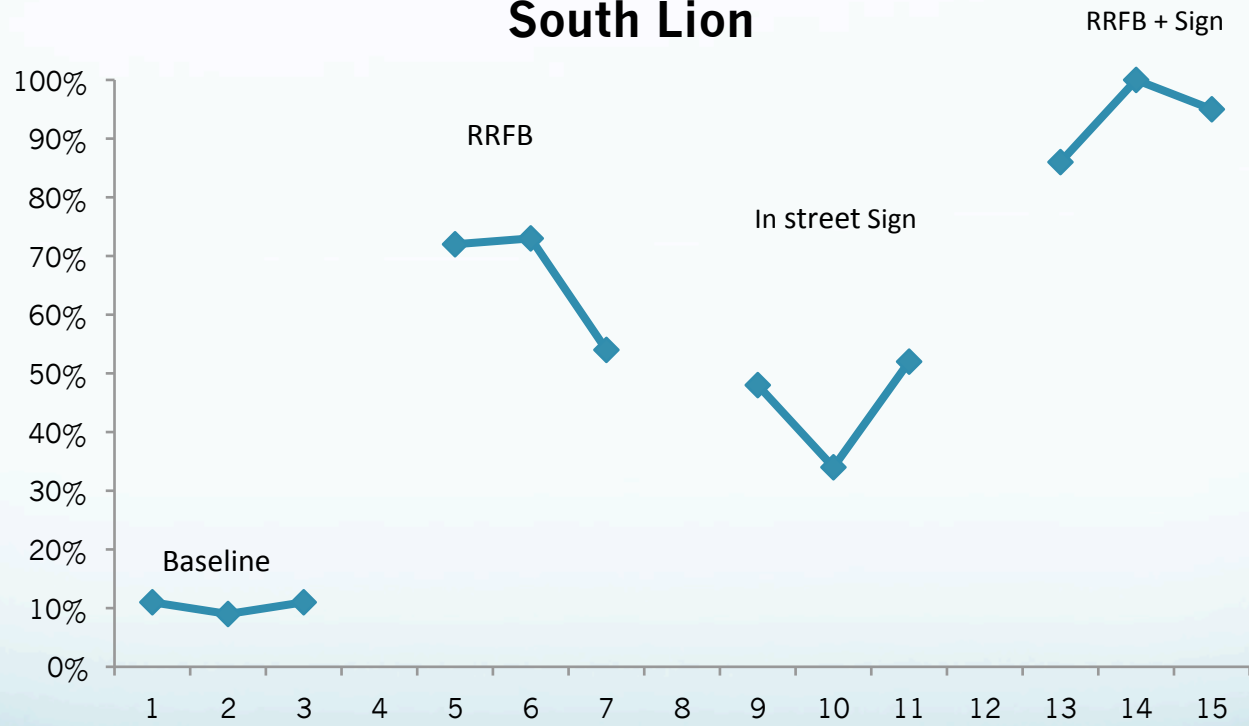


In Street Signs

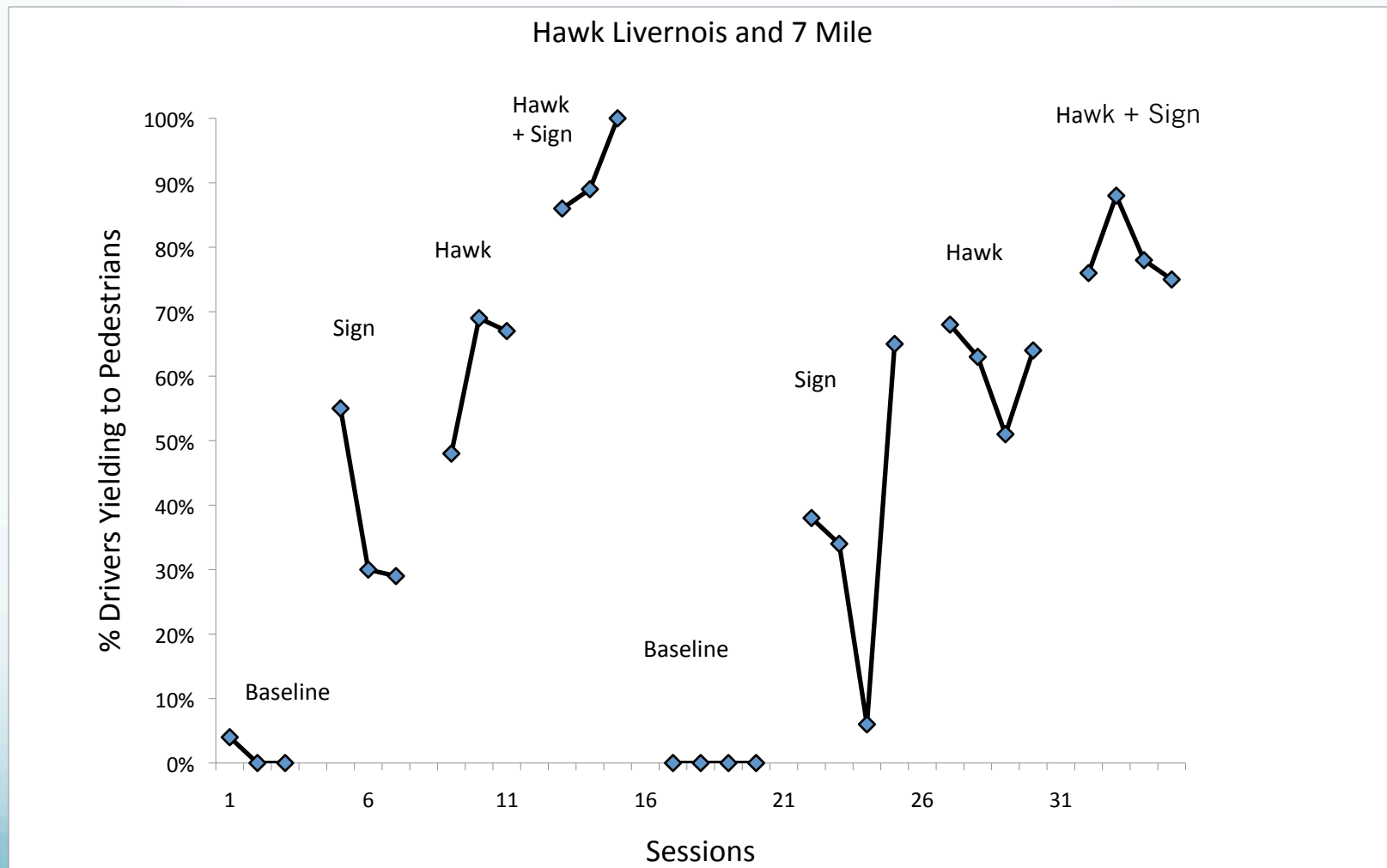


RRFB

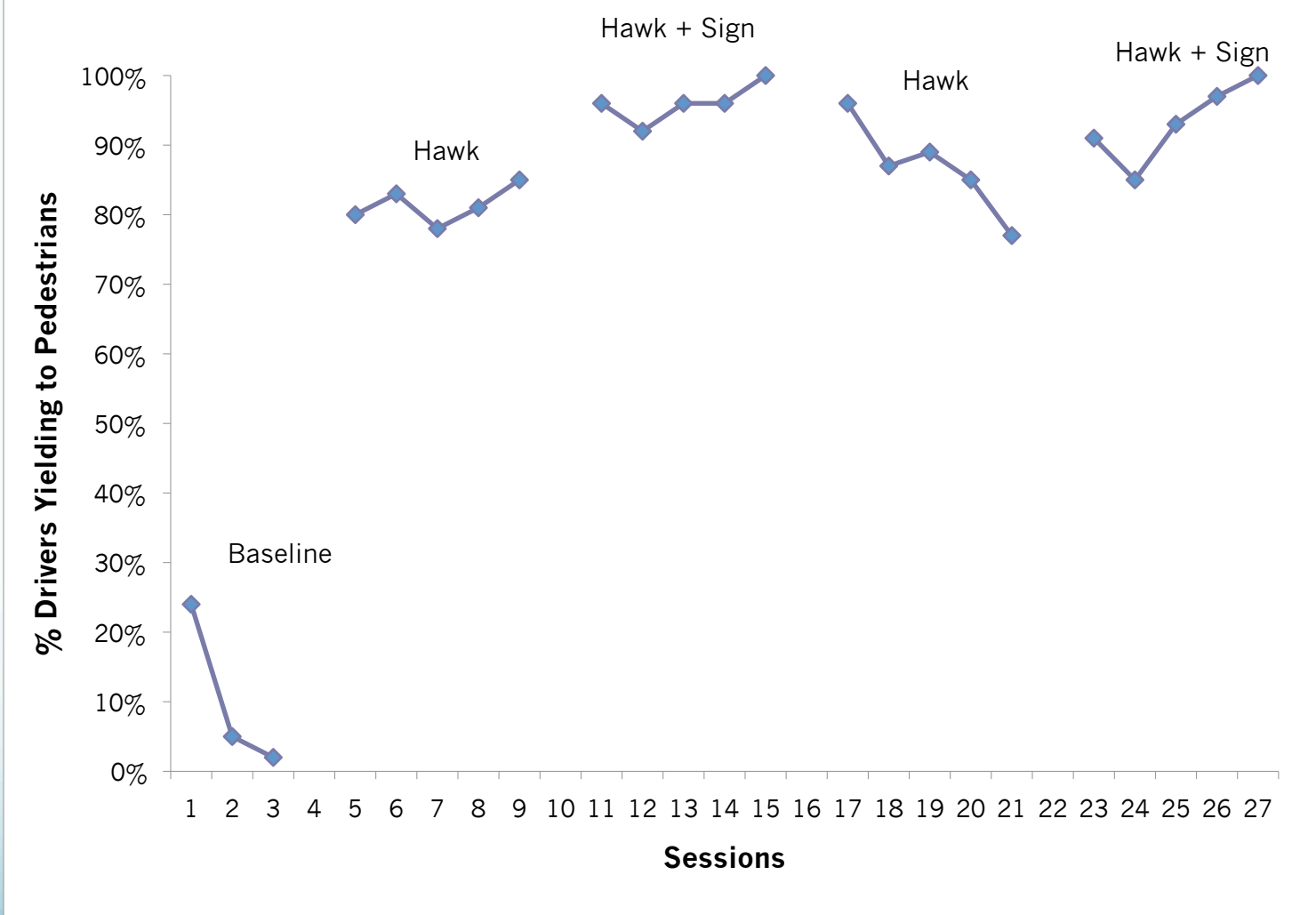
South Lion



Combining Hawk With the In-Street Sign



Cass with Hawk and Hawk+Sign



Where Do We Go From Here

1. Need to collect Crash Modification Factors for the RRFB that take into account contextual variables
2. We need to discover additional ways to enhance the efficacy of these devices
3. We need to find additional solutions that fit between a traffic signal and a marked crosswalk that are low cost