

Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections – Phase 3

Project No.

FDOT BDV25-977-43

Final Report

Prepared For

Florida Department of Transportation



November 2019

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Prepared by

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November 2019

Disclaimer

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Metric Conversion Chart

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
AREA				
in ²	squareinches	645.2	square millimeters	mm ²
ft ²	squarefeet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections – Phase 3		5. Report Date November 2019	
		6. Performing Organization Code	
7. Author(s) Pei-Sung Lin, Achilleas Kourtellis, Zhenyu Wang, Cong Chen, Rakesh Rangaswamy, and Jason Jackman		8. Performing Organization Report No.	
9. Performing Organization Name and Address Center for Urban Transportation Research University of South Florida 4202 E Fowler Ave, CUT100 Tampa, FL 33620		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. BDV25-977-43	
12. Sponsoring Agency Name and Address Florida Department of Transportation Research Center, MS 30 605 Suwannee St Tallahassee, FL 32399-0450		13. Type of Report and Period Covered Final Report July 2017–November 2019	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract This Phase 3 project aimed to implement and evaluate selected countermeasures recommended from the Phase 2 project via pilot studies in Florida to support future successful statewide implementation. The pedestrian signs being evaluated for this project included (1) “Stop Here on Red” (R10-6, R10-6a et.), (2) “No Turn on Red,” (R10-11, R10-11a et.) (3) “Turning Vehicles Yield to Pedestrians,” (R10-15) and (4) “Right on Red Arrow after Stop” (R10-17a), or “Right on Red after Stop.” Static and blank-out signs were implemented in the seven FDOT Districts. The overall results indicated that three pedestrian feature signs—“Right on Red after Stop,” “Turning Vehicles Yield to Pedestrians,” and “Stop Here on Red”—showed large increases of driver compliance after their implementation when compared to those before implementation. The increases of driver compliance after the implementation of “Right Turn on Red after Stop” signs for right-turning vehicles, “Stop Here on Red,” signs, and “Turning Vehicles Yield to Pedestrians” blank-out signs were all statistically significant at a confidence level of 95%. The implementation of dual blank-out signs “No Turn on Red” and “Turning Vehicles Yield to Pedestrians” showed that they can effectively improve safety by an increase in driver compliance and reduce unnecessary vehicle delay at signalized intersections by remaining blank when not needed. Researchers further demonstrated that combined pedestrian signage implementation and education outreach can achieve the highest driver compliance among four different treatments in the pilot implementations. The research result showed that the implementation of pedestrian feature signs alone can improve driver compliance considerably, and additional education outreach effort can further increase driver compliance. This research report also provides recommendations and guidelines to FDOT, other state DOTs, and local agencies on how to effectively implement the four major pedestrian feature signs in this study, and conduct education outreach of the signage to significantly increase driver compliance and improve pedestrian safety.			
17. Key Words pedestrian safety, SHRP 2 NDS, naturalistic driving study, traffic sign, pedestrian feature, effectiveness, signalized intersections, stop here on red (R10-11, R10-11a et.), no turn on red (R10-11, R10-11a et.), turning vehicles yield to pedestrians (R10-15), right on red arrow after stop (R10-17a), right on right turns after stop, right on red after stop		18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 118	22. Price

Acknowledgments

The research team is grateful for the full support and excellent guidance provided by the Florida Department of Transportation (FDOT) Project Manager, Joseph Santos, P.E., State Safety Engineer, Tenda McPherson, State Bicycle/Pedestrian Safety Program Manager, Darryll Dockstader, FDOT Research Center Manager, Jason Tuck, FDOT Performance and Workforce Coordinator, Jennifer Clark, FDOT Research Development Coordinator, and Amanda Ulmer, Business Systems Coordinator. The authors thank Ann Do, Product Lead, and Charles Fay, SHRP 2 Safety Research Manager with the Federal Highway Administration (FHWA), for their support and coordination of this project. The research team appreciates the support and assistance from the following FDOT Districts and local agencies for conducting pilot countermeasure implementations including both engineering countermeasures and education outreach:

- FDOT District 1: David Wheeler, John Kubicki, Mark Mathes, Rovindra Churaman, Steve Mille, David Agacinski
- FDOT District 2: Jerry Ausher, Cody Ko, Jennifer Graham, Derek Dixon
- FDOT District 3: Michael Lewis, Andrew White, Olen Pettis, Jordan Matt King
- FDOT District 4: Jonathan Overton, Mark Plass, Thomas Miller, Yujing Xie, Alexander Barr
- FDOT District 5: Jim Stroz, Chad Lingenfelter, Brenda Young
- FDOT District 6: Omar Meitin, Misleidys Leon, Elizabeth Stacey, William Abin, Isis Sotolongo, Ramon Sierra, Gary Ogle, Renato Marrero, Leonard Salazar
- FDOT District 7: Alex Henry, Peter Hsu, Ron Chin, Christopher Speese, Kevin Dunn
- Broward County: Carmelo Caratozzolo
- Orange County: Humberto Castellero
- Palm Beach County: Melissa Ackert
- Manatee County: Aaron Burkett
- VIBEngineering, Inc.: Sage Kamiya

We also thank the faculty, staff, and students at the Center for Urban Transportation Research (CUTR) and the administrative staff with Sponsored Research at the University of South Florida who supported our efforts in this project.

Executive Summary

In recent years, Florida has experienced serious pedestrian safety problems. Florida currently ranks 3rd (2017) in the U.S. for pedestrian fatality rates based on available official data. As such, Florida needs to increase safety and implement countermeasures that produce results. One of Florida's highest priorities is investigating major contributing causes for pedestrian fatalities and developing effective countermeasures to significantly improve pedestrian safety in the state.

The Phase 1 and Phase 2 reports of the three-phase research projects sponsored by the Federal Highway Administration (FHWA) and Florida Department of Transportation (FDOT) provided a proof of concept of proposed methodologies, performed detailed qualitative and quantitative analysis, offered FDOT a better understanding of the interactions between drivers and pedestrian features, and produced implementable countermeasures in engineering, education, and enforcement to improve pedestrian safety in Florida.

This Phase 3 project aimed to implement and evaluate selected countermeasures recommended from Phase 2 via pilot deployments in Florida to finalize countermeasures for supporting future successful statewide implementations. The pilot implementation focused more on deployment of engineering countermeasures and general education outreach to drivers on the engineering countermeasures.

The pedestrian feature signs being evaluated for this study included (1) "Stop Here on Red" (R10-6, R10-6a et.), (2) "No Turn on Red" (R10-11, R10-11a et.), (3) "Turning Vehicles Yield to Pedestrians" (R10-15), and (4) "Right on Red Arrow after Stop" (R10-17a) or "Right on Red after Stop." Static and blank-out signs were implemented in the seven FDOT Districts covering the north, central, and south regions of Florida. Each FDOT District had a pilot implementation site. With the support and assistance from the FDOT Central Office, FDOT Districts, and associated counties, the selected pedestrian features signs (engineering countermeasures) and education outreach efforts (education countermeasure) were successfully implemented in all FDOT Districts.

Before-after studies were conducted by collecting and analyzing observations on driver behaviors and compliance to the intents of pedestrian feature signs. Four groups of countermeasure treatments including (1) Engineering Only, (2) Engineering & Education Combined, (3) Education after Engineering, and (4) Education Only for Existing Signs were evaluated. Researchers closely examined the countermeasure treatments, and the impact of each implemented pedestrian feature sign, as well as its driver compliance rates before and after the implementation.

The major research findings, conclusions, and recommendations include the following:

- The overall results indicated that three pedestrian feature signs—"Right Turn on Red after Stop," "Turning Vehicles Yield to Pedestrians", and "Stop Here on Red"—showed

large increases of driver compliance after their implementation when compared to those before implementation. The increases in driver compliance after implementation of “Right Turn on Red after Stop” (exclusive right-turn lanes), “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” (blank-out) signs were all statistically significant at a confidence level of 95%.

- The result from the before-after data analysis showed that the compliance with “Right Turn on Red after Stop” signs for drivers from exclusive right-turn lanes increased significantly, from 10.2% to 25.2%., a 147% improvement. This sign is highly recommended to reduce the potential conflicts between pedestrians and right-turning vehicles.
- Both male and female drivers showed increased compliance with “Turning Vehicles Yield to Pedestrians,” “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” blank-out signs after implementations; the difference was statistically significant at the 95% confidence level.
- For “Turning Vehicles Yield to Pedestrians” signs, young drivers had higher compliance than middle-age and older drivers, and younger drivers were more likely to comply after implementation of the sign when compared to before implementation; the differences were significant at a 95% confidence level.
- The implementation of “No Turn on Red” blank-out signs showed that they can effectively improve safety via increased driver compliance and reduce unnecessary vehicle delay at signalized intersections as the signs were displayed only when needed; otherwise, the signs were blank (black display). The “No Turn on Red” blank-out signs are becoming more popular than static signs because they reduce unnecessary delays by remaining blank when not needed.
- Overall, there was a 75.2% compliance rate after implementation of the “No Turn on Red” blank-out signs, which is lower than the compliance rate of 90.9% from the “No Turn on Red” static signs in the Phase 2 study. To improve driver compliance rates for “No Turn on Red” blank-out signs, a traffic agency should consider implementing them based on a time-of-day schedule to coincide with higher pedestrian activity. Regular law enforcement at locations with “No Turn on Red” blank-out sign operations can likely improve driver compliance rates.
- Among four groups of countermeasure treatments, the analysis showed that combined pedestrian signage implementation and education outreach can achieve the highest driver compliance. The implementation of pedestrian feature signs alone can achieve driver compliance considerably (67% to 95%) when compared to combined sign implementation and education outreach. Additional education outreach effort after the installation of pedestrian feature signs can further increase driver compliance. Education outreach on existing pedestrian feature signs via roadside education yard signs showed improved driver compliance but it was not statistically significant.

- Researchers recommend and provide guidelines for the following four major pedestrian feature sign implementations:
 - Implement “No Turn on Red” static or blank-out signs when supported by an engineering study.
 - Implement “Right on Red Arrow after Stop,” “Right Turn on Red after Stop,” or “Right on Red after Stop” signs if “No Turn on Red” signs are not implemented, and high percentage of right-turning traffic do not have full stops before making right turns.
 - Implement “Turning Vehicles Yield to Pedestrians” static or blank-out signs to increase driver yielding behavior.
 - Implement “Stop Here on Red” signs at locations with frequent non-compliance.
- Education outreach approaches for targeted gender/age groups include, but are not limited to, interactive knowledge-based presentations, education outreach events, safety information distribution to target audiences, and Safety Ambassador recruitment.
- One or more education outreach activities should be conducted for all drivers, especially young drivers, to improve their compliance with “No Turn on Red” blank-out signs.
- One or more education outreach activities should be conducted for all drivers, especially older drivers, to improve their compliance with “Right Turn on Red after Stop” signs.
- One or more education outreach activities should be conducted for all drivers to improve their compliance with “Stop Here on Red” signs when they are in an exclusive right-turn lane.
- One or more education outreach activities should be conducted for older drivers to improve their compliance with “Turning Vehicles Yield to Pedestrians” signs.

This Phase 3 report provides recommendations and guidance to FDOT, other state DOTs, and local agencies on how to effectively implement the four major pedestrian feature signs in this study and education outreach to increase driver compliance and improve pedestrian safety.

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1. Introduction

1.1 Problem Statement

Over the years, Florida has experienced serious pedestrian safety problems. One of the State of Florida's highest priorities is investigating major contributing causes for pedestrian fatalities and developing effective countermeasures to significantly improve pedestrian safety in the state.

The Strategic Highway Research Program 2 (SHRP2) Naturalistic Driving Study (NDS) (Blatt, et al., 2015) recorded the driving behavior of a large sample of drivers in their personal vehicles, offering researchers comprehensive naturalistic driving behavioral data, and the Roadway Information Database (RID) provides information on road elements encountered in the more than five million trips taken by NDS participants for safety research. The SHRP2 safety data can be used to analyze driver behavior to understand the factors contributing to highway crashes, prove concepts to develop countermeasure, and conduct research to field deployment.

Specifically, the SHRP2 safety data offered researchers in Florida comprehensive data to investigate the interactions between drivers and various pedestrian features at selected signalized intersections through which they drive and support a comprehensive safety assessment of driver behavior and crash risk. The overall goals of these three-phase research projects sponsored by the Federal Highway Administration (FHWA) and Florida Department of Transportation (FDOT) were to use SHRP2 NDS and RID datasets to better understand the interaction between drivers and pedestrian features at signalized intersections, develop implementable countermeasures, conduct and evaluate pilot implementation of the countermeasures, and provide recommendations on how to effectively implement these countermeasures statewide to significantly increase pedestrian safety at signalized intersections in Florida.

The Phases 1 report (Lin, Wang, Kourtellis, & Guo, 2015) used small NDS safety datasets to prove the concept of proposed methodologies and obtain initial results to understand the interactions between drivers and pedestrian features at signalized intersections. The Phases 2 report (Lin, Kourtellis, Wang, Chen, & Guo, 2017) provided detailed qualitative and quantitative analysis using large NDS safety datasets, offered the Florida Department of Transportation (FDOT) a better understanding of the interactions between drivers and pedestrian features, and produced implementable countermeasures in engineering, education, and enforcement to improve pedestrian safety in Florida.

This Phase 3 project aimed to implement and evaluate selected countermeasures recommended from Phase 2 via pilot deployments in Florida to finalize countermeasures for supporting future successful statewide implementations. The pilot implementation focused more on deployment of engineering countermeasures and general education outreach to drivers on the engineering countermeasures. The description for the goals of these three-phase research projects is presented in Table 1.

Table 1. Description of Goals for the Three-phase Research Projects

Phase Number	Description of Project Goals
1	Prove the concept of proposed methodologies by using small NDS safety datasets and obtain initial results to understand the interactions between drivers and pedestrian features at signalized intersections
2	Perform comprehensive analyses using large NDS safety datasets to obtain detailed results and findings, and provide recommendations of countermeasures for pilot implementations
3	Conduct pilot deployments, evaluate selected countermeasures, and offer recommendations for future successful statewide deployments

1.2 Proposed Countermeasures in Phase 2

Key recommended implementable countermeasures from Phase 2 were divided into three categories—Engineering, Education, and Enforcement.

Engineering Countermeasures

- Implement “No Turn on Red” (R10-11, R10-11a et.) static or blank-out signs when possible.
- Implement “Right on Red Arrow after Stop,” (R10-17a) “Right Turn on Red after Stop,” or “Right on Red after Stop” signs if “No Turn on Red” (R10-11, R10-11a et.) signs are not implemented.
- Implement both “No Turn on Red” (R10-11, R10-11a et.) and “Stop Here on Red” (R10-6, R10-6a et.) signs at the same intersection.
- Implement “Right on Red Arrow after Stop” (R10-17a) and “Turning Vehicles Yield to Pedestrians” (R10-15) signs at the same intersection.
- Implement overhead signs for “No Turn on Red” (R10-11, R10-11a et.), “Right on Red Arrow after Stop” (R10-17a) or Right on Red after Stop signs when possible.
- Implement “Stop Here on Red” (R10-6, R10-6a et.) signs at locations with frequent non-compliance.

Education Countermeasures

- Conduct education outreach to female drivers to improve their compliance rate for “Stop Here on Red” signs.
- Conduct education outreach to young drivers to improve their compliance rate for “Stop Here on Red” signs.
- Conduct education outreach to male drivers to improve their compliance rate for “No Turn on Red” signs.

- Conduct education outreach to older drivers to improve their compliance rate for “No Turn on Red” and “Right on Red Arrow after Stop” signs.
- Conduct education outreach to reduce risky or/and distracted behaviors while driving, especially young drivers.

Enforcement Countermeasures

- Conduct High Visibility Enforcement (HVE) to improve compliance rates for “Stop Here on Red” and “Right on Red Arrow after Stop” signs when possible.

1.3 Project Objectives

The main objectives of the Phase 3 project were to:

1. Select recommended countermeasures from the Phase 2 project and study sites in north, central, and south Florida for pilot implementations.
2. Implement selected countermeasures at selected sites with focuses on engineering countermeasures and education outreach.
3. Conduct before-after studies to comprehensively evaluate the effectiveness of deployed countermeasures.
4. Provide findings from pilot implementations and recommendations for future successful statewide implementations.

2. Selected Countermeasures and Pilot Study Sites

Task 2 included two major subtasks. The first was to select the recommended countermeasures from the Phase 2 project for finalization for pilot implementations, and the second was to select candidate sites with pedestrian safety problems, pedestrian crashes, and/or conflicts between crossing pedestrians and right-turning traffic for consideration and finalization. Seven pilot study sites with one site in each of FDOT's seven Districts were selected for the pilot implementation. They covered the north (Districts 2 and 3), central (Districts 5 and 7), and south (Districts 1, 4 and 6) regions of Florida, as shown in Figure 1.



Figure 1. Regions for pilot implementations of selected countermeasures

The signs evaluated for this study included (1) “Stop Here on Red,” (2) “No Turn on Red,” (3) “Turning Vehicles Yield to Pedestrians,” and (4) “Right on Red Arrow after Stop” or “Right on Red after Stop.” Based on feedback from the FDOT Districts, these signs could be installed without a traffic study since they are a reminder of the law, except for the “No Turn on Red” sign, which would require an engineering study and traffic regulation to be legally enforceable. Additionally, the delay/queue impact of Right Turn on Red (RTOR) prohibition should be considered.

According to the *Manual on Uniform Traffic Control Devices for Streets or Highways* (MUTCD) (FHWA, 2012), a “No Turn on Red” sign should be considered when an engineering study finds that one or more of the following conditions exists:

- A. Inadequate sight distance to vehicles approaching from the left (or right, if applicable);
- B. Geometrics or operational characteristics of the intersection that might result in unexpected conflicts;
- C. An exclusive pedestrian phase;

- D. An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities;
- E. More than three right-turn-on-red accidents reported in a 12-month period for the particular approach; or
- F. The skew angle of the intersecting roadways creates difficulty for drivers to see traffic approaching from their left.

Because of the need for an engineering study for a “No Turn on Red” sign implementation and an examination of the structure for handling the additional windloading for overhead sign installation, further coordination and studies were required to finalize the engineering countermeasure at each pilot study site. For the selection of final study sites for pilot implementation, the CUTR research team selected three candidate sites from many potential sites in each FDOT District for further finalization.

Per MUTCD, the four pedestrian features signs included in this research project are part of traffic signal signs R10-1 through R10-21 to supplement traffic signal control and may be used to regulate road users. Based on guidance from MUTCD, when used, these traffic signal signs should be located adjacent to the signal face to which they apply.

2.1 Selection of Recommended Countermeasures

This subtask focused on the selection of recommended countermeasures from the Phase 2 project so the Phase 3 project could comprehensively evaluate these countermeasures via the pilot implementations. The proposed method to select engineering countermeasures at candidate sites was as follows:

- Implement “No Turn on Red” static or blank-out signs at a minimum of two sites based on engineering studies and compare the result between static and blank-out signs.
- Implement “Right on Red Arrow after Stop” or “Right on Red after Stop” signs at a minimum of two sites.
- Implement “Stop Here on Red” sign at sites with a short distance between a stop bar and a pedestrian crosswalk.
- Implement “Turning Vehicles Yield to Pedestrians” signs at a minimum of one site.
- Implement overhead signs for “No Turn on Red,” “Right on Red Arrow after Stop” or “Right on Red after Stop” signs.

The following combinations of signs could be applied:

- A dual blank-out sign with a “No Turn on Red” symbol and “Turning Vehicles Yield to Pedestrians” could be implemented on the same approach of a selected site.
- Both “No Turn on Red” and “Stop Here on Red” signs could be implemented on the same approach of a selected site.

- Both “Right on Red Arrow after Stop” and “Turning Vehicles Yield to Pedestrians” signs could be implemented on the same approach of a selected site.

The final recommended engineering countermeasure(s) implemented at a target approach of a pilot study site in each FDOT District was determined after further examination and discussions with corresponding FDOT District representative(s).

For education countermeasures, the research team designed specific yard signs based on the final selected engineering countermeasures at the pilot study sites and placed multiple yard signs in advance of studied intersections after the implementation of engineering countermeasures to educate drivers on the new implemented pedestrian feature sign(s).

2.2 Final Selection of Pilot Study Sites

The research team first identified the potential sites for the pilot implementations based on the frequency and severity of crashes involving pedestrians and bicyclists and right-turning vehicles, short distances between stop bars and pedestrian crosswalks, and/or recommendations from FDOT District representatives.

To select the candidate sites, all pedestrian crashes for 2012–2016 (five years) were used, which is a standard number of years, as pedestrian crashes are not as frequent as vehicle traffic crashes. Using Florida’s Integrated Report Exchange System (FIRES) provided by the Florida Department of Highway Safety and Motor Vehicles (DHSMV), pedestrian crashes in which the involved vehicle was making a right-turn maneuver were mapped. The research team identified hot spots using a high-frequency mapping tool. Figure 2 is an example screenshot of a heat map for the Tampa Bay area in FDOT District 7. Researchers used heat maps to identify hot spots of pedestrian and right-turn vehicle crashes.

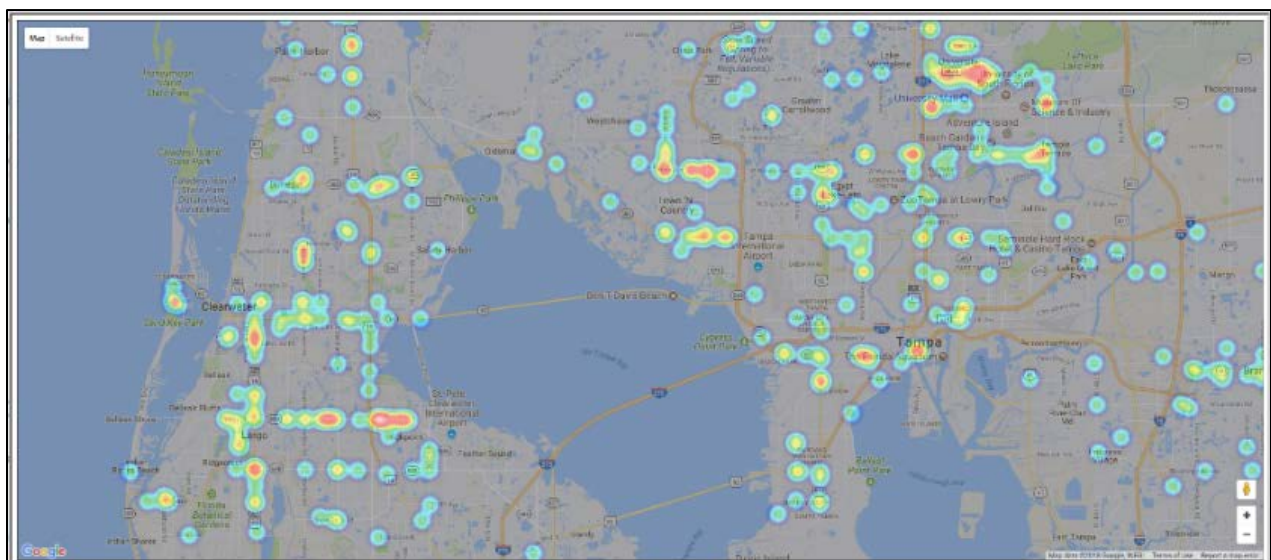


Figure 2. Pedestrian crash heat map in Tampa Bay area, FDOT District 7

Intersections with a high number of pedestrian- and bicyclist-related crashes in each FDOT District were selected as candidate locations. The research team provided 3–11 candidate sites to FDOT District representatives and requested their feedback and ranking of the top three sites in their District and top approach(es) for each of top three sites for further examinations.

Table 2 shows the top three candidate sites for each FDOT District and proposed engineering countermeasures. (Table 49 in Appendix A shows all potential sites based on crash history.)

Specifically, the CUTR team sent letters to all FDOT District Offices requesting that FDOT District representatives prioritize (rank) the candidate sites based on their experience and local knowledge for needs to improve pedestrian safety. An example of the letters sent to the Districts is shown in Appendix B.

In addition to crash heat maps, the Districts were also provided collision diagrams for sites. An example of a heat map for Pinellas County pedestrian crash sites involving right-turning vehicles for 2012–2016 is shown in Figure 3. Figure 4 shows an example of a diagram used to analyze the types of crashes and their location. In addition, all crash reports were obtained and analyzed to determine the exact approach of the intersection on which crashes occurred.

Based on the input provided by the Districts and physical limitations of some sites, the CUTR research team selected a final list of seven pilot study sites, one in each FDOT District. Table 3 shows the final pilot study sites and treatments including both engineering and education countermeasures by FDOT Districts. Engineering countermeasures were to be implemented on one approach of an intersection; District 3 had countermeasures on two approaches of the same intersection. The countermeasures selected for each site were based on a combination of factors:

- Presence of exclusive right-turn lanes
- Number of lanes
- Distance between stop bar and crosswalk
- Severity and frequency of crashes
- Annual Average Daily Traffic (AADT)
- Presence of existing signs

Table 2. Top 3 Recommended Intersections and Approaches for Each FDOT District

FDOT Dist.	Site No.	Region	Road 1	Road 2	Approach	Area	Countermeasure
1	1	South	US-41	Cortez Rd	NB	Bradenton	No Turn on Red, Turning Vehicle Yield to Ped, Stop Here on Red
	2	South	US-301	Fruitville Rd	SB and/ or EB	Sarasota	Right on Red after Stop, Stop Here on Red
	3	South	US-301	17th St	SB or/and WB	Sarasota	Stop Here on Red
2	1	North	N Main St	NE 16th Ave	SB	Gainesville	Right on Red Arrow after Stop
	2	North	Atlantic Blvd	Penman Rd	EB	Jacksonville	Right on Red after Stop
	3	North	Blaimore Blvd E	Blanding Blvd	WB	Jacksonville	Right on Red after Stop
3	1	North	US-98	Stahlman Ave	NB, EB	Destin	Right on Red after Stop, Turning Vehicles Yield to Peds
	2	North	Stadium Dr	W Call St	SB and WB	Tallahassee	Stop Here on Red, Right on Red after Stop, Turning Vehicles Yield to Peds
	3	North	High Rd	W Tennessee St	EB	Tallahassee	Stop Here on Red, Turning Vehicles Yield to Peds
4	1	South	Okeechobee Blvd	SR-809	EB	W Palm Beach	Right on Red after Stop, Stop Here on Red
	2	South	Andrews Ave	SR-842	WB	Ft Lauderdale	No Turn on Red, Turning Vehicles Yield to Peds
	3	South	S SR-7	Miramar Pkwy	EB	Miramar	No Turn on Red, Turning Vehicles Yield to Peds
5	1	Central	US-1	W Granada Blvd	NB	Ormond Beach	Blank-out No Turn on Red & Turning Vehicles Yield to Peds
	2	Central	Silver Star Rd	N Pine Hills Rd	NB	Orlando	Right on Red After Stop
	3	Central	S Semoran Blvd	Pershing Ave	EB	Orlando	Right on Red After Stop, Stop Here on Red
6	1	South	NW 199th St	US-441	EB	Miami Gardens	No Turn on Red & Turning Vehicles Yield to Peds
	2	South	5th St	Washington Ave	NB	Miami Beach	Turning Vehicles Yield to Peds
	3	South	W Flagler St	SW 67th Ave	NB	Miami	Stop Here on Red
7	1	Central	Roosevelt Blvd	Dodge St	NB	Largo	Right on Red after Stop & Stop Here on Red
	2	Central	MLK Jr Blvd	N Armenia Ave	NB	Tampa	Blank-out No Turn on Red & Turning Vehicles Yield to Peds, Right on Red after Stop
	3	Central	Park Blvd N	66th St N	EB	Pinellas Park	Right on Red after Stop

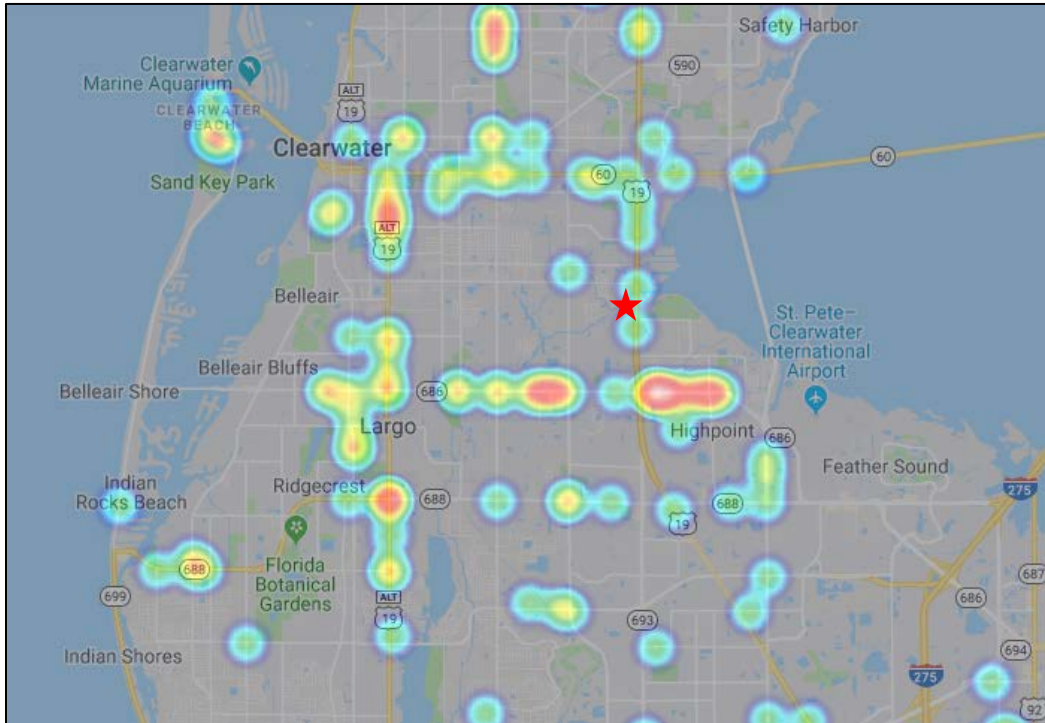


Figure 3. Pinellas County pedestrian crash sites involving right-turning vehicles, 2012–2016

Source: FIRES portal (DHSMV)

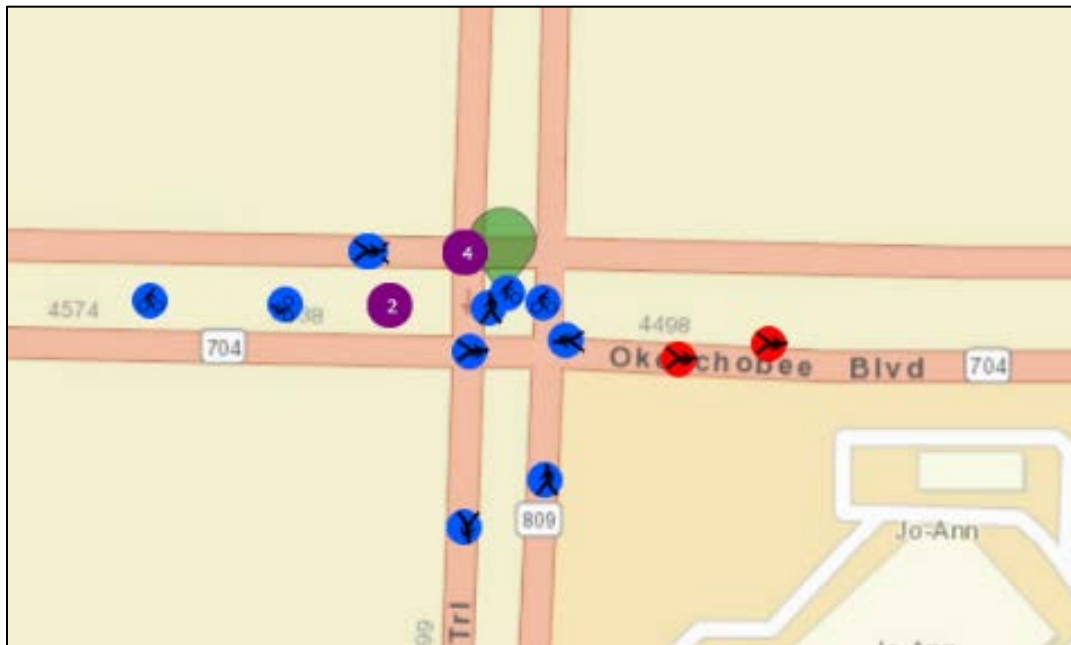


Figure 4. Collision diagram for potential site

Source: Signal 4 Analytics

Table 3. Implemented Pedestrian Feature Signs by FDOT Districts

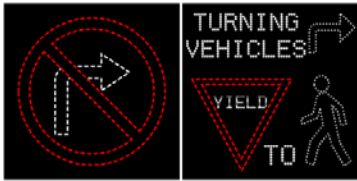









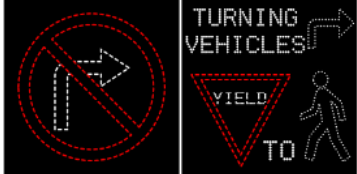

FDOT Dist.	Location & Direction	Treatment		Education	
		Blank-out Sign	Static Sign		
1	US-41 @ Cortez Rd, Bradenton FL NB	<p>Overhead Dual Sign 36"x36"</p> 	<p>Roadside Sign: "Stop Here on Red," 24"x30"</p>  <p>R10-6a</p>	Yes	
2	Atlantic Blvd @ Penman Rd, Jacksonville FL EB	N/A	<p>Roadside Sign: "Right Turn on Red after Stop," 24"x36"</p> 	Yes	
3	US-98 @ Stahlman Ave, Destin FL NB	N/A	<p>Roadside Sign: "Right Turn on Red after Stop," 24"x36"</p> 	<p>Roadside Sign: "Turning Vehicles Yield to Peds," 30"x30"</p>  <p>R10-15</p>	Yes
3	US-98 @ Stahlman Ave, Destin FL EB	N/A	<p>Roadside Sign: "Right Turn on Red after Stop," 24"x36"</p> 	<p>Roadside Sign: "Turning Vehicles Yield to Peds" 30"x 30"</p>  <p>R10-15</p>	Yes
4	N Dixie Hwy @ NE 48 th St, Pompano Beach FL EB	N/A	<p>Roadside Sign: "Right Turn on Red after Stop," 24"x36"</p> 	Yes	

Table 3. Implemented Pedestrian Feature Signs by FDOT Districts (cont'd)

FDOT Dist.	Location & Direction	Treatment		Education
		Blank-out Sign	Static Sign	
5	Silver Star Rd @ N Pine Hills Rd, Pine Hills FL SB	N/A	Roadside Sign: "Right Turn on Red after Stop," 24"x36" 	Yes
6	W 41 st St @Pine Tree Dr, Miami Beach FL NB	N/A	Existing Overhead Sign: "Turning Vehicles Yield to Pedestrians," 30"x30"  R10-15	Yes
7	Roosevelt Blvd @ Dodge St, Largo FL NB	Overhead Dual Sign 36"x36" 	Roadside Sign: "Stop Here on Red," 24"x30"  R10-6a	No

3. Deployment of Countermeasures

To achieve deployment of the selected countermeasures, the research team coordinated with the FDOT District offices and, on many occasions, the respective County offices to prepare, schedule, and coordinate the installation of the signs. Blank-out signs with dual modes of “No Turn on Red” and “Turning Vehicles Yield to Pedestrians” were popular. Two blank-out signs with dual modes were ordered by CUTR via an FDOT-approved vendor. The figures in the following subsections show each site before and after implementation.

3.1 District 1: US-41 @ Cortez Rd, Bradenton FL, NB

An overhead blank-out sign with dual modes was selected and installed for this site so that two different signs could be delivered with one installation. To minimize traffic delay, “No Turn on Red” was displayed only when a pedestrian call was served. Additionally, a roadside “Stop Here on Red” sign was installed near the stop bar. Figure 5 shows the site before implementation, and Figure 6 shows the site after implementation. The timing for display of this blank-out sign was as follows:

1. When NB direction was under red phase, the sign was blank (Figure 6).
2. When NB direction was under red phase AND a pedestrian call was served on the SB leg (east-west direction) of the intersection, the sign displayed “No Turn on Red” (Figure 7).
3. When NB direction was under green and yellow phases, the sign displayed “Turning Vehicles Yield to Pedestrians” (Figure 8).



Figure 5. D1 site before implementation

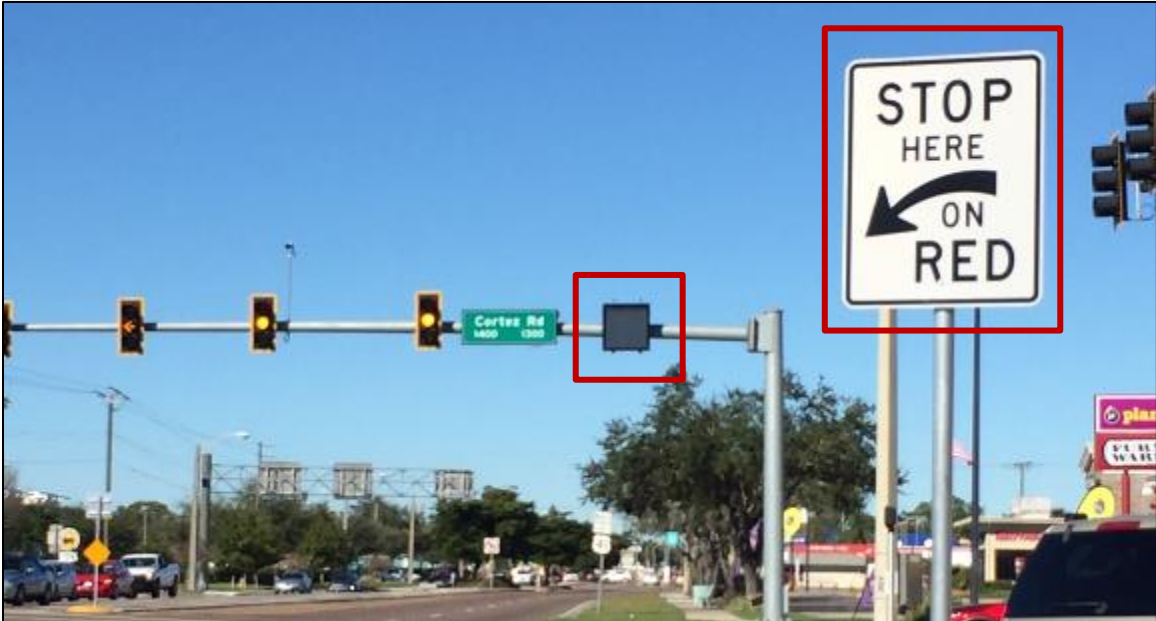


Figure 6. D1 site after implementation of blank-out sign and “Stop Here on Red” sign



Figure 7. D1 site after implementation of “No Turn on Red” blank-out sign



Figure 8. D1 site after implementation of “Turning Vehicles Yield to Pedestrians” blank-out sign

3.2 District 2: Atlantic Blvd @ Penman Rd, Jacksonville FL, EB

For District 2, a “Right Turn on Red after Stop” sign was installed to remind drivers to stop before making a right-on-red maneuver. Figure 9 shows the site before implementation, and Figure 10 shows the site after implementation.



Figure 9. D2 site before implementation



Figure 10. D2 site after implementation of “Right Turn on Red After Stop” sign

3.3 District 3: US-98 @ Stahlman Ave, Destin FL, NB & EB

For the District 3 site, two approaches were used to implement the same signs—“Right Turn on Red After Stop” and “Turning Vehicles Yield to Pedestrians.” Figure 11 shows the NB direction before implementation, and Figure 12 shows the NB direction after implementation. Figure 13 shows the EB direction before implementation, and Figure 14 shows the EB direction after implementation.



Figure 11. D3 site before implementation (NB)



Figure 12. D3 site after implementation (NB) of both “Right on Red After Stop” and “Turning Vehicles Yield to Pedestrians” signs



Figure 13. D3 site before implementation (EB)



Figure 14. D3 site after implementation (EB) of both “Right Turn on Red After Stop” and “Turning Vehicles Yield to Pedestrians” signs

3.4 District 4: N Dixie Hwy @ NE 48th St, Pompano Beach FL, EB

The before and after implementation of the “Right Turn on Red After Stop” sign for District 4 are shown in Figure 15 and Figure 16, respectively.



Figure 15. D4 site before implementation



Figure 16. D4 site after implementation of “Right Turn on Red After Stop” sign

3.5 District 5: Silver Star Rd @ N Pine Hills Rd, Pine Hills FL, SB

Before and after implementation photos for the District 5 site are shown in Figure 17 and Figure 18. The “Right Turn on Red After Stop” sign is shown in Figure 18.

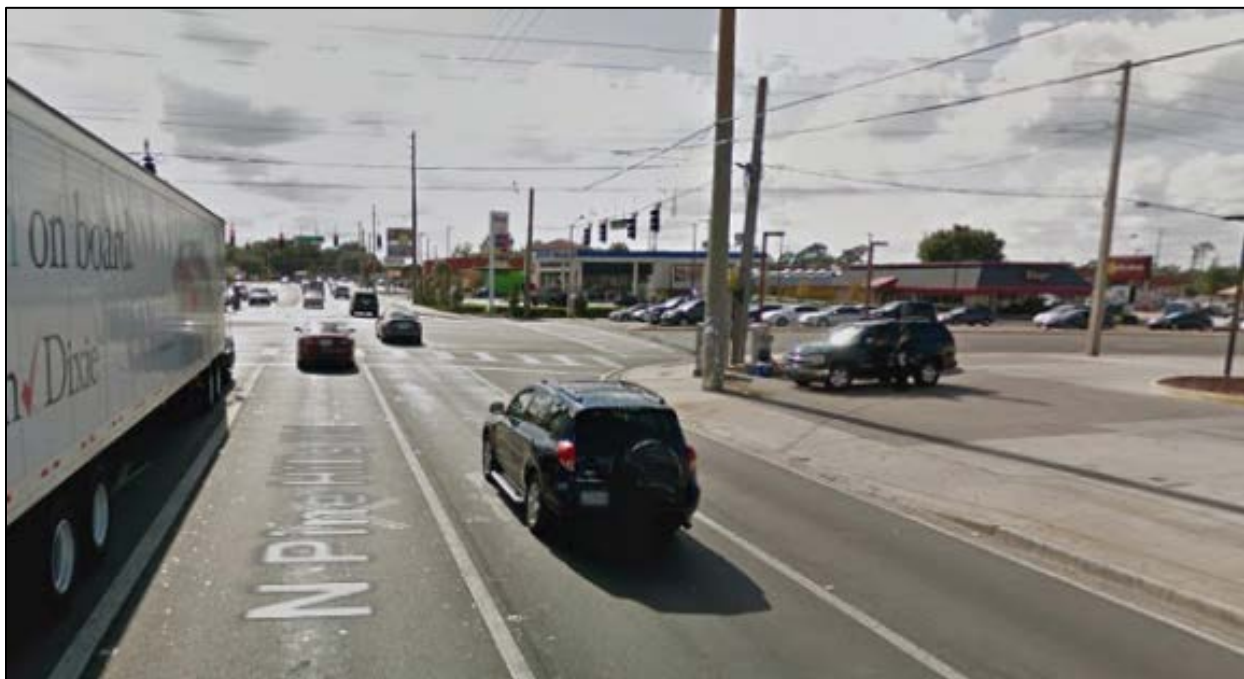


Figure 17. D5 site before implementation



Figure 18. D5 site after implementation of “Right Turn on Red” After Stop sign

3.6 District 6: W 41st St @ Pine Tree Dr, Miami Beach FL, NB

For District 6, the selected location has an existing “Turning Vehicles Yield to Pedestrians” sign. This site was selected to conduct additional education for the sign. Figure 19 shows the sign installed overhead on the mast arm.

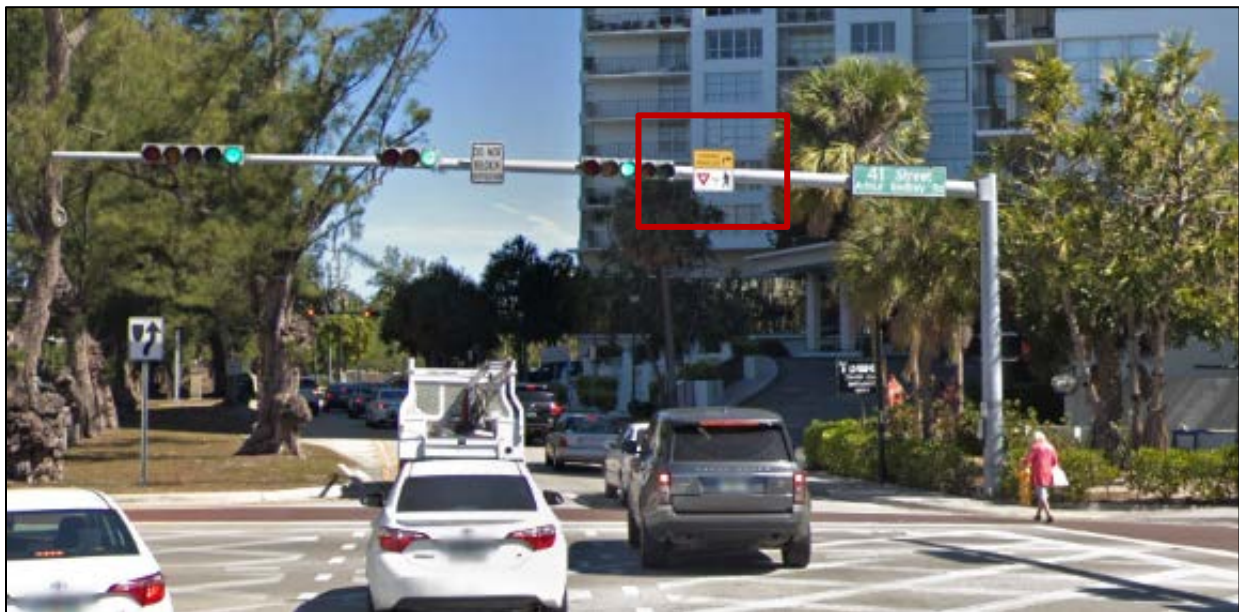


Figure 19. D6 site of using existing “Turning Vehicles Yield to Pedestrians” sign

3.7 District 7: Roosevelt Blvd @ Dodge St, Largo FL, NB

Similar to the District 1 site, the District 7 site (Figure 20) received a blank-out sign with dual modes and a roadside sign. The timing of the displays of the blank-out sign was as follows:

1. When NB direction was under Red phase, the sign was blank (Figure 21).
2. When NB direction was under Red phase and a pedestrian call was served on the SB leg of the intersection, the sign displayed “No Turn on Red” (Figure 22).
3. When NB direction was under Green or Yellow phases, the sign displayed “Turning Vehicles Yield to Pedestrians” (Figure 23).



Figure 20. D7 site before implementation



Figure 21. D7 site after implementation of blank-out sign and “Stop Here on Red” sign



Figure 22. D7 site after implementation of “No Turn on Red” blank-out sign



Figure 23. D7 site after implementation of “Turning Vehicles Yield to Pedestrians” sign

3.8 Education Outreach

A good approach to education efforts for this study was to reach drivers who passed through the pilot study sites after installation of new traffic signs to inform them of the intent of the signs. Education outreach efforts were carried out by placing yard signs at selected study locations for 2–3 weeks to educate and remind drivers on the intent of the signs.

The CUTR team first informed the FDOT Districts and local agencies about the purpose and location for yard sign placement. CUTR designed and produced the yard signs and placed them at selected study sites after deployment of the engineering countermeasures. Photos for yard sign placements in FDOT Districts 2, 3, 4, and 5 are shown in Figure 24 through Figure 27, respectively.



Figure 24. Placement of education yard signs at D2 study site



Figure 25. Placement of education yard signs at D3 study site



Figure 26. Placement of education yard signs at D4 study site



Figure 27. Placement of education yard signs at D5 study site

4. Data Collection and Compilation

To evaluate the effectiveness of engineering and education countermeasures, the team collected “before” and “after” observational data. The procedure of data collection is shown in Figure 28.

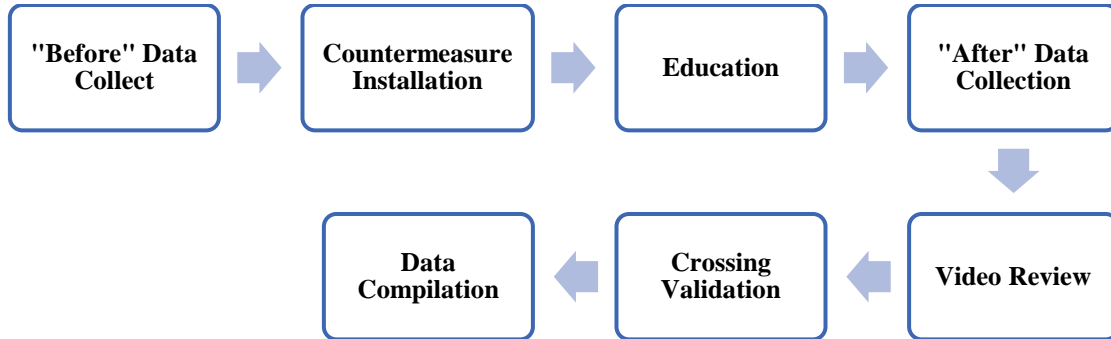


Figure 28. Procedure for data collection and compilation

To investigate the marginal effects of engineering treatments, education treatments, and their combination, data were collected in different configurations. As shown in Table 4, “before” data were collected at all sites, engineering treatments were implemented in all but the site in District 6 (existing sign was evaluated), “after” engineering treatment data were collected in Districts 1 and 7, education was conducted in all sites except in District 7, and “after” data of combined engineering treatments and education outreach were collected in all sites except District 7. Using this method, several scenarios could be tested to identify effects of engineering and education only.

Table 4. Data Collection Matrix

FDOT District	Data Collection before Implementation	Engineering Treatment	Data Collection after Implementation	Education	Data Collection after Education
1	√	√	√	√	√
2	√	√		√	√
3	√	√		√	√
4	√	√		√	√
5	√	√		√	√
6	√	Existing sign		√	√
7	√	√	√		

4.1 “Before” Data Collection

The project team observed driving behaviors at each site before installation of countermeasures as the baseline for evaluating the safety performance of the countermeasures. GoPro® cameras were used at the intersections to record videos of traffic operations, including driving behaviors,

traffic signal operation status, pedestrian presence, conflicting traffic, and driver information. In most scenarios, two cameras were used (Figure 29), as follows:

- *Camera 1* – installed at far-end location to record information on conflicting traffic, pedestrian presence, and traffic signal status.
- *Camera 2* – installed at near-end location to record vehicle types, driver characteristics, and compliance behaviors.

At some sites, if one camera was capable of collecting all necessary information, only one was used to reduce the workload for scene-matching in video reviewing. A one-day data collection period covered various traffic conditions, such as peak hours, non-peak hours, and lighting conditions (daytime and nighttime).

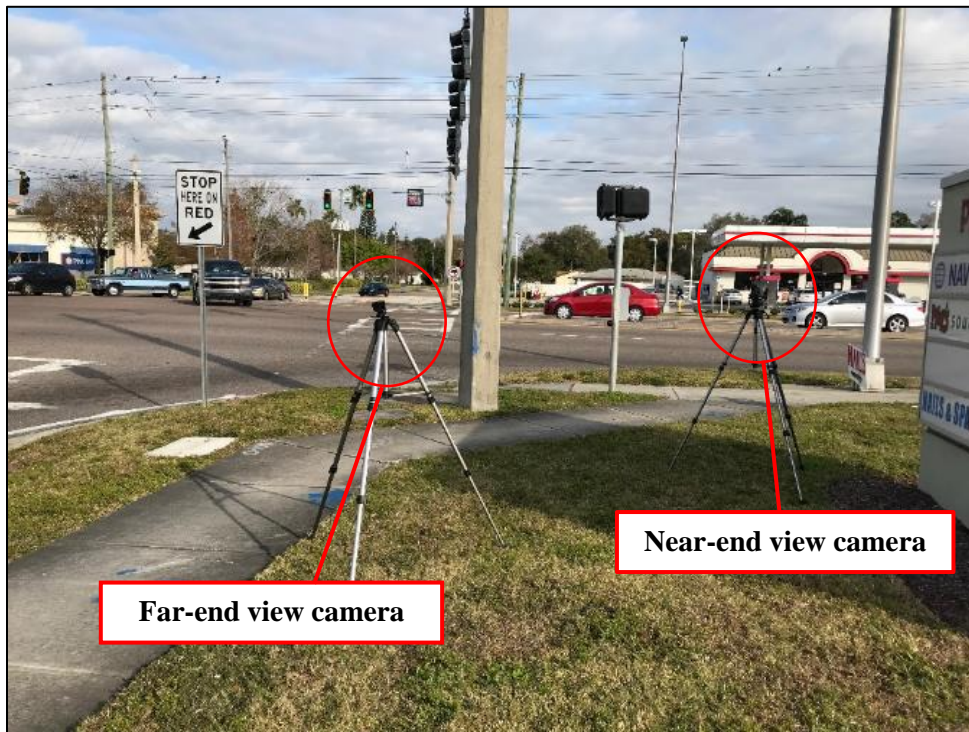


Figure 29. Installation of data collection devices

4.2 “After” Data Collection

Following baseline data collection, the proposed engineering countermeasure was implemented at each site. Education outreach was carried out by placing yard signs at the selected sites for at least one week to educate and remind drivers of the intent of the pedestrian feature signs. After completion of the education outreach, one day of data collection was conducted again at the study site. The method for the “after” data collection was similar to the “before” data collection. The collection day of the week for the “after” data was also controlled to exclude the influence of traffic pattern variation over days of week:

- Days of week grouped into three categories – weekdays (Monday–Thursday), Friday, and weekend (Saturday and Sunday)
- “After” data collection dates categorized same as “before” data collection

4.3 Video Review and Validation

After the data were collected in the field, the research team reviewed the recorded “before” and “after” videos to validate and organize data for analysis. First, a Python application was developed to add time stamps at 100 milliseconds superimposed on the videos. The time stamp was used to (1) record event time, (2) synchronize the event data between the two views, and (3) locate event scenes for validation. A Linux-powered Dell workstation with an 8-core CPU (E5-2680 at 2.7GHz) was used to conduct the timestamp process. The execution interface is shown in Figure 30, and an example of video scenes with timestamp is shown in Figure 31.

```

cvuser.tlp - cvuser@t7600.ddns.net:203 - Bitwise xterm - cvuser@T7600: ~
(cv) cvuser@T7600:~$ python timestamp_offset.py
Fixing the file
Starting to timestamp: /media/usb/NDS/AFTER/Bradenton 02_06_2019/Angle1/GH010191.MP4
here
[mov,mp4,m4a,3gp,3g2,mj2 @ 0x3209a20] Timecode frame rate 29/1 not supported
here22
=====output=====
b'[FORMAT]\nfilename=/media/usb/NDS/AFTER/Bradenton 02_06_2019/Angle1/GH010191.MP4\nnb_streams=5\nnb
_programs=0\nformat_name=mov,mp4,m4a,3gp,3g2,mj2\nformat_long_name=QuickTime / MOV\nstart_time=0:00:
00.000000\nduration=0:16:02.965333\nsize=3.726503 Gobyte\nbit_rate=33.241506 Mbit/s\nprobe_score=100
\nTAG:major_brand=mp41\nTAG:minor_version=538120216\nTAG:compatible_brands=mp41\nTAG:creation_time=2
019-02-05 09:53:47\n[/FORMAT]\n'
['2019-02-05', '09:00:34']
2019-02-05 09:00:34
['2019', '02', '05']
['09', '00', '34']

```

Figure 30. Execution interface for timestamp process



Figure 31. Example of timestamp on video scene

Four graduate assistants conducted video reviews after receiving comprehensive training to ensure consistency among reviewers. A review form was developed that listed all data inputs so reviewers could quickly input the data on a tablet and store it in electronic format. The review form is shown in Appendix C. Data inputs were grouped into four categories:

- *Site Condition* – site information such as name, lane type (exclusive turning lane or shared lane), before/after stage, date
- *Event Feature* – observed event such as event time, weather condition, lighting condition, traffic signal status, movement (through or right-turn), lateral position (through lane or right-turn lane), pedestrian presence
- *Vehicle/Driver Characteristics* – vehicle type, gender, and age
- *Driving Behavior* – surrogate safety measures of pedestrian features, such as stopping behavior, stopping position, yield to pedestrian, conflict, and distraction

The photos in Figure 32 show examples of events identified during video review:

- a) Right-turning SUV stopping after stop bar on red in conflicting traffic
- b) Right-turning car stopping before stop bar on red
- c) Right-turning car not yielding to pedestrian at green signal
- d) Observed driver distraction while turning (drinking)
- e) Observed driver characteristics (adult male)
- f) Observed yielding to pedestrian behavior in rainy conditions

The collected data from video review were stored in a two-dimensional table. A data collection supervisor randomly selected events for second review to validate the data inputs to ensure data collection consistency and accuracy.



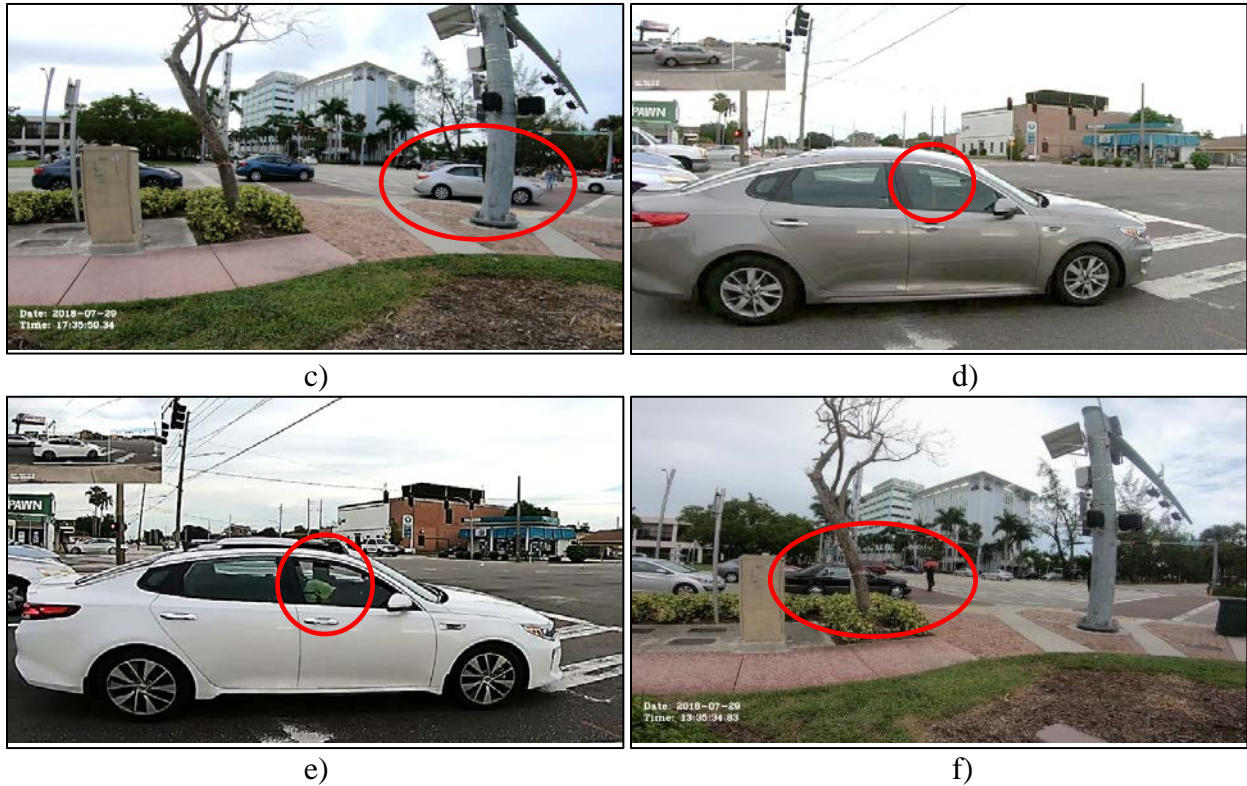


Figure 32. Events identified during video review

4.4 Data Compilation

All collected data were compiled into a two-dimensional table for data analysis, as shown in Table 5.

Table 5. Data Fields for Data Collection

Field Name	Type	Description
Site ID	Integer	Unique number for site
Lane Type	Categorical	Type of right-turn lane, Exclusive. Shared
Countermeasure 1	Categorical	First countermeasure: "Stop Here on Red" sign. "Right Turn on Red after Stop" sign. "Turning Vehicles Yield to Pedestrians" sign Overhead dual blank-out sign
Countermeasure 2	Categorical	Second countermeasure: "Stop Here on Red" sign, "Right Turn on Red after Stop" sign. "Turning Vehicles Yield to Pedestrians" sign Overhead dual blank-out sign
Measure Period ¹	Binary	Before/after
Event ID	Integer	Unique number for observed event
Date/Time	Date/Time	Event time at 100 milliseconds
Weather Condition	Categorical	Clear, rain, fog
Lighting Condition	Categorical	Daylight, nighttime, dawn/dusk
Vehicle Movement	Binary	Thru, right-turn
Lateral Position	Categorical	Right-turn lane, 1 st thru lane, 2 nd thru lane
Vehicle Type	Categorical	Passenger car, heavy truck, bus, bike

Field Name	Type	Description
Traffic Signal	Binary	Red, green
Driver Gender	Binary	Male, female, NA
Driver Age	Categorical	Young adult, older adult, NA
Pedestrian Presence ²	Categorical	None; yes-1 st crosswalk, yes-2 nd crosswalk
Stopping Behavior at Stop Bar	Categorical	Complete stop, rolling slow stop, rolling fast stop, no stop
Traffic Conflict	Binary	Yes, no
Yield to Pedestrian	Categorical	Yes, no, NA
Distraction	Binary	Yes, no

¹ “After” data collection was conducted twice in District 1, before education and after education. In District 6, only “after” data collection was conducted, one before education, one after education.

² 1st crosswalk located on approaching leg; 2nd crosswalk located on receiving leg.

4.5 Collected Data

This section describes the “before” and “after” data collection efforts at each site. Different combinations of engineering and education were applied to measure effectiveness of one over the other.

4.5.1 District 1: US-41 @ Cortez Rd, Bradenton FL, NB

The D1 site is shown in Figure 33, and data collection information is summarized in Table 6.

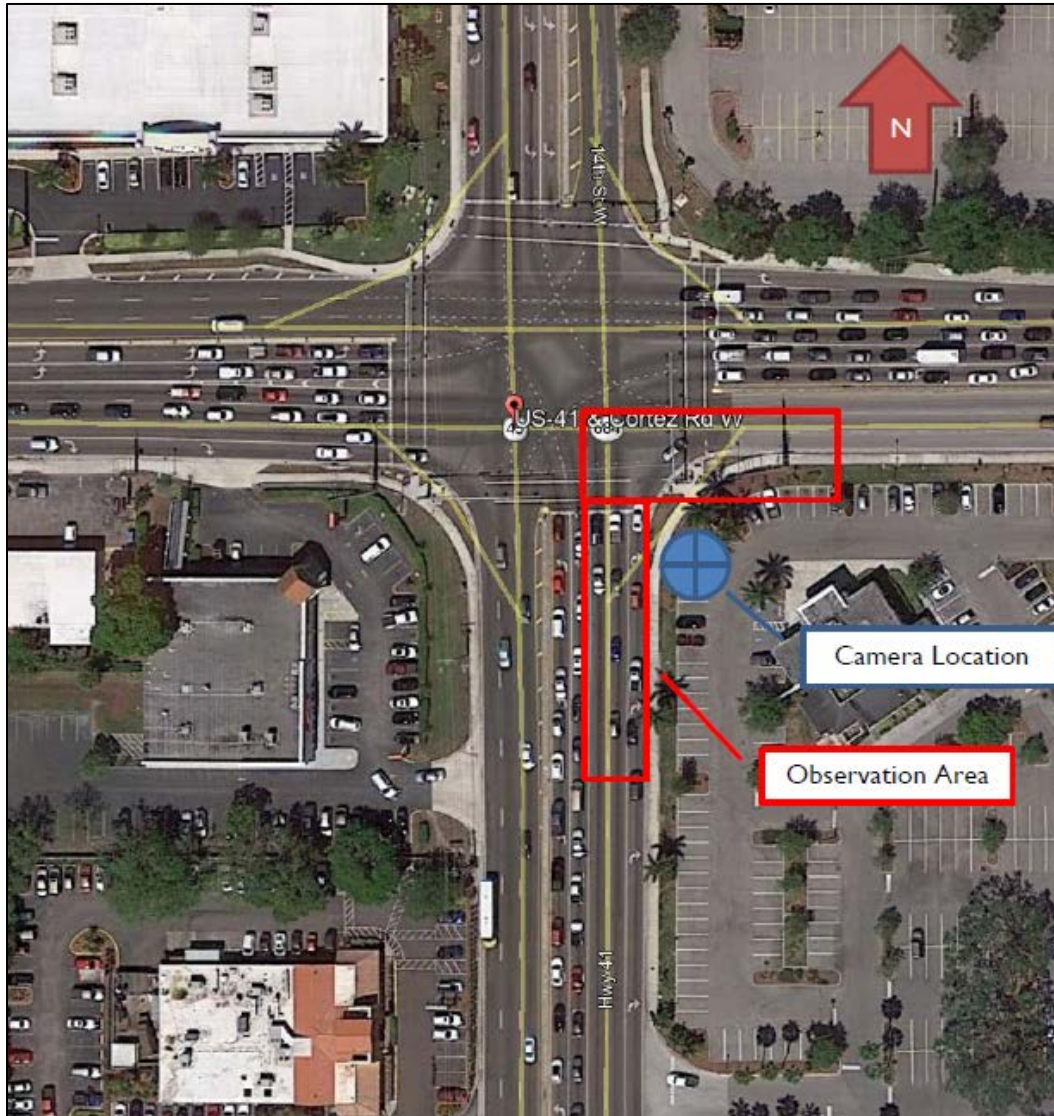


Figure 33. Layout of US-41 @ Cortez Rd, Bradenton, FL, NB

Table 6. Summary of Data Collection in District 1

Data Collection	Before	After 1	After 2
Approach	Northbound		
Right-Turn Lane	Exclusive		
Countermeasures	Dual blank-out sign: “No Turn on Red” + “Turning Vehicles Yield to Pedestrians”; Roadside sign: “Stop Here on Red”		
Time	06/19/2018, 12:00PM–10:00PM	02/05/2019, 9:50AM–9:00PM	03/07/2019, 9:00AM–9:00PM
Day of Week	Tuesday	Tuesday	Thursday
Weather Conditions	Clear	Clear	Clear
Number of Cameras	1	2	2

Three data collection efforts were conducted in District 1. The first (Before) was conducted before the implementation of treatment; the second (After 1) was conducted after the implementation of treatment but before the education; the third (After 2) was conducted after education. The data collected were used to evaluate the safety effectiveness of engineering countermeasures and education outreach. The reviewing scenes for Before, After 1, and After 2 are shown in Figure 34. For “after” data collection, two cameras were used to more accurately capture driver characteristics.



a) “Before” data collection in District 1 (one camera)



b) “After” data collection (far-end view)

c) “After” data collection (near-end view)

Figure 34. Video review scenes from the District 1 study site

4.5.2 District 2: Atlantic Blvd @ Penman Rd, Jacksonville, FL, EB

The D2 site is shown in Figure 35, and data collection information is summarized in Table 7.

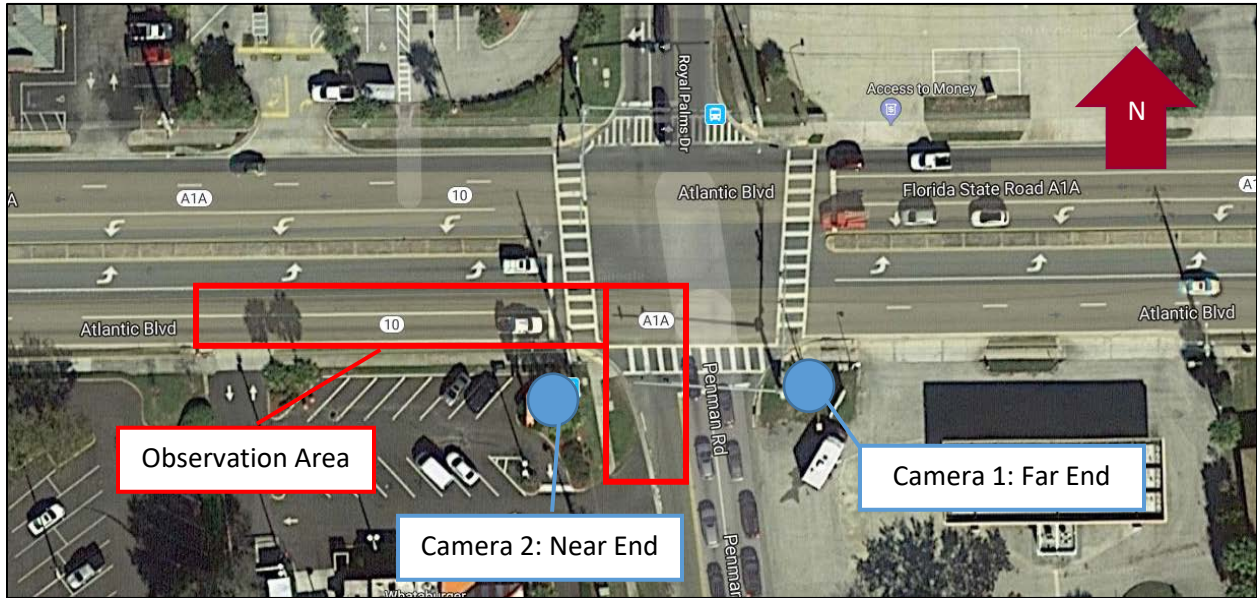


Figure 35. Layout at Atlantic Blvd @ Penman Rd, Jacksonville, FL, EB

Table 7. Summary of Data Collection in District 2

Data Collection	Before	After
Approach	Eastbound	
Right-turn lane	Shared	
Countermeasures	Roadside sign: “Right Turn on Red after Stop”	
Time	06/29/2018, 9:56AM–11:30AM 06/30/2018, 1:17PM–8:00PM	10/20/2019, 12:37PM–8:00PM
Day of week	Friday, Saturday	Saturday
Weather conditions	Clear	Clear
Number of cameras	2	2

The “before” data collection was conducted on two days—6/29/2018 (morning) and 6/30/2018 (afternoon/night). The “after” data collection was conducted on 10/20/2019. Two cameras were used to capture far-end information (traffic, signal, pedestrian, conflicting vehicles) and near-end information (driver characteristics and behaviors). The reviewing scenes for before and after data collection are shown in Figure 36.



a) “Before” data collection (far-end view) b) “Before” data collection (near-end view)



c) “After” data collection (far-end view) d) “After” data collection (near-end view)

Figure 36. Video review scenes from District 2 study site

4.5.3 District 3: US-98 @ Stahlman Ave, Destin FL, NB & EB

For the District 3 site, two approaches were used to implement the same signs, “Right Turn on Red after Stop” and “Turning Vehicles Yield to Pedestrians.” The layout of data collection in District 3 is shown in Figure 37, and a summary of data collection is presented in Table 8. The reviewing scenes for before and after data collection are shown in Figure 38 and Figure 39.

Table 8. Summary of Data Collection in District 3

Data Collection	Before	After	Before	After
Approach	Eastbound		Northbound	
Right-turn lane	Shared		Exclusive	
Countermeasures	Roadside signs: “Turning Vehicles Yield to Pedestrians” and “Right Turn on Red after Stop”		Roadside signs: “Turning Vehicles Yield to Pedestrians” and “Right Turn on Red after Stop”	
Time	06/28/2018 12:36PM–5:00PM	11/28/2018 11:44AM–:00PM	07/12/2018 10:31AM–9:30PM	11/29/2018 10:31AM–5:00PM
Day of week	Thursday	Wednesday	Thursday	Thursday
Weather conditions	Clear	Cloudy + rainy	Cloudy	Clear
Number of cameras	1	1	1	2

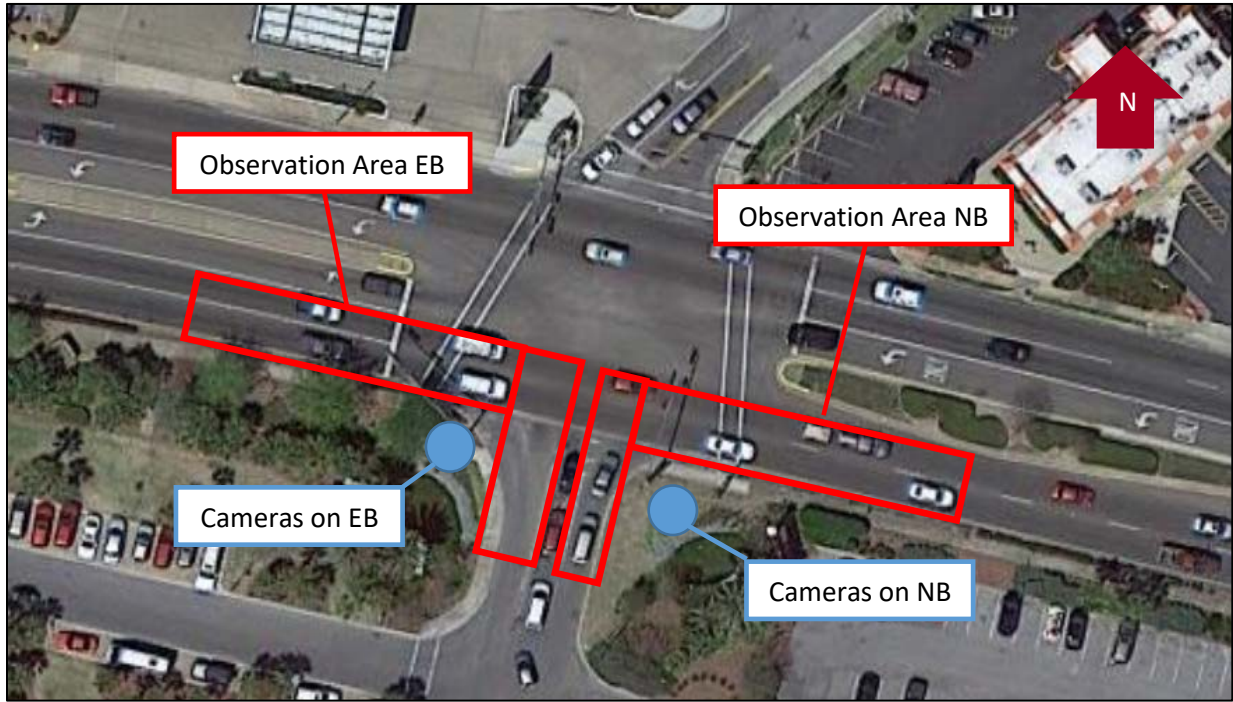
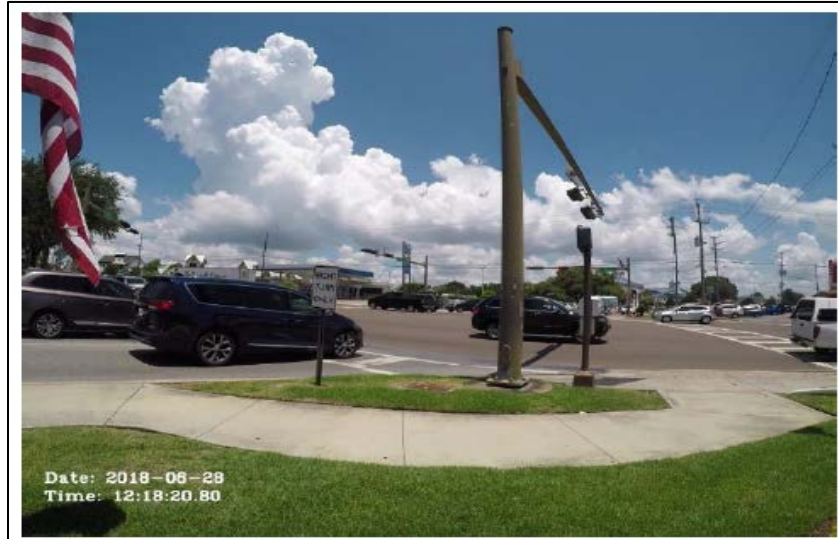


Figure 37. Layout at US-98 @ Stahlman Ave, Destin FL, NB & EB



a) “Before” data collection EB (one camera) b) “After” data collection EB (one camera)

Figure 38. Video review scenes from District 3 study site (EB)



a) “Before” data collection NB (one camera)



b) “After” data collection (far-end view) c) “After” data collection (near-end view)

Figure 39. Video review scenes from District 3 study site (NB)

4.5.4 District 4: N Dixie Hwy @ NE 48th St, Pompano Beach, FL, EB

The layout of data collection in District 4 is shown in Figure 40, and a summary of data collection is presented in Table 9. The reviewing scenes for before and after data collection are shown in Figure 41.

Table 9. Summary of Data Collection in District 4

Data Collection	Before	After
Approach	Eastbound	
Right-turn lane	Shared	
Countermeasures	Roadside sign: “Right Turn on Red after Stop”	
Time	08/20/2018, 12:09PM–8:30PM	10/22/2018, 12:30PM–7:30PM
Day of week	Monday	Monday
Weather conditions	Cloudy	Cloudy
Number of Cameras	2	2



Figure 40. Layout at N Dixie Hwy @ NE 48th St, Pompano Beach, FL, EB



a) “Before” data collection (far-end view) b) “Before” data collection (near-end view)



c) “After” data collection (far-end view) d) “After” data collection (near-end view)

Figure 41. Video review scenes from District 4 study site

4.5.5 District 5: Silver Star Rd @ N Pine Hills Rd, Pine Hills, FL, SB

The layout of data collection in District 5 is shown in Figure 42, and a summary of data collection is presented in Table 10. The reviewing scenes for before and after data collection are shown in Figure 43.

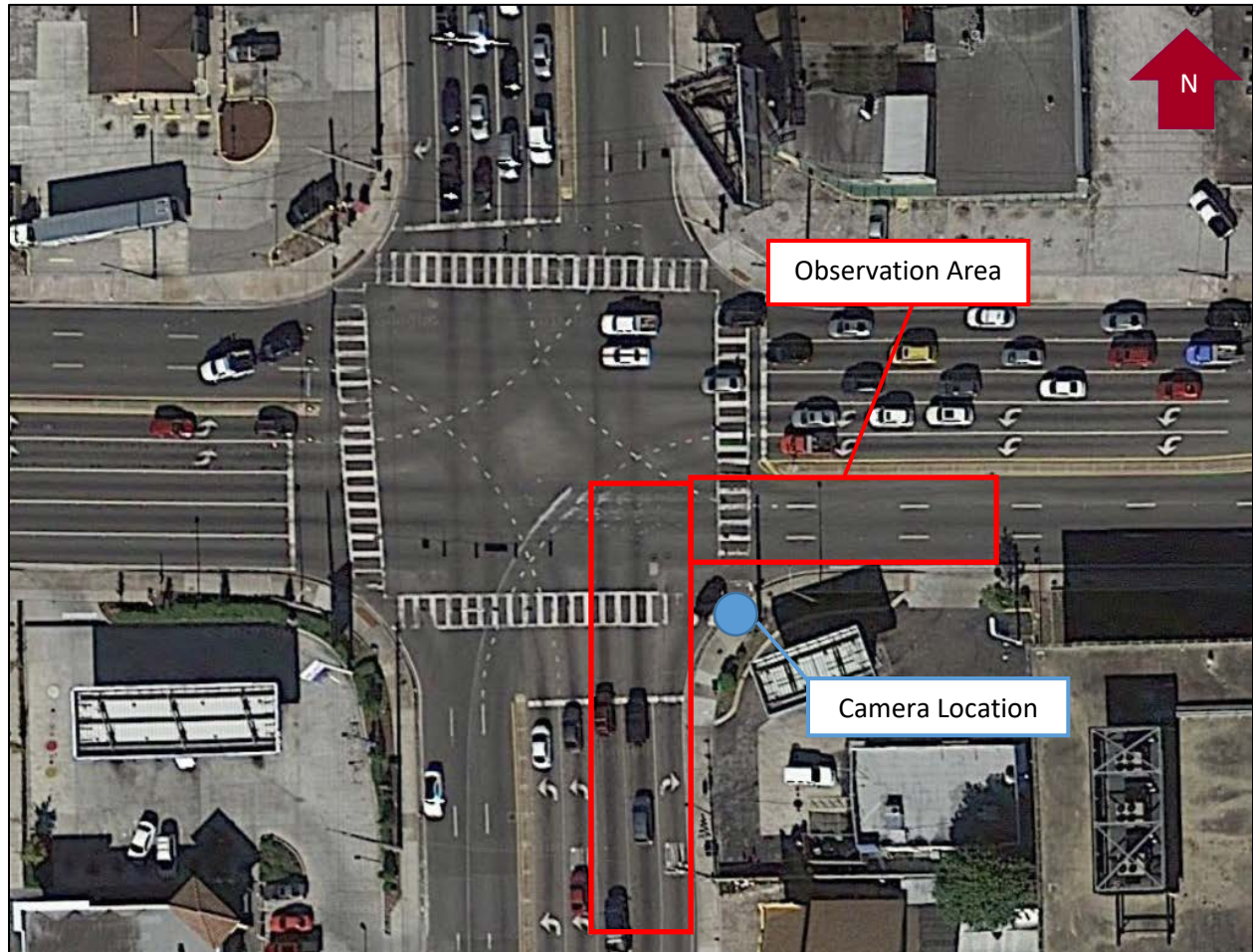


Figure 42. Layout at Silver Star Rd @ N Pine Hills Rd, Pine Hills, FL, NB

Table 10. Summary of Data Collection in District 5

Data Collection	Before	After
Approach	Southbound	
Right-turn lane	Exclusive	
Countermeasures	Roadside sign: "Right Turn on Red after Stop"	
Time	07/26/2018, 7:00PM–9:40PM 08/05/2018, 10:25AM–2:00PM	11/03/2018, 5:04PM–7:30PM 11/04/2018, 3:30PM–7:30PM
Day of week	Thursday, Sunday	Saturday, Sunday
Weather conditions	Cloudy	Clear
Camera	2	2



a) “Before” data collection (far-end view) b) “Before” data collection (near-end view)



c) “After” data collection (far-end view) d) “After” data collection (near-end view)

Figure 43. Video review scenes from District 5 study site

4.5.6 District 6: W 41st St @Pine Tree Dr, Miami Beach FL, NB

For District 6, the selected location has an existing “Turning Vehicles Yield to Pedestrians” sign. This site was selected to conduct additional education for the sign. Figure 44 shows the layout of data collection in District 6, and Table 11 presents a summary of data collection. The reviewing scenes for before and after data collection are shown in Figure 45.

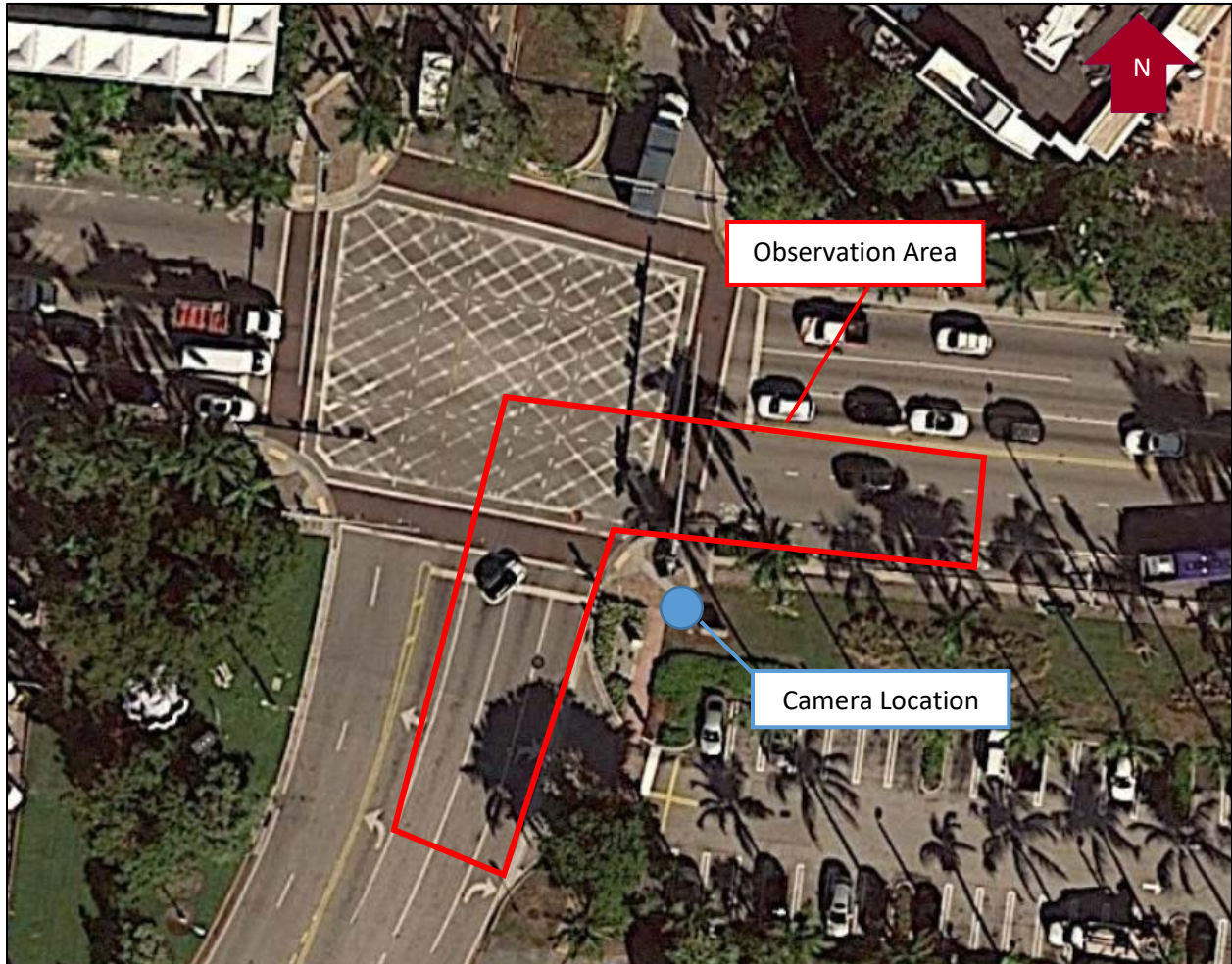


Figure 44. Layout at W 41st St @Pine Tree Dr, Miami Beach, FL, NB

Table 11. Summary of Data Collection in District 6

Data Collection	Before Education (with Sign)	After Education (with Sign)
Approach	Northbound	
Right-turn lane	Exclusive	
Countermeasures	Existing overhead sign: "Turning Vehicles Yield to Pedestrians"	
Time	07/29/2018, 1:32PM–8:26PM	01/13/2019, 10:43AM–5:56PM
Day of week	Saturday	Sunday
Weather conditions	Clear	Clear
Cameras	1	2



a) “Before” data collection (one camera)



b) “After: data collection (far-end view)

b) “After” data collection(near-end view)

Figure 45. Video review scenes from District 6 study site

4.5.7 District 7: Roosevelt Blvd @ Dodge St, Largo, FL, NB

Similar to the District 1 site, the District 7 site received a blank-out sign with dual modes and a roadside sign. This site was selected to conduct additional education for the sign. Figure 46 shows the layout of data collection in District 7, and Table 12 presents a summary of data collection. The reviewing scenes for before and after data collection are shown in Figure 47.

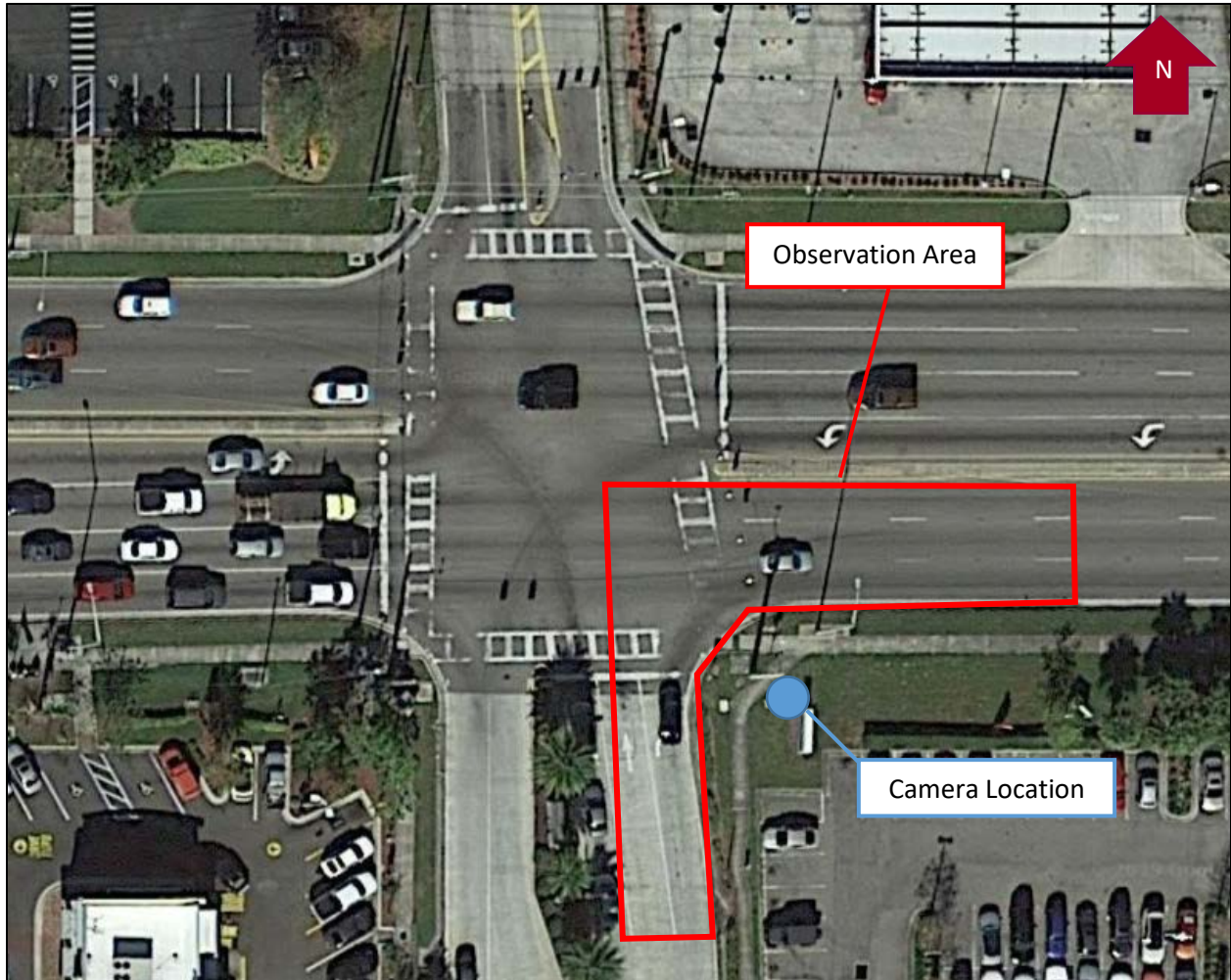


Figure 46. Layout at Roosevelt Blvd @ Dodge St, Largo, FL, NB

Table 12. Summary of Data Collection in District 7

Data Collection	Before	After
Approach	Northbound	
Right-turn lane	Exclusive	
Countermeasures	Dual blank-out sign: “No Turn on Red” + “Turning Vehicles Yield to Pedestrians”; Roadside sign: “Stop Here on Red”	
Time	05/10/2018, 9:07AM–9:30PM	01/31/2019, 9:00AM–10:00PM
Day of week	Thursday	Thursday
Weather conditions	Clear	Clear
Camera	1	2



a) "Before" data collection (one camera)



b) "After" data collection (far-end view)

c) "After" data collection (near-end view)

Figure 47. Video review scenes from District 7 study site

5. Data Analysis and Evaluation

The research team compiled both “before” data (collected before implementation of countermeasures) and “after” data (collected after implementation of countermeasures) into four groups of countermeasure treatments, and the effects of these four countermeasure treatments were evaluated, as follows:




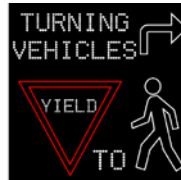

- *Engineering & Education Combined* – The selected pedestrian signs were implemented at the studied intersection locations, and education efforts were implemented shortly after; therefore, the combined influence of both pedestrian sign implementations and education efforts was evaluated. This is a preferred method for any new engineering implementation and was one of the recommendations from the Phase 2 project. Current knowledge of effective countermeasures shows that combined engineering and education efforts produce better compliance than engineering treatment alone. This method was used at the majority of the sites.
- *Engineering Only* – The selected pedestrian signs were implemented at an intersection with no education efforts. This is a common method to implement pedestrian feature signs. The evaluation of this countermeasure treatment was to study the effect of engineering countermeasures alone.
- *Education after Engineering* – The selected pedestrian signs were installed at an intersection, and education efforts were conducted shortly after installation to improve compliance. For this countermeasure treatment, the effect of education effort after engineering implementation was evaluated.
- *Education Only* – The selected pedestrian sign(s) already existed at an intersection, and only education efforts were conducted after the “before education” data collection to enhance the effects of existing signs. For this countermeasure treatment, the effect of education effort on existing pedestrian feature signs was evaluated.

Each group included different pedestrian signs at signalized intersections that are directly related to pedestrian safety. Driver compliance with pedestrian features was the main performance measure. A description of the intention and compliance for each sign is shown in Table 13. The data analysis for this project focused on examining the effects of countermeasure treatments and individual pedestrian feature signs on driver compliance rates from actual field implementation. The project team further examined the effects of driver characteristic information (gender or age) on driver compliance rates based on available data. Of note is that driver characteristic data could be difficult to obtain via field observations due to factors such as tinted windows of vehicles, speeds of vehicles, and camera angles.

Quantitative methods, including statistical analysis, were applied to compare the effect of different pedestrian features on driving behaviors in all four groups. The effect of each pedestrian feature on driving behaviors and driver compliance before and after implementing the

countermeasure was evaluated in detail. The impact of driver characteristics, behaviors, and performance on driver interaction with pedestrian features was also evaluated.

Table 13. Intention and Compliance Behaviors for Each Pedestrian Feature

Feature Name	Feature Sign	Feature Intention	Compliance Behaviors
“Stop Here on Red”		Used to require drivers to stop at stop bar where sign installed to ensure everyone’s safety; vehicles stopping at stop bar and not on crosswalk can avoid hitting pedestrians crossing at crosswalk.	Stop before stop line on red signal
“No Turn on Red” (blank-out sign)		Used primarily at intersections with higher number of conflicts between vehicles making right turns on red and vehicles or pedestrians crossing; especially in Florida, turning right on red is a major cause of pedestrian crashes at intersections; applies when traffic signal is red and blank-out sign displays “No Turn on Red” symbol.	Stop on red and wait for green signal
“Turning Vehicles Yield to Pedestrians”		Informs turning vehicles making right or left turn (with appropriate arrow) at intersections to yield to crossing pedestrians; applies when traffic signal is red or green.	Yield to pedestrians on green, yellow or red signal
“Turning Vehicles Yield to Pedestrians” (blank-out sign)		Informs turning vehicles making right or left turn at intersections to yield to crossing pedestrians; applies when traffic signal is red or green and blank-out sign displays “Turning Vehicles Yield to Pedestrians” symbol.	Yield to pedestrians on green, yellow or red
“Right Turn on Red After Stop”		Requires drivers to stop on red before making a right turn; usually coupled with red light cameras for enforcement; installed where there is higher number of violations of drivers not making stop on red before proceeding to make right turn.	Stop, observe, and turn on red signal

Through analysis, the research team answered the following questions from actual implementations of pedestrian feature signs:

- What are the effects of implementations for (1) combined engineering and education countermeasures, (2) engineering countermeasures only, (3) education outreach after engineering countermeasure deployments, and (4) education outreach on existing

pedestrian feature signs on driver compliance rates with studied pedestrian feature signs at signalized intersections?

- What is the overall effectiveness of each studied pedestrian feature in terms of driver compliance?
- What are the impacts of driver demographics and characteristics such as gender and age on their compliance with the intent of each studied pedestrian feature sign from field observations?

5.1 Data and Methods Used for Data Analysis

Quantitative and statistical data analysis was conducted to provide quantifiable and easy-to-understand results for better understanding of interactions between drivers and pedestrian features at signalized intersections. The method of data collection included video recordings of the specific approach and data reduction from videos. The data collected and reviewed for the analysis are summarized in Table 14. During the data review, driver characteristic information such as gender and age could not be identified for some observations due to several factors, including tinted windows, sunshine reflection, camera angles, and insufficient lighting at evening time, etc.

Table 14. Summary of Data Collected for Analysis

Category	Data Fields
Site Condition	Lighting condition
	Weather condition
	Type and position of pedestrian features
Driver Behaviors and Contributing Factors	Signal status when arriving at stop bar
	Timeline arriving at stop bar
	Lane choice
	Driver behaviors (stop, slow down, yield, go through), Count of drivers
	Stop position (before or passing stop bar)
Pedestrian	Impacting factors (pedestrian/bike, conflicting traffic, leading car, other)
	Driver interactions with pedestrian(s) (yield or not), Count of interactions
Driver Characteristics	Pedestrian location
	Gender
	Age

5.1.1 Quantitative and Statistical Analysis

As noted, the reviewed data were categorized into four groups of countermeasure treatments, and the corresponding effects were evaluated:

- *Engineering & Education Combined* – “Right Turn on Red After Stop” (static), “Stop Here on Red,” (static), “Turning Vehicles Yield to Pedestrians” (static), “No Turn on Red” (blank-out), and “Turning Vehicles Yield to Pedestrians” (blank-out) signs were implemented in this group. Comparisons were made between “before” and “after”

countermeasures for Districts 1, 2, 3, 4, and 5. (See Figures 1 and 2 for examples of a site before implementation and after implementation with education efforts.)

- *Engineering Only* – “Stop Here on Red” (static), “Turning Vehicles Yield to Pedestrians” (blank-out), and “No Turn on Red” (blank-out) signs were considered in this group. Comparisons were made between “before” and “after” countermeasures in Districts 1 and 7.
- *Education after Engineering* – “Stop Here on Red” (static), “No Turn on Red” (blank-out), and “Turning Vehicles Yield to Pedestrians” (blank-out) signs were considered in this group. Comparisons were made between “before” and “after” countermeasures in District 1.
- *Education Only* – “Turning Vehicles Yield to Pedestrians” (static) sign was considered in this group. Comparisons were made between before and after education efforts in District 6.

A series of quantitative and statistical comparisons of compliance was conducted between behaviors before and after implementations; the higher the proportion of compliance observed, the better the safety performance is. Chi-square tests were used to determine if the percentage of driver compliance at “before” countermeasure sites (P_{FE}) was significantly different from that at “after” countermeasure sites (P_{CE}). All hypothesis tests were conducted at a minimum confidence level of 90%.

- $H_0: P_{FE} = P_{CE}$ (proportion of compliant driver behaviors at “before” countermeasure sites is same as that at “after” countermeasure sites)
- $H_a: P_{FE} \neq P_{CE}$ (proportion of compliant driver behaviors at “before” countermeasure sites is different from that at “after” countermeasure sites)

Data analysis addressed the major research question, “Based on information from the collected dataset, how do drivers interact with pedestrian features at signalized intersections?” Quantitative and statistical analyses were conducted based on each of four groups of countermeasure treatments, pedestrian feature signs individually, and overall performance. For each feature sign in each group, the following analyses were performed:

- Comparison of compliance with features between “before” and “after” engineering and/or education countermeasures
- Comparison of compliance at feature sites by driver gender
- Comparison of compliance at feature sites by driver age

The analysis results and research findings are presented in the following sections.

5.2 Engineering-Only

5.2.1 “Stop Here on Red” Sign



Figure 48 and Table 15 show the comparison results of driver compliance for the “Stop Here on Red” sign before and after the sign was implemented for the sites in Districts 1 and 7.

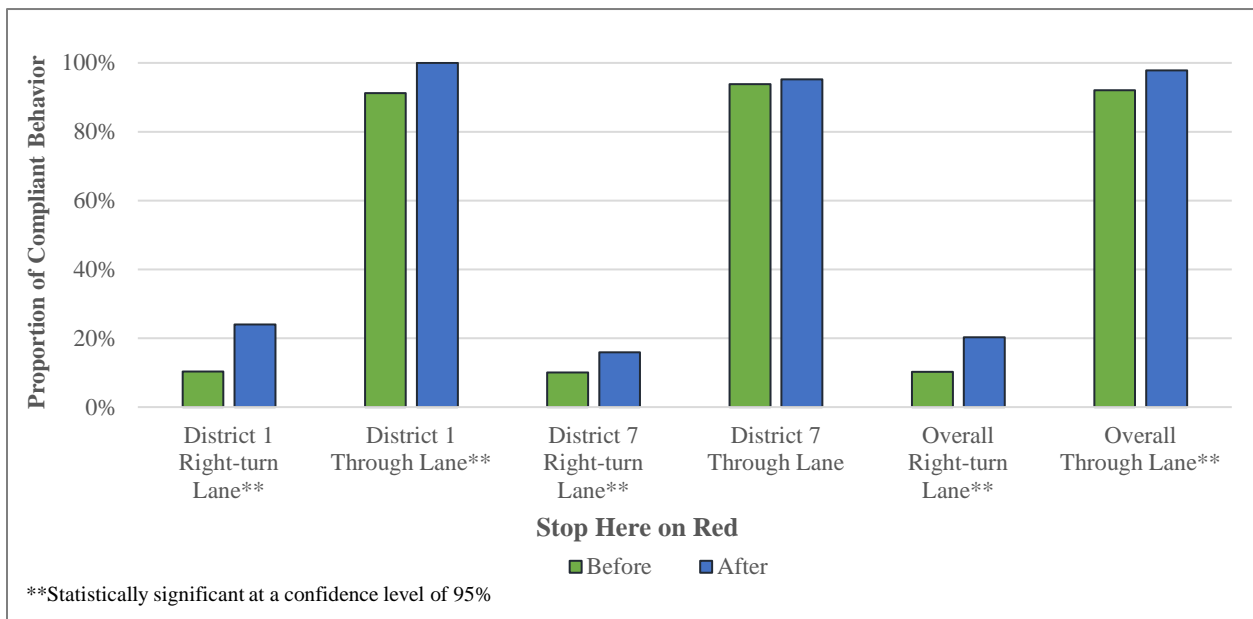


Figure 48. Comparison of compliance for “Stop Here on Red” sign, Districts 1 and 7

Table 15. Comparison of Compliance for “Stop Here on Red” Sign, Districts 1 and 7

Location	Before	After
District 1 right-turn lane	143 (10.3%)	316 (24%)
District 1 through lane	104 (91.2%)	100 (100%)
District 7 right-turn lane	84 (10.1%)	174 (15.9%)
District 7 through lane	60 (93.8%)	80 (95.2%)
Overall right-turn lane	227 (10.2%)	490 (20.3%)
Overall through lane	164 (92.1%)	180 (97.8%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- There was an increase in driver compliance after the “Stop Here on Red” sign was implemented at through and right-turn lanes in both Districts. The proportion of driver compliance with the sign for both right-turn and through-lane drivers in District 1 and right lane drivers in District 7 was significant at a 95% confidence level when compared with before and after the countermeasure.
- The proportion of compliance with the sign was much higher among through-lane drivers than right-turn lane drivers. A potential reason for this is that drivers in the right lane were more likely to pass the stop bar to make a full stop, as they were trying to have adequate sight distance for the right- turn maneuver. This was considered non-compliant behavior, as drivers are required to stop behind the stop bar.
- The compliance rate for right-turn lane after implementation increased more than 100%.

Figure 49 and Table 16 show the comparison results of driver compliance by gender for the “Stop Here on Red” sign between a right-turn lane and a through lane before and after the sign was implemented.



Figure 49. Comparison of compliance for “Stop Here on Red” sign by gender, Districts 1 and 7

Table 16. Comparison of Compliance for “Stop Here on Red” Sign by Gender, Districts 1 and 7

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Overall right-turn lane	96 (10.1%)	181 (21.9%)	58 (11.6%)	115 (25.9%)
Overall through lane	54 (93.1%)	47 (97.9%)	18 (94.7%)	20 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observation.

Analysis reveals results as follows:

- Overall, for both male and female drivers, there was an increase in compliance after the countermeasure was implemented. The proportion of compliance with the sign was much higher among through-lane drivers than right-turn-lane drivers.
- Overall, with respect to gender, the difference in the proportion of compliance behavior of male drivers in a right-turn lane was significant at a 95% confidence level when compared with before and after implementation of the sign.

Figure 50 and Table 17 show the comparison results of driver compliance by age at a “Stop Here on Red” sign between a right-turn lane and a through lane before and after the sign was implemented based on overall data.

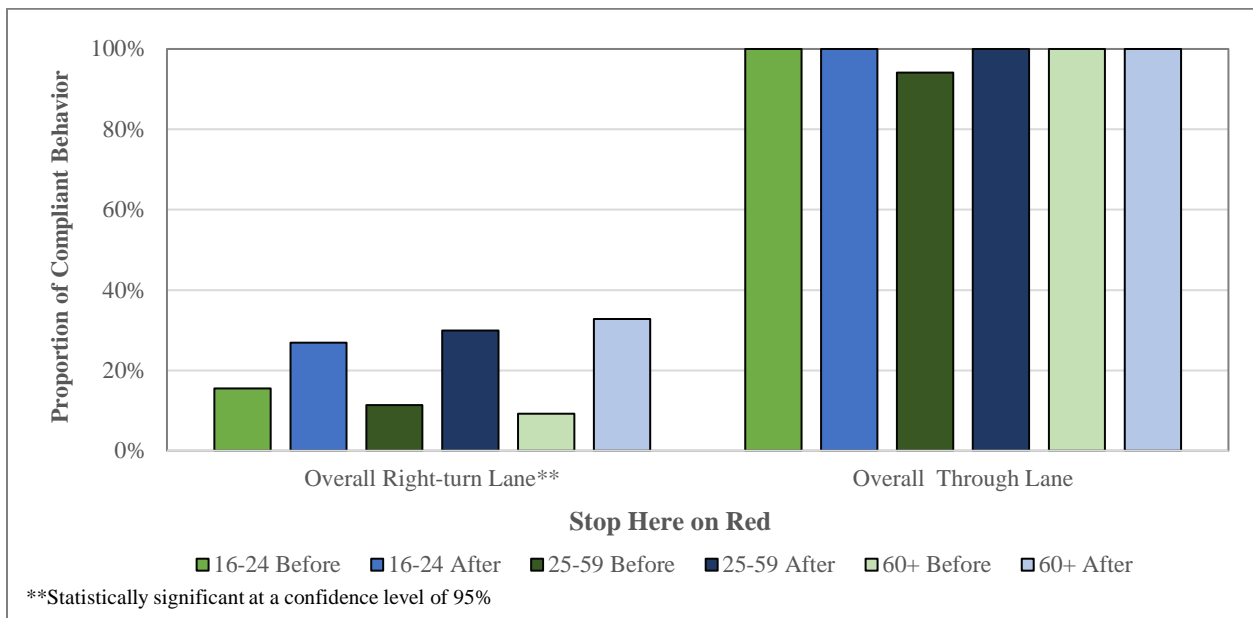


Figure 50. Comparison of compliance for “Stop Here on Red” sign by age, Districts 1 and 7

Table 17. Comparison of Compliance for “Stop Here on Red” Sign by Age, Districts 1 and 7

Location	16-24		25-59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Overall right-turn lane	13 (15.5%)	77 (26.9%)	111 (11.5%)	164 (25.8%)	10 (9.2%)	21 (32.8%)
Overall through lane	7 (100%)	12 (100%)	48 (100%)	42 (94.1%)	8 (100%)	3 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- For all age groups, there was an overall increase in compliance after countermeasure implementation compared to before. Compliance with the sign was much higher in through lanes compared to right-turn lanes.
- Older drivers showed the highest proportion of compliance after the countermeasure was installed in the right lane (32.8%), followed by young drivers (26.9%) and middle-age drivers (25.8%). Overall, the difference in proportion of compliance behavior for all the drivers using a right-turn lane was significant at a 95% confidence level when compared to before and after countermeasure data.
- Young, middle-age, and older drivers in through lanes complied with the feature at 100%.

5.2.2 “Turning Vehicles Yield to Pedestrians” (Blank-out) Sign



Figure 51 and Table 18 show the comparison results of driver compliance for a “Turning Vehicles Yield to Pedestrians” blank-out sign before and after the sign was implemented for the sites in Districts 1 and 7.

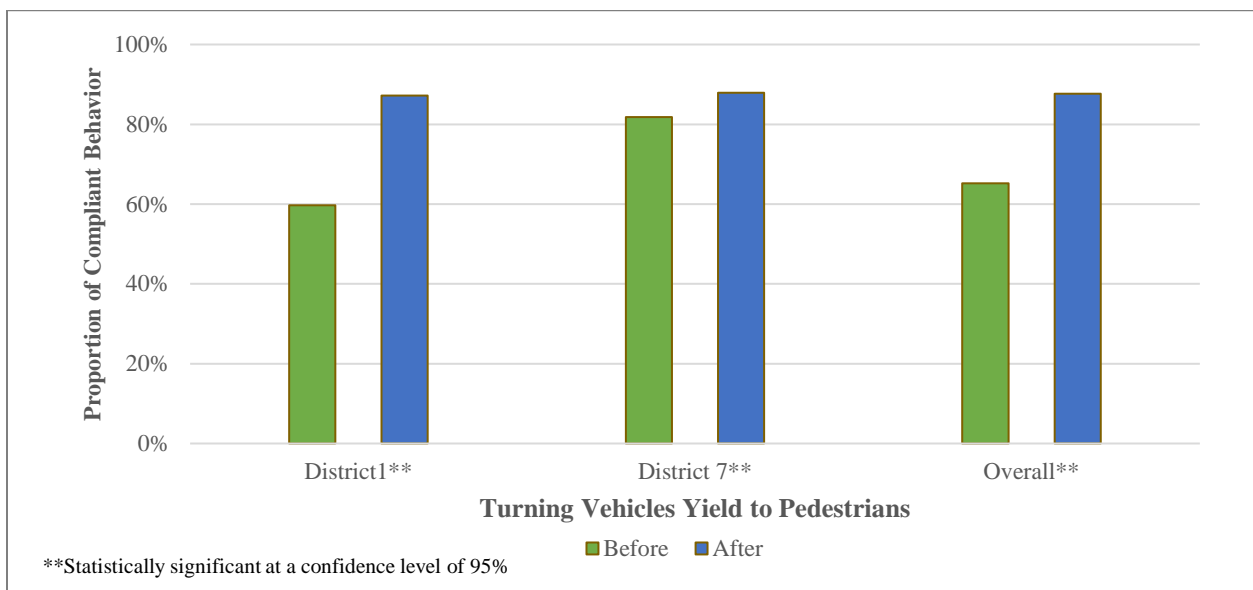


Figure 51. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign, Districts 1 and 7

Table 18. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign, Districts 1 and 7

Location	Before	After
District 1	40 (59.7%)	34 (73.9%)
District 7	18 (81.8%)	87 (87.9%)
Overall	58 (65.2%)	121 (83.4%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- There was a large increase in compliance after implementation of the “Turning Vehicles Yield to Pedestrians” blank-out sign in District 1, from 59.7% to 73.9%, and District 7, from 81.8% to 87.9%. The overall increase in compliance after implementation for combined Districts 1 and 7 was from 65.2% to 83.4%, which was statistically significant at a 95% confidence level.

Figure 52 and Table 19 show the comparison results of driver compliance by gender for a “Turning Vehicles Yield to Pedestrians” sign before and after the sign was implemented for the sites in Districts 1 and 7.

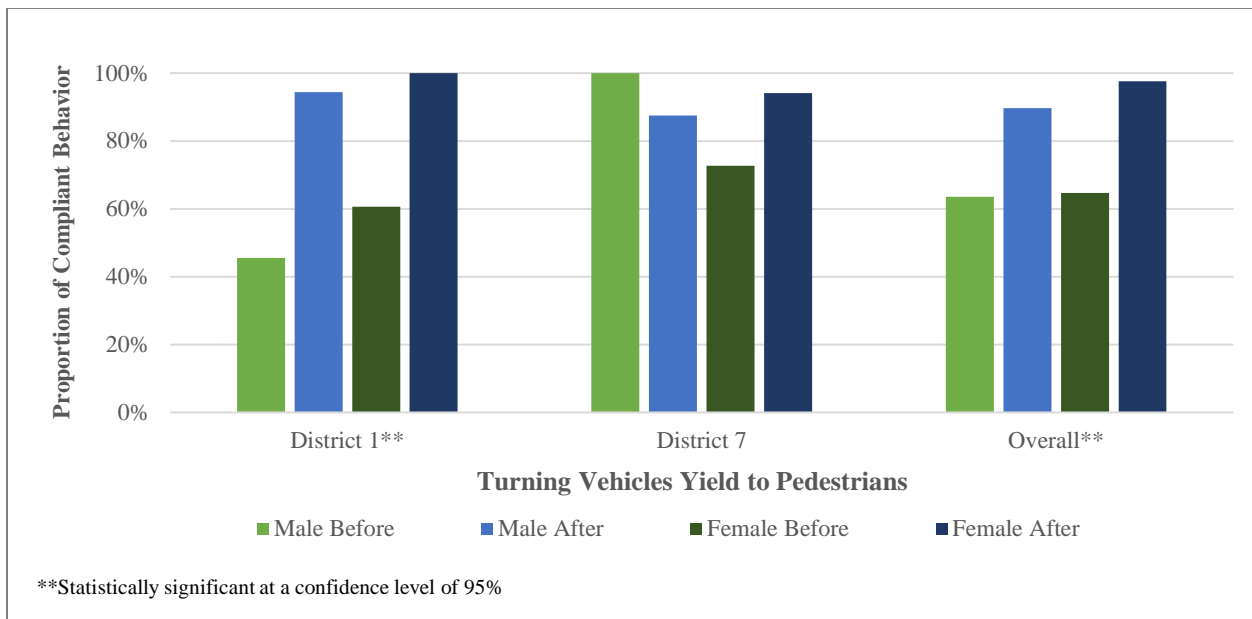


Figure 52. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by gender, Districts 1 and 7

Table 19. Comparison of Compliance for “No Turn on Red” Sign by Gender, Districts 1 and 7

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	20 (45.5%)	17 (76.5%)	5 (60.6%)	13 (81%)
District 7	8 (100%)	35 (87.5%)	6 (72.7%)	16 (94.1%)
Overall	28 (63.6%)	52 (85.2%)	11 (64.7%)	29 (85.3%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates the proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, both male and female drivers showed a large increase in compliance after implementation of the sign with education efforts; with respect to each gender, the difference in proportion of compliance was significant at a 95% confidence level when compared with before and after implementation of the sign.
- Female drivers were more likely to comply with the feature than male drivers.

5.2.3 “No Turn on Red” (Blank-out) Sign



Figure 53 and Table 20 show the comparison results of driver compliance for the “No Turn on Red” sign before and after the sign was implemented for the sites in Districts 1 and 7.

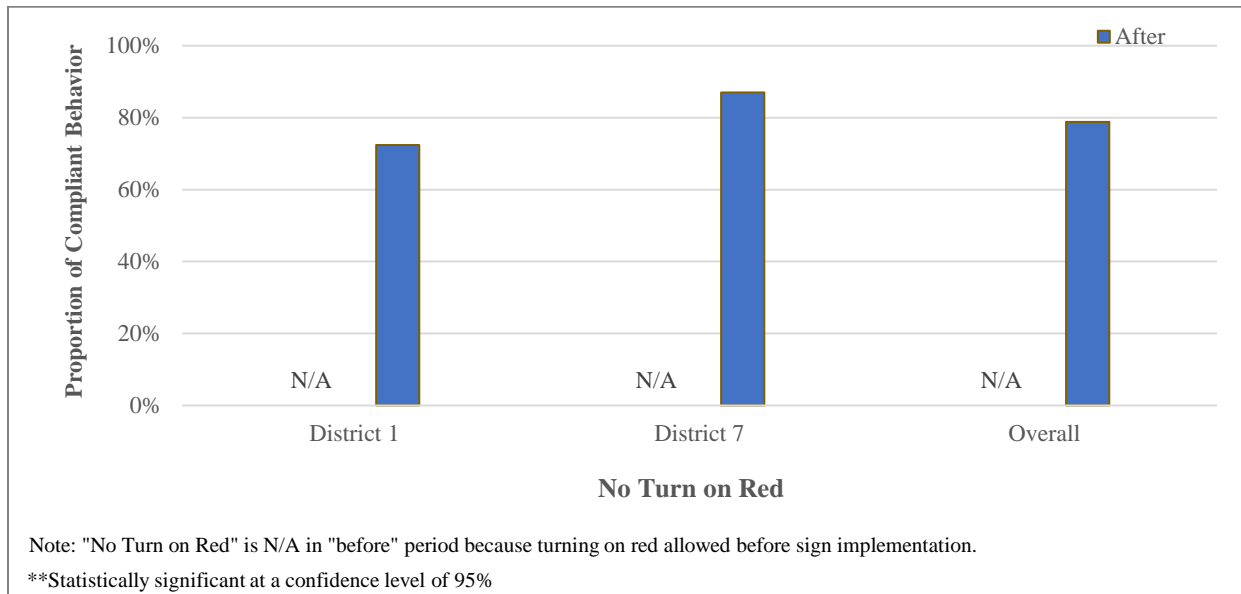


Figure 53. Comparison of compliance for “No Turn on Red” sign, Districts 1 and 7

Table 20. Comparison of Compliance for “No Turn on Red” Sign, Districts 1 and 7

Location	Before	After
District 1	0 (N/A)	42 (72.4%)
District 7	0 (N/A)	40 (87%)
Overall	0 (N/A)	82 (75.2%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was a 75.2% compliance rate after implementation of the “No Turn on Red” (blank-out) sign, which is lower than the compliance rate of 90.9% from the Phase 2 study. Comparison results reveal that blank-out “No Turn on Red” sign can offer a flexibility to display when pedestrians press buttons to minimize unnecessary vehicle delay during daytime but cannot maintain as high a driver compliance rate as that for a static “No Turn on Red” sign.
- To improve driver compliance rates for the “No Turn on Red” (blank-out) sign, a traffic agency should consider implementing it based on a time-of day schedule with active pedestrian activities to cross streets. Regular law enforcement at the locations with “No Turn on Red” (blank-out) sign operations can likely improve the compliance rate.

Figure 54 and Table 21 show the comparison results of driver compliance by gender for the “No Turn on Red” sign before and after the sign was implemented.

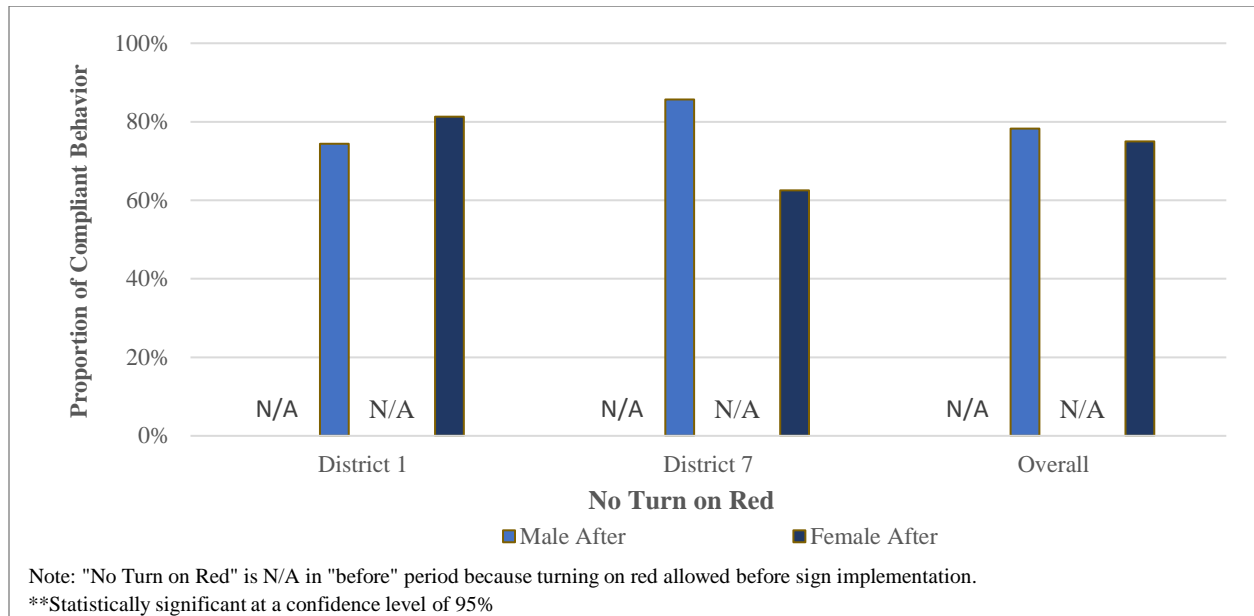


Figure 54. Comparison of compliance for “No Turn on Red” sign by gender, Districts 1 and 7

Table 21. Comparison of Compliance for “No Turn on Red” Sign by Gender, Districts 1 and 7

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	0 (N/A)	29 (70.7%)	0 (N/A)	13 (68.4%)
District 7	0 (N/A)	18 (85.7%)	0 (N/A)	5 (62.5%)
Overall	0 (N/A)	47 (75.8%)	0 (N/A)	18 (66.7%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Male drivers showed a higher compliance rate (76%) for “No Turn on Red” (blank-out) sign than that (67%) of female drivers.

Figure 55 and Table 22 show the comparison results of driver compliance by age for the “No Turn on Red” sign before and after the sign was implemented.

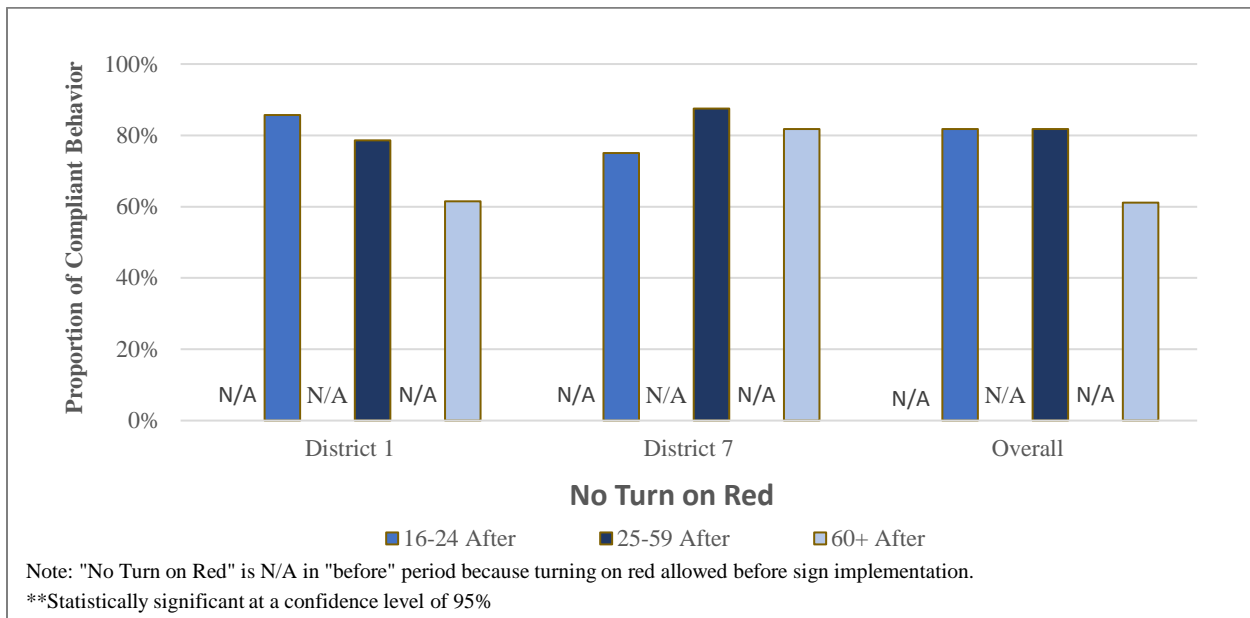


Figure 55. Comparison of compliance for “No Turn on Red” sign by age, Districts 1 and 7

Table 22. Comparison of Compliance for “No Turn on Red” Sign by Age, Districts 1 and 7

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	0 (N/A)	12 (85.7%)	0 (N/A)	22 (78.6%)	0 (N/A)	8 (61.5%)
District 7	0 (N/A)	6 (75%)	0 (N/A)	14 (87.5%)	0 (N/A)	3 (60%)
Overall	0 (N/A)	18 (83.3%)	0 (N/A)	36 (82.1%)	0 (N/A)	11 (61.1%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, young and middle-age drivers had similar compliance rates above 82%. Older drivers had the lowest compliance rate, at 61%.

5.3 Engineering & Education Combined

5.3.1 “Right Turn on Red after Stop” Sign



Figure 56 and Table 23 show the comparison results of driver compliance at a “Right Turn on Red after Stop” feature sign before and after the sign was implemented with education efforts applied in Districts 2, 3, 4, and 5.

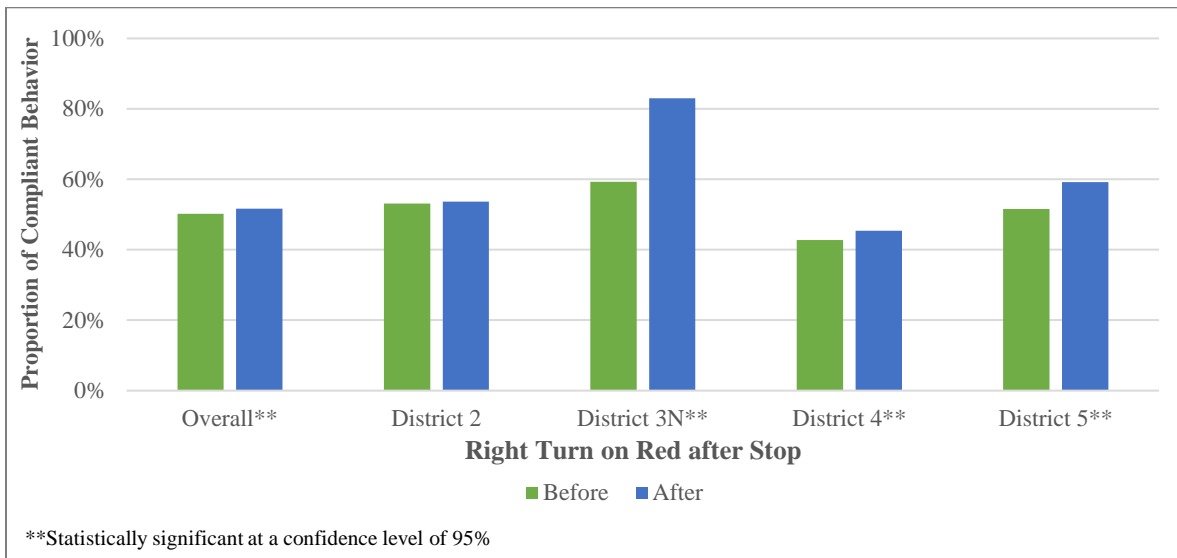


Figure 56. Comparison of compliance with “Right Turn on Red after Stop” sign

Table 23. Comparison of Compliance for “Right Turn on Red after Stop” Sign

Location	Before	After
Overall	571 (50.2%)	732 (60.9%)
District 2	26 (53.1%)	29 (53.7%)
District 3N	143 (59.3%)	200 (83%)
District 4	192 (42.8%)	239 (45.4%)
District 5	210 (51.6%)	264 (59.2%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was an increase in compliance for the “Right Turn on Red after Stop” sign, from 50.2% to 60.9% after implementation, and the difference of 10.7% was statistically significant at a 95% confidence level when compared to before implementation behavior.
- The highest compliance rate with the sign was 83% at the site for District 3 NB after sign implementation, and the increase of 23.7% from 59.3% was statistically significant at 95% confident level.

Figure 57 and Table 24 show the comparison results of driver compliance by gender before and after the sign was implemented with education efforts at sites in Districts 3, 4 and 5.

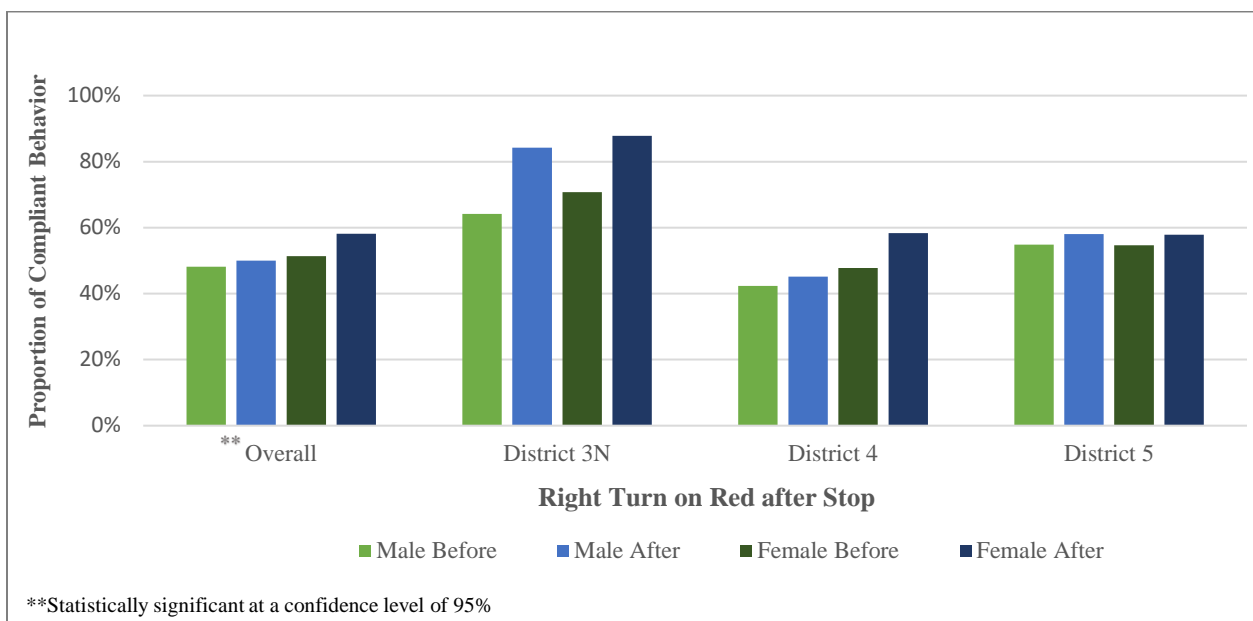


Figure 57. Comparison of compliance for “Right Turn on Red after Stop” by gender, Districts 3, 4, and 5

Table 24. Comparison of Compliance for “Right Turn on Red after Stop” by Gender, Districts 3, 4, and 5

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Overall*	239 (52.4%)	350 (59.1%)	110 (57%)	154 (64.7%)
District 3N	70 (64.2%)	129 (84.2%)	29 (70.7%)	48 (84.2%)
District 4	74 (42.3%)	117 (45.2%)	33 (47.8%)	56 (58.3%)
District 5	86 (54.8%)	91 (58%)	41 (54.7%)	44 (57.9%)

* Overall includes observations for gender in District 2.

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates the proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was an increase in compliance for both male and female drivers after implementation of the sign with education efforts. Female drivers were more likely to comply with the sign than male drivers.
- In District 3N and District 4, female drivers were more likely to comply with the feature than male drivers, and in District 5, male drivers were more likely to comply with the feature than female drivers. The difference was significant for male drivers at a 95% confidence level when compared with before and after sign implementation.
- Due to the limited number of observations for gender in District 2, comparison of compliance by gender is not shown.

Figure 58 and Table 25 show the comparison results of driver compliance by age before and after the sign was implemented with education efforts at sites in Districts 3N, 4, and 5.

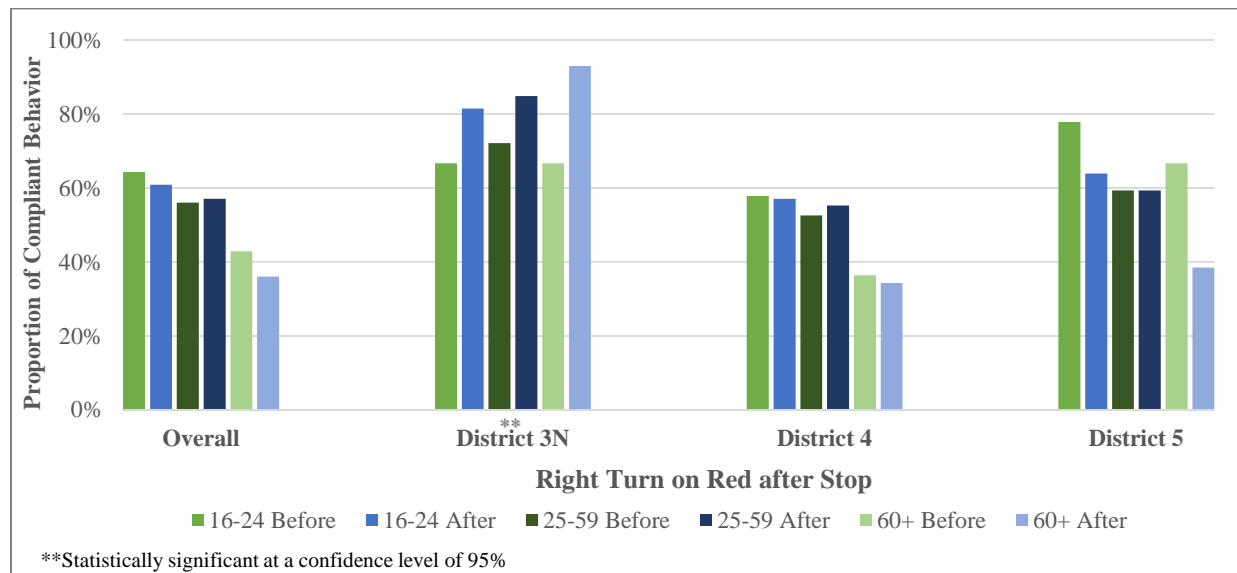


Figure 58. Comparison of compliance for “Right Turn on Red after Stop” by age, Districts 3, 4 and 5

Table 25. Comparison of Compliance for “Right Turn on Red after Stop” by Age, Districts 3, 4, and 5

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Overall*	21 (61.8%)	64 (66.7%)	221 (59.9%)	325 (63.4%)	13 (52%)	64 (59.8%)
District 3N	2 (66.7%)	22 (81.5%)	49(72.1%)	106 (84.8%)	6(66.7%)	40 (93%)
District 4	11 (57.9%)	16 (57.1%)	72 (52.6%)	109 (55.3%)	4 (36.4%)	12 (34.3%)
District 5	7 (77.8%)	23 (63.9%)	86 (59.3%)	96 (59.3%)	2 (66.7%)	10 (38.5%)

* Overall includes observations for gender in District 2.

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was an increase in compliance for all age groups compared to before countermeasure implementation, and middle-age drivers were more likely to comply with the feature than young and older drivers; the differences were significant at a 95% confidence level when compared with before and after sign implementation.
- Overall, including data from District 2, which is not shown in Table 24 after breaking down by gender or age, young drivers (ages 16–24) had the highest compliance (66.7%), followed by middle-age drivers (63.4%) and older drivers (59.8%).
- Older drivers had a slight decrease in compliance at the site in District 4 and a large decrease at the site in District 5. Due to small sample size, the comparison is not statistically significant.
- Due to the limited number of observations for age in District 2, comparison of compliance for different age groups is not shown.

5.3.2 “Stop Here on Red” Sign



Figure 59 and Table 26 show the comparison results of driver compliance at a “Stop Here on Red” sign between a right-turn lane and a through lane before and after the sign was implemented with education efforts at the site in District 1.

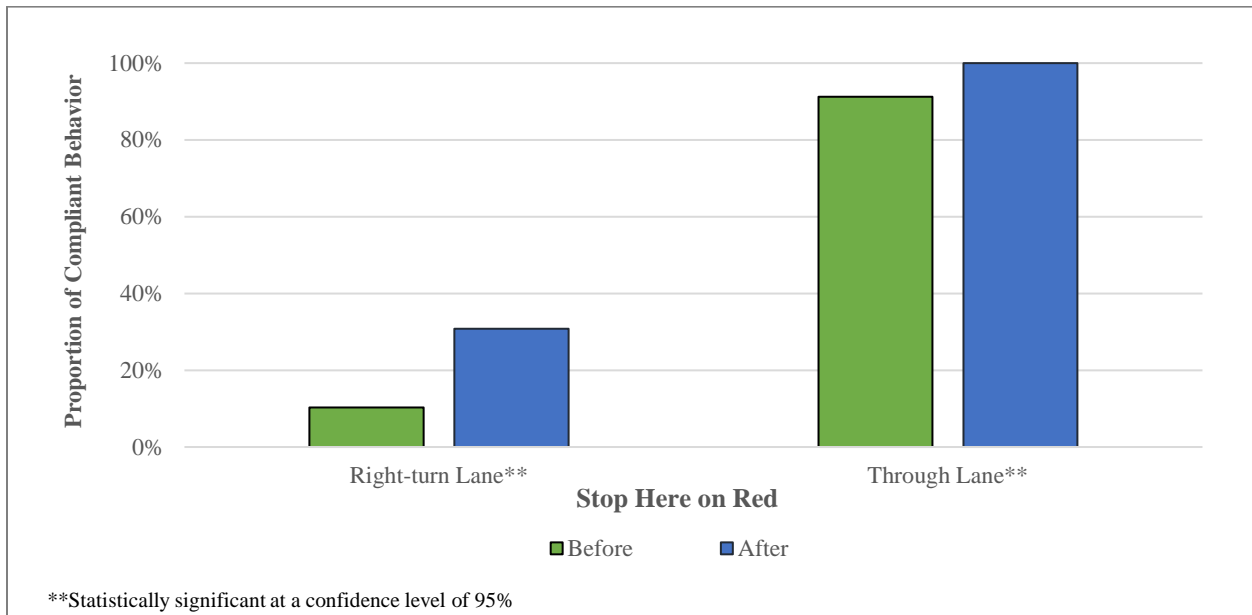


Figure 59. Comparison of compliance for “Stop Here on Red” sign, District 1

Table 26. Comparison of Compliance for “Stop Here on Red” Sign, District 1

Location	Before	After
Right-turn lane	143 (10.3%)	554 (30.8%)
Through lane	104 (91.2%)	43 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was a significant increase in compliance rates for both right-turn and through lanes, especially for right-turn lanes.
- Compliance with the sign was much higher in through lanes than in right-turn lanes. Both right-turn-lane and through-lane compliance was significant at a 95% confidence level when compared with before and after sign implementation with education efforts.
- The compliance rate for right-turn lane after implementation increased about 200%.

Figure 60 and Table 27 show the comparison results of driver compliance by gender for a “Stop Here on Red” sign for a right-turn lane and a through lane before and after implementation of sign with education efforts at the site in District 1.



Figure 60. Comparison of compliance for “Stop Here on Red” sign by gender, District 1

Table 27. Comparison of Compliance for “Stop Here on Red” Sign by Gender, District 1

Location	Male		Female	
	Before	After	Before	After
Right-turn lane	52 (10%)	379 (27.3%)	36 (13%)	174 (29.2%)
Through lane	25 (92.6%)	50 (100%)	11 (91.7%)	13 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, both male and female drivers showed an increase in compliance after implementation of the sign with education efforts. Compliance with the sign feature was much higher in a through lane than a right-turn lane.
- Female drivers in a right-turn lane were more likely to comply with the feature than male drivers. With respect to gender, the difference in a right-turn lane compliance was significant at a 95% confidence level when compared with before and after sign implementation with education efforts applied.

Figure 61 and Table 28 show the comparison results of driver compliance by age for a “Stop Here on Red” sign between a right-turn lane and a through lane before and after the sign was implemented with education at the site in District 1.

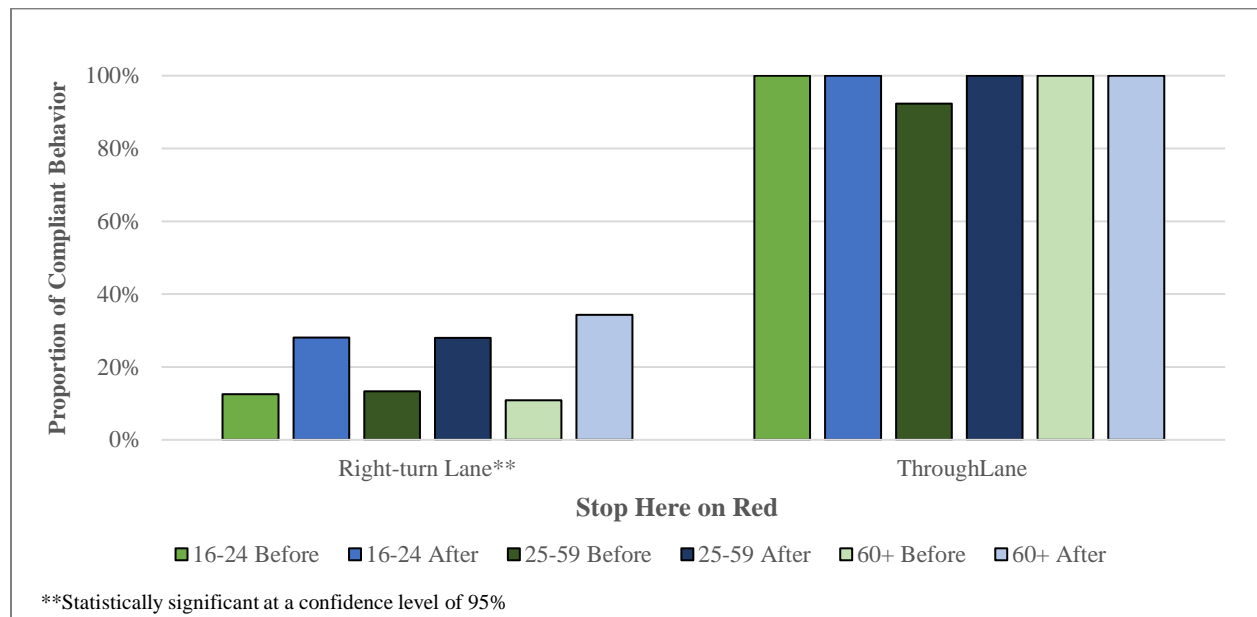


Figure 61. Comparison of compliance for “Stop Here on Red” sign by age, District 1

Table 28. Comparison of Compliance for “Stop Here on Red” Sign by Age, District 1

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Right-turn lane	6 (12.5%)	158 (28.1%)	63(13.3%)	277 (28%)	5(10.9%)	49(34.3%)
Through lane	5 (100%)	14 (100%)	24(92.3%)	21 (100%)	4 (100%)	6 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, all age groups exhibited an increase in compliance after implementation of the sign with education effort for a right-turn lane.

- Older drivers showed the highest proportion of compliance after implementation (34.3%), followed by younger drivers (28.1%) and middle-age drivers (28%); all age group results were significant at a 95% confidence level for a right-turn lane when compared with before and after sign implementation with education efforts applied.

5.3.3 “Turning Vehicles Yield to Pedestrians” Sign



Figure 62 and Table 29 show the comparison results of driver compliance with a “Turning Vehicles Yield to Pedestrians” static sign before and after implementing the sign and with education efforts at the site in District 3 NB.

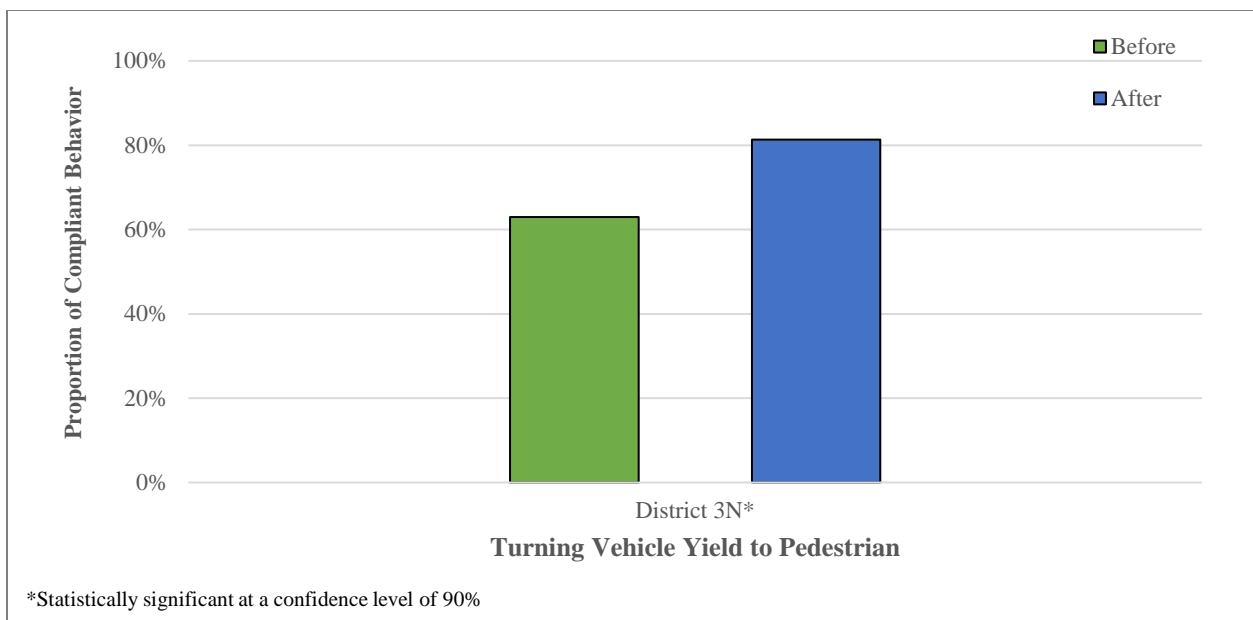


Figure 62. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign, District 3 NB

Table 29. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign, District 3 NB

Location	Before	After
District 3 NB	17 (63%)	61 (81.3%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- There was a large increase in compliance for the “Turning Vehicles Yield to Pedestrian” sign, from 63.0% to 81.3% after implementation, and the difference was significant at a 95% confidence level.
- Due to the limited number of observations for gender and age in District 3N, comparison of compliance for different gender and age groups is not shown.

5.3.4 “No Turn on Red” (Blank-Out) Sign



Figure 63 and Table 30 show the results of driver compliance for the “No Turn on Red” blank-out sign after implementing the sign and with education efforts at the site in District 1.

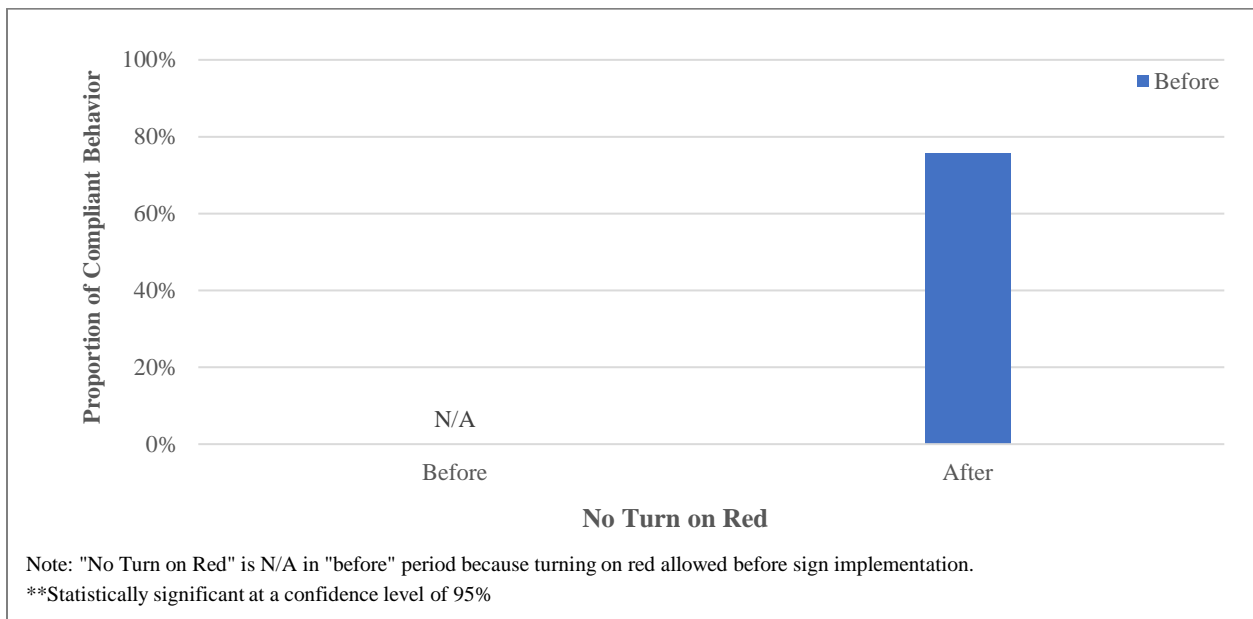


Figure 63. Comparison of compliance for “No Turn on Red” sign, District 1

Table 30. Comparison of Compliance for “No Turn on Red” Sign, District 1

Location	Before	After
District 1	0 (N/A)	170 (75.6%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- There was an overall 75.6% compliance rate after implementation of the “No Turn on Red” (blank-out) sign; this is lower than the compliance rate of 90.9% obtained from the Phase 2 study. As indicated in the engineering treatment only, the comparison result reveals that blank-out “No Turn on Red” sign can offer a flexibility to display when pedestrians press buttons to minimize unnecessary vehicle delay during daytime, but cannot maintain as high a high driver compliance rate as that for a static “No Turn on Red” sign.
- To improve driver compliance rate for the “No Turn on Red” (blank-out) sign, a traffic agency should consider implementing it based on a time-of day schedule with active pedestrian activities to cross streets. Regular law enforcement at the locations with “No Turn on Red” (blank-out) sign operations can likely improve the compliance rate.

Figure 64 and Table 31 show the comparison results of driver compliance by gender after the sign was implemented with education efforts at site in District 1.

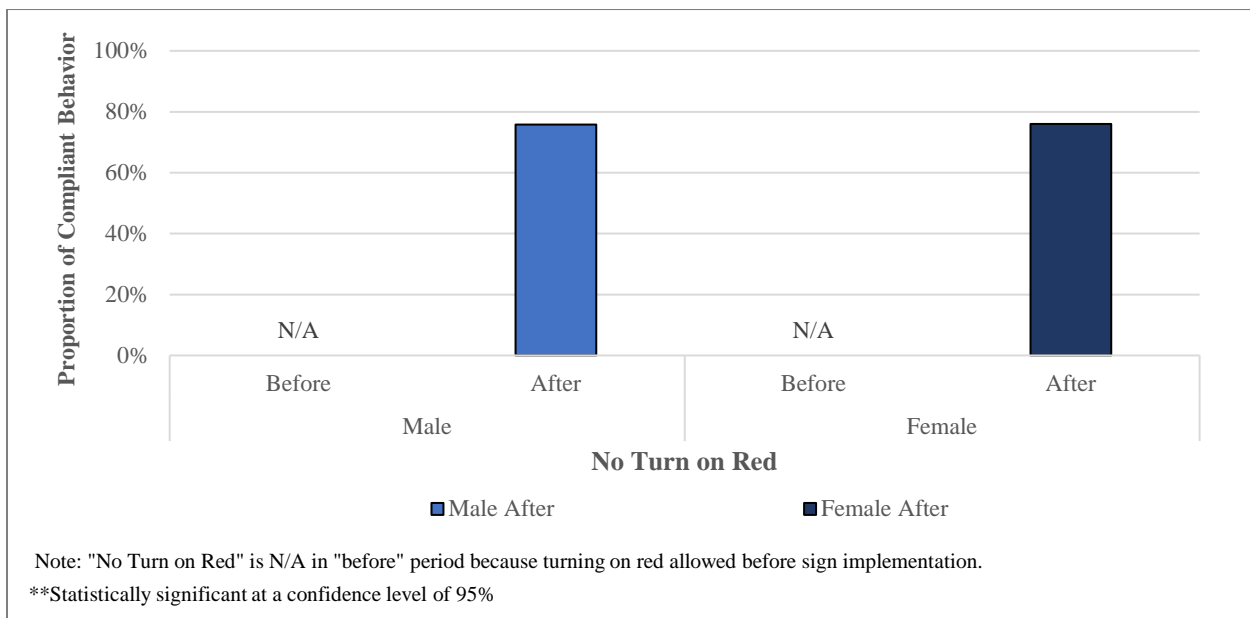


Figure 64. Comparison of compliance for “No Turn on Red” sign by gender, District 1

Table 31. Comparison of Compliance for “No Turn on Red” Sign by Gender, District 1

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	0 (N/A)	94 (75.8%)	0 (N/A)	73 (76%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- For the pedestrian blank-out feature “No Turn on Red,” the compliance rate for female drivers was similar to that of male drivers.

Figure 65 and Table 32 show the comparison results of driver compliance by age after the sign was implemented with education efforts at the site in District 1.

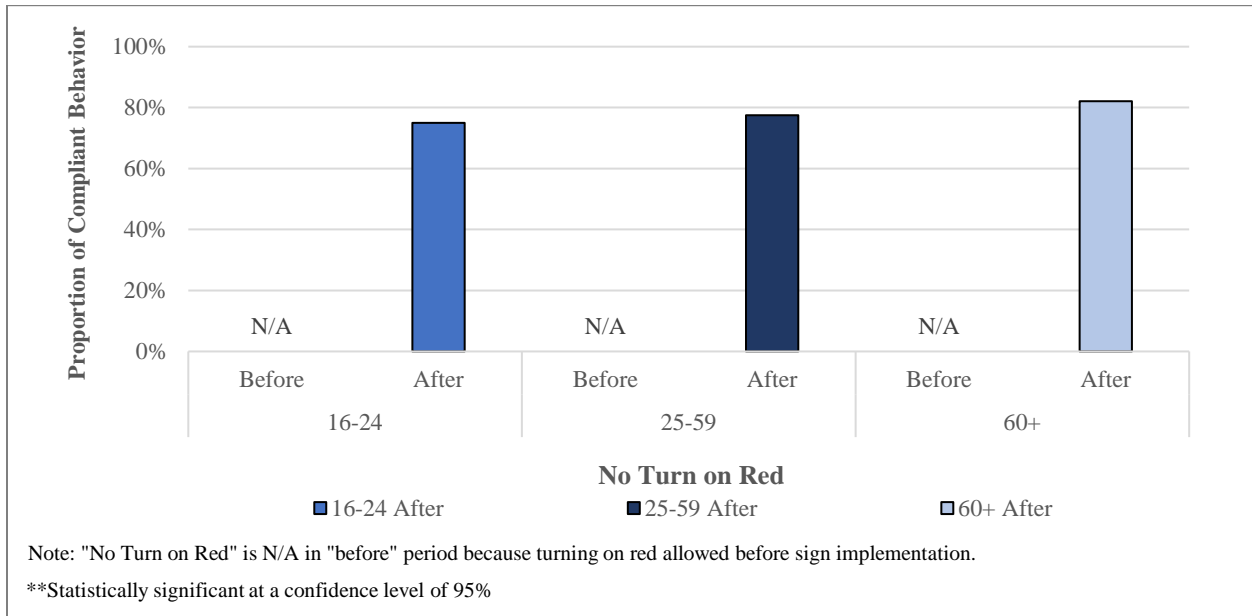


Figure 65. Comparison of compliance for “No Turn on Red” sign by age, District 1

Table 32. Comparison of Compliance for “No Turn on Red” Sign by Age, District 1

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	0 (N/A)	60 (75%)	0 (N/A)	79 (77.5%)	0 (N/A)	23 (82.1%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- For the pedestrian blank-out feature “No Turn on Red,” older drivers showed the highest proportion of compliance (82.1%), followed by middle-age drivers (77.5%) and young drivers (75%). Significance test is not applicable to this dataset.

5.3.5 “Turning Vehicles Yield to Pedestrians” (Blank-Out) Sign



Figure 66 and Table 33 show the comparison results of driver compliance for “Turning Vehicles Yield to Pedestrians” blank-out sign before and after the sign was implemented at the site with education efforts in District 1.

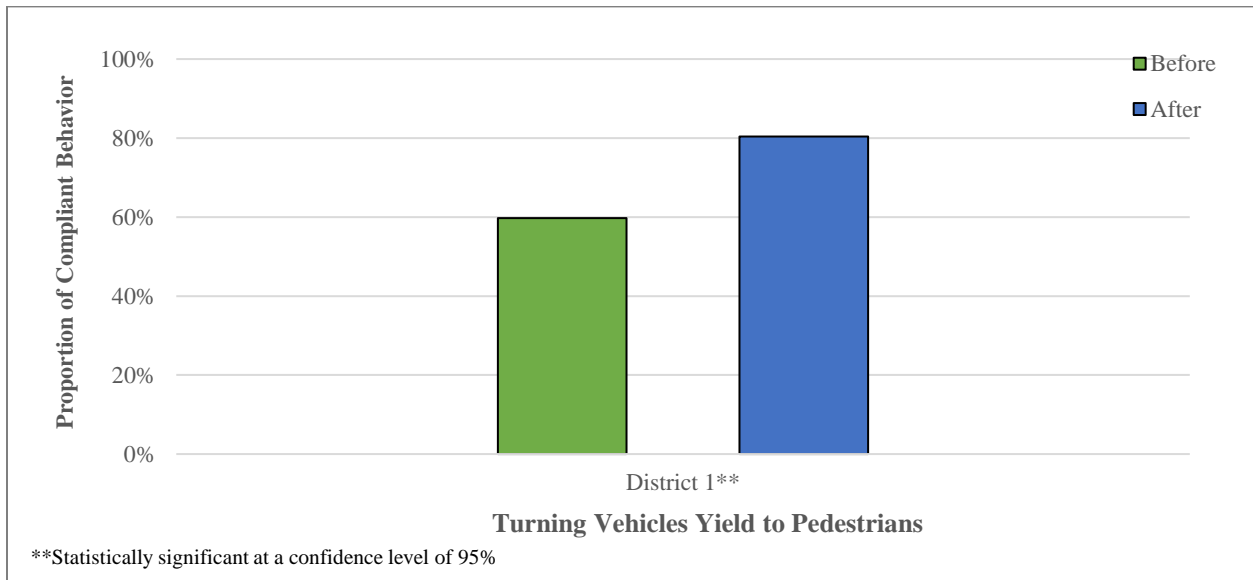


Figure 66. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign, District 1

Table 33. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign, District 1

Location	Before	After
District 1	40 (59.7%)	119 (80.4%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, there was a large increase in compliance, from 59.7% to 80.4%, after implementation of the blank-out sign and education efforts. The difference in the proportion of driver compliance was significant at a 95% confidence level.

Figure 67 and Table 34 show the comparison results of driver compliance by gender for “Turning Vehicles Yield to Pedestrians” before and after the sign was implemented at the site with education efforts in District 1.

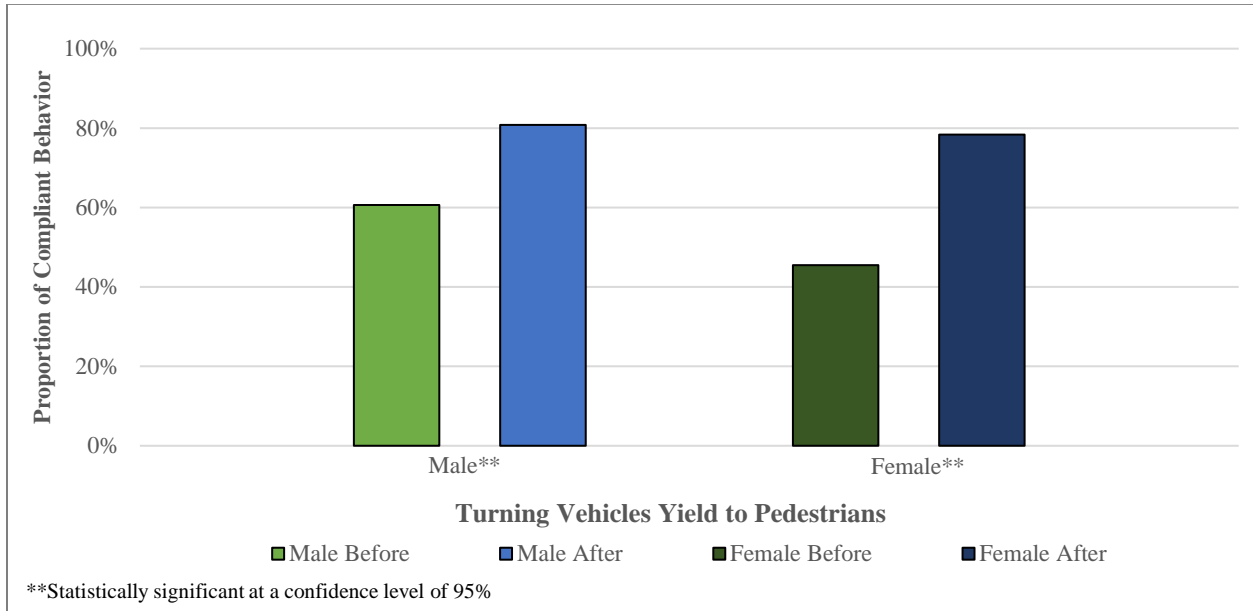


Figure 67. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by gender, District 1

Table 34. Comparison of Compliance for “No Turn on Red” Sign by Gender, District 1

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	20 (60.6%)	59 (80.8%)	5 (45.5%)	29 (78.4%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates the proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- Overall, both male and female drivers showed a large increase in compliance after implementation of the blank-out sign with education efforts; with respect to each gender, the difference in proportion of compliance was significant at a 95% confidence level when compared with before the implementation of the sign.
- Male drivers were more likely to comply with the feature sign than female drivers.

Figure 68 and Table 35 show the comparison results of driver compliance by age for “Turning Vehicles Yield to Pedestrians” blank-out sign before and after the sign was implemented at the site with education efforts in District 1.

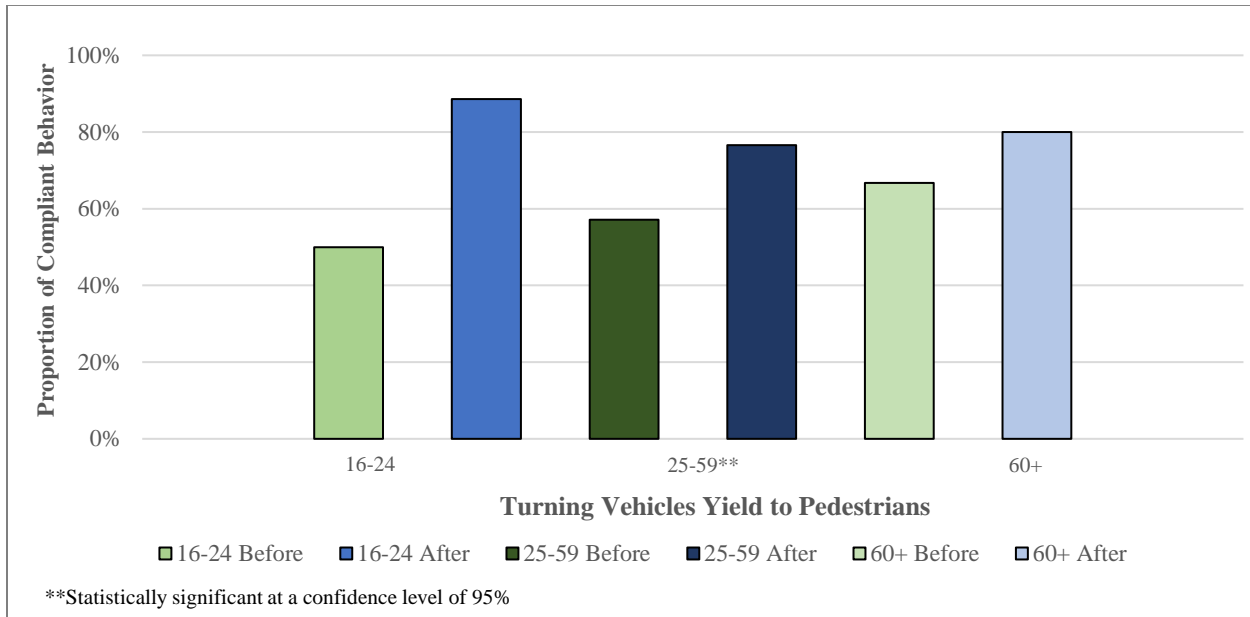


Figure 68. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by age, District 1

Table 35. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign by Age, District 1

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	1 (50%)	31 (88.6%)	16 (57.1%)	49 (76.6%)	2 (66.7%)	6 (80%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates the proportion of compliant behavior observations in total observations.

Analysis reveals results as follows:

- For the pedestrian blank-out sign “Turning Vehicles Yield to Pedestrians,” younger drivers showed the highest proportion of compliance (88.6%), followed by older and middle-age drivers. The difference in the proportion of compliance in middle-age drivers was significant at a 95% confidence level when compared with before and after the countermeasure.

5.4 Education after Engineering

This group of countermeasure treatments was to investigate the marginal effects of conducting education after the implementation of a specific feature sign. Data were collected (1) before installation of a sign, (2) after installation of a sign, and (3) after application of education efforts. In this pilot implementation, data were collected in this manner for the three pedestrian signs in FDOT District 1.

5.4.1 “Stop Here on Red” Sign



Figure 69 and Table 36 show the comparison results of driver compliance before and after education efforts for a “Stop Here on Red” sign at the site in District 1.

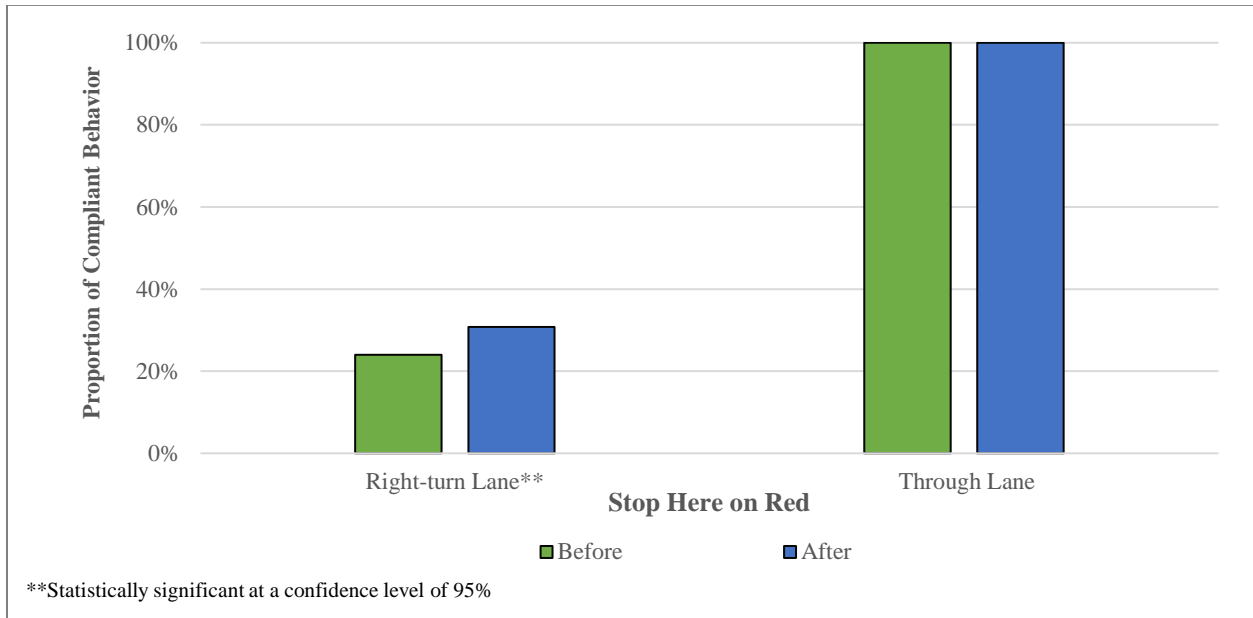


Figure 69. Comparison of compliance for “Stop Here on Red” sign, District 1

Table 36. Comparison of Compliance for “Stop Here on Red” Sign, District 1

Location	Before Signage	Before Education	After Education
Right-turn lane	143 (10.3%)	316 (24%)	554 (30.8%)
Through lane	104 (91.2%)	100 (100%)	43 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- Before implementation of the “Stop Here on Red” sign, the proportion of compliance for a right-turn lane was 10.3%; after sign implementation, it increased to 24.0%. The compliance rate increased further, from 24.0% to 30.8%, after education. The difference in driver compliance behavior at right-turn lane is significant at a 95% confidence level.
- Drivers in through lanes completely complied with the feature before and after education.

Figure 70 and Table 37 show the comparison results of driver compliance by gender before and after education efforts for the “Stop Here on Red” sign between right-turn lanes and through lanes at the site in District 1.



Figure 70. Comparison of compliance for “Stop Here on Red” sign by gender, District 1

Table 37. Comparison of Compliance for “Stop Here on Red” Sign by Gender, District 1

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Right-turn lane	118 (25.8%)	261 (28%)	79 (28.9%)	95 (29.4%)
Through lane	31 (100%)	19 (100%)	8 (100%)	5 (100%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- Both male and female drivers in right-turn lanes showed a small increase in compliance after education. Compliance with the sign was much higher for through-lane drivers when compared to right-turn-lane drivers due to the fact that when a right turn on red is allowed, drivers do not stop behind the stop bar. With respect to gender, the difference in the proportion of driver compliance behavior in a right-turn lane was not significant at a 95% confidence level.

Figure 71 and Table 38 show the comparison results of driver compliance by age before and after education efforts for the “Stop Here on Red” sign between right-turn lanes and through lanes at the site in District 1.

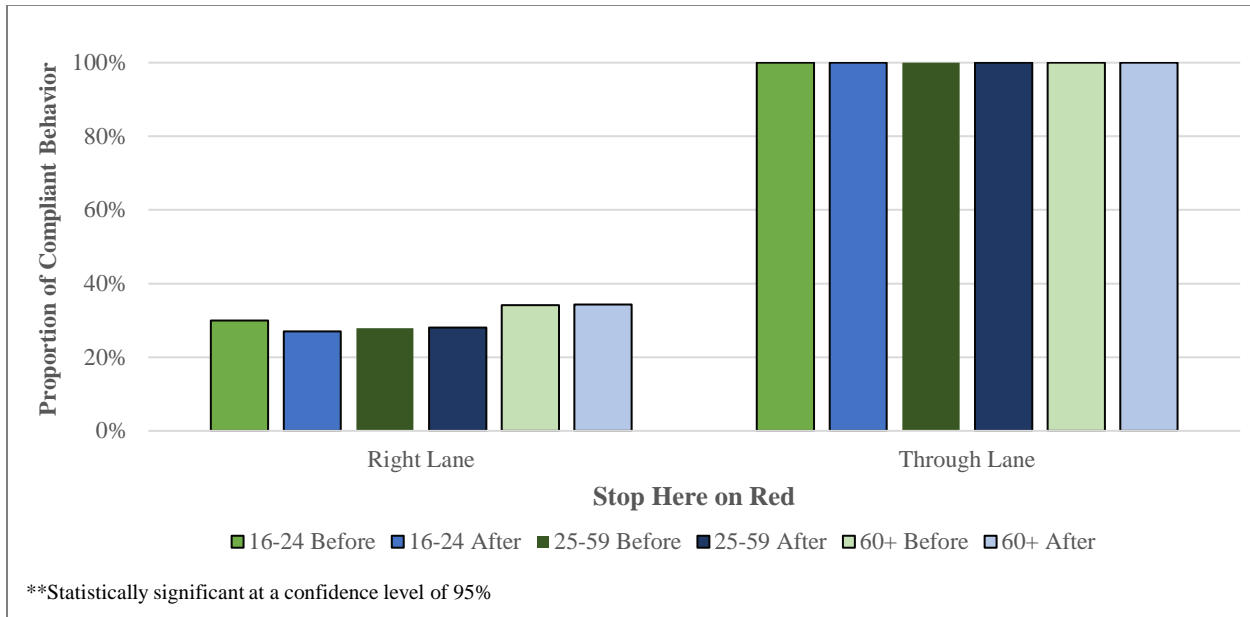


Figure 71. Comparison of compliance for “Stop Here on Red” sign by age, District 1

Table 38. Comparison of compliance for “Stop Here on Red” sign by age, District 1

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Right-turn lane	62 (30%)	96 (27%)	107 (27.9%)	170 (28.1%)	15 (34.1%)	34 (34.3%)
Through lane	7 (100%)	7 (100%)	10 (100%)	11 (100%)	2 (100%)	4 (100%)

Note: Number in each cell indicates the number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations

Analysis results reveal the following:

- Overall, all age groups had mixed results in compliance in a right-turn lane; however, the difference was small and was not statistically significant. As expected, compliance with the sign was much higher in through lanes than in right-turn lanes.
- Young drivers showed slight decrease in compliance after education in right-turn lanes. Older drivers (34.3%) showed a slight increase in compliance, followed by middle-age drivers (28.1%). With respect to each age group, the difference in driver compliance behavior in a right-turn lane was not significant.
- Young, middle-age, and older drivers in through lanes had 100% compliance with the feature sign.

5.4.2 “No Turn on Red” (Blank-Out) Sign



Figure 72 and Table 39 show the comparison results of driver compliance before and after education for the “No Turn on Red” blank-out sign implementation at the site in District 1.

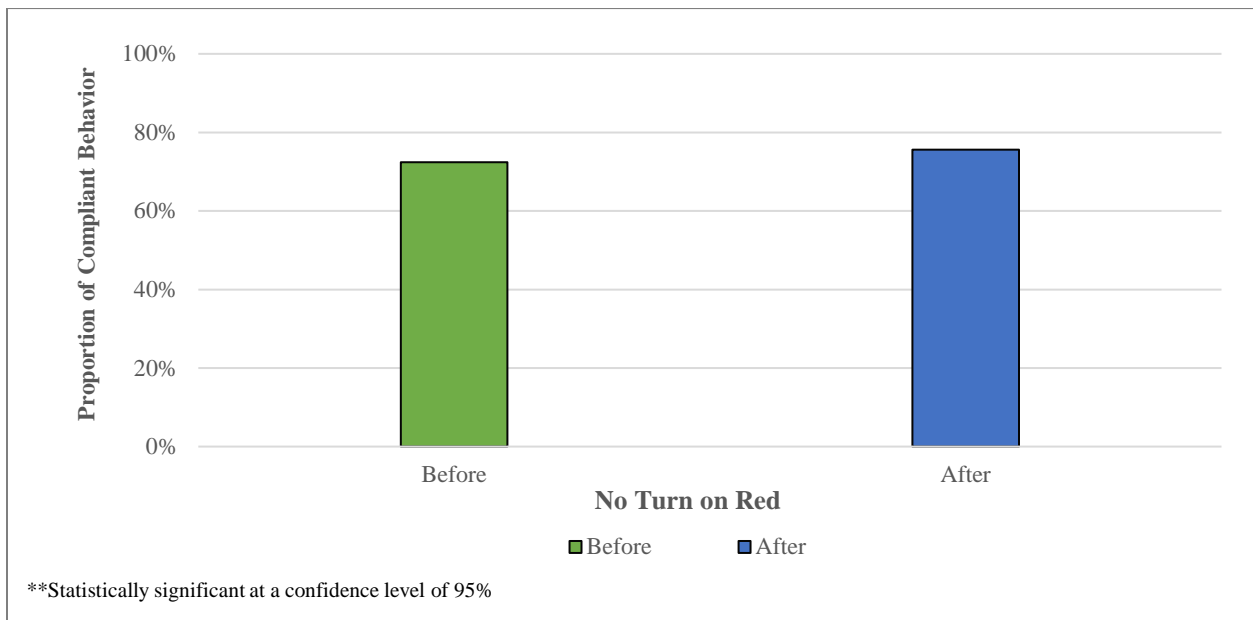


Figure 72. Comparison of compliance for “No Turn on Red” sign, District 1

Table 39. Comparison of Compliance for “No Turn on Red” Sign, District 1

Location	Before	After
District 1	42 (72.4%)	170 (75.6%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- There was a small increase in compliance, from 72.4% to 75.6%, with the sign after education was applied at the site. This education was implemented after installation of the sign and was treated as a separate countermeasure and not combined with the engineering countermeasure (installation of sign). The difference in driver compliance is not significant at a 95% confidence level.

Figure 73 and Table 40 show the comparison results of driver compliance before and after education efforts by gender for the “No Turn on Red” blank-out sign implementation at the site in District 1.

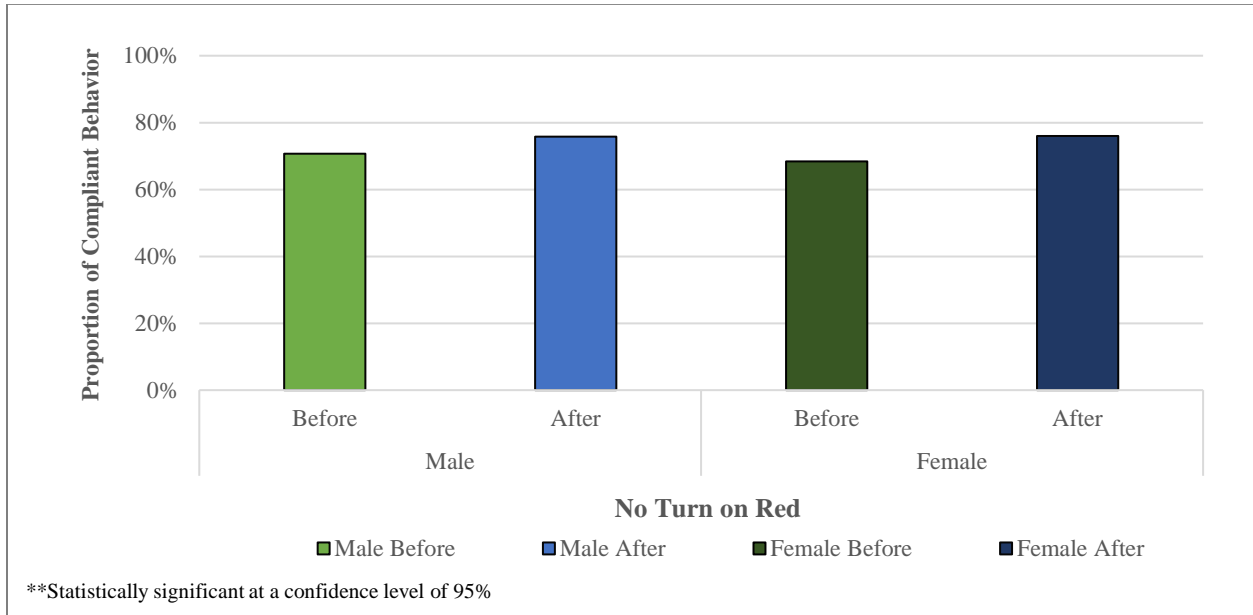


Figure 73. Comparison of compliance for “No Turn on Red” sign by gender, District 1

Table 40. Comparison of Compliance for “No Turn on Red” Sign by Gender, District 1

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	29 (70.7%)	94 (75.8%)	13 (68.4%)	73 (76%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- There was an increase in compliance by both males and females after the “No Turn on Red” blank-out sign was implemented.
- Both male and female drivers had a 76% compliance rate. The difference in the proportion of drivers by gender compliance is not significant at a 95% confidence level.

Figure 74 and Table 41 show the comparison results of driver compliance by age before and after education efforts for the “No Turn on Red” blank-out sign implementation at the site in District 1.

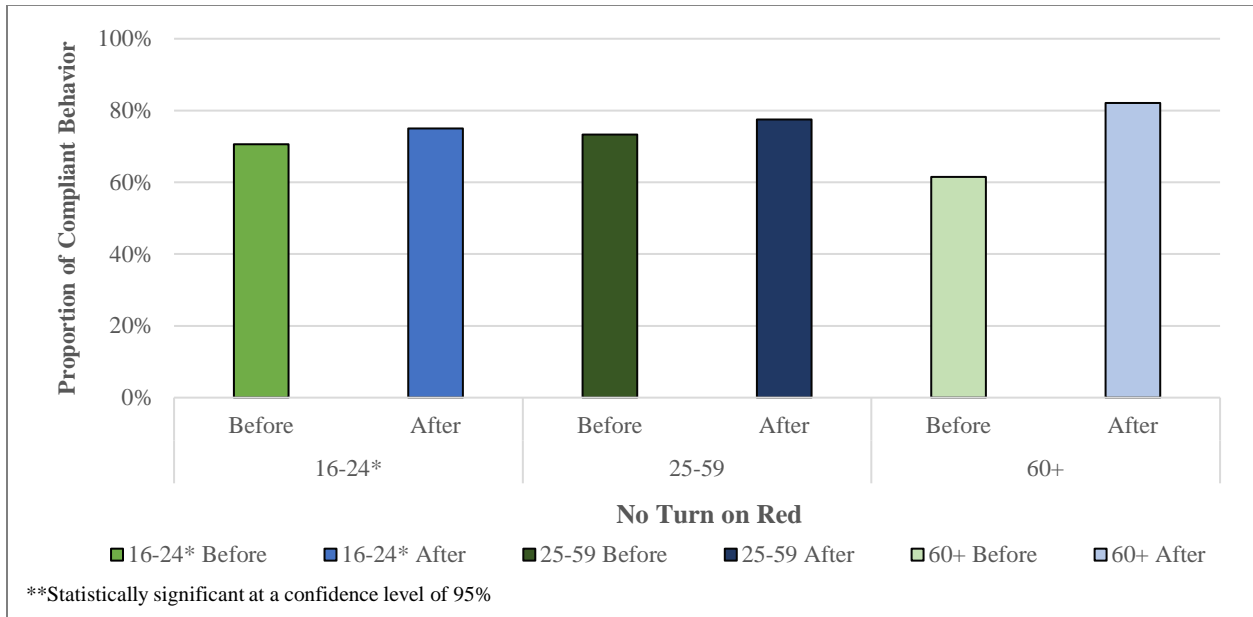


Figure 74. Comparison of compliance for “No Turn on Red” sign by age, District 1

Table 41. Comparison of Compliance for “No Turn on Red” Sign by Age, District 1

Location	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	12 (70.6%)	60 (75%)	22 (73.3%)	79 (77.5%)	8 (61.5%)	23 (82.1%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- All age groups exhibited an increase in compliance after education.
- Older drivers showed the highest proportion of compliance after education (82.1%), followed by middle-age drivers (77.5%) and younger drivers (75%). The difference in compliance by driver age is not significant at a 95% confidence level.

5.4.3 “Turning Vehicles Yield to Pedestrians” (Blank-Out) Sign



Figure 75 and Table 42 show the comparison results of driver compliance before and after education efforts for the “Turning Vehicles Yield to Pedestrians” blank-out sign implementation at the site in District 1.

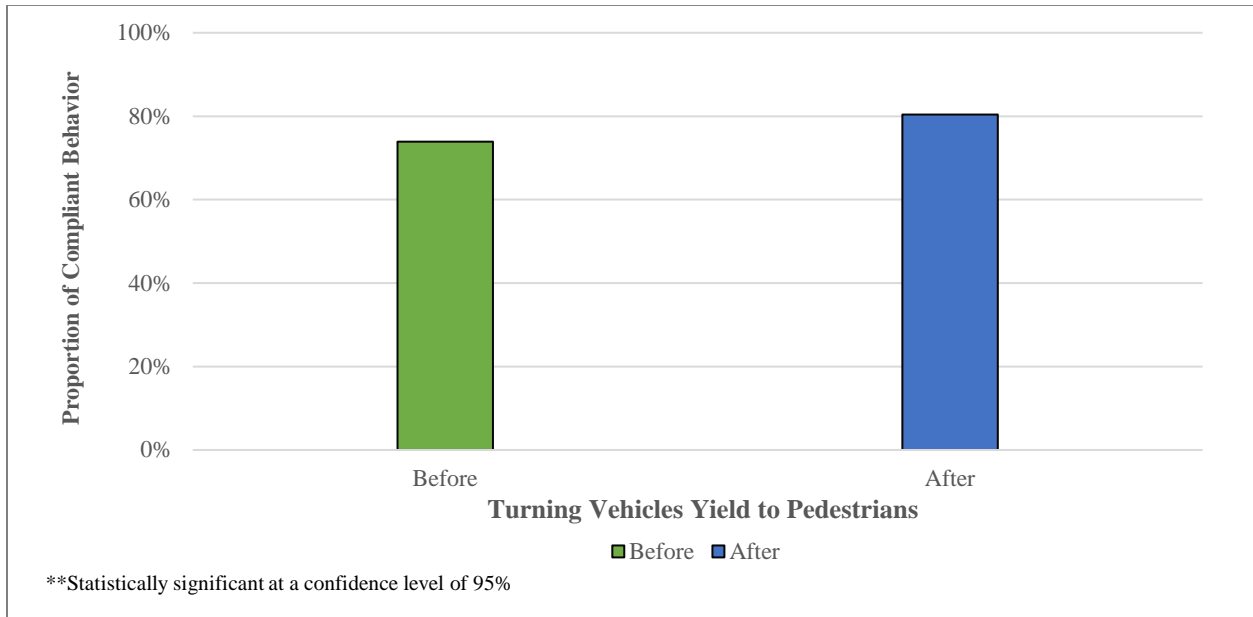


Figure 75. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign, District 1

Table 42. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign, District 1

Location	Before Signage	Before Education	After Education
District 1	40 (59.7%)	34 (73.9%)	119 (80.4%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- There was an increase in compliance in District 1 after education. The difference in the proportion of driver compliance is not significant at a 95% confidence level.
- Before the implementation of the “Turning Vehicles Yield to Pedestrians” blank-out sign, the proportion of compliance was only 59.7%; after sign implementation, it increased to 73.9%. The compliance rate increased further from 73.9% to 80.4% after education. The difference in driver compliance behavior from before education to after education is significant at a 95% confidence level.

Figure 76 and Table 43 show the comparison results of driver compliance by gender for the “Turning Vehicle Yield to Pedestrian” blank-out sign implementation at the site in District 1.

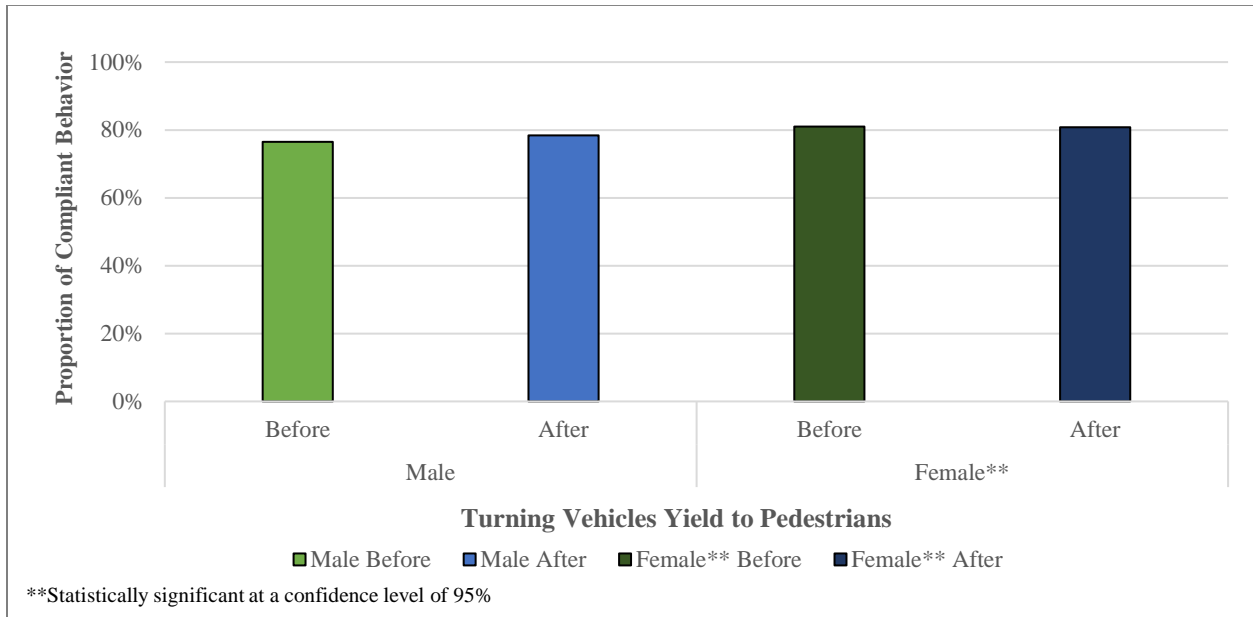


Figure 76. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by gender, District 1

Table 43. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign by Gender, District 1

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	17 (76.5%)	59 (78.4%)	13 (81%)	29 (80.8%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- Both male and female drivers had an increase in compliance after education efforts were applied.
- Both female and male drivers experienced similar compliance. The rate was not significant at a 95% confidence level when compared with before and after education efforts were applied.

Figure 77 and Table 44 show the comparison results of driver compliance by age for the “Turning Vehicle Yield to Pedestrian” blank-out sign implementation at the site in District 1.

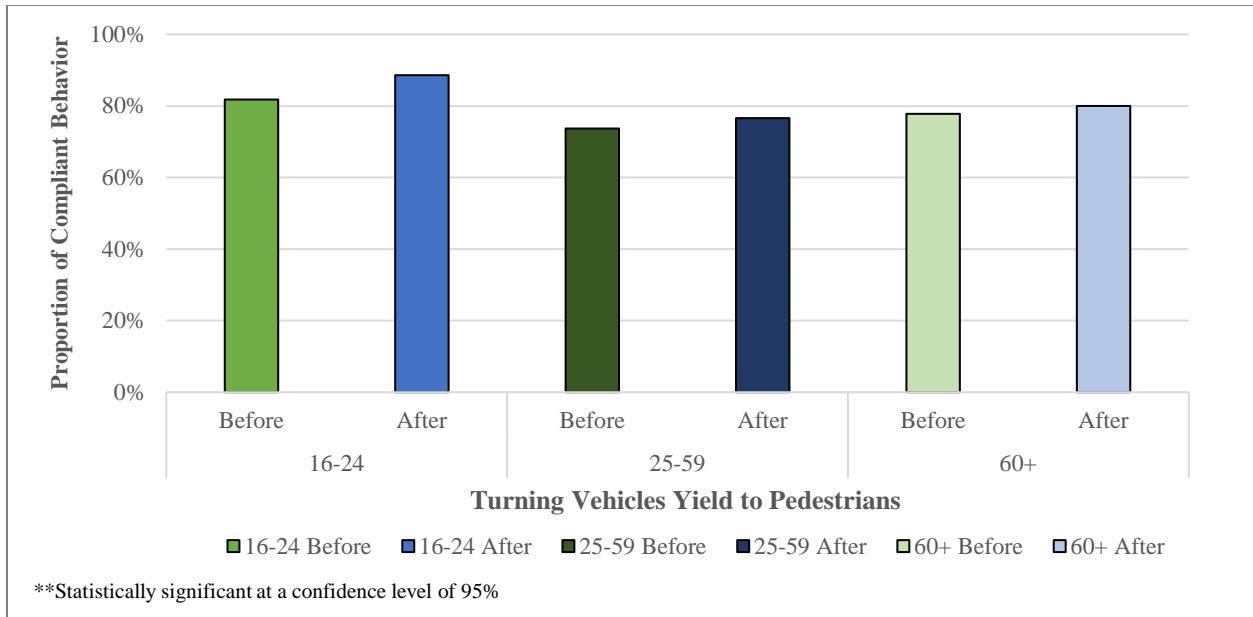


Figure 77. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by age, District 1

Table 44. Comparison of Compliance for “Turning Vehicle Yield to Pedestrians” Sign by Age, District 1

Location	16-24		25-59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 1	9 (81.8%)	31 (88.6%)	14(73.7%)	49 (76.6%)	7(77.8%)	8(80%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- There was a small increased in compliance in all age groups after education efforts were applied.
- Young drivers showed the highest proportion of compliance after education efforts were applied, followed by older drivers and middle-age drivers. The difference in driver compliance behavior by age is not significant at a 95% confidence level.

5.5 Education-Only for Existing Signs

5.5.1 “Turning Vehicles Yield to Pedestrians” Sign



Figure 78 and Table 45 show the comparison results of driver compliance for the “Turning Vehicles Yield to Pedestrians” sign before and after education efforts were applied at the site in District 6.

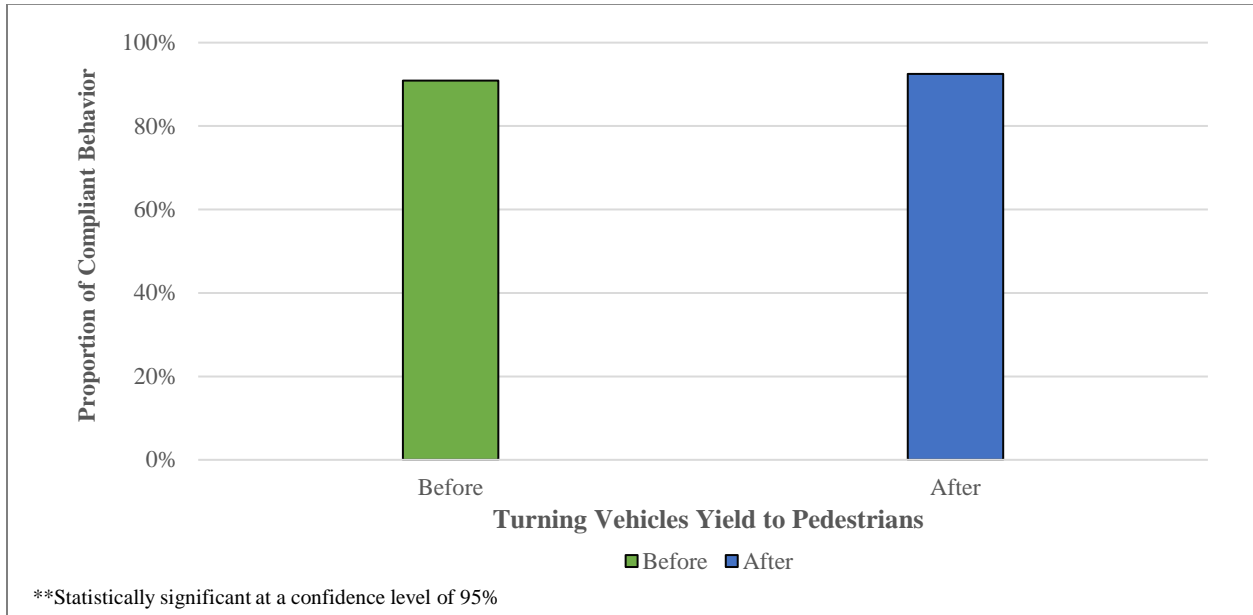


Figure 78. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign, District 6

Table 45. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign, District 6

Location	Before	After
District 6	140 (90.9%)	221 (92.5%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- There was a small increase in compliance after education efforts took place. The difference in driver compliance behavior is not significant at a 95% confidence level.

Figure 79 and Table 46 show the comparison results of driver compliance by gender for the “Turning Vehicles Yield to Pedestrians” sign before and after education efforts were applied at the site in District 6.

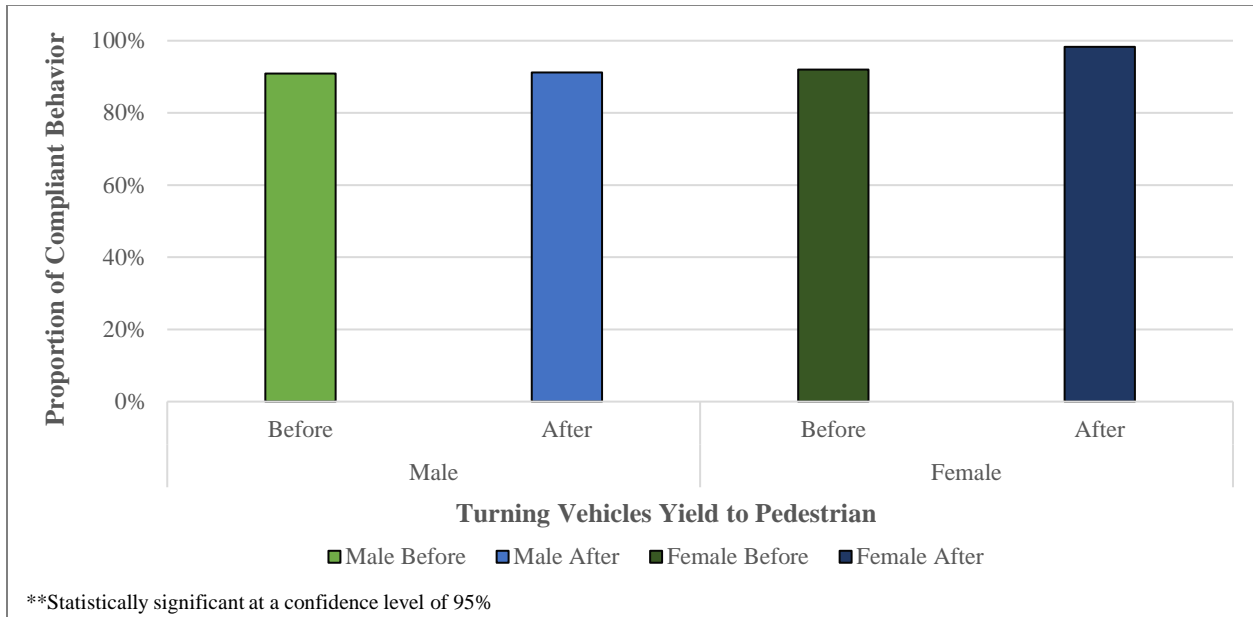


Figure 79. Comparison of compliance for “Turning Vehicles Yield to Pedestrians” sign by gender, District 6

Table 46. Comparison of Compliance for “Turning Vehicles Yield to Pedestrians” Sign by Gender, District 6

Location	Male		Female	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
District 6	70 (90.9%)	134 (91.2%)	23 (92%)	58 (98.3%)

Note: Number in each cell indicates number of compliant behavior observations, and percentage indicates proportion of compliant behavior observations in total observations.

Analysis results reveal the following:

- Both male and female drivers showed an increase in compliance after education efforts were applied.
- Female drivers were more likely to comply with the feature than male drivers. The difference in driver compliance by gender is not significant at a 95% confidence level.

5.6 Overall Results

Figure 80 and Table 47 show the distribution of interactions between drivers and signs for each pedestrian sign.

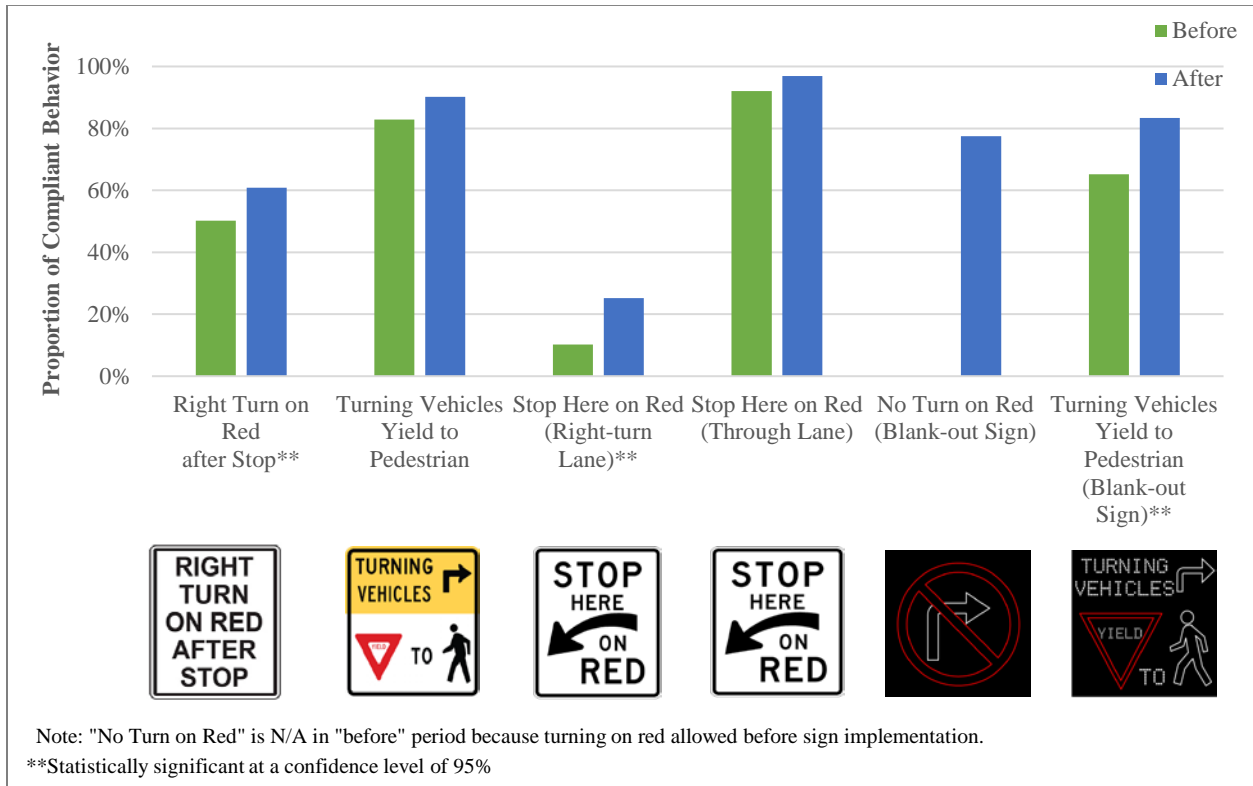


Figure 80. Overall comparison of compliance with pedestrian features

Table 47. Overall Comparison of Compliance with Pedestrian Features

Pedestrian Signs	Before	After	Improvement of Driver Compliance
Right Turn on Red after Stop	571 (50.2%)	732 (60.9%)	21.3%
Turning Vehicles Yield to Pedestrians	157 (82.9%)	276 (90.2%)	8.8%
Stop Here on Red (right-turn lane)	227 (10.2%)	728 (25.2%)	147.1%
Stop Here on Red (through lane)	164 (92.1%)	123 (96.9%)	5.2%
No Turn on Red (blank-out sign)	N/A	210 (77.5%)	N/A
Turning Vehicles Yield to Pedestrians (blank-out sign)	58 (65.2%)	206 (83.4%)	27.9%

A description of results for each feature is as follows.

- Three pedestrian signs—“Right Turn on Red after Stop,” “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” (blank-out sign)—showed large increases in compliance after their implementation when compared to before implementation. The difference for before and after implementation of “Right Turn on Red after Stop” (right-turn lanes), “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” (blank-out) signs was significant at a confidence level of 95%.
- Compliance with “Stop Here on Red” signs was much higher among through-lane drivers than right-turn-lane drivers. A potential reason is that drivers in the right lane were more

likely to pass the stop bar to make a full stop, as they were trying to have adequate sight distance for the right- turn maneuver. This was considered non-compliant behavior, as drivers are required to stop behind the stop bar. The implementation of “Stop Here on Red” signs can significantly increase the compliance rate for right-turn lane.

- Blank-out signs of “No Turn on Red” were not applied in this comparison due to a change in the definition of compliance, in which turning on red after stopping is not allowed after implementation of the sign but is allowed before implementation of the sign.
- There was an overall 77.5% compliance rate after implementation of the “No Turn on Red” (blank-out) sign, which is lower than the compliance rate of 90.9% for the “No Turn on Red” (static) sign obtained from the Phase 2 study. Comparison results reveal that blank-out “No Turn on Red” signs can offer flexibility to display when pedestrians press buttons to minimize unnecessary vehicle delay during daytime but cannot maintain as high a driver compliance rate as that for a static “No Turn on Red” sign. Some supplemental strategies are needed to increase the compliance rate.

Figure 81 and Table 48 shows the distribution of interactions between drivers and feature signs for each pedestrian sign by gender. A description of results for each feature is provided as follows.

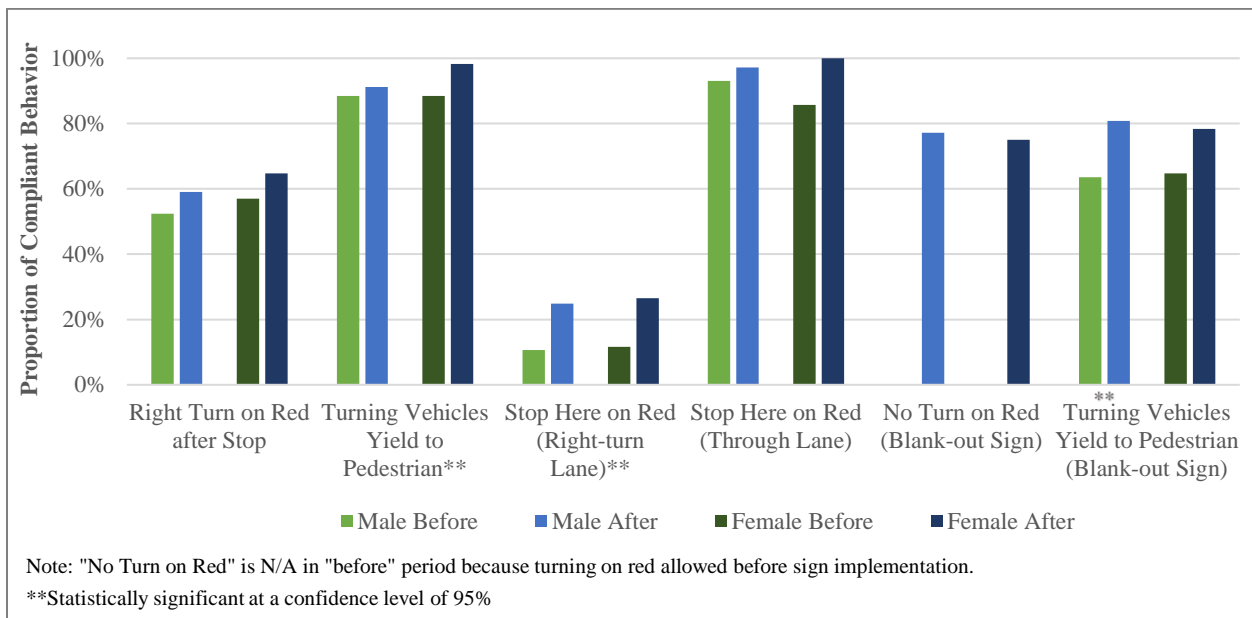


Figure 81. Overall comparison of compliance by gender

Table 48. Overall Comparison of Compliance by Gender

Pedestrian Signs	Male		Female	
	Before	After	Before	After
Right Turn on Red after Stop	248 (52.7%)	350 (59.1%)	113 (57.4%)	154 (64.7%)
Turning Vehicles Yield to Pedestrians	77 (88.5%)	134 (91.2%)	23 (88.5%)	58 (98.3%)
Stop Here on Red (right-turn lane)	96 (10.6%)	324 (24.9%)	58 (11.6%)	131 (26.5%)
Stop Here on Red (through lane)	54 (93.1%)	35 (97.2%)	18 (85.7%)	17 (100%)
No Turn on Red (blank-out Sign)	N/A	112 (77.2%)	N/A	78 (75%)
Turning Vehicles Yield to Pedestrians (blank-out Sign)	28 (63.6%)	59 (80.8%)	11 (64.7%)	29 (78.4%)

Analysis results reveal the following:

- For “Turning Vehicles Yield to Pedestrians” signs, both male and female drivers were more likely to comply after implementation of the sign compared to before implementation; the differences were significant at a 95% confidence level.
- For “Stop Here on Red” signs, both male and female drivers using a right-turn lane had higher compliance rates after implementation of the sign compared with before implementation; the differences were significant at a 95% confidence level.
- For “Turning Vehicles Yield to Pedestrians” blank-out signs, male drivers were more likely to comply after implementation of the sign compared to before implementation; the differences were significant at a 95% confidence level.
- For “Right Turn on Red after Stop” signs, compliance was higher for both male and female drivers after implementation of the pedestrian sign compared to before implementation and were not significant.

Figure 82 and Table 49 shows the distribution of interactions between drivers and feature signs for each sign by age. A description of results for each feature is provided as follows.

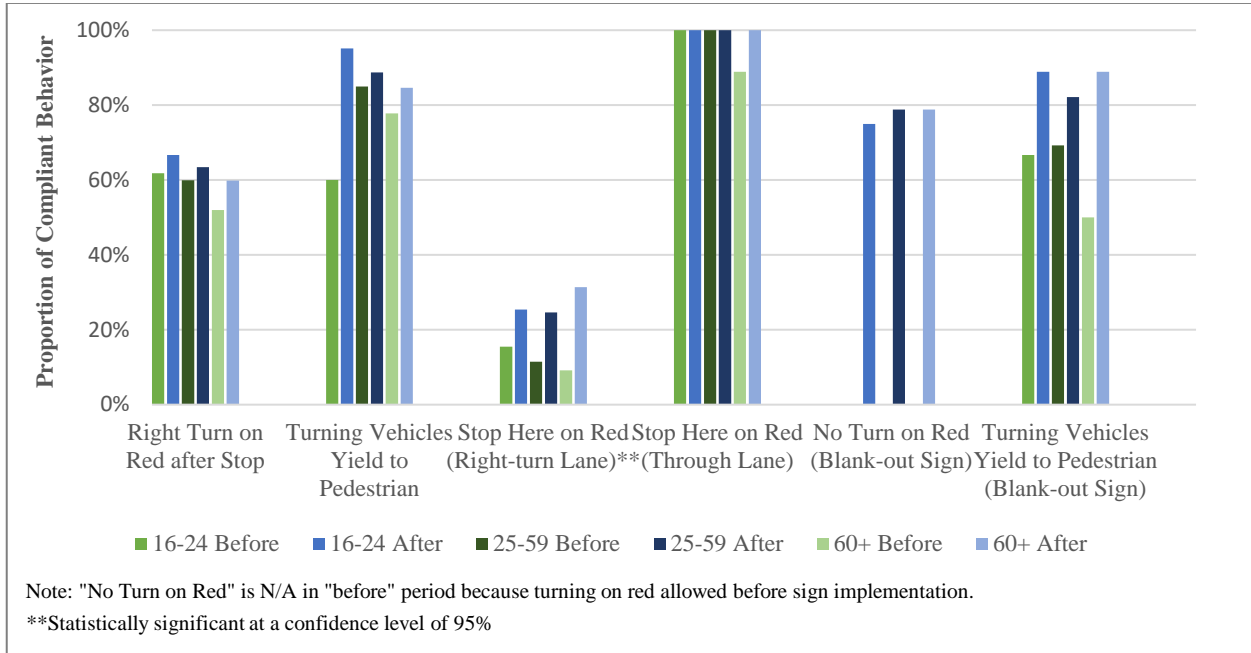


Figure 82. Overall comparison of compliance by age

Table 49. Overall Comparison of Compliance by Age

Pedestrian Signs	16–24		25–59		60+	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Right Turn on Red after Stop	21 (61.8%)	64 (66.7%)	221 (59.9%)	325 (63.4%)	13 (52%)	64 (59.8%)
Turning Vehicles Yield to Pedestrians	9 (60%)	39 (95.1%)	51 (85%)	157 (88.7%)	7 (77.8%)	22 (84.6%)
Stop Here on Red (right-turn lane)	13 (15.5%)	110 (25.4%)	111 (11.5%)	223 (24.6%)	10 (9.2%)	37 (31.4%)
Stop Here on Red (through lane)	7 (100%)	9 (100%)	48 (100%)	29 (100%)	8 (88.9%)	2 (100%)
No Turn on Red (blank-out sign)	N/A	66 (75%)	N/A	93 (78.8%)	N/A	26 (78.8%)
Turning Vehicles Yield to Pedestrians (blank-out sign)	2 (66.7%)	40 (88.9%)	27 (69.2%)	78 (82.1%)	3 (50%)	16 (88.9%)

Analysis results reveal the following:

- For “Turning Vehicles Yield to Pedestrians” signs, young drivers had higher compliance than middle-age and older drivers, and younger drivers were more likely to comply after

implementation of the sign when compared with before implementation; the differences were significant at a 95% confidence level.

- For “Stop Here on Red” signs, drivers were more likely to comply after implementation of the sign when compared with before implementation in a right-turn lane; the differences were significant at a 95% confidence level.

6. Recommendations and Guidelines for Countermeasure Implementation

The four categories of countermeasure treatments in this study include 1) Engineering & Education Combined, 2) Engineering Only, 3) Education after Engineering, and 4) Education Only. From the before-after data analysis of studied pedestrian feature signs in each category, the following major findings are noted:

- The Engineering & Education Combined treatment produced the highest driver compliance rates for each studied pedestrian feature sign. It is statistically significant that the implementation of pedestrian feature signs using this treatment can significantly improve driver compliance rates with the implemented pedestrian feature signs.
- The Engineering Only treatment can reach almost full driver compliance, the same as that achieved by the Engineering & Education Combined treatment.
- The Education after Engineering treatment demonstrates that it can improve driver compliance, but the additional improvement may not be statistically significant.
- The Education Only treatment can also improve driver compliance, but the improvement may not be statistically significant.

Based on the research findings of Phase 3 and results obtained in Phase 2, final recommendations are made for statewide implementation of engineering and education countermeasures regarding the four pedestrian features signs. These recommendations can serve as implementation guidelines for FDOT for engineering and education countermeasures as well as where and how they should be implemented, with the goal of improving driver compliance with pedestrian features, increasing pedestrian safety, and reducing pedestrian crashes, injuries, and fatalities at signalized intersections.

6.1 Recommendations and Guidelines for Engineering Countermeasure Implementation

6.1.1 Recommendation 1: Implement “No Turn on Red” static or blank-out signs when supported by an engineering study.

Guidelines:

- a) Per MUTCD, this type of signs may be used to regulate road users. Based on guidance from MUTCD, when used, the sign should be located adjacent to the signal face to which they apply. These signs include those “No Turn on Red” as shown in Figure 83.
- b) Per MUTCD, “No Turn on Red” (R10-11, R10-11a) signs (Figure 83) should be considered when an engineering study finds that one or more of the following conditions exists:
 - Inadequate sight distance to vehicles approaching from the left (or right, if applicable);

- o Geometrics or operational characteristics of the intersection that might result in unexpected conflicts;
 - o An exclusive pedestrian phase;
 - o An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities;
 - o More than three right-turn-on-red accidents reported in a 12-month period for the particular approach; or
 - o The skew angle of the intersecting roadways creates difficulty for drivers to see traffic approaching from their left.
- c) If the implementation of a “No Turn on Red” (R10-11, R10-11a) static sign at a signalized intersection causes a significant delay or queue backup for right-turning traffic, a “No Turn on Red” blank-out sign can be considered. The “No Turn on Red” blank-out sign also can be programmed to turn on during specific periods.
- d) A blank-out sign with dual modes of “No Turn on Red” and “Turning Vehicles Yield to Pedestrians” is recommended at intersections where the needs for both signs are met.
- e) The results from the Phases 2 and 3 projects of this research showed that drivers had a lower compliance rate for “No Turn on Red” blank-out signs than that for static signs, perhaps due to the lower frequency of display. It is recommended that an agency consider activating the blank-out signs based on time of day with active pedestrian crossing activities.
- f) Enforcement efforts are recommended to maximize the safety effect of the blank-out signs.
- g) Due to higher driver compliance, overhead “No Turn on Red” static or blank-out signs are recommended for installation besides the right-most signal head when the signal structure is good for handling the additional windloading for overhead sign installation.
- h) The design and implementation of the sign should be consistent with MUTCD and State of Florida specifications.



R10-11 R10-11a

Figure 83. Examples of “No Turn on Red” static and blank-out signs

6.1.2 Recommendation 2: Implement “Right on Red Arrow after Stop,” “Right Turn on Red after Stop,” or “Right on Red after Stop” signs if “No Turn on Red” signs are not implemented, and high percentage of right-turning traffic do not have full stops before making right turns.

Guidelines:

- a) Per MUTCD, this type of signs may be used to regulate road users. Based on guidance from MUTCD, when used, the sign should be located adjacent to the signal face to which they apply.
- b) Per MUTCD, turns on red are permitted and the signal indication is a steady Red Arrow, the “Right on Red Arrow after Stop” (R10-17a) sign should be installed adjacent to the red arrow signal indication.
- c) “Right on Red Arrow after Stop” signs should be implemented at locations with an exclusive right-turn lane and a right-turn red arrow as shown in Figure 84.
- d) “Right Turn on Red after Stop” or “Right on Red after Stop” signs should be implemented at locations with an exclusive right-turn lane but no right-turn red arrow as shown in Figure 84.
- e) Based on the findings from this research, “Right on Red Arrow after Stop” (R10-17a), “Right Turn on Red after Stop,” or “Right on Red after Stop” signs should be considered if “No Turn on Red” signs are not implemented, and high percentage (50% or higher) of right-turning traffic do not have full stops before making right turns. The signs could be removed if frequent compliance is achieved.
- f) Due to higher driver compliance, overhead signs are recommended for installation besides the right-most signal head when the signal structure is good for handling the additional windloading for overhead sign installation.
- g) Photo-enforcement efforts may be considered depending on State and local regulations to maximize the safety benefit of the implemented sign.
- h) The design and implementation of the sign should be consistent with MUTCD and State of Florida specifications.

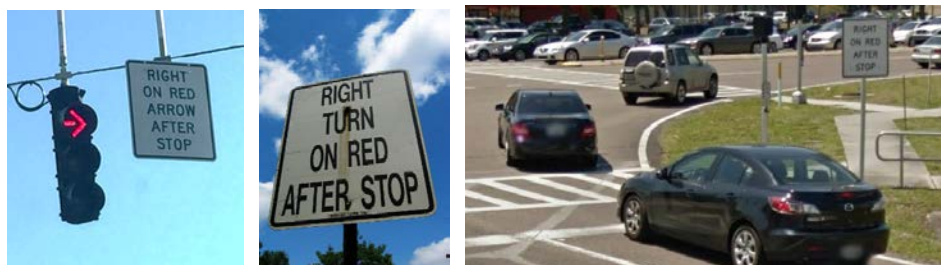


Figure 84. Examples of “Right on Red Arrow after Stop” and “Right Turn on Red after Stop” signs

6.1.3 Recommendation 3: Implement “Turning Vehicles Yield to Pedestrians” static or blank-out signs to increase driver yielding behavior.

Guidelines:

- a) Per MUTCD, this type of signs may be used to regulate road users. Based on guidance from MUTCD, when used, the sign should be located adjacent to the signal face to which they apply.
- b) Per MUTCD, in order to remind drivers who are making turns to yield to pedestrians, a “Turning Vehicles Yield to Pedestrians” (R10-15) sign may be used.
- c) The “Turning Vehicles Yield to Pedestrians” (R10-15) sign should be considered especially at intersections where right turns on red are permitted and pedestrian crosswalks are marked.
- d) Based on the findings from this research, for intersections with driver yielding rates of 80% or lower, implementation of “Turning Vehicles Yield to Pedestrians” (R10-15) static or blank-out signs, as shown in Figure 85, are recommended. Agencies can determine their threshold values of driver yielding rates for installing the sign.
- i) Overhead implementation is recommended for installation besides the right-most or left-most signal head depending on turning traffic when the signal structure is good for handling the additional windloading for overhead sign installation.
- e) Enforcement efforts are recommended to maximize the safety effect of the blank-out signs.
- f) The design and implementation of the sign should be consistent with MUTCD and State of Florida specifications.



Figure 85. Example of “Turning Vehicles Yield to Pedestrians” blank-out signs

6.1.4 Recommendation 4: Implement “Stop Here on Red” signs at locations with frequent non-compliance.

Guidelines:

- a) Per MUTCD, this type of signs may be used to regulate road users. Based on guidance from MUTCD, when used, the sign should be located adjacent to the signal face to which they apply.
- b) Per MUTCD, a “Stop Here on Red” (R10-6 or R10-6a) sign shall be installed on the right-hand side of the approach at the point at which drivers are expected to stop when the steady CIRCULAR RED lens is illuminated
- c) Per MUTCS, a “Stop Here on Red (R10-6 or R10-6a) sign may be used at locations where highway vehicles frequently violate the stop line or where it is not obvious to road users where to stop.
- d) “Stop Here on Red” (R10-6 or R10-6a) signs should be implemented on roadsides along with a Stop line (Figure 86).
- e) Based on the findings from this research, “Stop Here on Red” (R10-6 or R10-6a) signs should be considered at locations with high percentage of violation (80% or higher) of the stop line for right-turning traffic. The signs could be removed if frequent compliance is achieved. To improve the visibility of a pedestrian on a crosswalk, the sign should also be considered where there is a short distance (less than 6 ft) between a stop bar and a crosswalk.
- f) Enforcement efforts are recommended to maximize the safety effect of the sign.
- g) The design and implementation of the sign should be consistent with MUTCD and State of Florida specifications.



Figure 86. Example of “Stop Here on Red” sign.

6.2 Recommendations and Guidelines for Education Countermeasure Implementation

6.2.1 Recommendation 1: Conduct education outreach near or at an intersection after implementation of pedestrian feature signs to maximize the safety benefit.

Guidelines:

- a) *Education Outreach* – Driver education can be provided through the use of yard signs as a simple means to reach drivers approaching the intersection with the newly-installed pedestrian feature signs. The yard signs should be designed to draw the attention of drivers and inform them of the signage ahead. They should be properly placed on a roadside such that they will not affect the travel of vehicles and pedestrians. The strategy is to line up the signs in a row with a distance of 10–12 ft between each. Multiple yard signs may be aligned (up to four signs). Signs should be displayed for at least one week to provide continuous information. Approval will be needed to install signs near an intersection.
- b) *Signage Design* – When designing yard signs, the intention is not to duplicate the actual installed sign but to provide a warning to drivers to watch for approaching signage. The colors of the signs should contrast with the surrounding environment while standing out for drivers to notice.
- c) *Pre-and-Post Observation* – Pre- and-post observation of driver behavior at the selected approach(es) near the implemented intersection is suggested to assess driver compliance.
- d) *Barriers* – For certain locations, yard sign placement may be difficult due to lack of right-of-way and or available grass or soil between sidewalk and road. Engineering judgment is recommended on the use of existing road infrastructure for education outreach.

Figure 87 are examples of yard-sign education for the selected pedestrian features signs. Designs of these yard signs are shown in Appendix D.



Figure 87. Example of yard sign education for “Right Turn on Red after Stop” sign

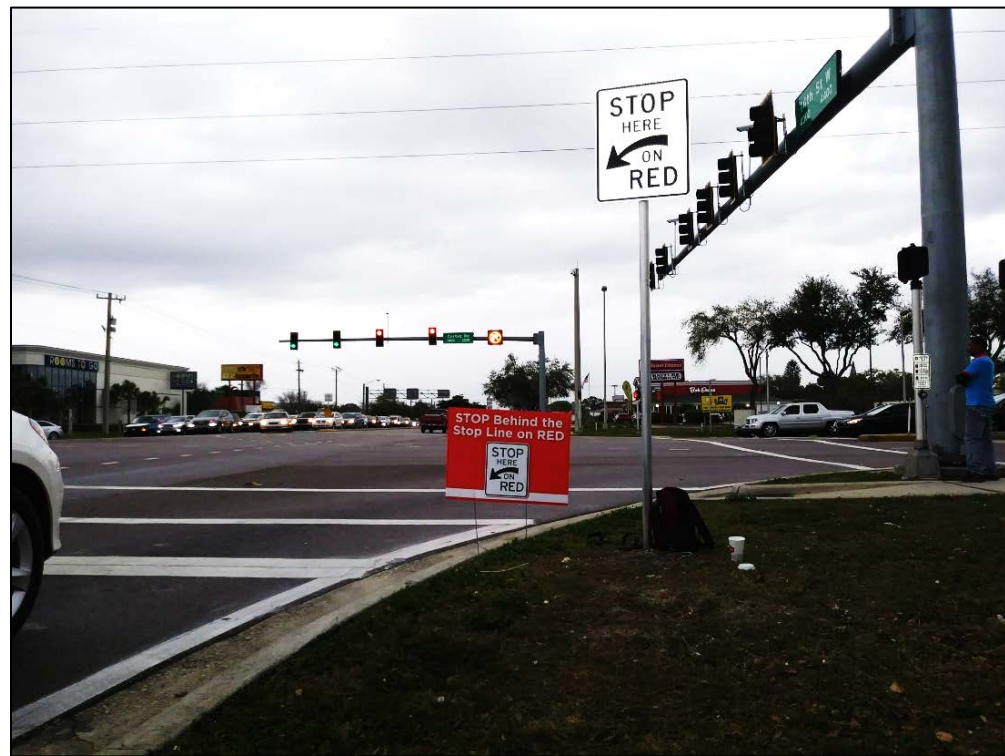


Figure 88. Example of yard sign education for “Stop Here on Red” sign



Figure 89. Example of yard sign education for “Turning Vehicles Yield to Pedestrians” and “No Turn on Red” blank-out signs

6.2.2 Recommendation 2: Focus on specific gender and/or focus groups for education outreach.

Guidelines:

- Education outreach approaches for targeted gender/age groups include, but are not limited to, interactive knowledge-based presentations, education outreach events, safety information distribution to target audiences, and Safety Ambassador recruitment.
- One or more education outreach activities should be conducted for all drivers, especially young drivers to improve their compliance with “No Turn on Red” blank-out signs.
- One or more education outreach activities should be conducted for all drivers, especially older drivers to improve their compliance with “Right Turn on Red after Stop” signs.
- One or more education outreach activities should be conducted for all drivers to improve their compliance for “Stop Here on Red” signs when they are on an exclusive right-turn lane.
- One or more education outreach activities should be conducted for older drivers to improve their compliance with “Turning Vehicles Yield to Pedestrians” signs.

7. Conclusions

This Phase 3 project aimed to implement and evaluate selected countermeasures recommended from Phase 2 via pilot implementation in the north, central, and south regions of Florida to further investigate their effectiveness and provide recommendations for supporting future successful statewide implementations.

The pedestrian features signs being evaluated for this study included (1) “Stop Here on Red,” (2) “No Turn on Red,” (3) “Turning Vehicles Yield to Pedestrians,” and (4) “Right on Red Arrow after Stop” or “Right on Red after Stop.” Static and blank-out signs were implemented in the seven FDOT Districts covering the north, central, and south regions of Florida. Each FDOT District had a pilot implementation site. With the support and assistance from the FDOT Central Office, FDOT Districts, and associated counties, the selected pedestrian features signs (engineering countermeasures) and education outreach efforts (education countermeasure) were successfully implemented in all FDOT Districts.

Before-after studies were conducted by collecting and analyzing observations on driver behaviors and compliance to the intents of pedestrian feature signs. Four groups of countermeasure treatments including (1) Engineering Only, (2) Engineering & Education Combined, (3) Education after Engineering, and (4) Education Only for Existing Signs were evaluated. Researchers closely examined the countermeasure treatments, and the impact of each implemented pedestrian feature sign, as well as its driver compliance rates before and after the implementation.

The major research findings and conclusions include the following:

- The overall results indicated that three pedestrian feature signs—“Right Turn on Red after Stop,” “Turning Vehicles Yield to Pedestrians”, and “Stop Here on Red”—showed large increases of driver compliance after their implementation when compared to those before implementation. The increases in driver compliance after implementation of “Right Turn on Red after Stop” (exclusive right-turn lanes), “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” (blank-out) signs were all statistically significant at a confidence level of 95%.
- The result from the before-after data analysis showed that the compliance with “Right Turn on Red after Stop” signs for drivers from exclusive right-turn lanes increased significantly, from 10.2% to 25.2%., a 147% improvement. This sign is highly recommended to reduce the potential conflicts between pedestrians and right-turning vehicles.
- Both male and female drivers showed increased compliance with “Turning Vehicles Yield to Pedestrians,” “Stop Here on Red,” and “Turning Vehicles Yield to Pedestrians” blank-out signs after implementations; the difference was statistically significant at the 95% confidence level.

- For “Turning Vehicles Yield to Pedestrians” signs, young drivers had higher compliance than middle-age and older drivers, and younger drivers were more likely to comply after implementation of the sign when compared to before implementation; the differences were significant at a 95% confidence level.
- The implementation of “No Turn on Red” blank-out signs showed that they can effectively improve safety via increased driver compliance and reduce unnecessary vehicle delay at signalized intersections as the signs were displayed only when needed; otherwise, the signs were blank (black display). The “No Turn on Red” blank-out signs are becoming more popular than static signs because they reduce unnecessary delays by remaining blank when not needed.
- Overall, there was a 75.2% compliance rate after implementation of the “No Turn on Red” blank-out signs, which is lower than the compliance rate of 90.9% from the “No Turn on Red” static signs in the Phase 2 study. To improve driver compliance rates for “No Turn on Red” blank-out signs, a traffic agency should consider implementing them based on a time-of-day schedule to coincide with higher pedestrian activity. Regular law enforcement at locations with “No Turn on Red” blank-out sign operations can likely improve driver compliance rates.
- Among four groups of countermeasure treatments, the analysis showed that combined pedestrian signage implementation and education outreach can achieve the highest driver compliance. The implementation of pedestrian feature signs alone can achieve driver compliance considerably (67% to 95%) when compared to combined sign implementation and education outreach. Additional education outreach effort after the installation of pedestrian feature signs can further increase driver compliance. Education outreach on existing pedestrian feature signs via roadside education yard signs showed improved driver compliance but it was not statistically significant.
- Education outreach approaches for targeted gender/age groups include, but are not limited to, interactive knowledge-based presentations, education outreach events, safety information distribution to target audiences, and Safety Ambassador recruitment.

This report provides recommendations and guidance to FDOT, other state DOTs, and local agencies on how to effectively implement the four major pedestrian features signs in this study and education outreach.

















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Appendices

Appendix A: Potential Countermeasure Sites by FDOT District

Table 50. Potential Study Sites

#	Region	Road 1	Road 2	FDOT District	Area	Northbound				Southbound				Westbound				Facing East			
																					
1	South	US-41	Bee Ridge Rd	1	Sarasota	No	No	Yes	no	No	No	Yes	No	No	No	Yes	No	No	No	No	No
2	South	US-301	Fruitville Rd	1	Sarasota	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
3	South	US-301	17th St	1	Sarasota	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
4	South	Cortez Rd W	14th St W	1	Bradenton	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
5	North	Collins Rd	Blanding Blvd	2	Jacksonville	No	Yes	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No
6	North	Blaimore Blvd E	Blanding Blvd	2	Jacksonville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
7	North	Atlantic Blvd	Penman Rd	2	Jacksonville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
8	North	NW 13th St	SR-222	2	Gainesville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
9	North	NW 38th St	NW 39th Ave	2	Gainesville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
10	North	N Main St	NE 16th Ave	2	Gainesville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
11	North	W University Ave	N Main St	2	Gainesville	No	Yes (with blank-out sign)	No	No	No	Yes (with blank-out sign)	No	No	No	Yes (with blank-out sign)	No	No	No	Yes (with blank-out sign)	No	No
12	North	SR-24	SW 23rd Terrace	2	Gainesville	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
13	North	High Rd	W Tennessee St	3	Tallahassee	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
14	North	Stadium Dr	W Call St	3	Tallahassee	No	No	No	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No	No
15	North	US-98	Stahlman Ave	3	Destin	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
16	Central	SR-40	NE Watula Ave	5	Ocala	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
17	Central	US-1	W Granada Blvd	5	Ormond Beach	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
18	Central	US-92	SR-5A	5	Daytona Beach	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
19	Central	SR-434	US-17/SR-15	5	Winter Springs	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
20	Central	SR-436	Palm Springs Dr	5	Altamonte Springs	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
21	Central	Orlando Ave	E Horatio Ave	5	Maitland	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
22	Central	Silver Star Rd	N Pine Hills Rd	5	Orlando	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No
23	Central	SR-50	N Chickasaw Trail	5	Orlando	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
24	Central	Orange Ave	Michigan St	5	Orlando	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
25	Central	S Semoran Blvd	Pershing Ave	5	Orlando	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
26	Central	N Courtney Pkwy	E Merritt Ave	5	Merritt Island	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
27	Central	Mariner Blvd	Madenia St	7	Spring Hill	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
28	Central	US-19	Embassy Blvd	7	Port Richey	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
29	Central	US-19	Moog Rd	7	Beacon Square	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
30	Central	Keene Rd	San Christopher Dr	7	Dunedin	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
31	Central	SR-582 (Fowler Ave)	N 56th St	7	Tampa	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No	Yes	No

#	Region	Road 1	Road 2	FDOT District	Area	Northbound				Southbound				Westbound				Facing East			
																					
32	Central	W Busch Blvd	N Florida Ave	7	Tampa	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
33	Central	MLK Jr Blvd	N Armenia Ave	7	Tampa	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
34	Central	ALT US-19	Ulmerton Rd	7	Largo	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
35	Central	Roosevelt Blvd	Dodge St	7	Largo	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
36	Central	Park Blvd N	66th St N	7	Pinellas Park	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
37	South	Okeechobee Blvd	SR-809	4	W Palm Beach	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No
38	South	Summit Blvd	SR-809	4	Palm Beach	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
39	South	Linton Blvd	SW 10th Ave	4	Delray Beach	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
40	South	SR-811	NE 48th St	4	Pompano Beach	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
41	South	Oakland Park Blvd	SR-845	4	Oakland Park	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
42	South	Andrews Ave	SR-482	4	Ft Lauderdale	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
43	South	S SR-7	Miramar Pkwy	4	Miramar	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
44	South	NW 199th St	US-441	6	Miami Gardens	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
45	South	Palm Ave	E 32nd St	6	Hialeah	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
46	South	5th St	Washington Ave	6	Miami Beach	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No
47	South	W Flagler St	SW 67th Ave	6	Miami	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
48	South	US-41	SW 27th Ave	6	Miami	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
49	South	W 41st St	Pine Tree Dr	6	Miami Beach	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
50	South	NW 7th St	NW 57th Ave	6	Miami	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
51	South	SR-934	NE 2nd Ave	6	Miami	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Note: The sites were marked as “No” if the sign was not currently installed and “Yes” if it was currently installed.

Appendix B: Sample Letter to Districts

Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections using the SHRP2 Naturalistic Driving Study Data, Phase 3

CUTR is studying countermeasures for signalized intersections as the result of the first two phases of a project in which data from the Naturalistic Driving Study were analyzed. Recommended countermeasures might include one or a combination of the following.

Engineering Countermeasures

- Implement “No Turn on Red” static or blank-out signs when possible.
- Implement “Right on Red Arrow After Stop,” “Right Turn on Red After Stop,” or “Right on Red After Stop” signs if “No Turn on Red” signs are not implemented.
- Implement both “No Turn on Red” and “Stop Here on Red” signs at the same intersection.
- Implement “Right on Red Arrow After Stop” and “Turning Vehicles Yield to Pedestrians” signs at the same intersection.
- Implement overhead signs for “No Turn on Red” or “Right on Red Arrow After Stop” signs when possible.
- Implement “Stop Here on Red” signs at locations with frequent non-compliance.
- Implement at least one pedestrian feature sign.

Education Countermeasures

- Conduct education outreach to all drivers to improve their compliance rate for “Stop Here on Red” signs.
- Conduct education outreach to young drivers to improve their compliance rate for “Stop Here on Red” signs.
- Conduct education outreach to male drivers to improve their compliance rate for “No Turn on Red” signs.
- Conduct education outreach to older drivers to improve their compliance rate for “No Turn on Red” and “Right on Red Arrow After Stop” signs.
- Conduct education outreach to reduce risky or/and distracted behaviors while driving, especially for young drivers.

Potential sites were selected based on cluster analysis of pedestrian crashes 2012–2016 and right-turning vehicles. The project is being conducted statewide, and several sites will be selected in each FDOT District.

The CUTR research team is asking your FDOT District for input to prioritize (rank) the following sites based on your experience and local knowledge for needs to improve pedestrian safety.

#	Road 1	Road 2	FDOT District	Area	Pedestrian Traffic? (Low, Medium, High)	Rank
1	US-41	Bee Ridge Rd	1	Sarasota		
2	US-301	Fruitville Rd	1	Sarasota		
3	US-301	17th St	1	Sarasota		
4	Cortez Rd W	14th St W	1	Bradenton		

Appendix C: Video Review Form

<u>Understanding Interactions between Drivers and Pedestrian Features at Signalized Intersections Survey</u>	
Reviewer Name: _____	Date: MM/DD/YY Time: HH/MM/SS
District Name: _____	Location Name: _____
1. Weather Condition	
<input type="radio"/> Clear sky <input type="radio"/> Rainy <input type="radio"/> Fog	
2. Lighting Condition	
<input type="radio"/> Daylight <input type="radio"/> Dark <input type="radio"/> Dawn/Dusk	
3. Lane Type (If it is Dedicated lanes skip question 4)	
<input type="radio"/> Dedicated Right/Through Lanes <input type="radio"/> Shared lane	
4. Vehicle Movement in the shared lane	
<input type="radio"/> Through movement <input type="radio"/> Right movement	
5. Lane Movement	
<input type="radio"/> Through Lane <input type="radio"/> Right Lane	
6. Signal Status	
<input type="radio"/> Green <input type="radio"/> Red	
7. Vehicle Type	
<input type="radio"/> Passenger Car <input type="radio"/> Heavy Truck <input type="radio"/> Bus <input type="radio"/> Bike	
8. Did vehicle make first stop at the stop bar?	
<input type="radio"/> Yes <input type="radio"/> No	
9. Drivers Gender	
<input type="radio"/> Male <input type="radio"/> Female <input type="radio"/> Not Available	
10. Age of the driver	
<input type="radio"/> Young <input type="radio"/> Middle <input type="radio"/> Old <input type="radio"/> Not Available	
11. Drivers stopping behavior	
<input type="radio"/> Complete Stop <input type="radio"/> Rolling slow <input type="radio"/> Rolling Fast <input type="radio"/> No stop	
12. Was there any traffic conflict with the turning vehicle?	
<input type="radio"/> Yes <input type="radio"/> No	
13. Was pedestrian present at the cross-walk1 while driver making a right turn?	
<input type="radio"/> Yes <input type="radio"/> No	
14. Was pedestrian present at the cross-walk1 while driver making a right turn?	
<input type="radio"/> Yes <input type="radio"/> No	
15. Did driver yield to the pedestrian on the crosswalk?	
<input type="radio"/> Yes <input type="radio"/> No	
16. Was driver distracted while he was waiting at the signal/while driving?	
<input type="radio"/> Yes <input type="radio"/> No	

Appendix D: Education Yard Sign Designs

