Compliance at Pedestrian Crossings

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Session 8A, Wednesday, June 26, 2019, 8:30 – 10:00 AM

ITE Western District Annual Meeting
Monterey 2019 California
Harbouring the Future of Transportation

Outline

- Introduction
- Data collection
- Methodology
- Data summary
- Statistical results
- Questions

Introduction

Background

- The Utah Department of Transportation (UDOT) often provides enhancements at pedestrian crossings to minimize the risk of injury or death to pedestrians
- Some treatments are relatively new, so the safety benefits of these treatments are not well documented, especially at the local level
- These enhancements can be powerful tools to protect pedestrians from injury or even death

Literature Review

- Crosswalk enhancements tend to increase pedestrian safety:
  - Safety increase – Crash decrease
    - Nationally (54.7% CRF) for HAWK
    - Texas (29% CRF) for HAWK
    - Oregon (7 % CRF) for RRFB
  - Compliance Increase (Reported CO)
    - HAWK: 93-99% (Nationally)
    - OFB: 47-52% (Nationally)
    - RRFB: 95-99% (Nationally)

Purpose and Need

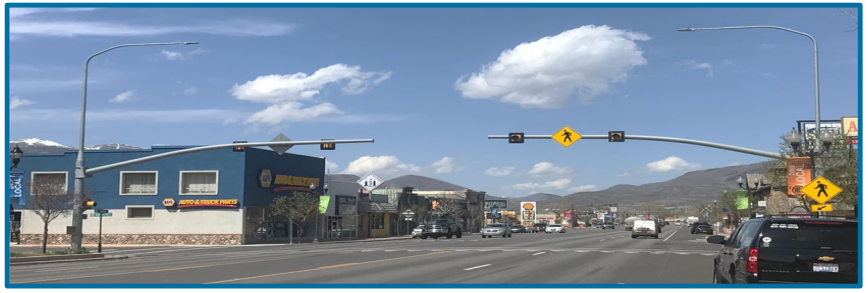
- The goal of enhanced crossings is to increase vehicle compliance with respect to yielding to pedestrians, thereby decreasing vehicle-pedestrian collisions
- There is a **need** to understand how effective these crossings are so as to provide appropriate improvements at high-risk locations
- The **purpose** of this research is to determine compliance rates at enhanced pedestrian crossings

Data Collection

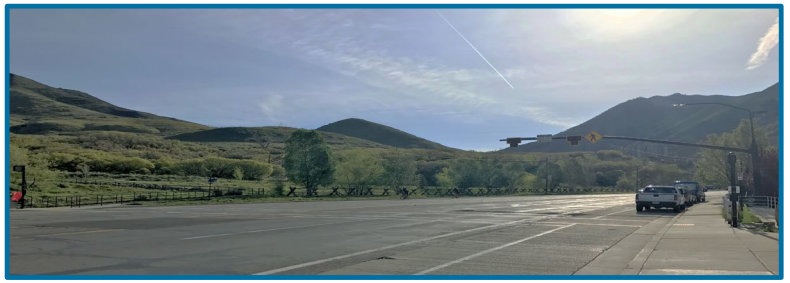
Technologies Studied

Base Crosswalk

Overhead Flashing Beacon (OFB)



High-intensity Activated crossWalK (HAWK)



Overhead Rectangular Rapid Flash Beacon (ORRFB)

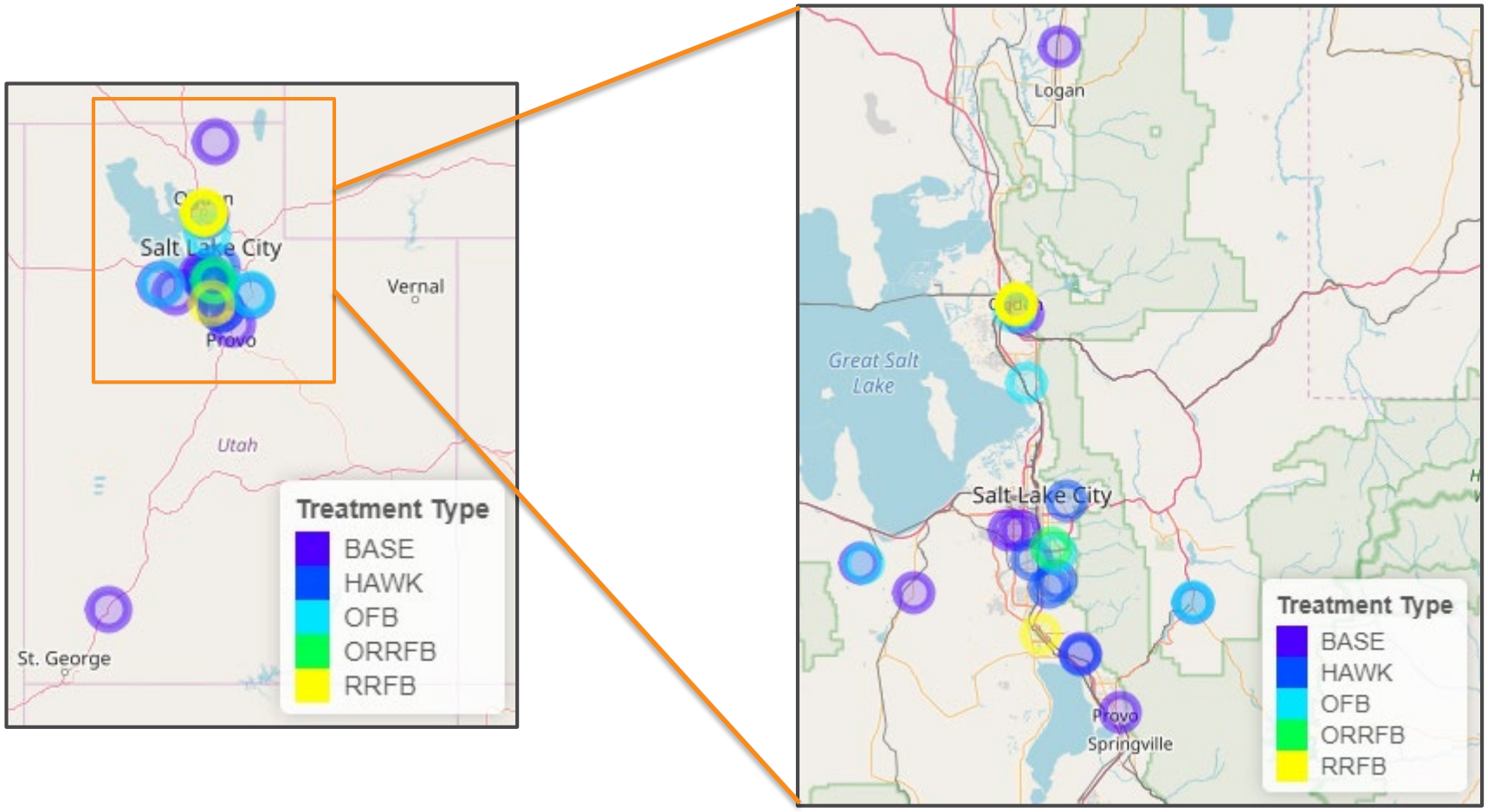
RRFB

Locations Considered

- Control for:
  - Speed (35-45 mph)
  - Number of lanes (5 → 2 in each direction and TWLTL)
  - Daylight (daytime only)
- Avoid Central Business District
- Collect data on: AADT, land use, walk score, pavement markings, pedestrian volume, weather, additional treatments

- Goal: **400** data points for each treatment

Locations Considered



Camera Installation

- CountCam2
- RYOBI automatic drill
- Steel duct clamp, worm drive fastener
- CountCam2 aluminum poles

Camera Installation

Pole Attachment

Camera Focus

Camera Installation

Stability

Installed Camera

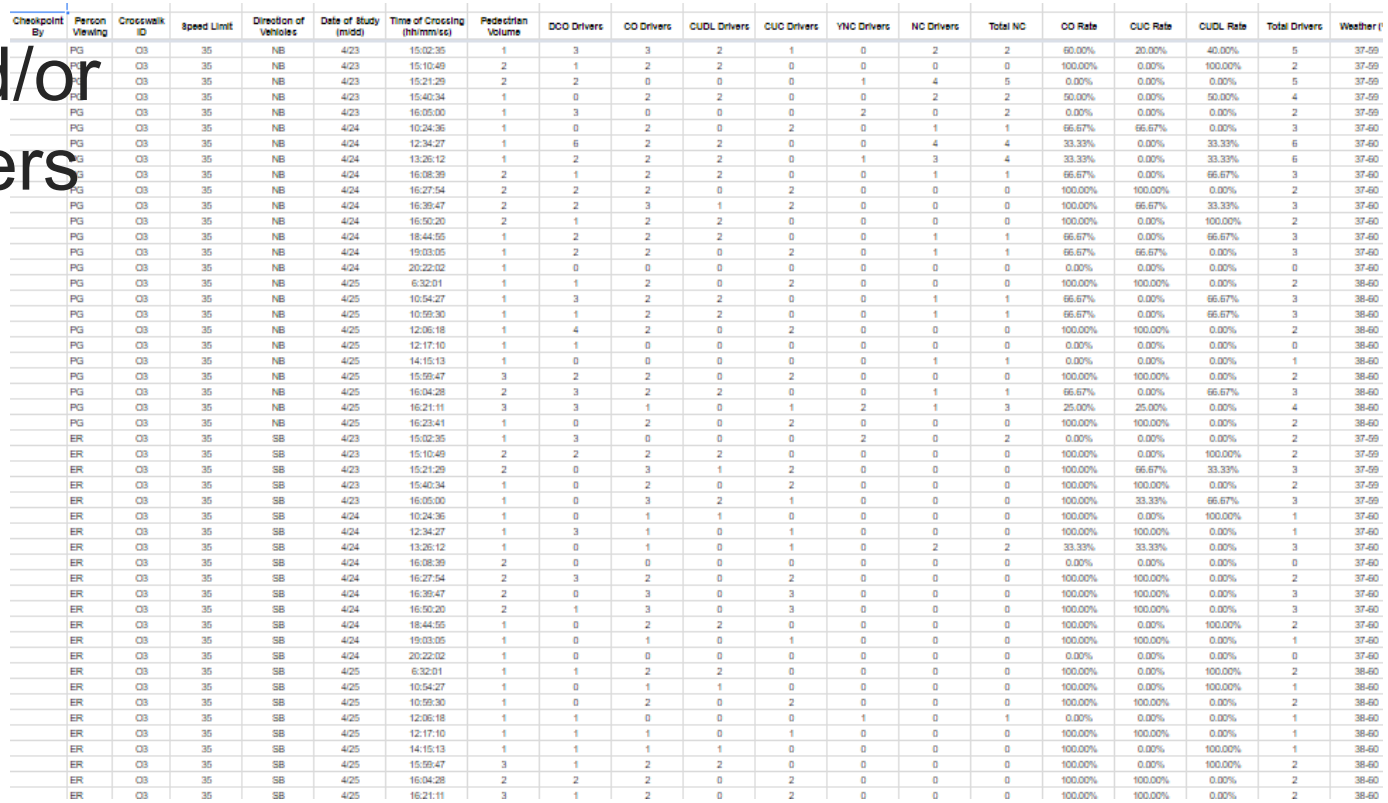
Methodology

Methodology

- Calculate stopping sight distance (SSD) from AASHTO based on posted speed limit
- Set two cameras at each crosswalk to see each approach and the crosswalk
- Collect two-days of video
- Download video, recharge batteries
- Re-deploy cameras at new locations

Methodology

- Review video in “fast forward” mode until a pedestrian is observed
- Note compliant (CO) and/or non-compliant (NC) drivers
- Log pedestrian crossing and quantity of CO/NC drivers in spreadsheet including timestamp of crossing



Checkpoint By	Person Viewing	Crosswalk ID	Speed Limit	Direction of Vehicles	Date of Study (m/d/d)	Time of Crossing (hh:mm:ss)	Pedestrian Volume	DCO Drivers	CO Drivers	CUDL Drivers	CUC Drivers	YNC Drivers	NC Drivers	Total NC	CO Rate	CUC Rate	CUDL Rate	Total Drivers	Weather
	PG	C3	35	NB	4/23	15:02:35	1	3	3	2	1	0	2	2	60.00%	20.00%	40.00%	5	37-59
	PG	C3	35	NB	4/23	15:10:49	2	1	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	37-59
	PG	C3	35	NB	4/23	15:21:29	2	2	0	0	0	1	4	5	0.00%	0.00%	0.00%	5	37-59
	PG	C3	35	NB	4/23	15:40:34	1	0	2	2	0	0	2	2	50.00%	0.00%	50.00%	4	37-59
	PG	C3	35	NB	4/23	16:05:00	1	3	0	0	0	2	0	2	0.00%	0.00%	0.00%	2	37-59
	PG	C3	35	NB	4/24	10:24:36	1	0	2	0	2	0	1	1	66.67%	66.67%	0.00%	3	37-60
	PG	C3	35	NB	4/24	12:34:27	1	6	2	2	0	0	4	4	33.33%	0.00%	33.33%	6	37-60
	PG	C3	35	NB	4/24	13:26:12	1	2	2	2	0	1	3	4	33.33%	0.00%	33.33%	6	37-60
	PG	C3	35	NB	4/24	16:08:39	2	1	2	2	0	0	1	1	66.67%	0.00%	66.67%	3	37-60
	PG	C3	35	NB	4/24	16:27:54	2	2	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	37-60
	PG	C3	35	NB	4/24	16:39:47	2	2	3	1	2	0	0	0	100.00%	66.67%	33.33%	3	37-60
	PG	C3	35	NB	4/24	16:50:20	2	1	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	37-60
	PG	C3	35	NB	4/24	18:44:55	1	2	2	2	0	0	1	1	66.67%	0.00%	66.67%	3	37-60
	PG	C3	35	NB	4/24	19:03:05	1	2	2	0	2	0	1	1	66.67%	66.67%	0.00%	3	37-60
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	PG	C3	35	NB	4/25	6:32:01	1	1	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
	PG	C3	35	NB	4/25	10:54:27	1	3	2	2	0	0	1	1	66.67%	0.00%	66.67%	3	38-60
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	PG	C3	35	NB	4/25	12:06:18	1	4	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
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	PG	C3	35	NB	4/25	14:15:13	1	0	0	0	0	0	1	1	0.00%	0.00%	0.00%	1	38-60
	PG	C3	35	NB	4/25	15:59:47	3	2	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
	PG	C3	35	NB	4/25	16:04:28	2	3	2	2	0	0	1	1	66.67%	0.00%	66.67%	3	38-60
	PG	C3	35	NB	4/25	16:21:11	3	3	1	0	1	2	1	3	25.00%	25.00%	0.00%	4	38-60
	PG	C3	35	NB	4/25	16:23:41	1	0	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
	ER	C3	35	SB	4/23	15:02:35	1	3	0	0	0	2	0	2	0.00%	0.00%	0.00%	2	37-59
	ER	C3	35	SB	4/23	15:10:49	2	2	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	37-59
	ER	C3	35	SB	4/23	15:21:29	2	0	3	1	2	0	0	0	100.00%	66.67%	33.33%	3	37-59
	ER	C3	35	SB	4/23	15:40:34	1	0	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	37-59
	ER	C3	35	SB	4/23	16:05:00	1	0	3	2	1	0	0	0	100.00%	33.33%	66.67%	3	37-59
	ER	C3	35	SB	4/24	10:24:36	1	0	1	1	0	0	0	0	100.00%	0.00%	100.00%	1	37-60
	ER	C3	35	SB	4/24	12:34:27	1	3	1	0	1	0	0	0	100.00%	100.00%	0.00%	1	37-60
	ER	C3	35	SB	4/24	13:26:12	1	0	1	0	1	0	2	2	33.33%	33.33%	0.00%	3	37-60
	ER	C3	35	SB	4/24	16:08:39	2	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0	37-60
	ER	C3	35	SB	4/24	16:27:54	2	3	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	37-60
	ER	C3	35	SB	4/24	16:39:47	2	0	3	0	3	0	0	0	100.00%	100.00%	0.00%	3	37-60
	ER	C3	35	SB	4/24	16:50:20	2	1	3	0	3	0	0	0	100.00%	100.00%	0.00%	3	37-60
	ER	C3	35	SB	4/24	18:44:55	1	0	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	37-60
	ER	C3	35	SB	4/24	19:03:05	1	0	1	0	1	0	0	0	100.00%	100.00%	0.00%	1	37-60
	ER	C3	35	SB	4/24	20:22:02	1	0	0	0	0	0	0	0	0.00%	0.00%	0.00%	0	37-60
	ER	C3	35	SB	4/25	6:32:01	1	1	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	38-60
	ER	C3	35	SB	4/25	10:54:27	1	0	1	1	0	0	0	0	100.00%	0.00%	100.00%	1	38-60
	ER	C3	35	SB	4/25	10:59:30	1	0	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
	ER	C3	35	SB	4/25	12:06:18	1	1	0	0	0	1	0	1	0.00%	0.00%	0.00%	1	38-60
	ER	C3	35	SB	4/25	12:17:10	1	1	1	0	1	0	0	0	100.00%	100.00%	0.00%	1	38-60
	ER	C3	35	SB	4/25	14:15:13	1	1	1	1	0	0	0	0	100.00%	0.00%	100.00%	1	38-60
	ER	C3	35	SB	4/25	15:59:47	3	1	2	2	0	0	0	0	100.00%	0.00%	100.00%	2	38-60
	ER	C3	35	SB	4/25	16:04:28	2	2	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60
	ER	C3	35	SB	4/25	16:21:11	3	1	2	0	2	0	0	0	100.00%	100.00%	0.00%	2	38-60

What is Compliance?

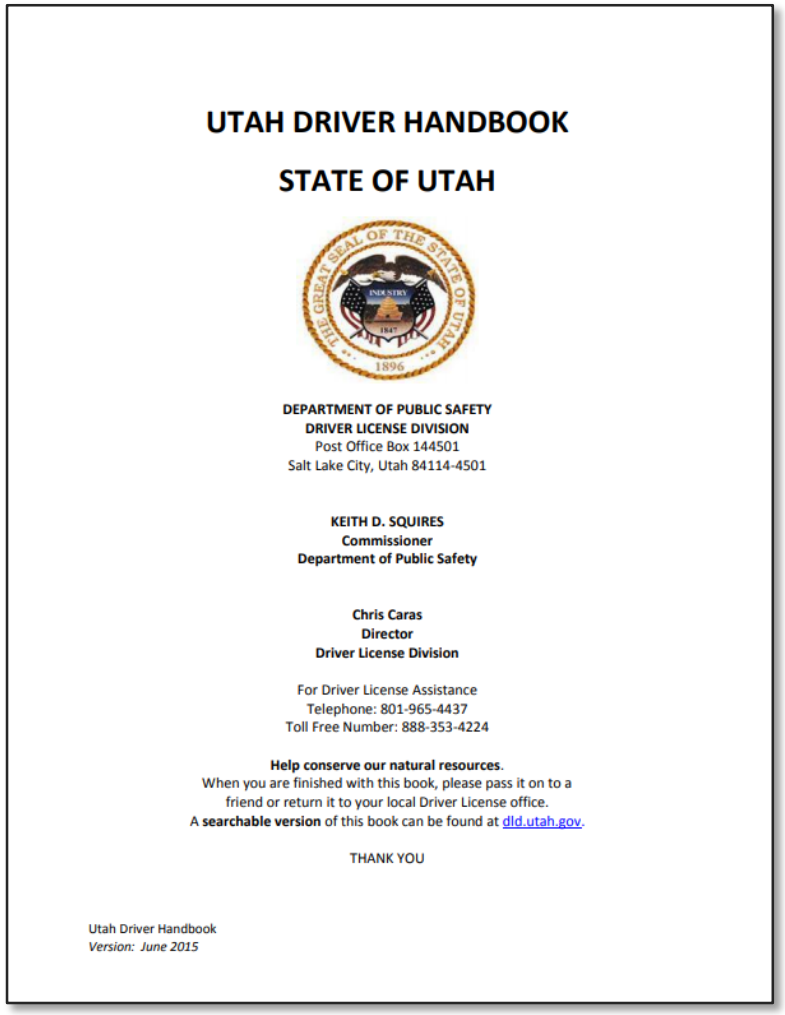
- The operator of a vehicle shall yield the right-of-way by slowing down or stopping if necessary:
  - (i) to a pedestrian crossing the roadway within a crosswalk when the pedestrian is on the half of the roadway upon which the vehicle is traveling; or
  - (ii) when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger

Utah Code 41-6a-1002(1a)

What is Compliance?

- Yield the right-of-way to pedestrians that are still in the intersection (pg. 7-1)
- Yield to pedestrians entering or in a crosswalk, even if it is not marked (pg. 7-7)

Utah Driver Handbook, June 2015



UTAH DRIVER HANDBOOK

STATE OF UTAH

DEPARTMENT OF PUBLIC SAFETY
DRIVER LICENSE DIVISION
Post Office Box 144501
Salt Lake City, Utah 84114-4501

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Commissioner
Department of Public Safety

Chris Caras
Director
Driver License Division

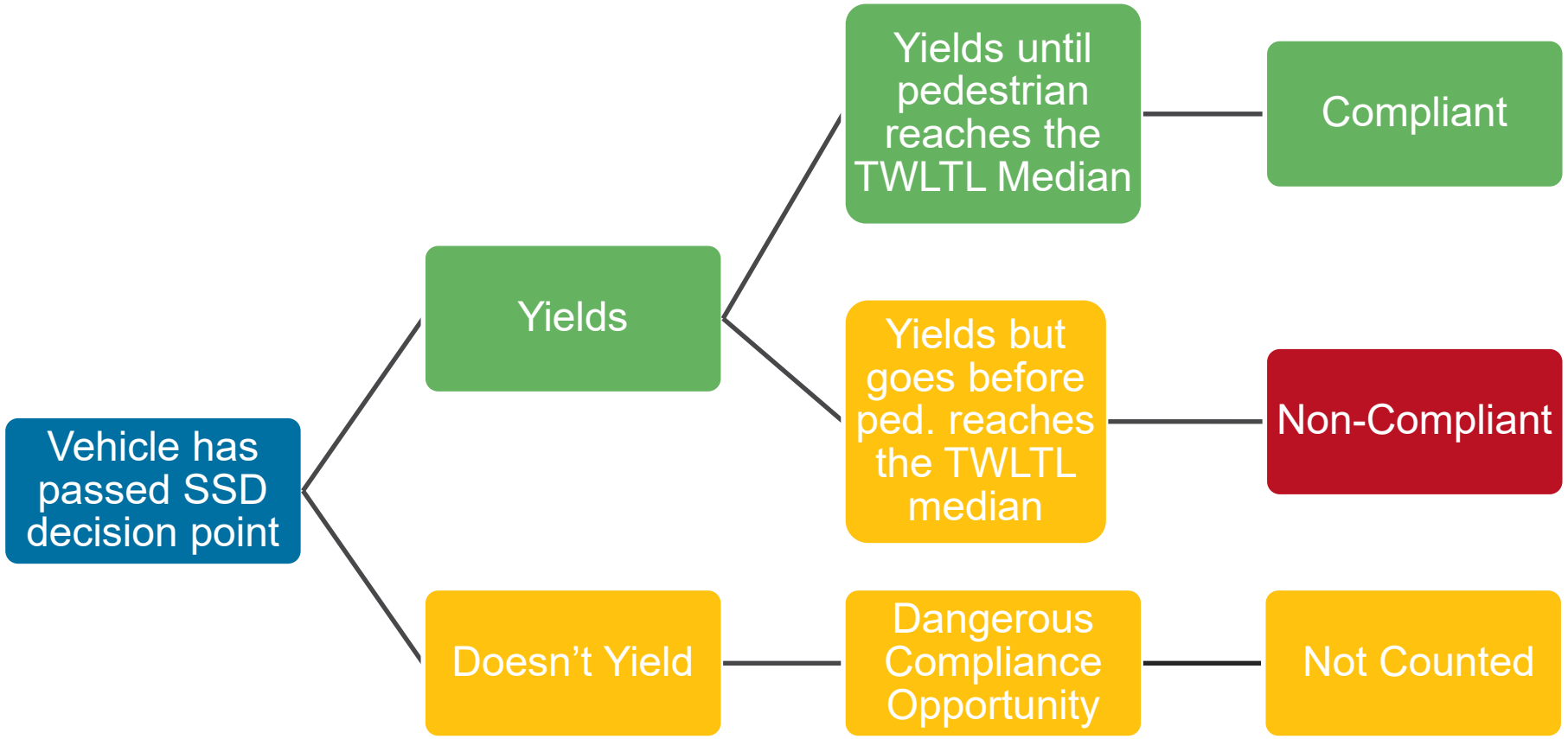
For Driver License Assistance
Telephone: 801-965-4437
Toll Free Number: 888-353-4224

Help conserve our natural resources.
When you are finished with this book, please pass it on to a friend or return it to your local Driver License office.
A **searchable version** of this book can be found at dld.utah.gov.

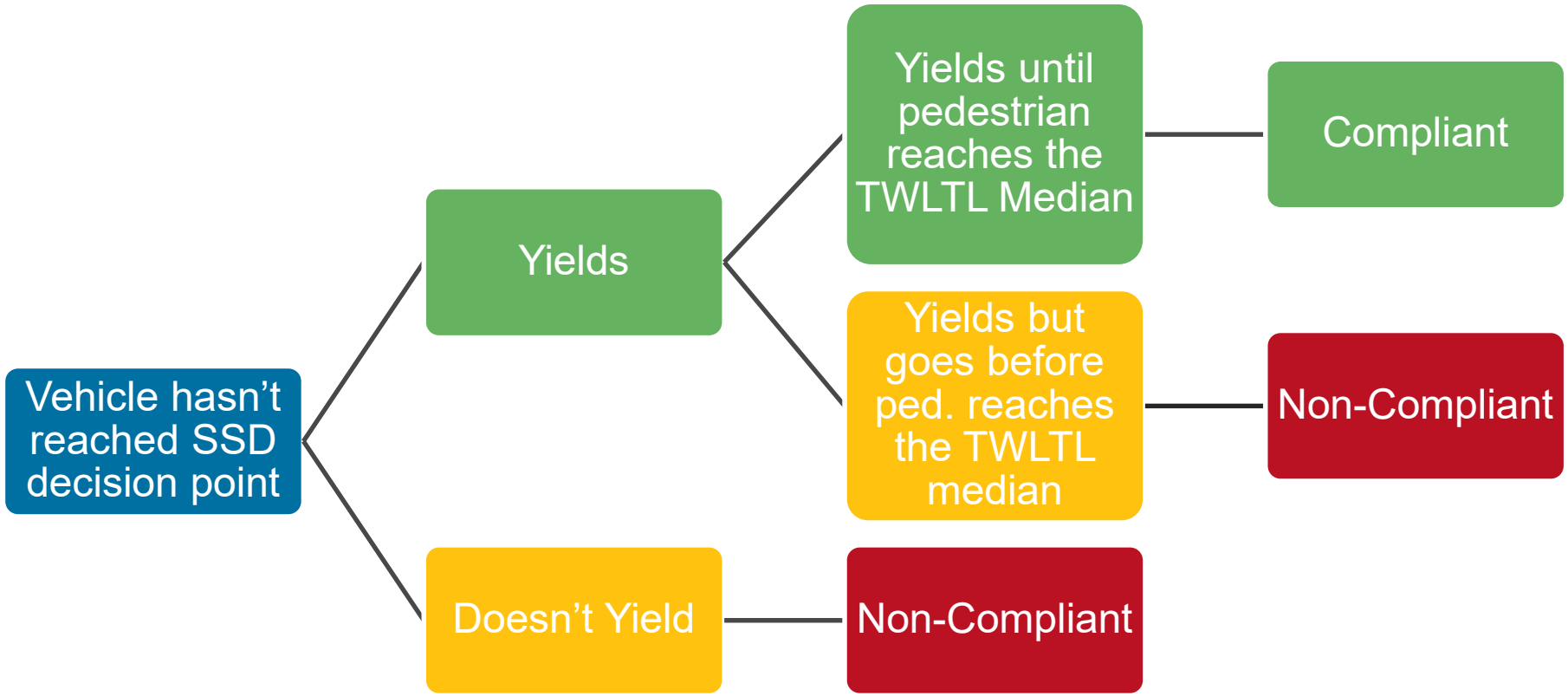
THANK YOU

Utah Driver Handbook
Version: June 2015

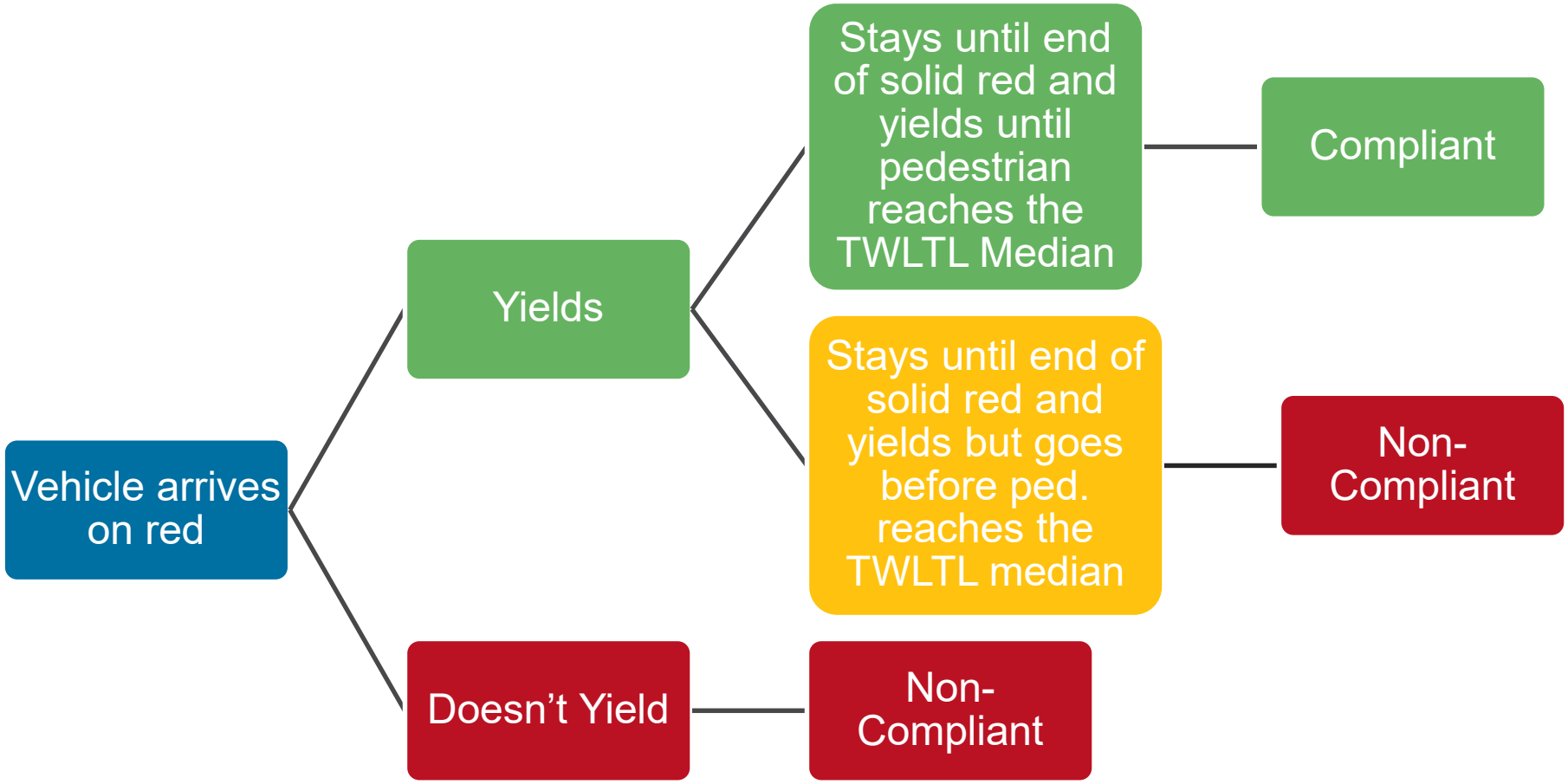
Non-HAWK (Past SSD Decision Point)



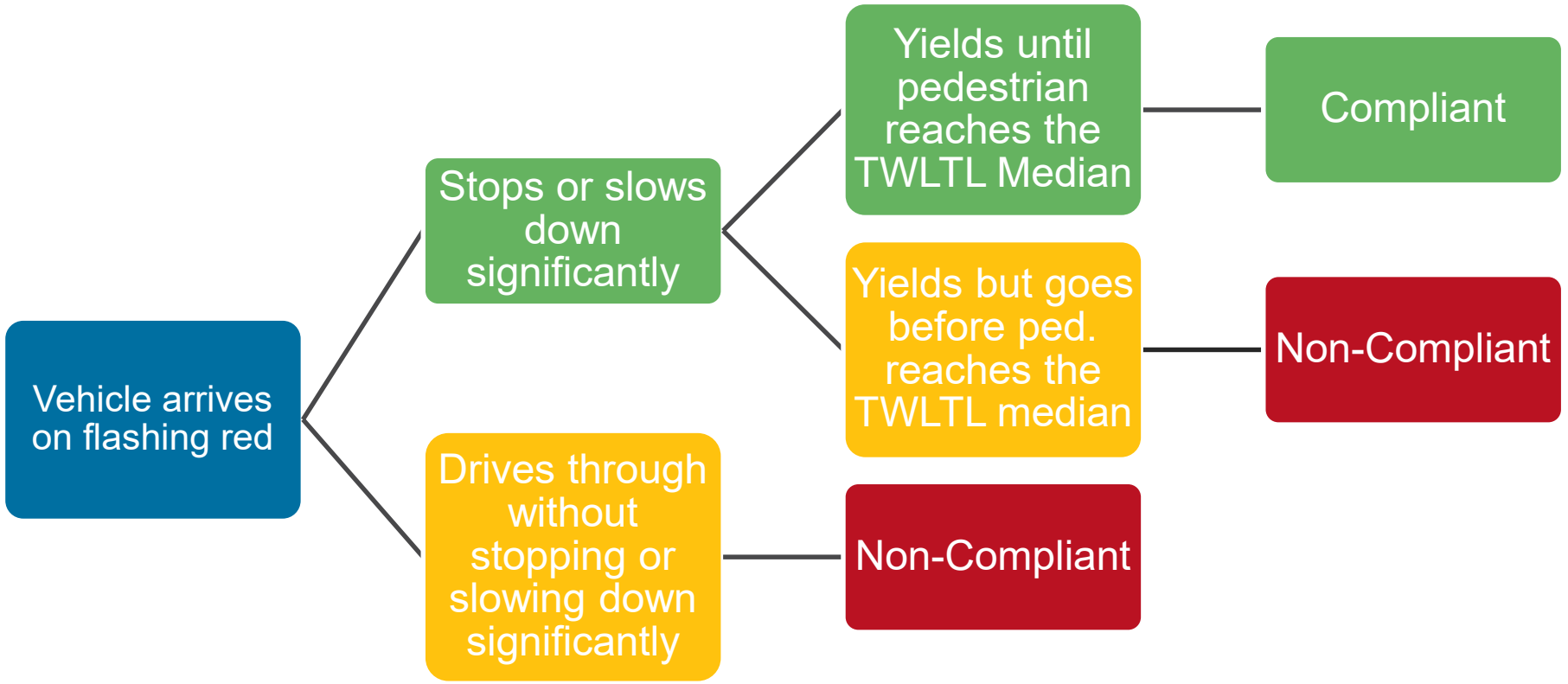
Non-HAWK (has time to safely stop)



HAWK (Solid Red)

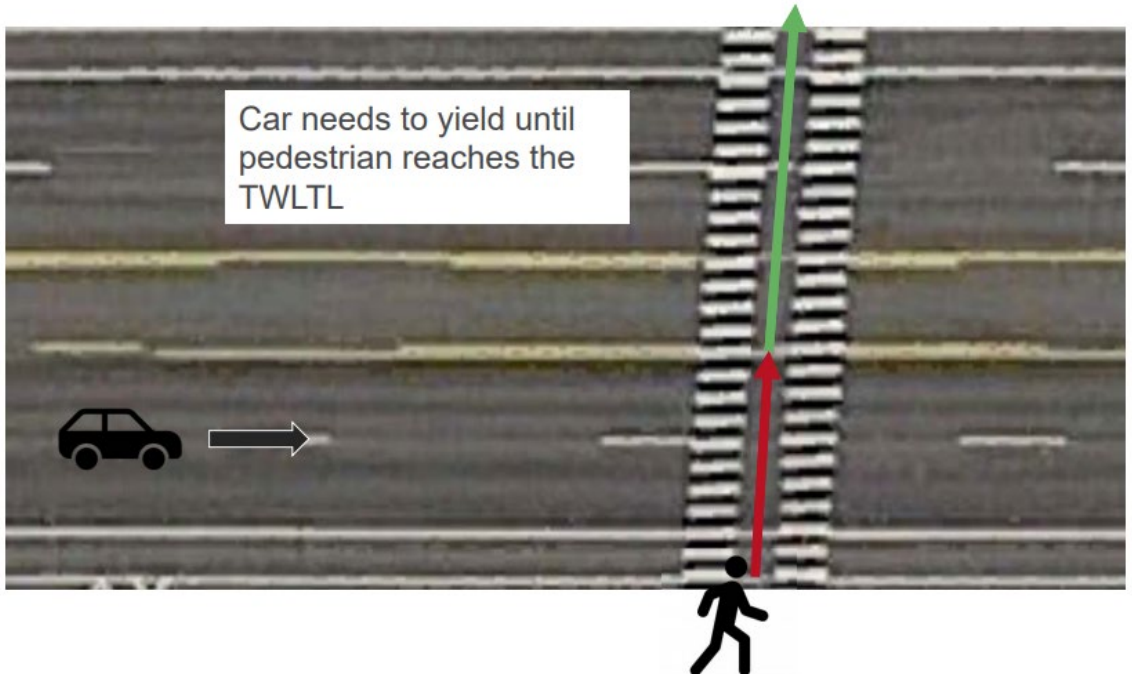


HAWK (Flashing Red)

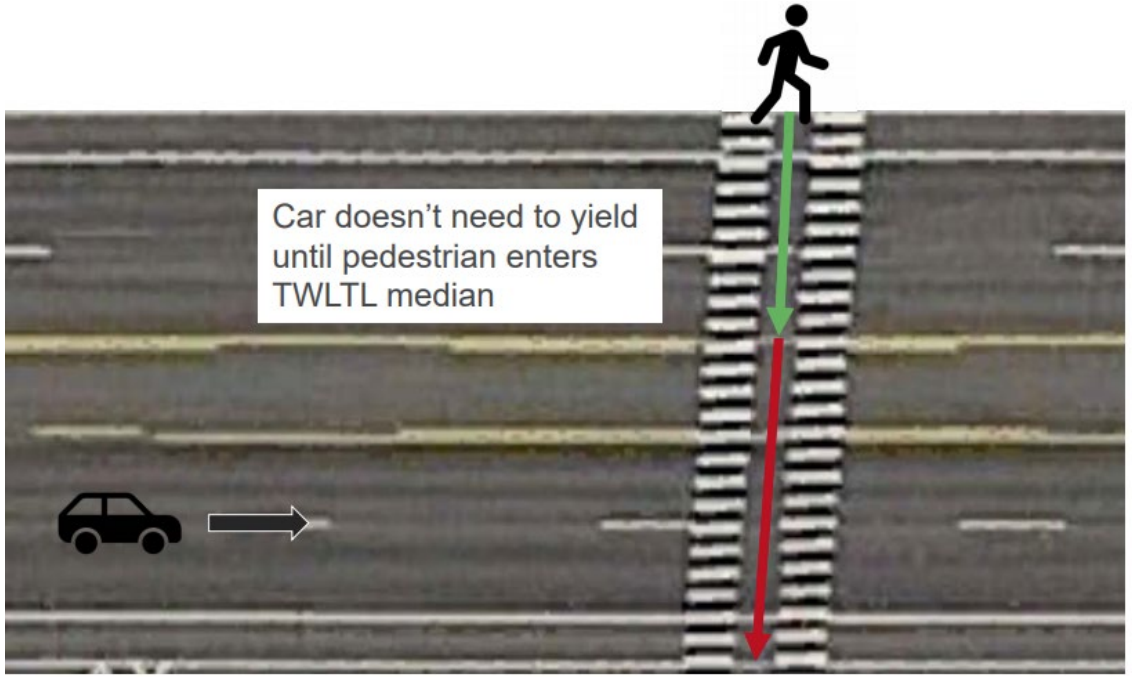


Driver Compliance According to Pedestrian Approach

Near Approach



Far Approach

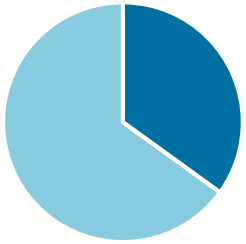


Data Summary

Data Summary by Type of Enhancement

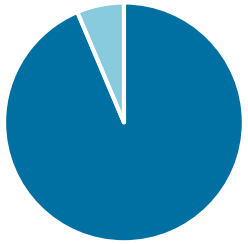
2241 observations

Base



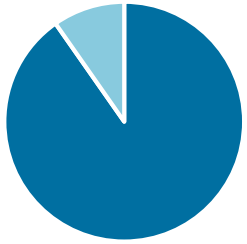
Compliant Non Compliant

HAWK



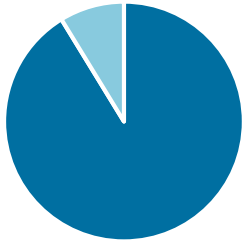
Compliant Non Compliant

ORRFB



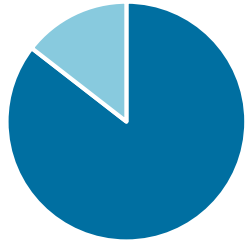
Compliant Non Compliant

RRFB



Compliant Non Compliant

OFB



Compliant Non Compliant

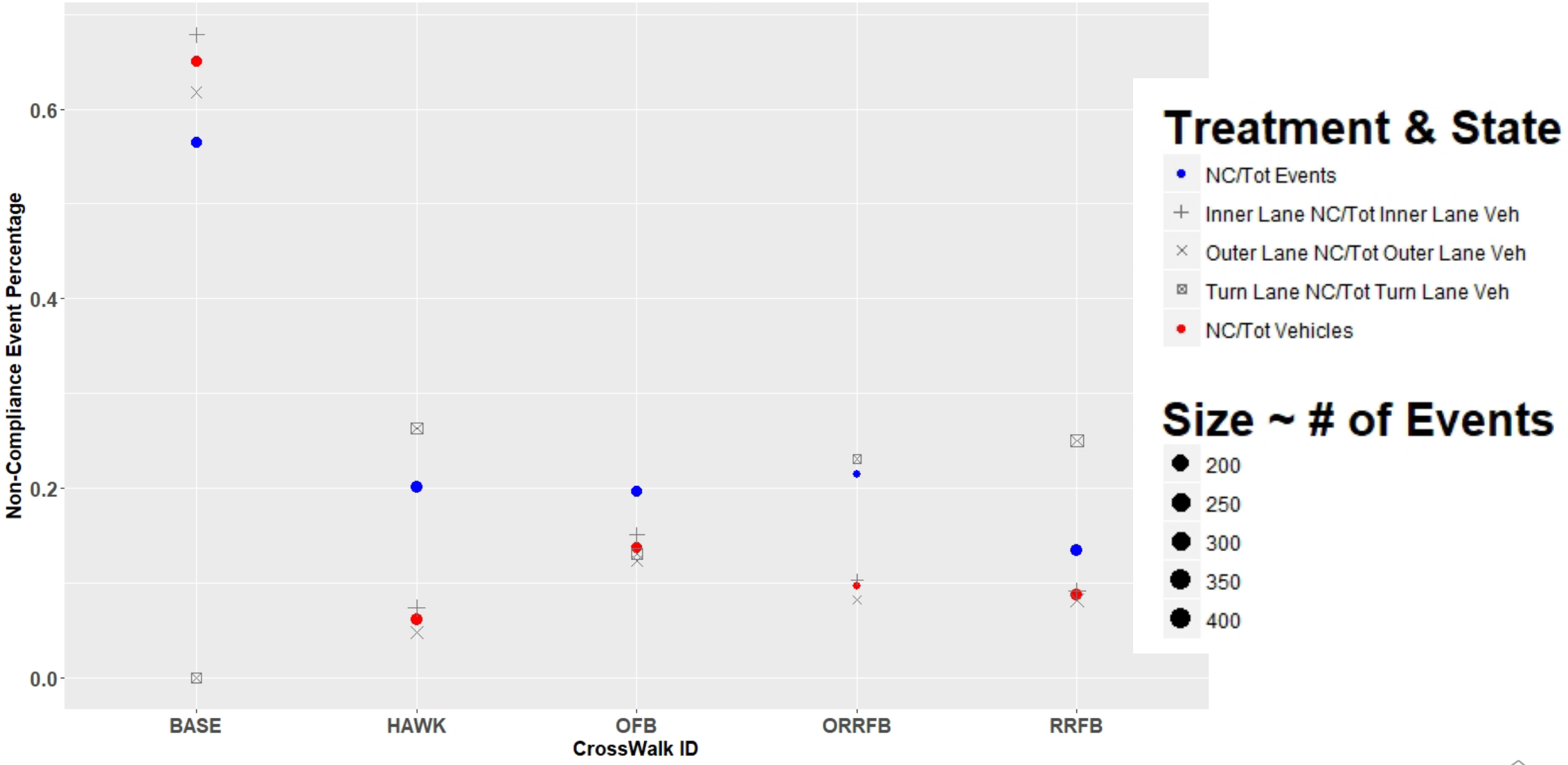
	CO Rate	NC Rate
Base	35%	65%
HAWK	94%	6%
OFB	86%	14%
ORRFB	90%	10%
RRFB	91%	9%

Statistical Results

Background

- It was observed during data collection that the leading driver behavior has significant impact on driver compliance of the following vehicles
- It was also determined that pedestrian safety is more compromised by the leading vehicle than the following vehicles
- To minimize such effects, an event-based analysis was used in the statistical analysis:
  - Event: pedestrian(s) is crossing at the same time as vehicle(s) is passing
  - NC Event: one or more vehicles are not compliant according to Utah code

NC Event Rate per Treatment Type



Chi-Square Analysis

- The Chi-square test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies of compliant events between each pair of treatment types
- The null hypothesis is that the two treatment types in the test have the same impact on event compliance rate
- The alternative hypothesis is that the two treatment types in the test have different impacts on event compliance rates
- The difference between treatment types are more significant as the P-value of the Chi-square test becomes closer to 0

Chi-Square Results

- RRFB and ORRFB have a similar impact on compliance rate (P-value = 0.711)
- In addition, the high (>0.10) P-values (i.e., 0.599 and 0.191) show that the HAWK has a similar impact as OFB and ORRFB on compliance rate

Type	OFB	RRFB	BASE	ORRFB	HAWK
OFB	1.000	0.010	0.000	0.079	0.599
RRFB	0.010	1.000	0.000	0.711	0.034
BASE	0.000	0.000	1.000	0.000	0.000
ORRFB	0.079	0.711	0.000	1.000	0.191
HAWK	0.599	0.034	0.000	0.191	1.000

Binomial Logit Regression Analysis

- The binomial-logit regression is used to estimate the impact of various factors, such as treatment type, on driver compliance rates
- Several models were estimated and any independent variables that showed statistically insignificant impacts on an event being non-compliant were removed

Binomial Logit Regression Model Estimate Results

- The results show that the HAWK (-3.629) has a higher impact on reducing the probability of an event being NC than OFB (-1.469)
- Similarly, OFB has higher impact on reducing the probability of an event being NC than RRFB and ORRFB (-0.856)

Variable	Estimate	Std. Error	Significance
Intercept	*5.013*	*1.104*	***
HAWK	*-3.629*	*0.328*	***
OFB	*-1.469*	*0.218*	***
RRFB & ORRFB	*-0.856*	*0.187*	***
Total # Drivers in an Event	*0.977*	*0.065*	***
Stopping Sight Distance (ft)	*-0.018*	*0.003*	***
Walk Score	*-0.041*	*0.006*	***

Binomial Logit Regression Odds Ratio Results

- The odds ratio shows the constant effect of a factor (e.g., HAWK) on the likelihood of an outcome (e.g., an event being compliant)
- For example, the odds of reducing the chance of an event being NC (increased compliance) for HAWK crosswalks compared to Base crosswalks is 97%

Variable	Reducing chance of event to be NC		
	2.5% Conf. Int.	*Mean*	95% Conf. Int.
HAWK	*98%*	*97%*	96%
OFB	*81%*	*77%*	71%
RRFB & ORRFB	*65%*	*58%*	49%
Total # Drivers in an Event	*-149%*	*-166%*	-183%
Stopping Sight Distance (ft)	*2%*	*2%*	1%
Walk Score	*5%*	*4%*	3%

Results

- The Binomial-Logit regression model estimates show that adding a pedestrian enhancement to a marked crosswalk at a location with 5 lanes and a speed limit between 35 mph to 45 mph, can increase compliance event rate by:
  - 97% for HAWK
  - 77% for OFB
  - 58% for RRFB and ORRFB

- The total number of vehicles in an event, SSD, and walkability score showed significant impacts on compliance rates

Questions?

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