LEADING PEDESTRIAN INTERVAL (LPI)

SIGNALIZED INTERSECTIONS ALONG MAJOR CORRIDORS

Florida Department of Transportation – District 7

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May 15, 2024

Pedestrian Crashes 2019 -2023

All Roadways within District Seven

Year	2019		2020		2021		2022		2023		2024	
County	Fatal	Total	Fatal	Total	Fatal	Total	Fatal	Total	Fatal	Total	Fatal	Total
Citrus	1	51	6	50	8	55	6	56	5	55	1	17
Hernando	7	68	4	93	3	83	6	106	9	116	1	39
Hillsborough	59	685	52	613	66	713	59	726	66	719	18	242
Pasco	24	208	27	185	22	175	28	218	29	188	6	72
Pinellas	42	642	30	491	60	551	35	532	41	541	8	195
Total	133	1654	119	1432	159	1577	134	1638	150	1619	34	565
% Change from Previous Year	n/a	n/a	-11%	-13%	34%	10%	-16%	4%	12%	-1%	n/a	n/a

Crash Data from District Seven Safety Office

D7 LPI INITIATIVE

In 2021, District Secretary David Gwynn challenged staff:

Embark on a mission to address safety deficiencies related to bicycle and pedestrians at all signalized intersections.

One element was to identify signalized intersections where a Leading Pedestrian Interval (LPI) could be installed, with minimal cost, to enhance pedestrian safety, and then implement those locations.

Pedestrian Crashes – Year-to-Date

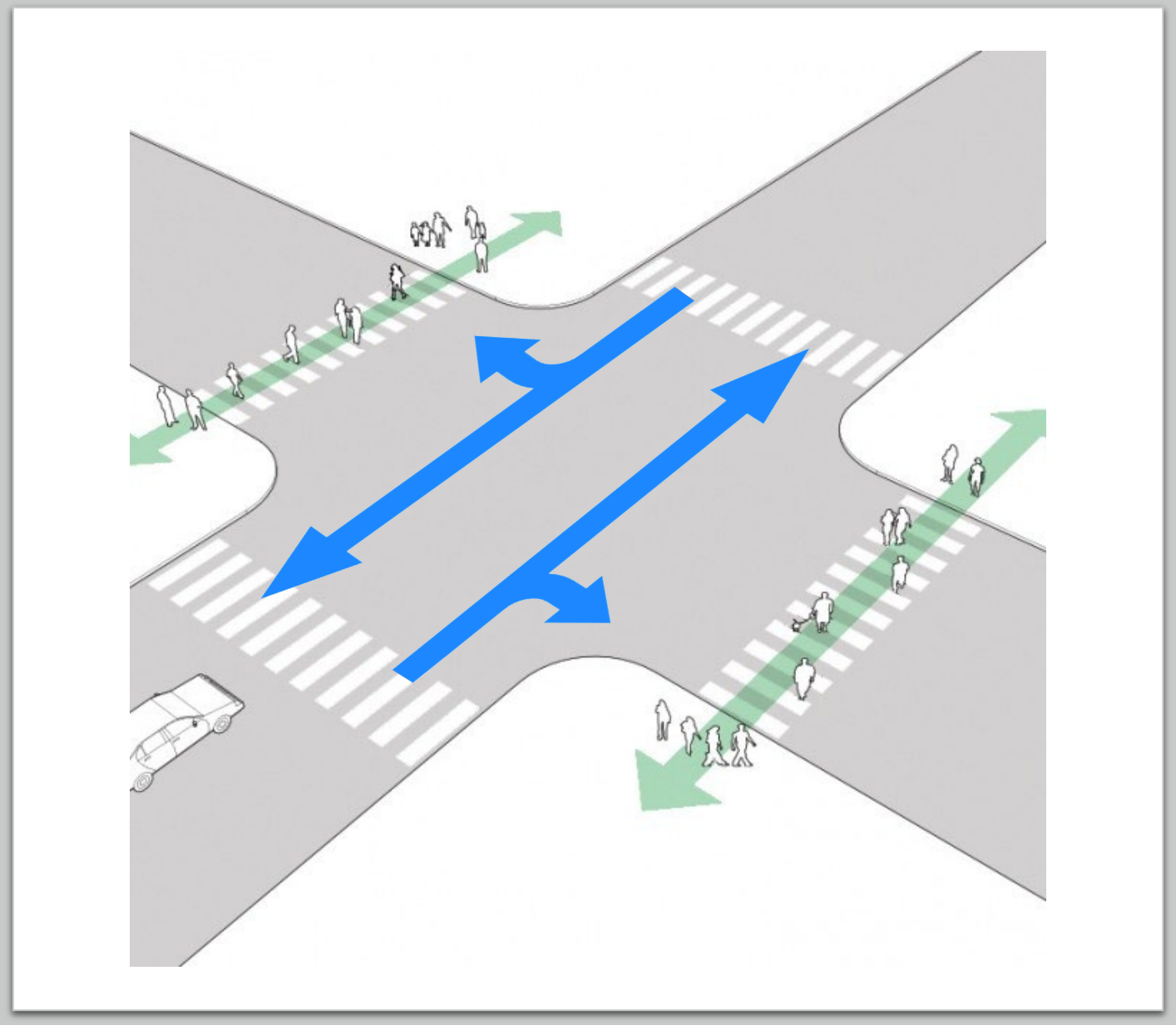
All Roadways within District Seven

Year	Jan-April 2023		Jan-April 2024	
County	Fatal	Total	Fatal	Total
Citrus	1	16	1	17
Hernando	3	41	1	33
Hillsborough	26	275	18	228
Pasco	9	67	6	69
Pinellas	18	201	8	181
Total	57	600	34	528
% Change from Previous Year	n/a	n/a	-40%	-12%

Crash Data from District Seven Safety Office

WHAT IS AN LPI?

- A Leading Pedestrian Interval (LPI) gives pedestrians a 3 to 7 second head start before vehicles entering the intersection with a corresponding green signal in the same direction of travel.



Benefits of an LPI

- With the head start provided by an LPI, pedestrians can better establish their presence in the crosswalk before vehicles can turn across the crosswalk.

- LPIs provide the following benefits:
  - Increased visibility of crossing pedestrians.
  - Reduced conflicts between pedestrians and vehicles.
  - Increased likelihood of motorists yielding to pedestrians.
  - Enhanced safety for pedestrians who may be slower to start into the intersection.

TECHBRIEF

Pedestrian and Bicycle Safety

Safety Evaluation of Leading Pedestrian Intervals on Pedestrian Safety

FHWA Publication No.: FHWA-HRT-18-060

FHWA Contact: Ann Do, HRDS-30, (202) 493-3319, ann.do@dot.gov

This document is a technical summary of the Federal Highway Administration report *Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety* (FHWA-HRT-18-044).

Introduction and Objective

Pedestrian safety is an important issue for the United States, with pedestrian fatalities representing approximately 16 percent of all traffic-related fatalities in 2016.[1] In recognition of the magnitude of this problem, the Federal Highway Administration (FHWA) funded a study to evaluate promising infrastructure improvements to increase pedestrian safety. Following a literature review that summarized the existing knowledge on 18 countermeasures, FHWA and a Technical Advisory Panel selected 2 as the highest priorities for detailed evaluation in this study—the provision of protected and protected/permissive left-turn phasing and the provision of leading pedestrian intervals (LPIs). The objective of the study was to develop statistically rigorous crash modification factors (CMFs) for these countermeasures using state-of-the-art analytical methods.

This TechBrief summarizes the LPI evaluation. FHWA wrote a separate TechBrief for the evaluation of protected left-turn phasing.[2] The safety effectiveness of the countermeasure was measured by crash frequency for total crashes (all severities combined), total injury crashes (K, A, B, and C injuries on the KABCO scale, where K is fatal injury, A is incapacitating injury, B is nonincapacitating injury, C is possible injury, and O is property damage only), and vehicle–pedestrian crashes (all severities combined). The analysis was conducted using an empirical Bayesian (EB) before–after study design and data from urban inter sections in three cities that had installed one

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

www.fhwa.dot.gov/research

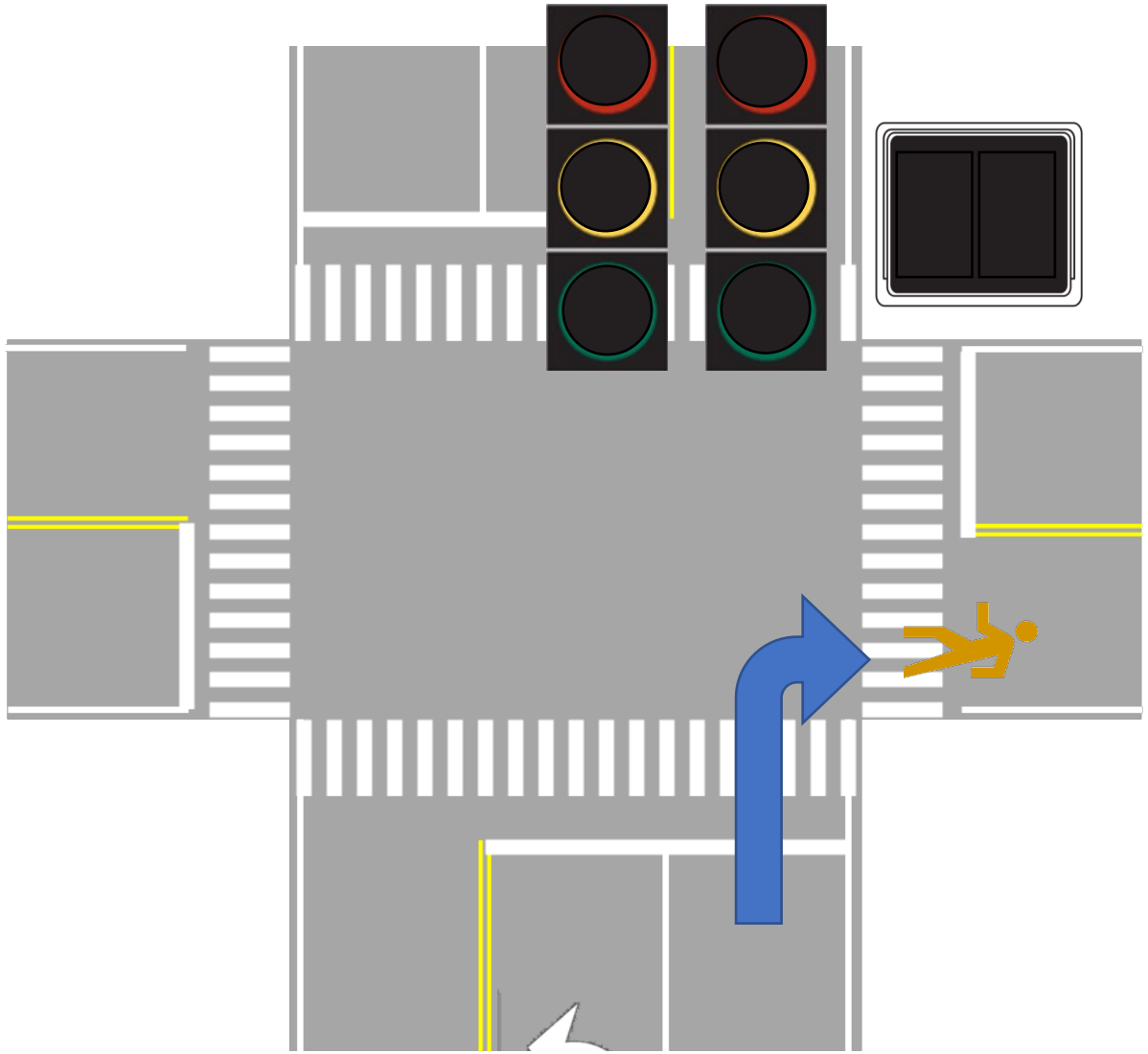
https://www.fhwa.dot.gov/publications/research/safety/18060/18060.pdf

FHWA Research

Leading Pedestrian Intervals:

- Crash Modification Factor of 0.87 (reduction of 13%) for total crashes and for vehicle-pedestrian crashes.
- Crash Modification Factor of 0.86 for total injury crashes

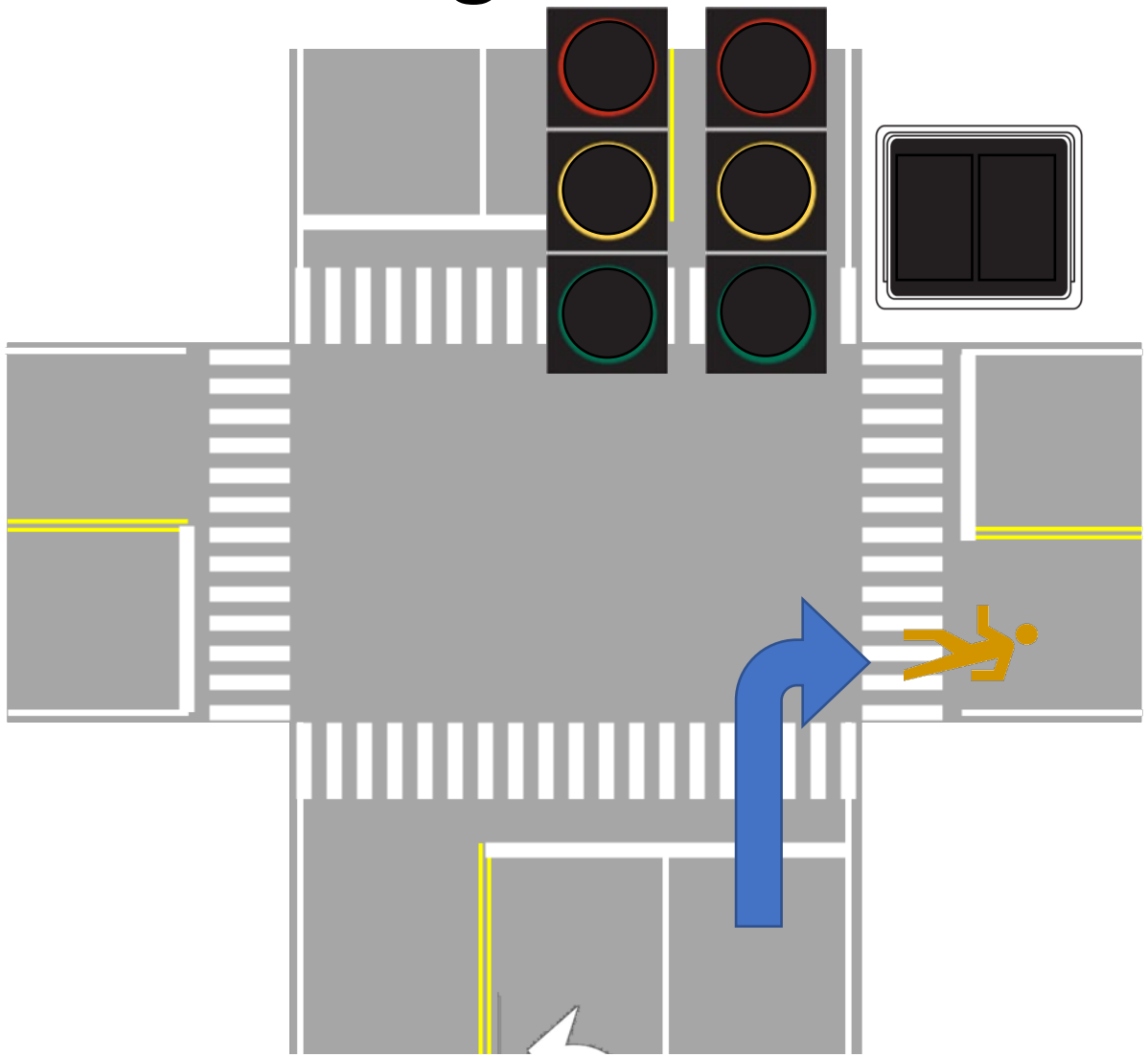
Traditional Pedestrian Interval Operation



- Historically, the Walk interval was initiated at the beginning of the concurrent vehicle movement
- Pedestrians and turning vehicles received right-of-way indications at the same time
- Aggressive turning drivers may prevent cautious pedestrians from starting into the crosswalk

8

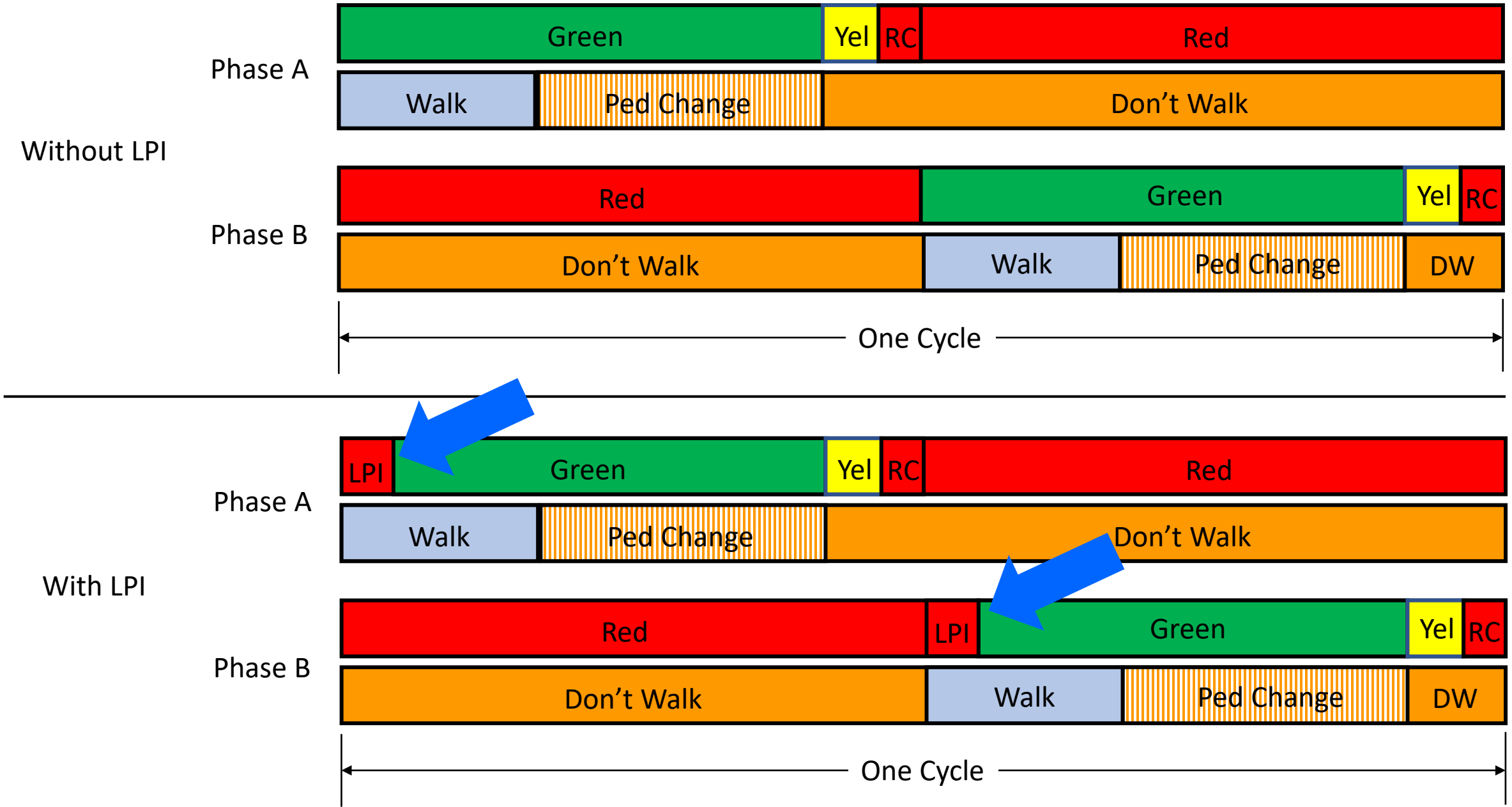
Leading Pedestrian Interval (LPI)



- The Leading Pedestrian Interval provides pedestrians a head-start to claim the crosswalk before turning vehicles receive a green indication
- Extremely effective in urban intersections
- Consider No Turn On Red restrictions at suburban intersections
- Consider Accessible Pedestrian Signals

9

LPI – Minimal Impact on Cycle



FDOT - District Seven LPI Implementation Status

On the State Highway System - As of September 2023

Maintaining Agency	Intersections Implemented	Planned / On-Hold Intersections
City of Tampa	111	0
City of St. Petersburg	85	1
City of Clearwater	34	0
City of Plant City	6	0
Hillsborough County	27	0
Pinellas County	207	5
Pasco County	119	1
Hernando County	34	5
Citrus County	29	0
TOTAL	**652**	**12**

Total Signals on SHS in District Seven – 1,122

Field LPI Implementation:

Approximately:

- 85 Percent: Simple database change
- 15 Percent: Replace Intersection Controller and/or MMU in existing cabinet

Ease of implementation based on the age of the existing controller equipment

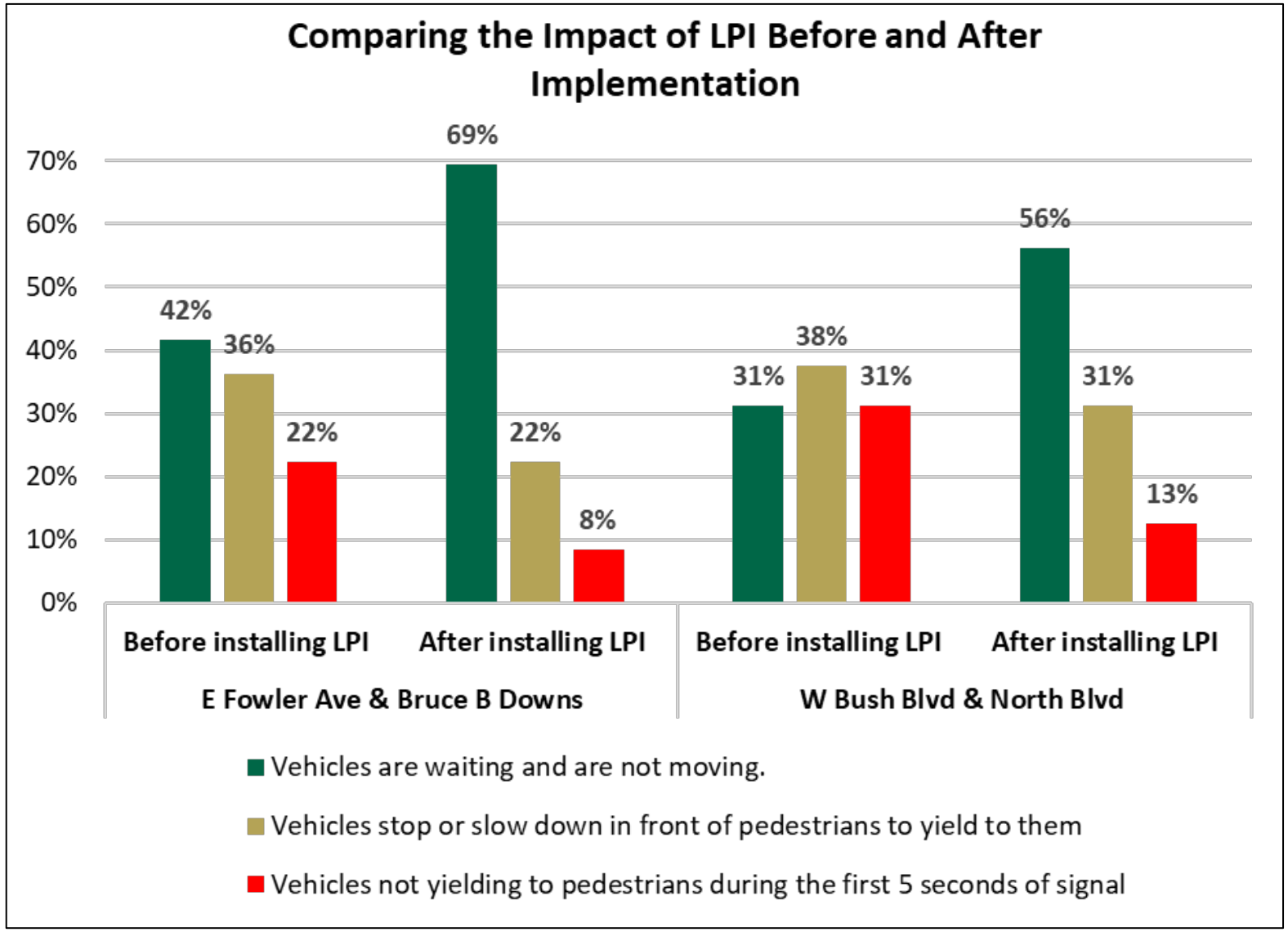
- Verify a TS2 cabinet was in place.
- Verify a MMU was installed.
- Verify a TS2 Controller was used.
- Program for advance walk or delayed green for the associated LPI.
- Determine if any free flow right turns existed in the direction of the proposed LPI. If so no value for adding the LPI.
- Verify the proposed LPI movement could be accommodated by the existing phase split.
- If not, determine if the phase split could be adjusted as necessary without affecting the current cycle length.
- Program the LPI times for the associated phases.
- Field verify the installed LPI timings for the associated pedestrian movements.

Lessons Learned

General Observations

- District standard LPI duration set at 3 seconds
  - Did not have a significant impact on vehicular capacities at most locations
  - Appears to provide sufficient start-up time for pedestrians at most locations; exception might be urban core with on-street parking
  - Some local agencies have used longer values off the state highway system
- Best not to use Pedestrian Recall when LPI is deployed
  - Introduces unnecessary vehicular delay every cycle
- Check operations in the field when implementing to ensure desired operation (i.e., don’t just download the LPI)

USF - Center for Urban Transportation Research
LPI – Observed Impacts Before and After



Overall Impact

26% ↑ **71% improvement**

-10% ↓

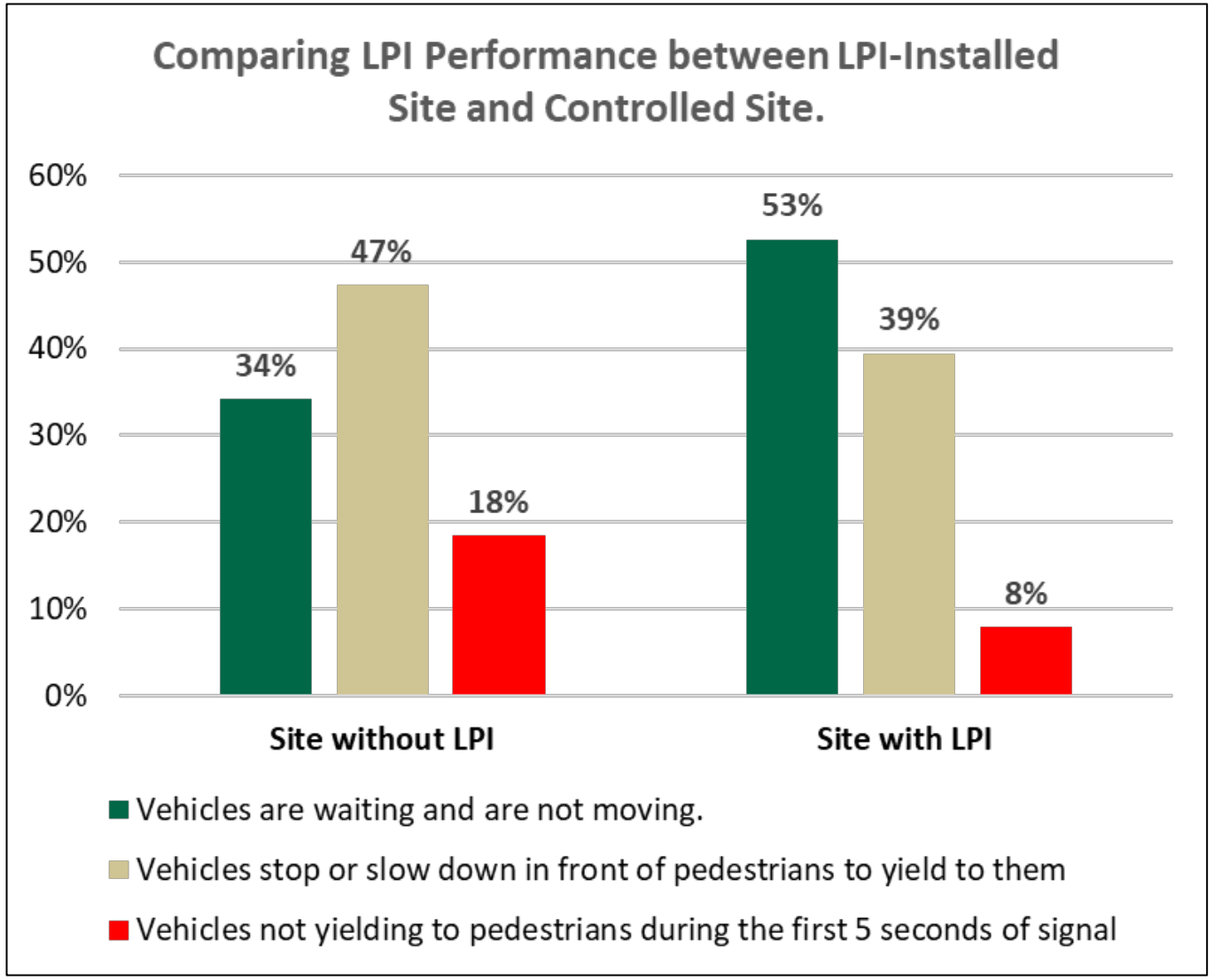
-16% ↓ **61% improvement**

Evaluating the Effectiveness of LPIs as a Systemic Implementation

Dr. Pei-Sung Lin. P.E., PTOE. FITE
Dr. Yaye Keita
Rakesh Rangaswamy

CUTR, University of South Florida

USF - Center for Urban Transportation Research
LPI – Observed Impacts Before and After



Overall Impact

18% ↑	**56% improvement**
-8% ↓	
-11% ↓	**56% improvement**

Evaluating the Effectiveness of LPIs as a Systemic Implementation

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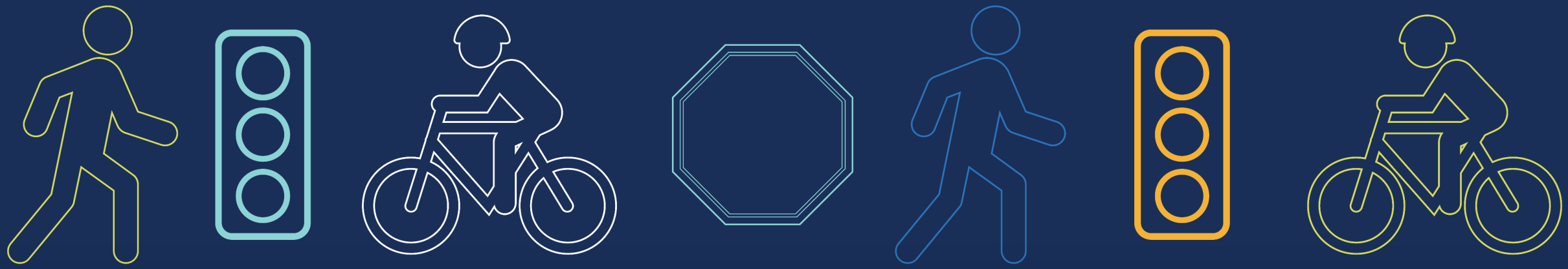
Educational Video and Brochure

https://www.youtube.com/watch?v=xfTHzeDwbAA



Operating Intersections for Ped Safety

Signal timing to advance safety in Portland, OR – May 2024

U.S. Department of Transportation
Federal Highway Administration

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

Outline

- Safety that you can/can’t see
- Inspiration from Barcelona
- Role of Signals in Safety
  - Automated enforcement
  - Speed management w/ timing
  - Protected left turn guidelines (w/peds)
  - Rest in Red

Portland traffic deaths by travel mode

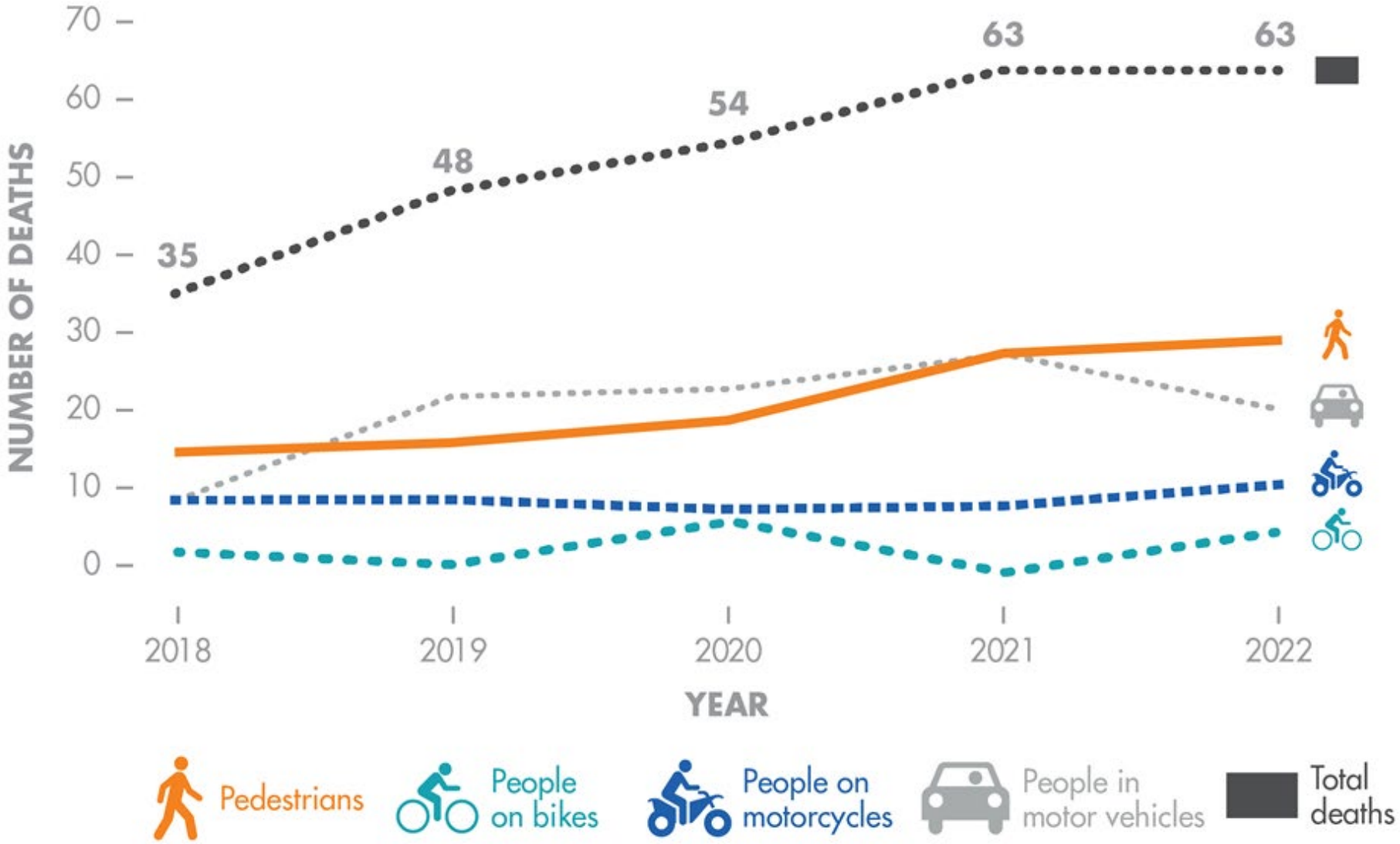
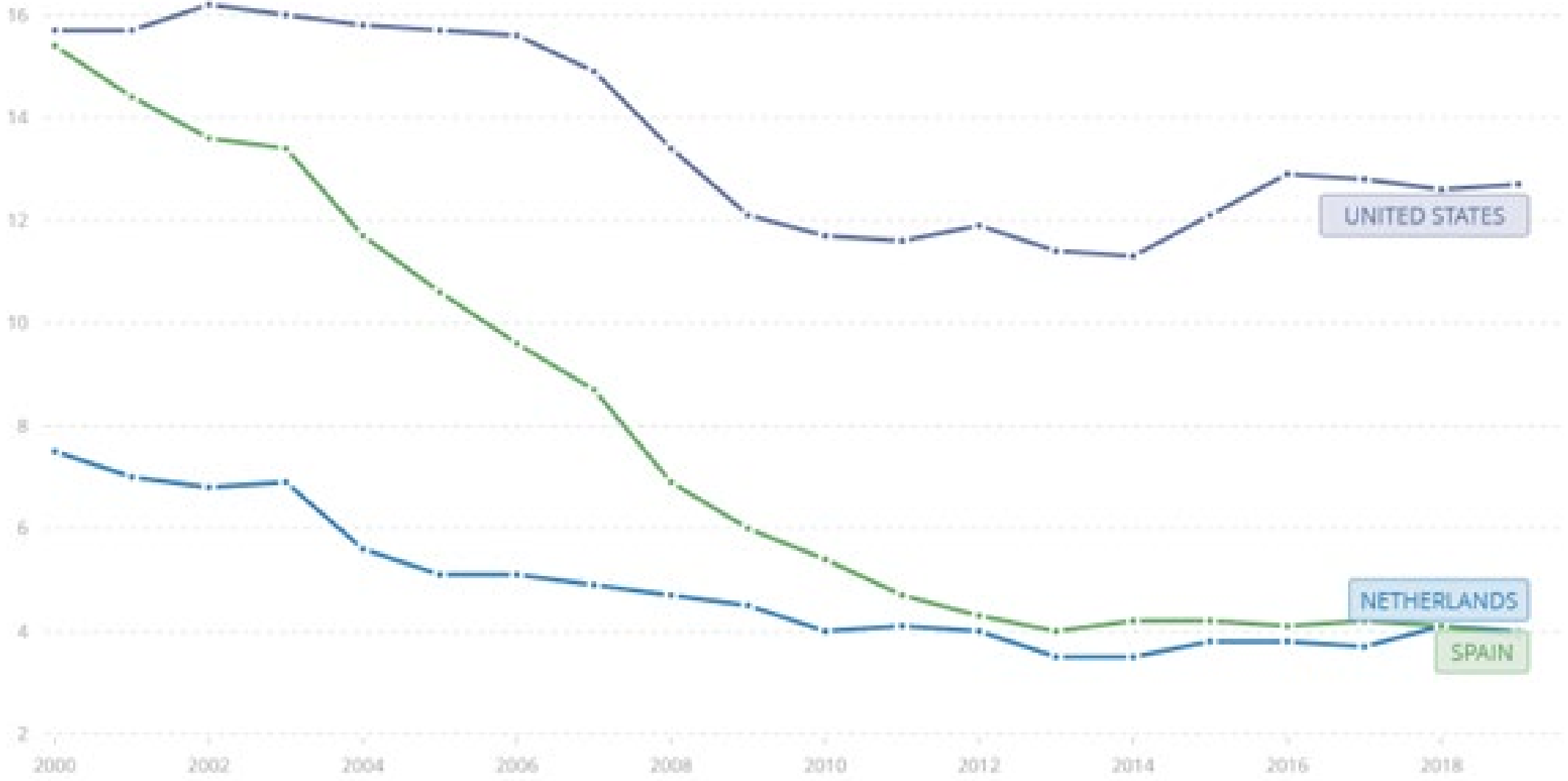


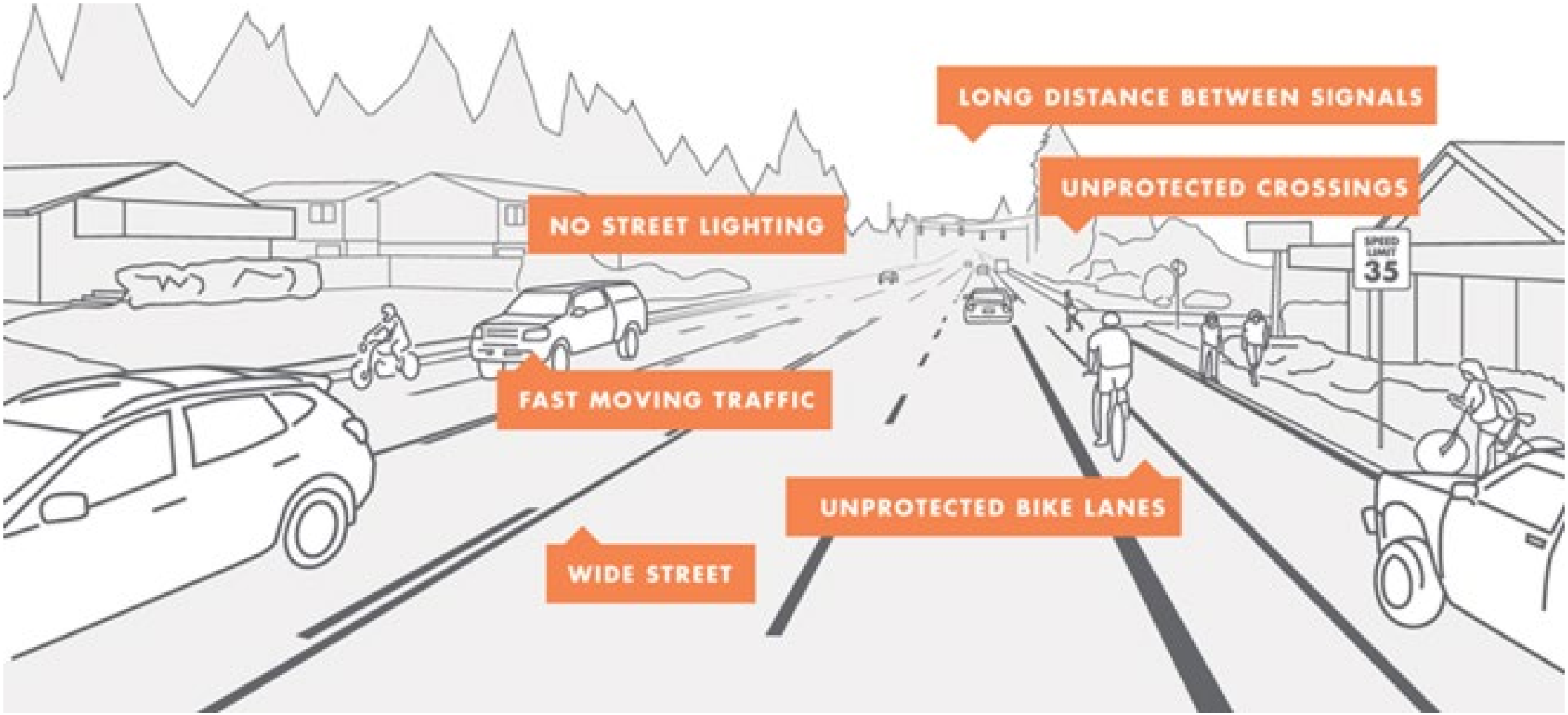
Figure 1. Portland traffic deaths by travel mode, 2018-2022.
Data: Portland Police Bureau (2021-2022), ODOT (2018-2020).

Mortality Rate per Population



Source: Various, aggregated by The World Bank

Elements of Safety that you can see



Elements of Safety that you can’t see

Traffic signal timing is “invisible”

Inspiration from Barcelona


EXCEPTE
BICI

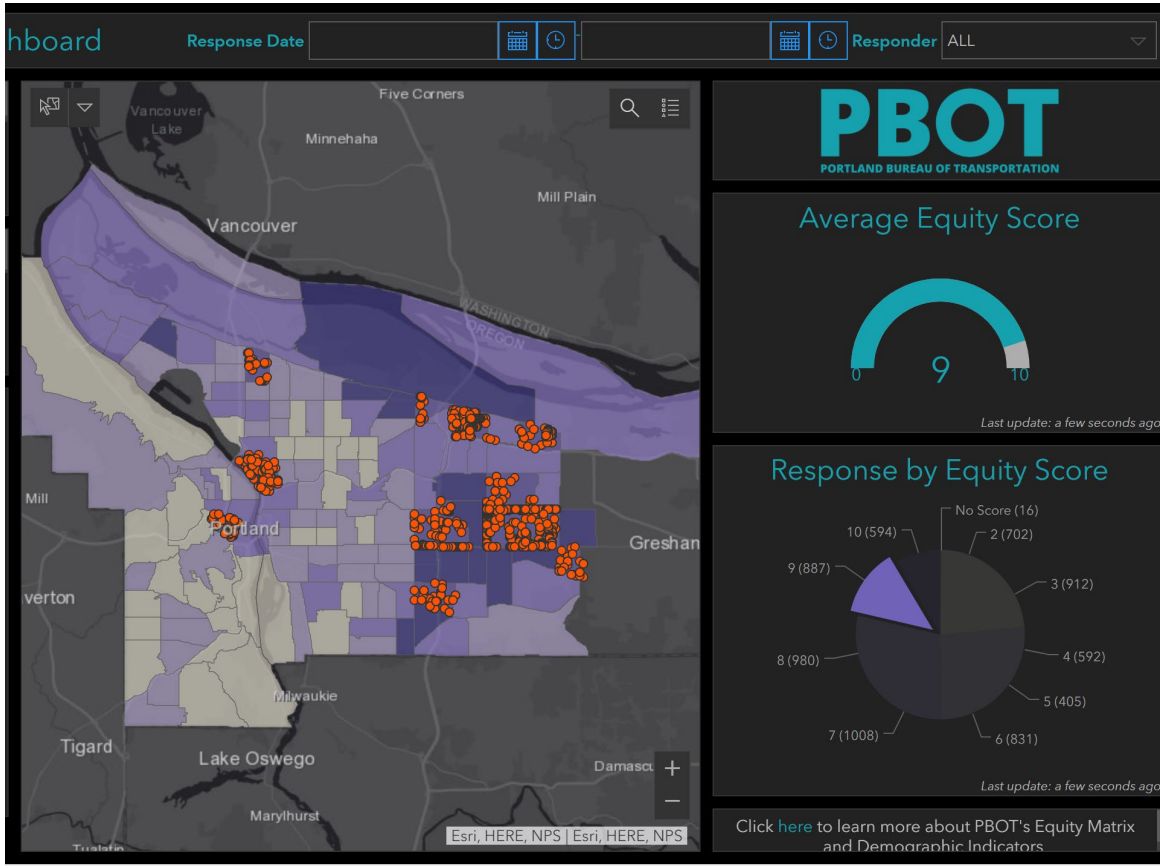

BICIBUS

Next Generation Safety Techniques

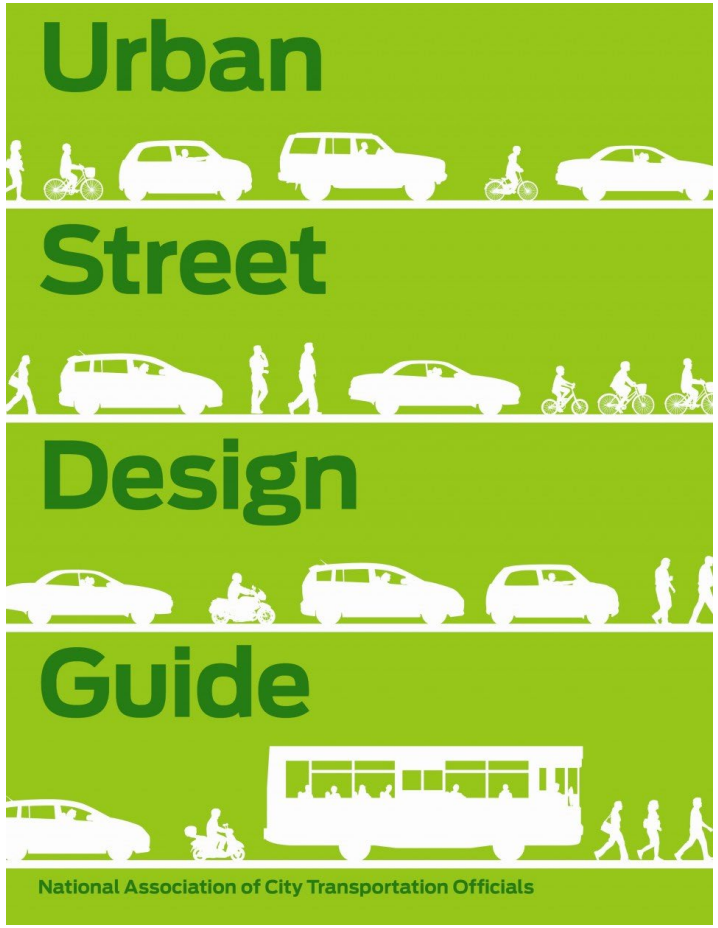
- Speed enforcement at traffic signals and fixed locations
- Speed management with traffic signal timing
- Left turn protection at signals considering people walking
- Rest in Red signal operations

Signals that hold people accountable

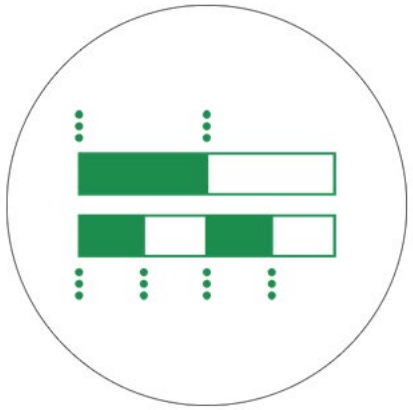
- Use automated enforcement strategically
- Deploy with thoughtful consideration to equity



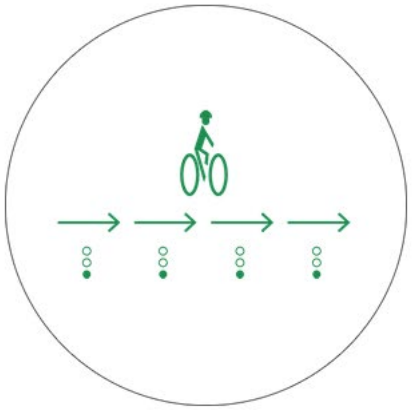
Signalization Principles



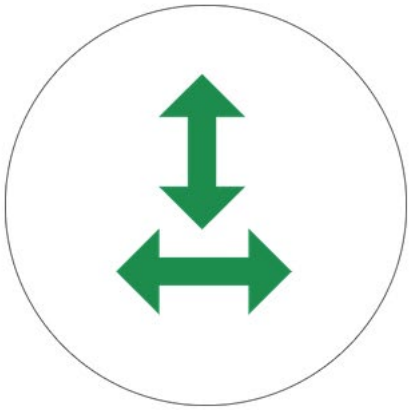
Source: NACTO Urban Street Design Guide



Keep Cycles Short

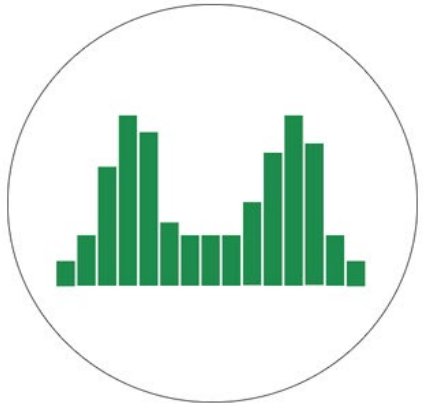


Prioritize VRUs



Signal Phasing

Use Intended Speed



Adjust by Time of Day

Context Sensitive Timing

Cycle Lengths for Speed Management

- Longer cycle lengths result in more people waiting in the street or ignoring the signal
- Shorter cycle lengths increase signal compliance for active transportation

Source: NYC DOT

Signals timed for slow speed traffic

- Offsets set for slower speeds than previous
- Time and/or space can be used effectively to implement objectives

Progression Speeds

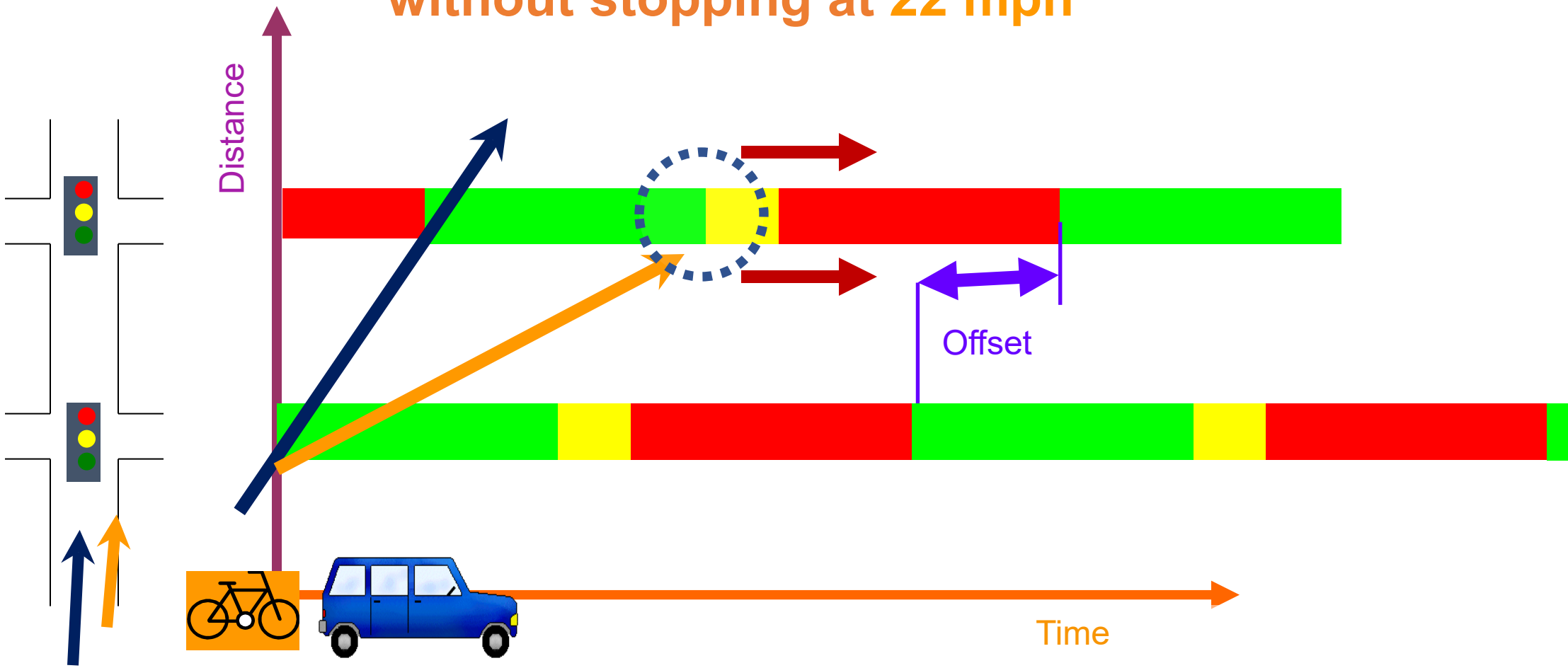
Synchronize signals to maintain safe vehicular travel speeds and discourage speeding

Progression Speed to manage speeds

Progression Speed: Cycling Streets

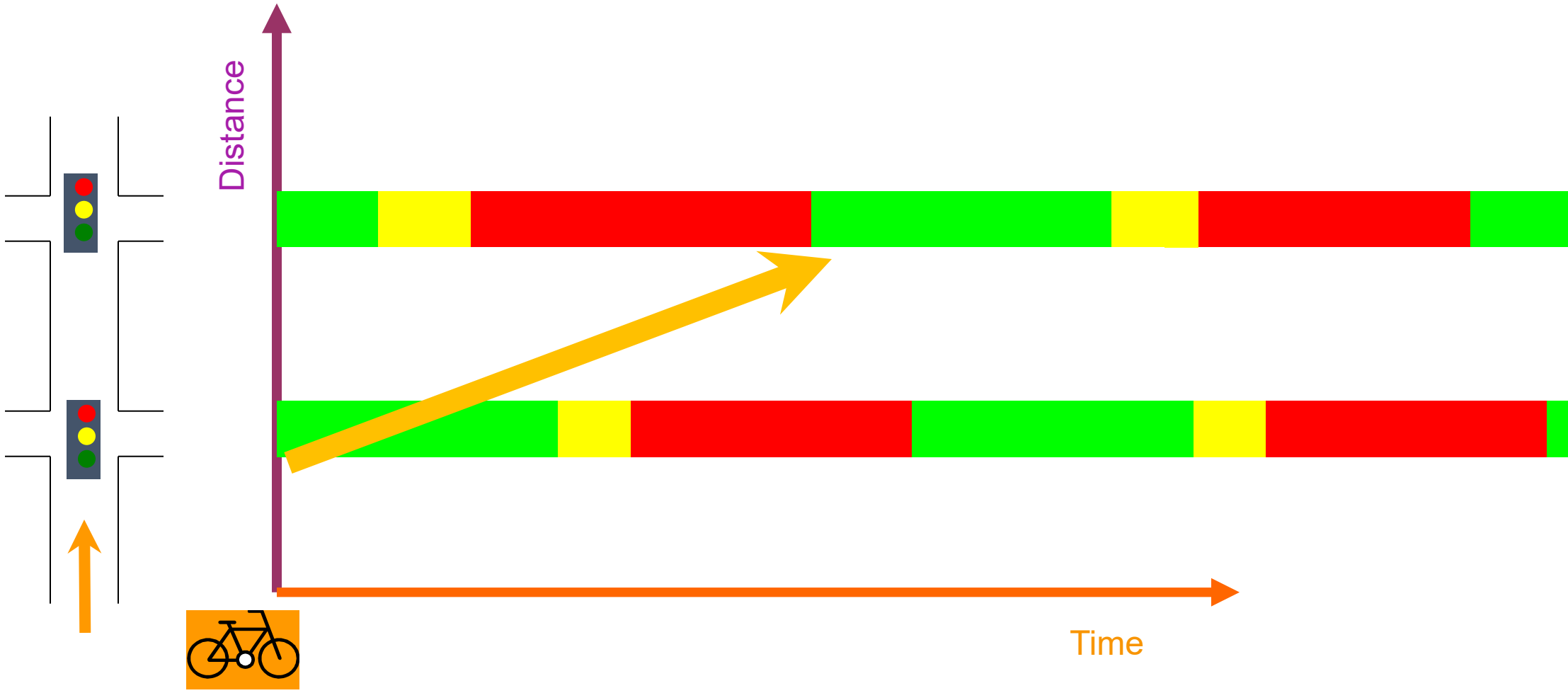
- Signal timing set to speed limit - 30 mph

bicycle traffic "could" get through without stopping at 22 mph

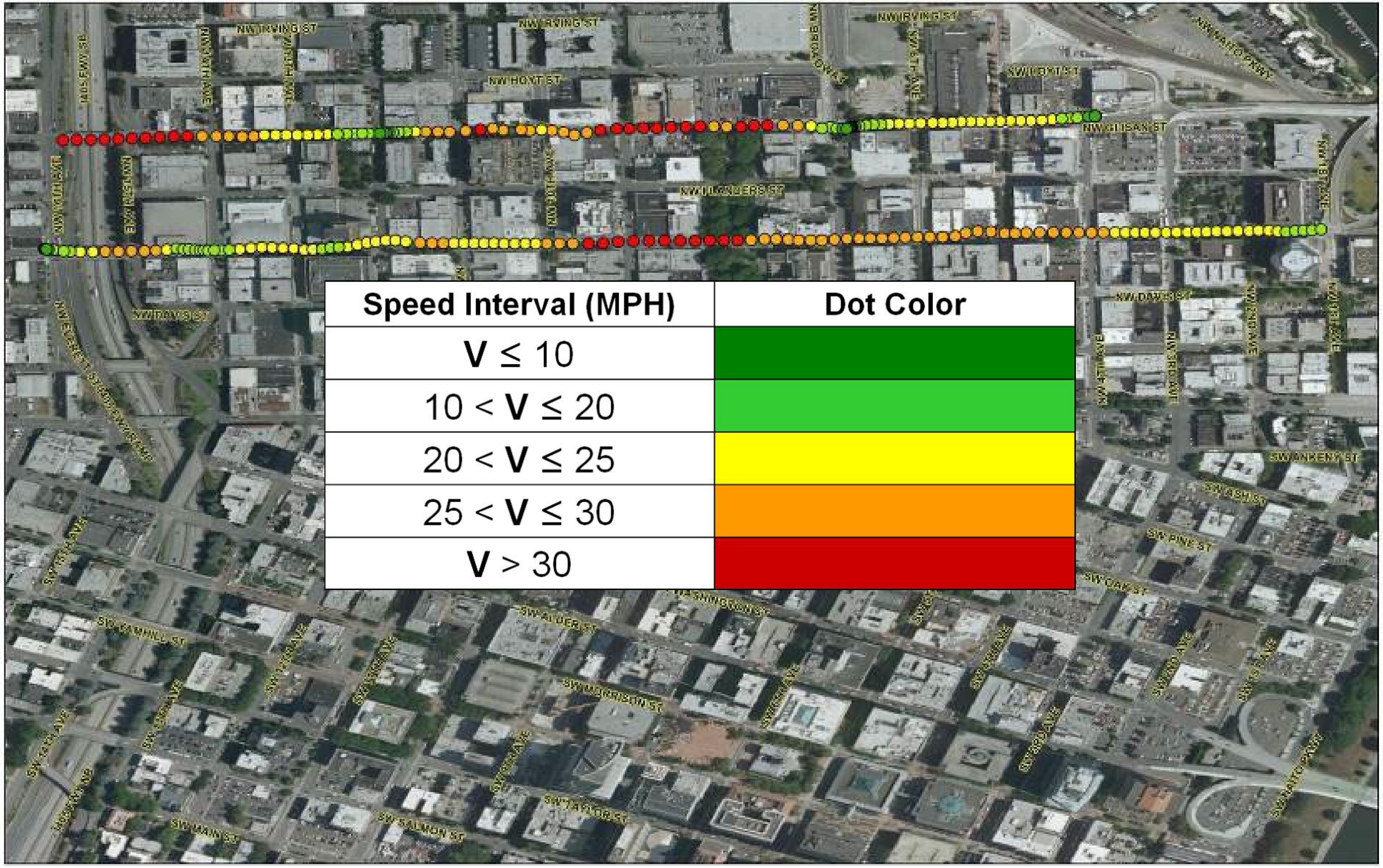


Progression Speed: Cycling Streets

- bicycle traffic travels through at 13 mph without stopping

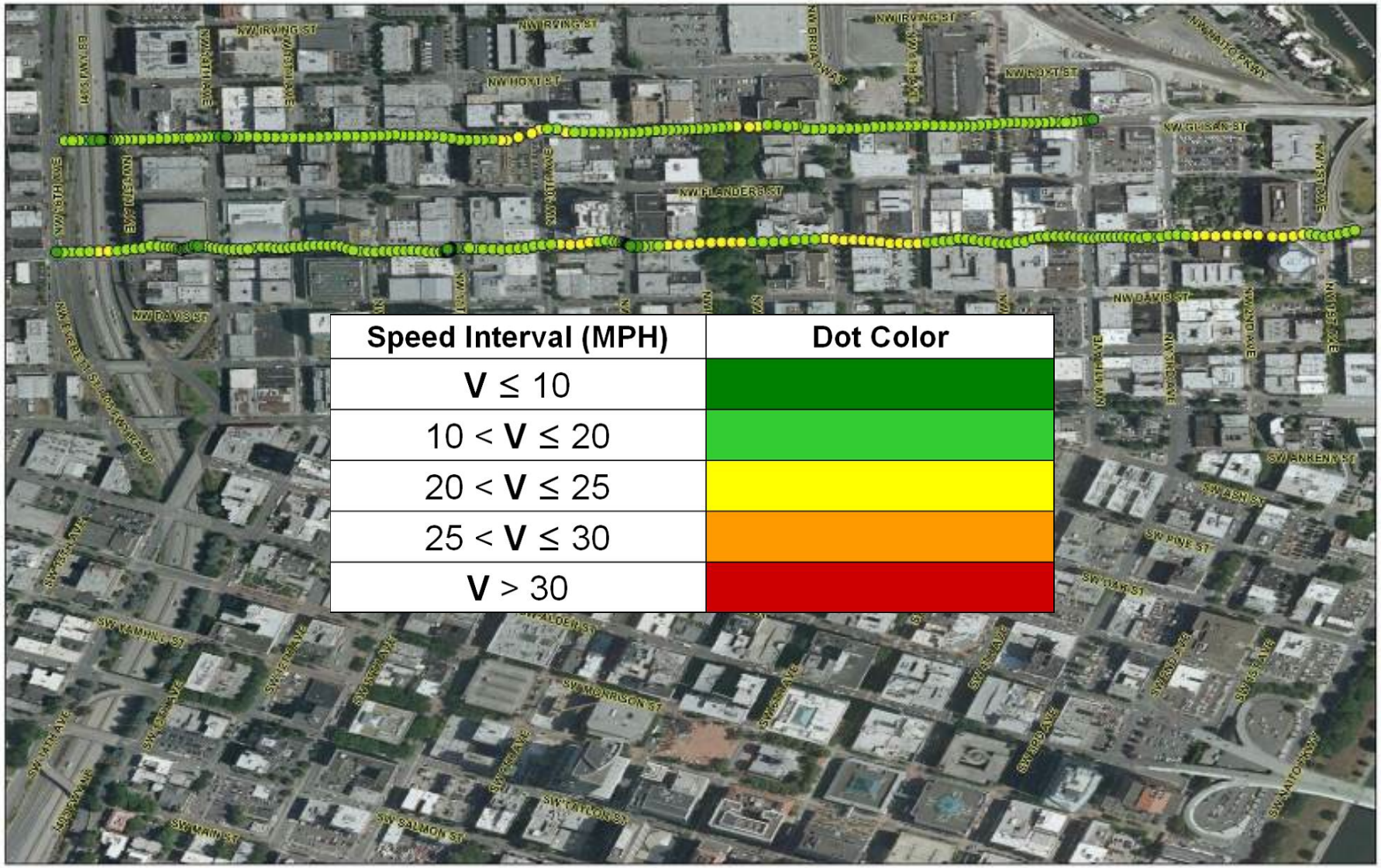


Changing Metrics for Engineers
Speeds Before Changes



Speed Interval (MPH)	Dot Color
V ≤ 10	(dark green)
10 < **V** ≤ 20	(light green)
20 < **V** ≤ 25	(yellow)
25 < **V** ≤ 30	(orange)
V > 30	(red)

Speeds After Changes



Speed Interval (MPH)	Dot Color
V ≤ 10	
10 < **V** ≤ 20	
20 < **V** ≤ 25	
25 < **V** ≤ 30	
V > 30	

Revising Left Turn Signal Phasing Guidance

Signal Phasing – Protected Turns

- Increased pedestrian comfort
- Improved safety
- Guidance in the industry is lacking

Signal Timing Manual version 3 may address this

Source: Dongho Chang

Inventory of Policies and Guidance Used by Other Agencies

- Oregon Department of Transportation Left-Turn Policy
- Los Angeles Department of Transportation Left-Turn Policy
- NCHRP Report 812: Signal Timing Manual Left-Turn Guidance
- PBOT Leading Pedestrian Interval Draft Guidance
- NACTO Urban Street Design Guide

Traffic Signal Phasing Policy Comparison

CRITERIA	ODOT LEFT-TURN POLICY	LADOT LEFT-TURN POLICY	STM2 LEFT-TURN GUIDANCE
Multiple left-turn lanes	✓	✓	✓
Restricted sight distance	Based on AASHTO	Based on LADOT Standard Drawing	< 5.5 seconds of travel time
Number of opposing lanes of traffic	3+	4+ (including bike)	4+
Intersection geometry	✓	✓	
Maneuverability of particular classes of vehicles	✓	✓	
Intersection of two major streets		"Boulevard" classification	
Crash history involving left-turn movements	5+ within 1 year period (within last 3 years, including pedestrian-related)	3-5+ within recent 1 year period; 6+ within recent 2 year period; 7+ within recent 3 year period	4+ within 1 year period; 6+ within 2 year period; 7+ within 3 year period
Crash history involving pedestrians		3-4+ within recent 5 year period	
Speed of opposing traffic	45+ mph	45+ mph	45+ mph
Adequacy of gaps	✓		
Proximity to a school		Within 500 feet or one block	
"Vision Zero" corridors		✓	
Safety concerns			
Community support			
Pedestrian Districts			
Major City Bikeways			
Product of opposing through and left-turn hourly volumes	50,000 (for 1 opposing lane); 100,000 (for 2 opposing lanes)	100,000 (including 5x conflicting pedestrian volume)	50,000 (for 1 opposing lane); 100,000 (for 2-3 opposing lanes)
Product of conflicting pedestrian and left-turn hourly volumes		10,000	
Left-turn volume	200+ hourly		3+ per cycle during peak hour
High pedestrian volumes	✓	100+ hourly	

Criteria	ODOT	LADOT	Signal Timing Manual 2
Product of conflicting pedestrian and left-turn volume (hr)		10,000	
Left-turn volume	200+ hourly		3+ per cycle during peak hour
High pedestrian volumes	✓	100+ hourly	

Left Turn Criteria focused on Multimodal Safety

- Crash history
- Major City Bikeway (bigger streets)
- Downtown like settings
  - lowest cycle length possible,
  - slower progression speeds

Traffic Signal Phasing Considerations

GEOMETRY	SAFETY	VOLUMES	OPERATIONS
• Multiple left-turn lanes • Restricted sight distance • Number of opposing lanes of traffic • Intersection geometry • Maneuverability of particular classes of vehicles • Intersection of two major streets	• Crash history involving left-turn movements • Crash history involving pedestrians • Speed of opposing traffic • Adequacy of gaps • Proximity to a school • “Vision Zero” corridors • Safety concerns • Community support • Pedestrian Districts • Major City Bikeways	• Product of opposing through and left-turn hourly volumes • Product of conflicting pedestrian and left-turn hourly volumes • Left-turn volume • High pedestrian volumes • High bicycle volumes • High percentage of left-turning heavy vehicles • Projected volumes warrant a different mode	• Opposing left-turn mode • U-turns permitted • Vehicle delay • Queues exceed left-turn pocket • Transit cycle failures • Traffic signal progression • Preemption-related operational requirements

Left Turn Criteria for Consideration

REVISIONS TO EXISTING CRITERIA…		SAFETY	PEDESTRIAN
Number of opposing lanes of traffic	*Include bike lanes*	◑	
Crash history involving left-turn movements	*Consider severity*	●	
Speed of opposing traffic	*Lower speed (e.g., 35+ mph)*	●	
High pedestrian volumes	*Add value (e.g., 100+)*		●
NEW CRITERIA…		**SAFETY**	**PEDESTRIAN**
Crash history involving pedestrians		●	●
Proximity to a school		●	
“Vision Zero” corridors		●	
Safety concerns		●	
Community support		●	
Pedestrian Districts		●	●
Major City Bikeways		●	
Product of conflicting pedestrian and left-turn hourly volumes		◑	●
Vehicle delay			
Queues exceed left-turn pocket			
Transit cycle failures			

MassDOT Separated Bike Lane Design Guide – Signal Phasing

Separated Bike Lane Operation	Motor Vehicles per Hour Turning across Separated Bike Lane			
	Two-way Street			One-way Street
	Right Turn	Left Turn across One Lane	Left Turn across Two Lanes	Right or Left Turn
One-way	150	100	50	150
Two-way	100	50	0	100

EXHIBIT 6A: Considerations for Time-separated Bicycle Movements

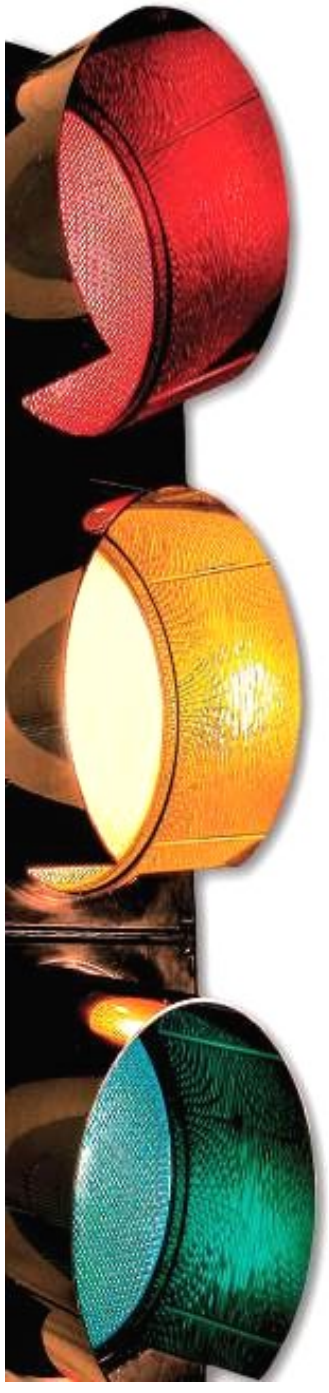
British Columbia Active Transportation Design Guide

TABLE G-32 // CONSIDERATIONS FOR TIME-SEPARATED BICYCLE MOVEMENTS - LOW SPEED STREETS (50KM/HR AND BELOW)

PROTECTED BICYCLE LANE OPERATION	MOTOR VEHICLES PER HOUR TURNING ACROSS PROTECTED BICYCLE LANE			
	Two-Way Motor Vehicle Road			One-Way Motor Vehicle Road
	Right Turn	Left Turn Across One Lane	Left Turn Across Two Lanes	Right of Left Turn
Uni-Directional	250	150	50	250
Bi-Directional	150	100	0	150

TABLE G-33 // CONSIDERATIONS FOR TIME-SEPARATED BICYCLE MOVEMENTS – HIGH SPEED STREETS (>50 KM/HR)

PROTECTED BICYCLE LANE OPERATION	MOTOR VEHICLES PER HOUR TURNING ACROSS PROTECTED BICYCLE LANE			
	Two-Way Motor Vehicle Road			One-Way Motor Vehicle Road
	Right Turn	Left Turn Across One Lane	Left Turn Across Two Lanes	Right of Left Turn
Uni-Directional	100	100	0	100
Bi-Directional	50	50	0	0



Rest in Red

PORTLAND

PBOT to pilot ‘Rest on Red’ program

by: Jami Seymore
Posted: Feb 20, 2024 / 05:47 PM PST
Updated: Feb 20, 2024 / 10:19 PM PST

Powell Boulevard will be the first street to get the pilot test

SHARE

PORTLAND, Ore. (KOIN) — As 2024 has seen double the number of traffic deaths in the same time period a year ago, the Portland Bureau of Transportation is trying a new strategy to improve safety.

“We absolutely consider every one of these fatalities on our streets to be heartbreaking,” said PBOT’s Hannah Schafer.

Table of Contents

Traffic Control Systems Handbook: Chapter 7. Local Controllers

Source: Eagle Products

Figure 7-1. Model 2070 Controller.

	sustained.
Red Rest	Requires the controller unit to rest in red in all phases of the timing ring(s) by continuous application of an external signal. The registration of a serviceable conflicting call results in the immediate advance from Red Rest to green of the demanding phase. The registration of a serviceable conflicting call before entry into the Red Rest state results in the termination of the active phase and the selection of the next phase in the normal manner, with appropriate change and clearance intervals. The registration of a serviceable call on the active phase before entry into the Red Rest state even with this signal applied, results (if Red Revert is active) in the continuation of the termination of the active phase with appropriate yellow change interval and Red display for the duration selected in Red Revert. The formerly active phase is then reassigned right-of-way.
Inhibit Maximum	Disables the maximum termination functions of all phases in the selected timing ring. This input does not, however,


SIGNALS
SET FOR
30
MPH

Building the Safest

Rest in Red was implemented with NE Lloyd & Blumenauer Bridge as a part of the signal turn-on

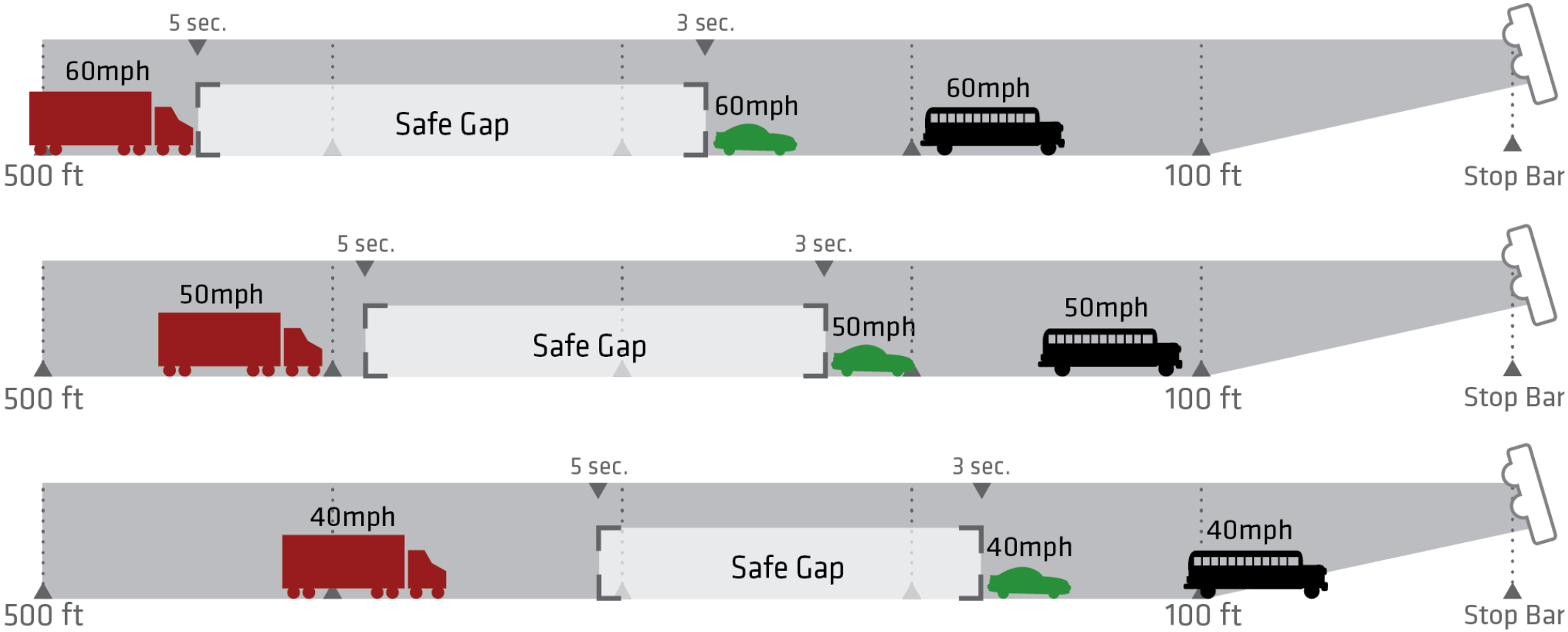
Noticed issues with detection reaching too far to address “speeding opportunities”


http://www.youtube.com/watch?v=_emZ9fXeqCE

SE 28th & Powell

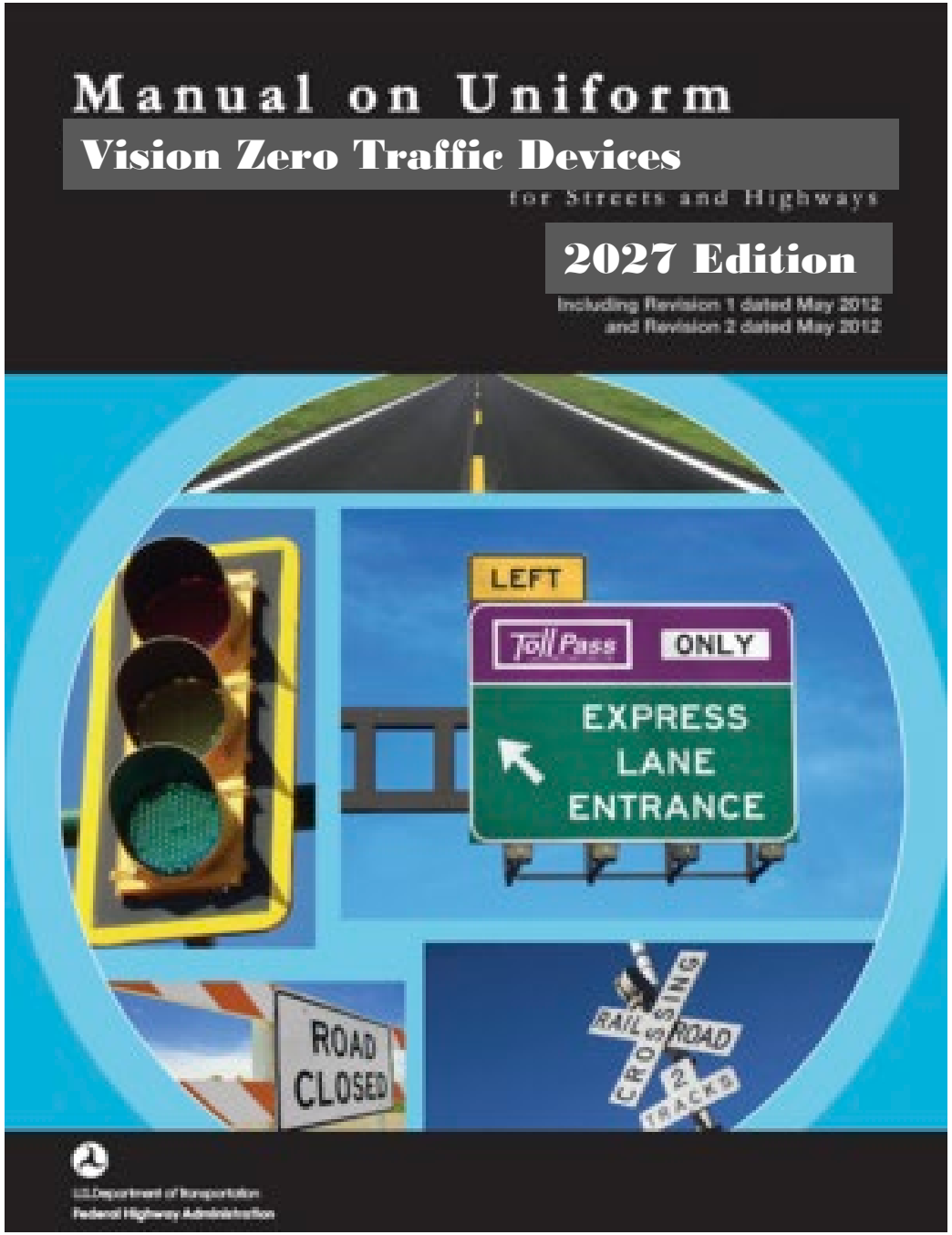
Rest in Red

- Does ETA based detection systems that use speed encourage speeding?
- As detection senses, should it be tied to speed limit or type of user?



MUVZTD??

Dream scenario: FHWA Office of Safety releases **Manual of Uniform Vision Zero Traffic Devices**



Dream Scenario #2

FHWA invites practitioners on an International Tour on best practices for Safety in Traffic Signal Timing

Thanks for your time!

Source: Portland State University (Flickr)

Matt Duncan, P.E. PTOE
City of Lakewood, Colorado
Traffic Operations Engineering Manager

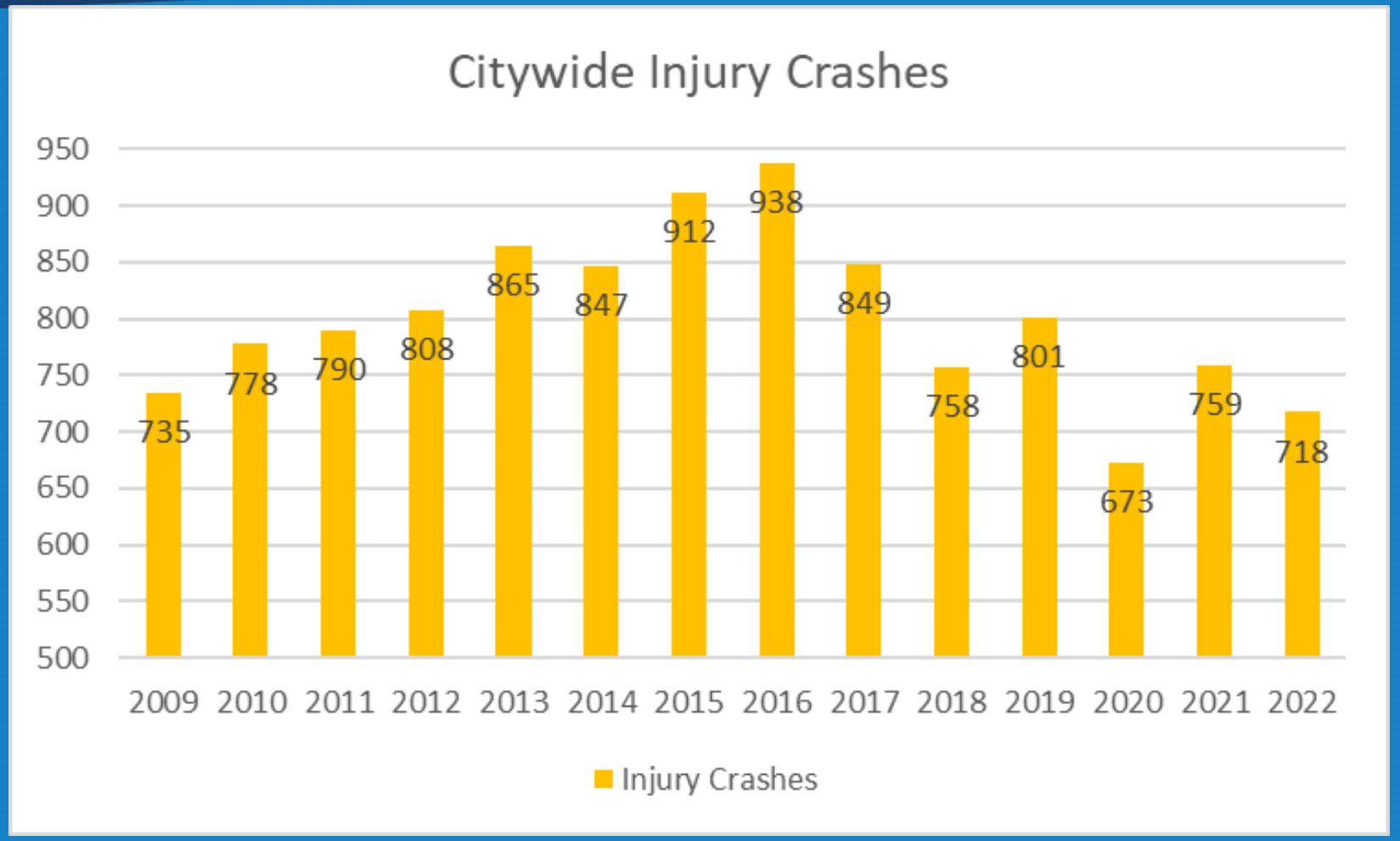
Traffic Safety Trifecta

Detectives, Engineers and the Coroner:

Rethinking Pedestrian Safety through a Public Health Lens

Lakewood
Full of Possibilities.

Understanding the Problem



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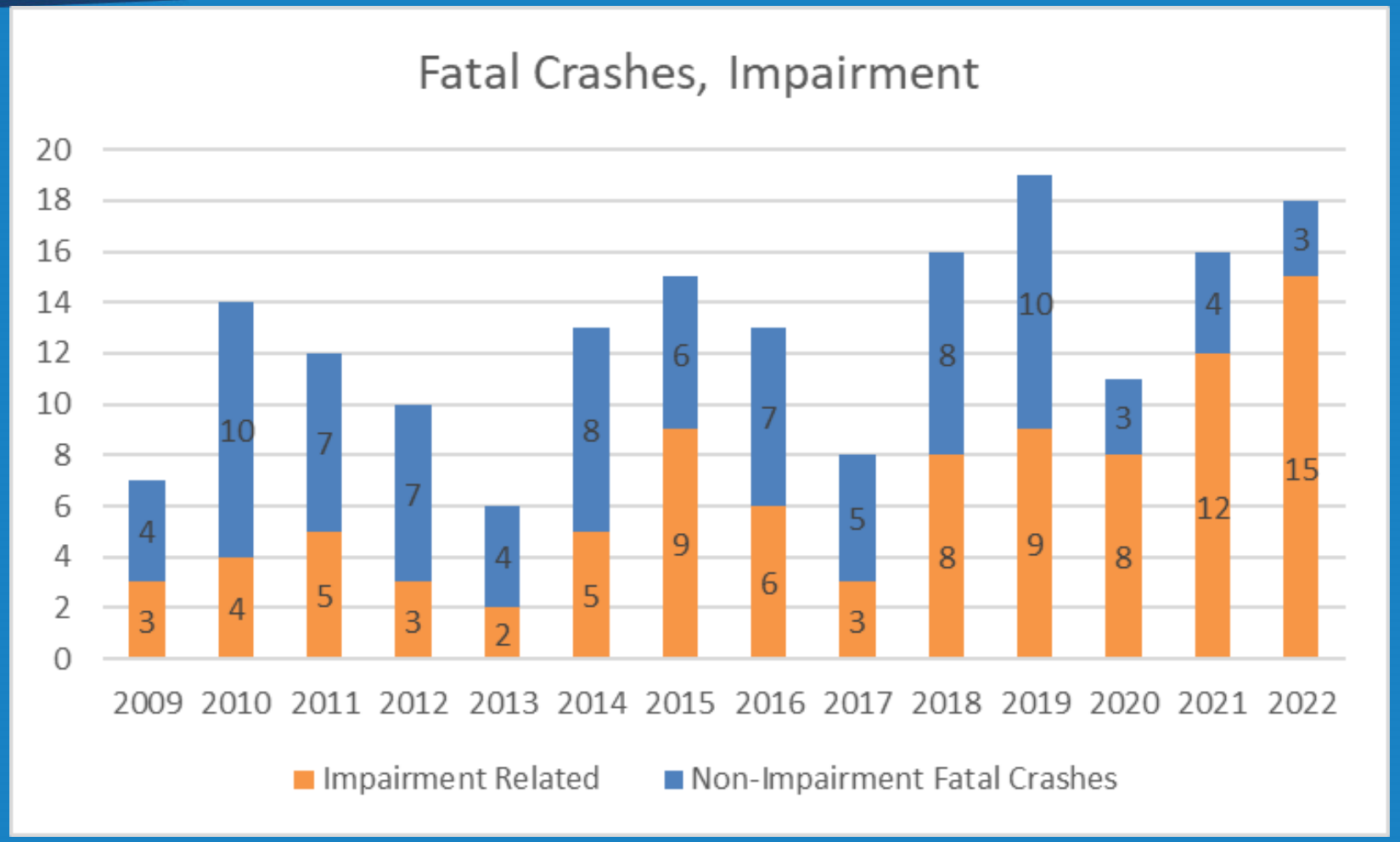
Understanding the Problem



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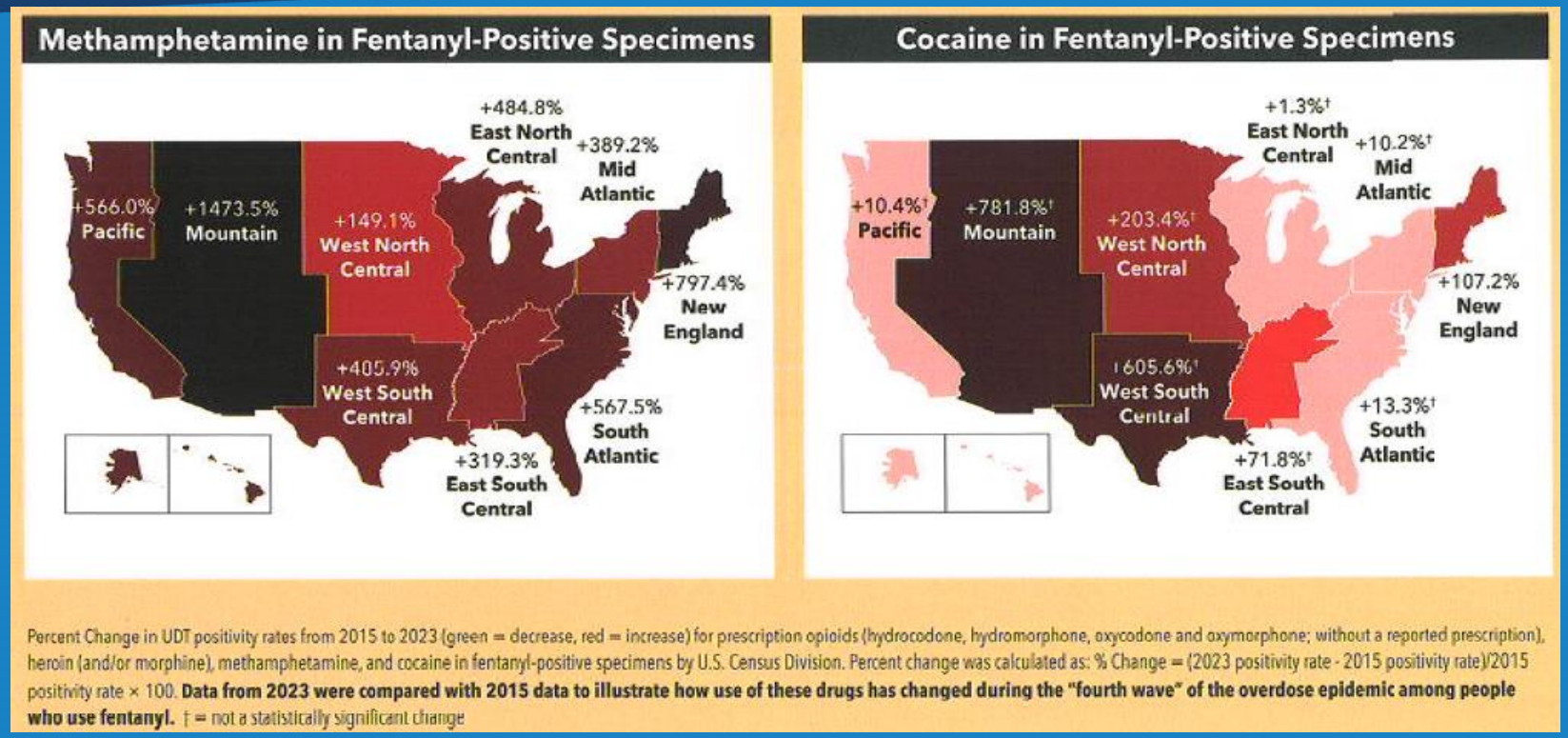
Understanding the Problem



Above: %-Change in fentanyl positivity rates from 2015 – 2023, U.S. Census Division, drug testing laboratory data.

- Millennium Health "The Fourth Wave", February 2024

CASE #1

ARTERIAL, MIDBLOCK
PEDESTRIAN vs SEDAN
DARK, DRY
1 KILLED
DEATH OF OFFENDER- NCF
SUNDAY DECEMBER, 23:39 PM

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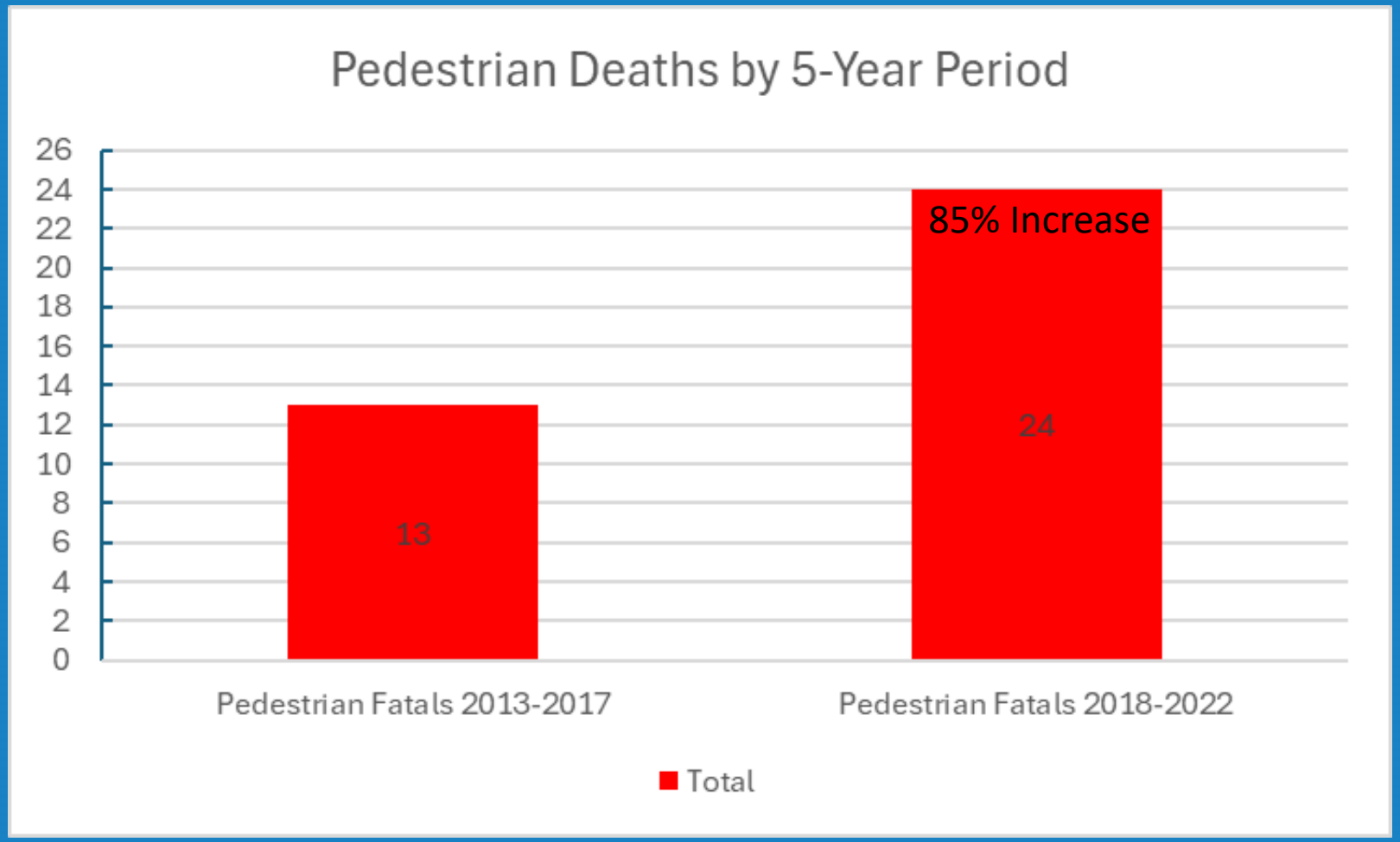
Understanding the Problem



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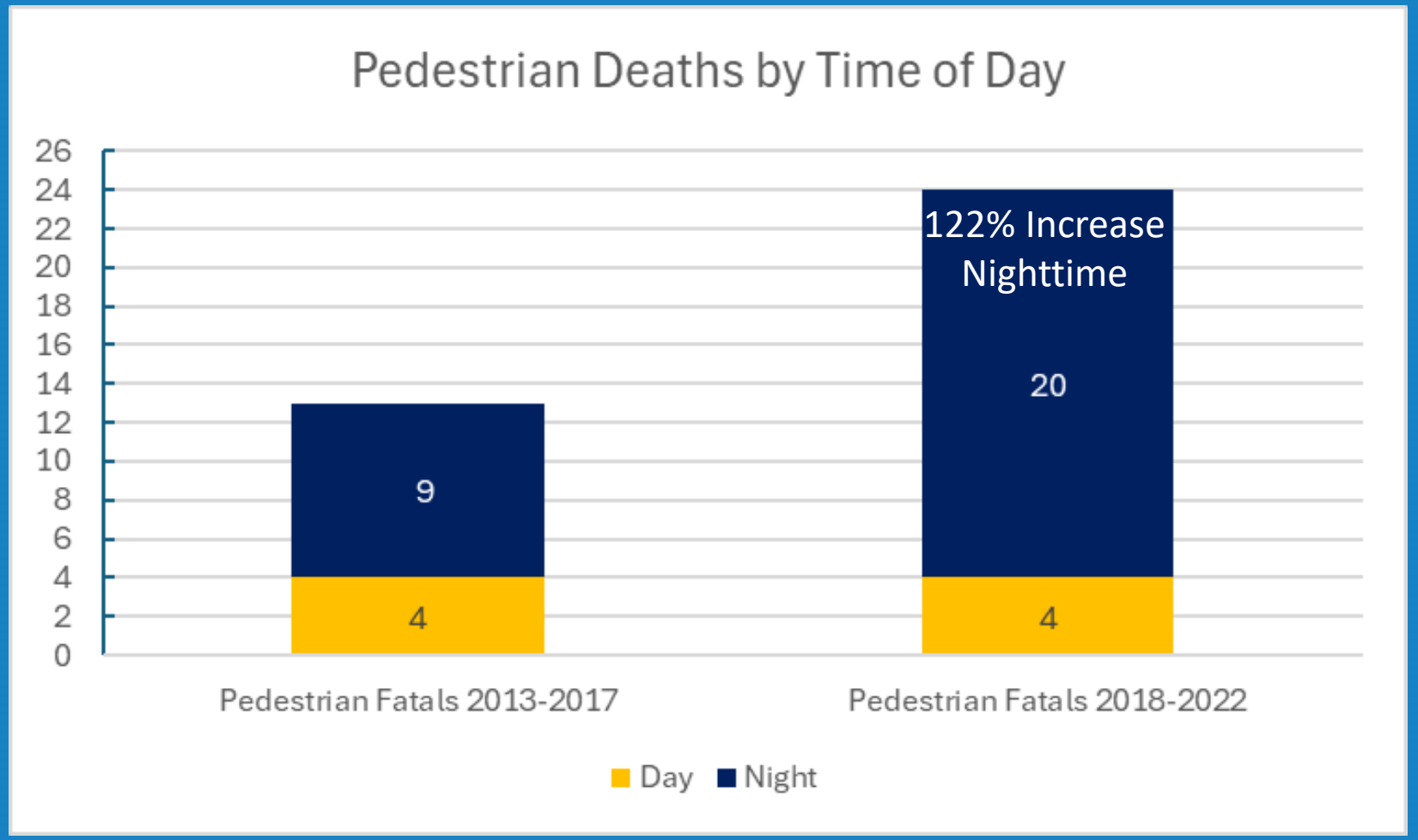
Understanding the Problem



Case #2
ARTERIAL at LOCAL ST
PED-ENCUMBRANCE vs SEDAN
EVENING, DRY
1 KILLED
LEAVING SCENE/ACCDNT INV DEATH
THURSDAY, SEPTEMBER 18:59 PM

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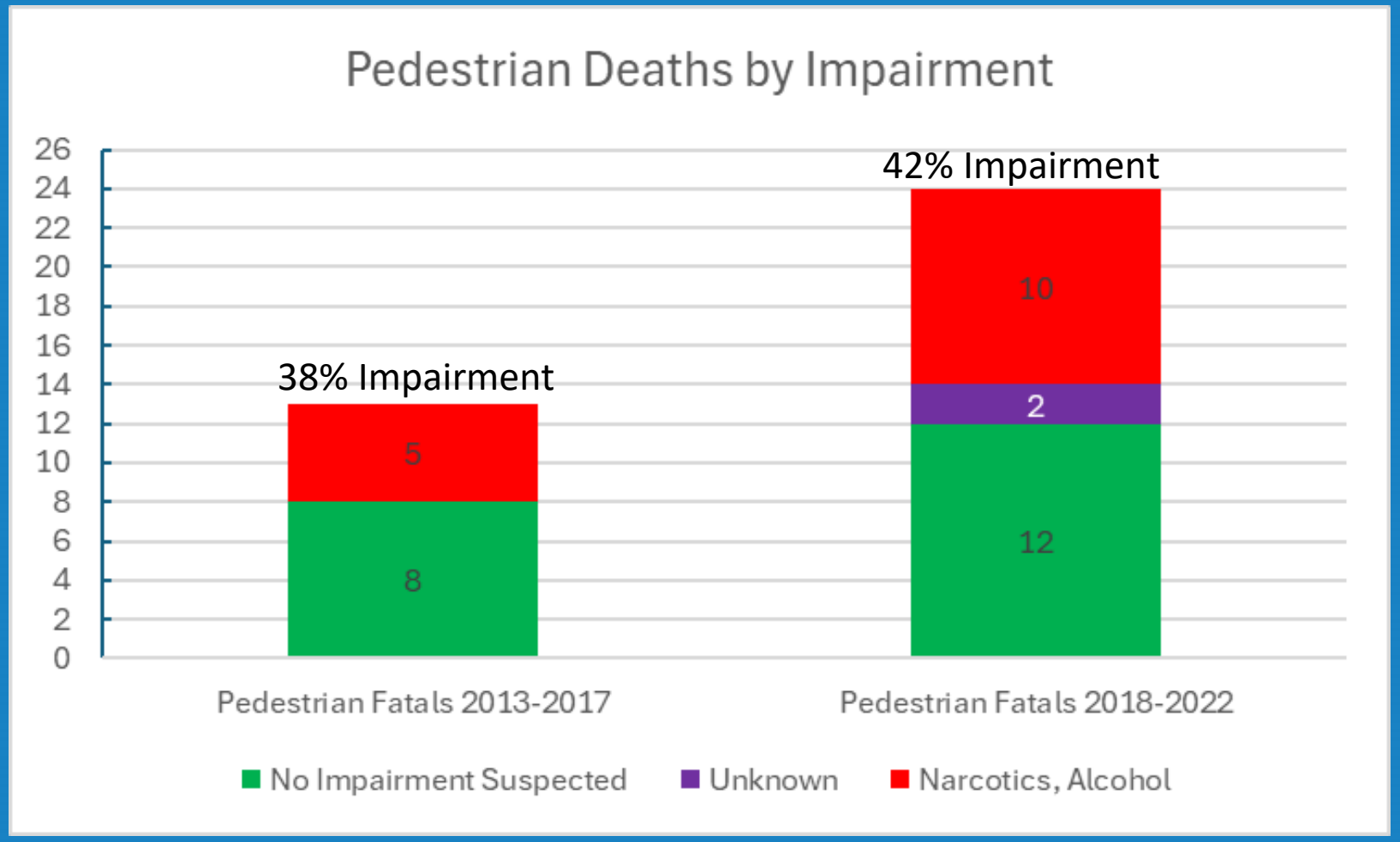
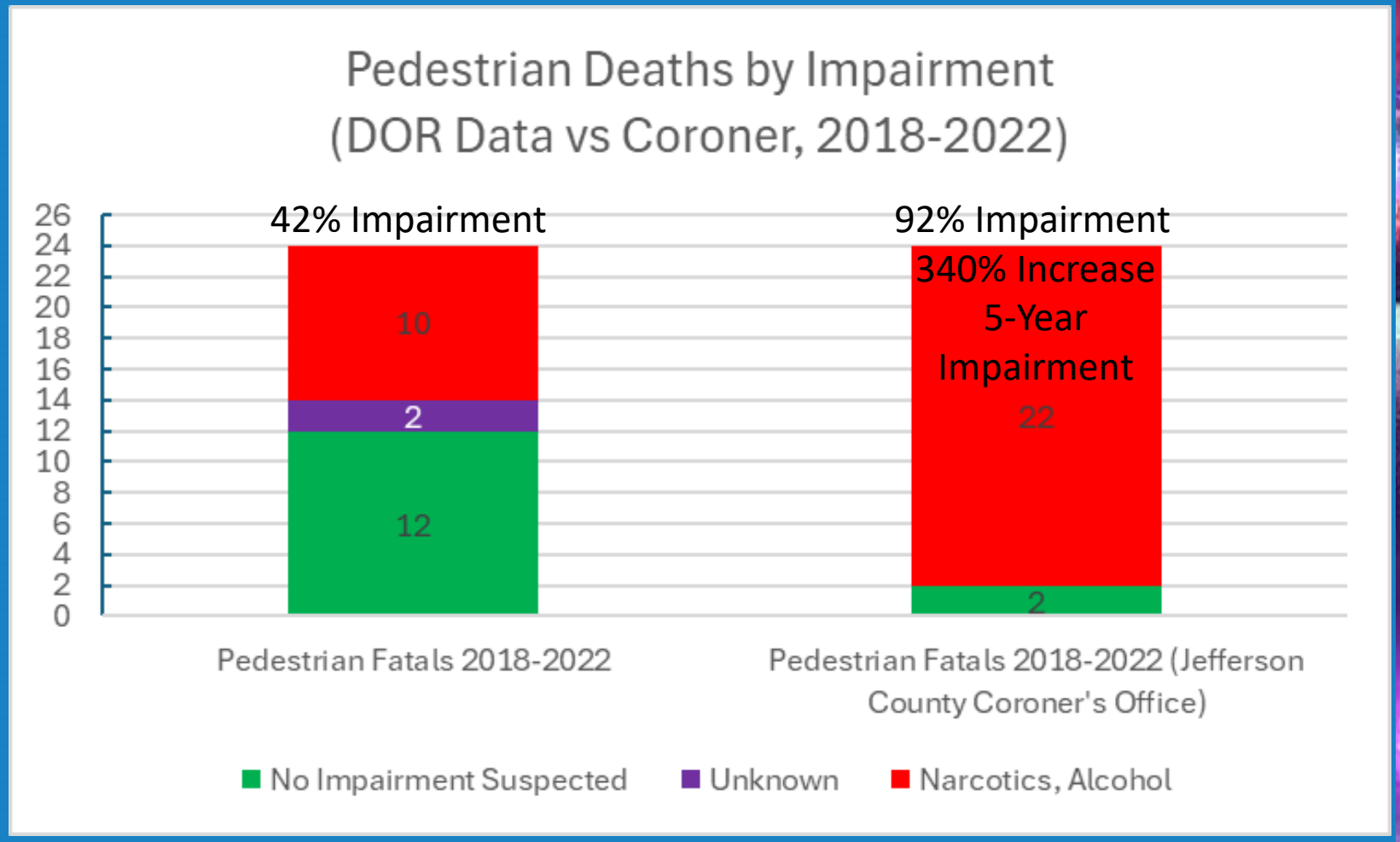
Investigative Insight

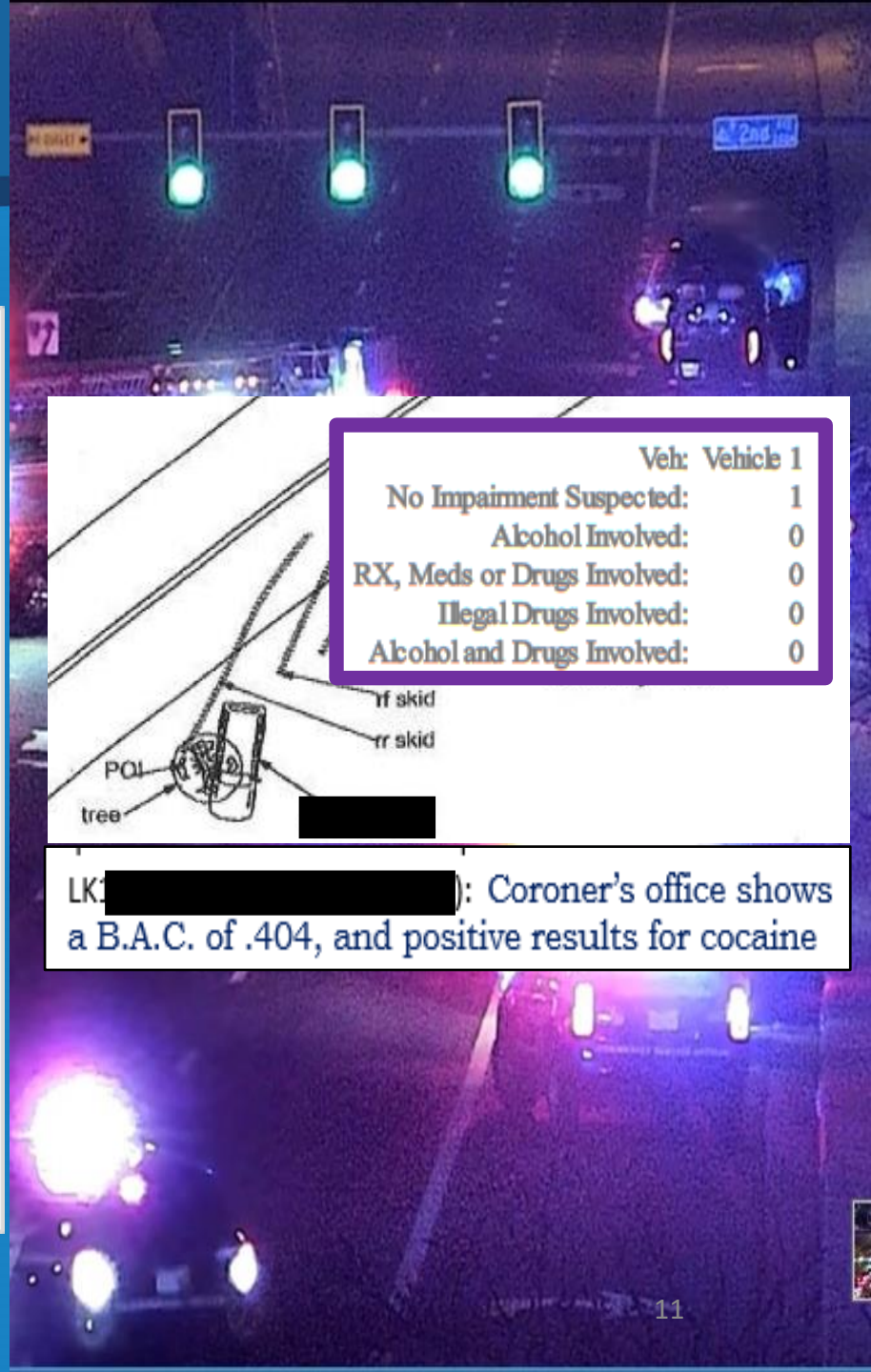
Lakewood
Full of Possibilities.

Understanding the Problem



Understanding the Problem





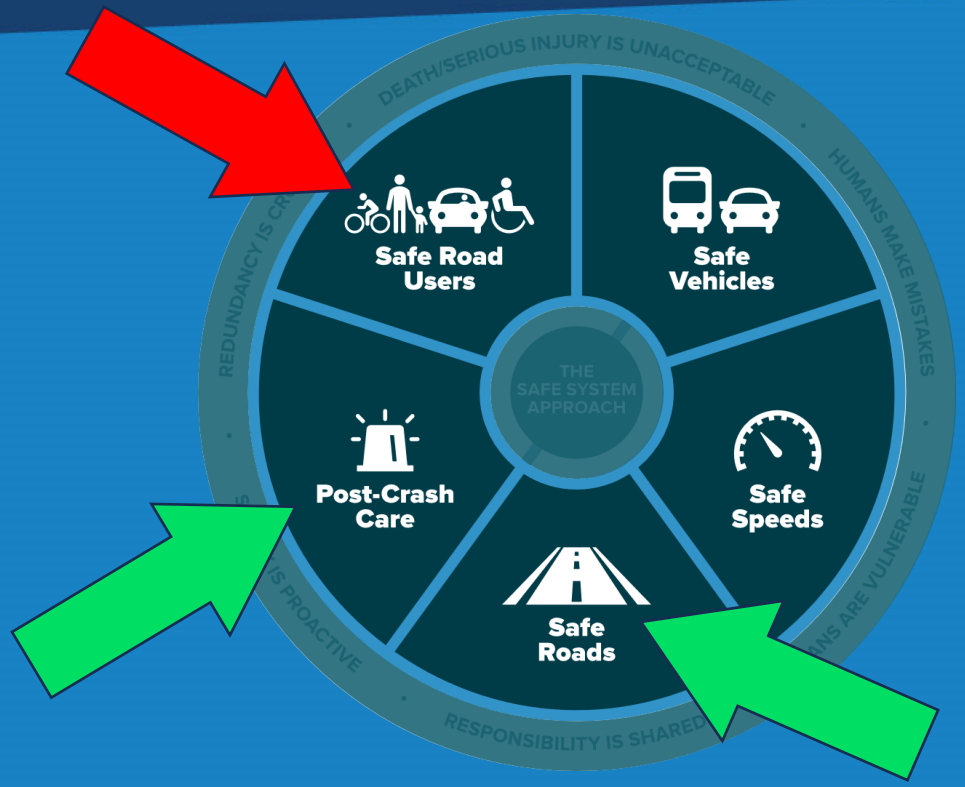
CASE #3
ARTERIAL at LOCAL ST
PEDESTRIAN vs JEEP
1 KILLED
DARK, DRY
DEATH OF THE OFFENDER- NCF
SATURDAY MARCH, 02:47 AM

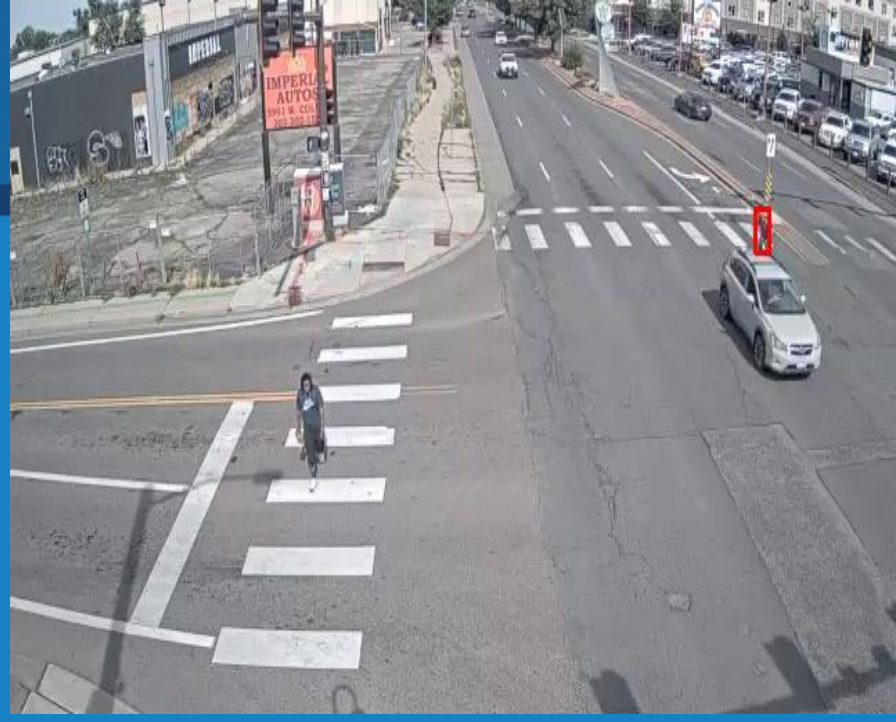
Lakewood
Full of Possibilities.

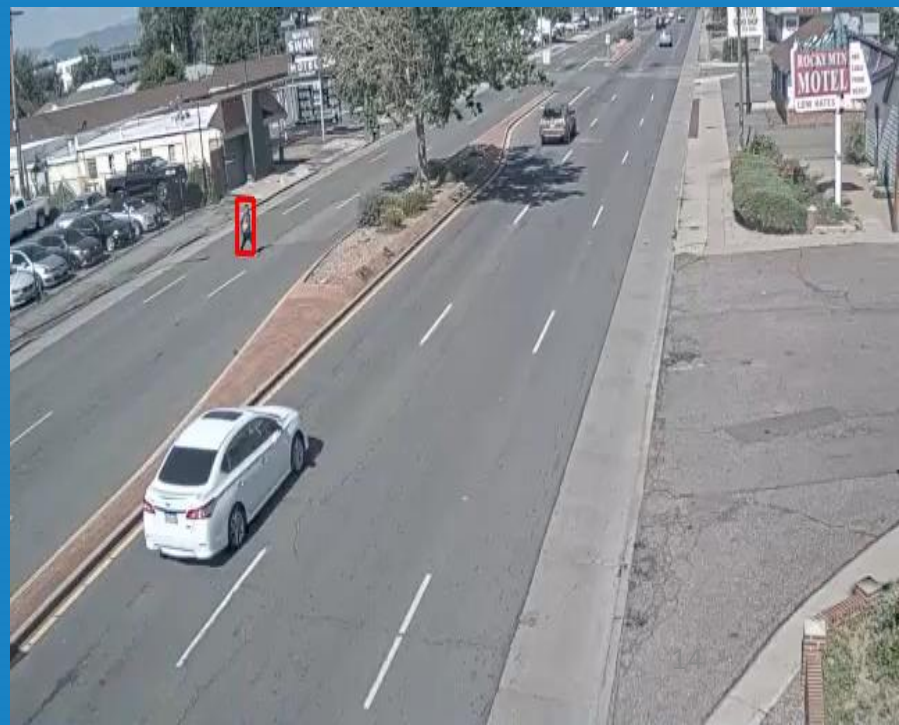
Investigative Insight

Lakewood
Full of Possibilities.

Understanding the Problem







"All recommendations made following a death review must arise from the evidence obtained from the review …or stem directly from the deaths reviewed during this study."

-Office of the Chief Coroner for Ontario

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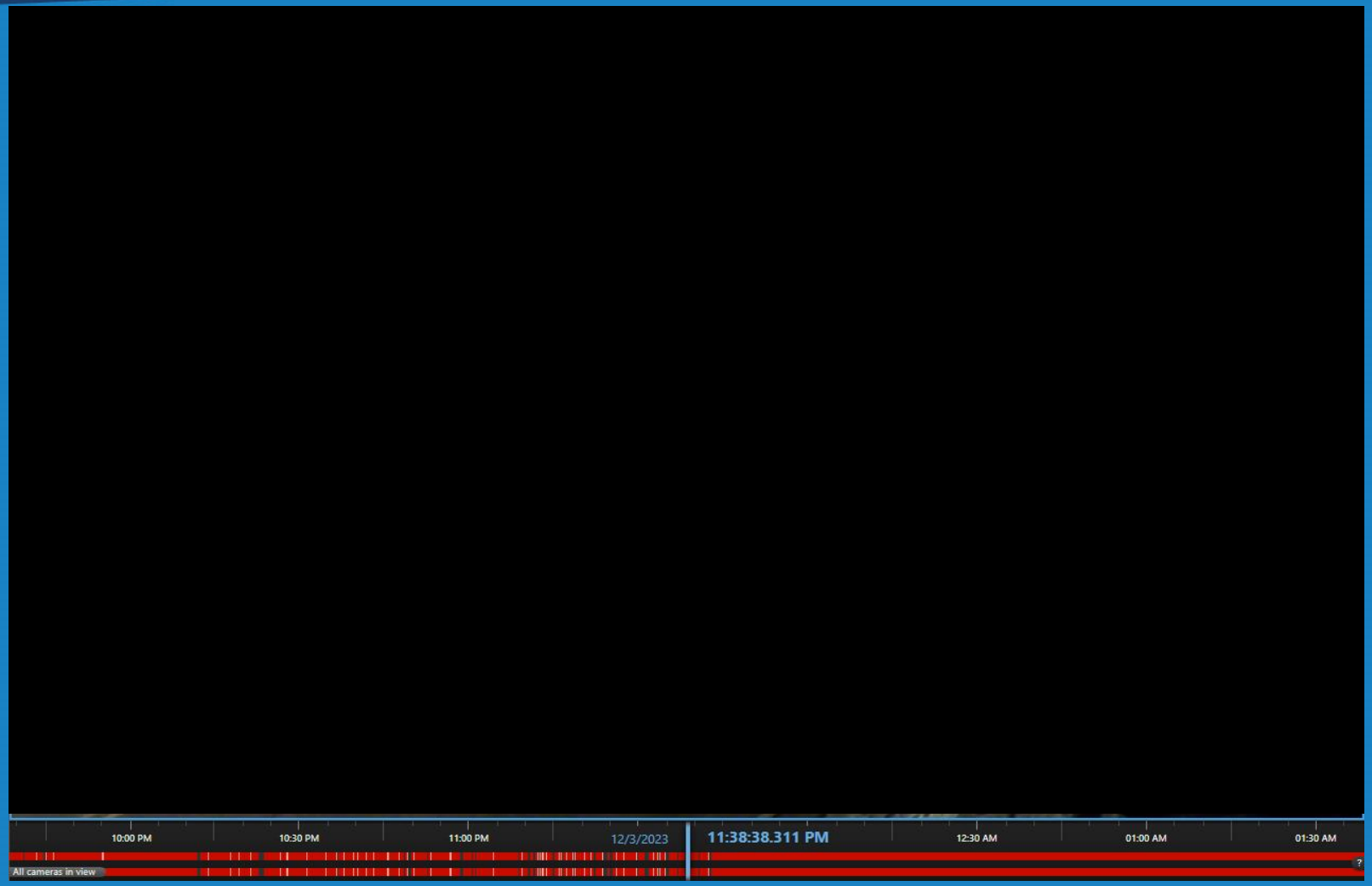
Using Evidence: Lighting



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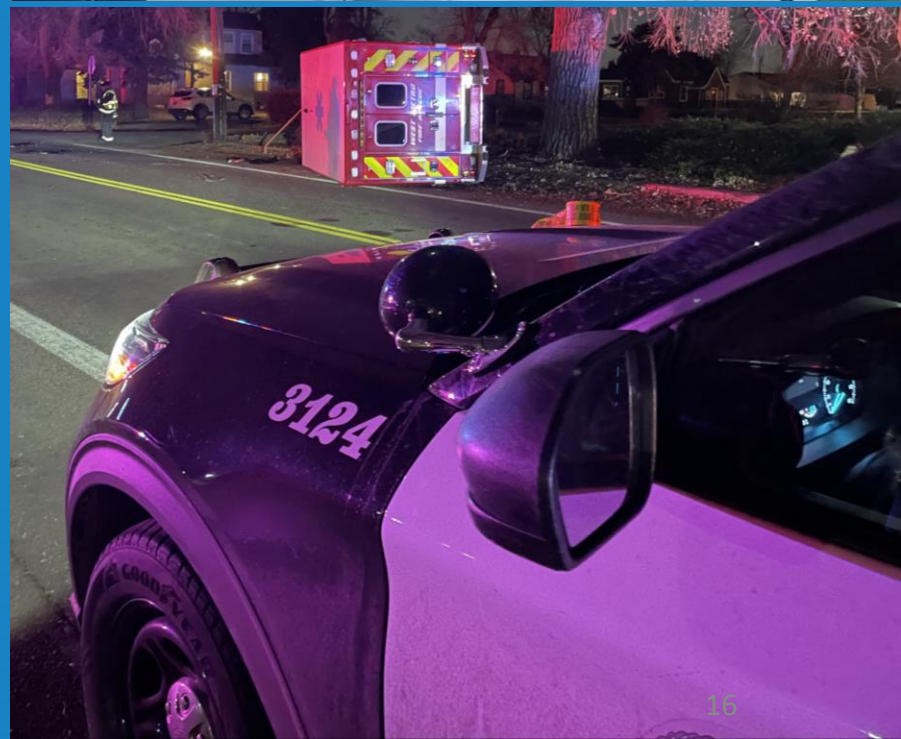
Using Evidence: Post-Crash Care



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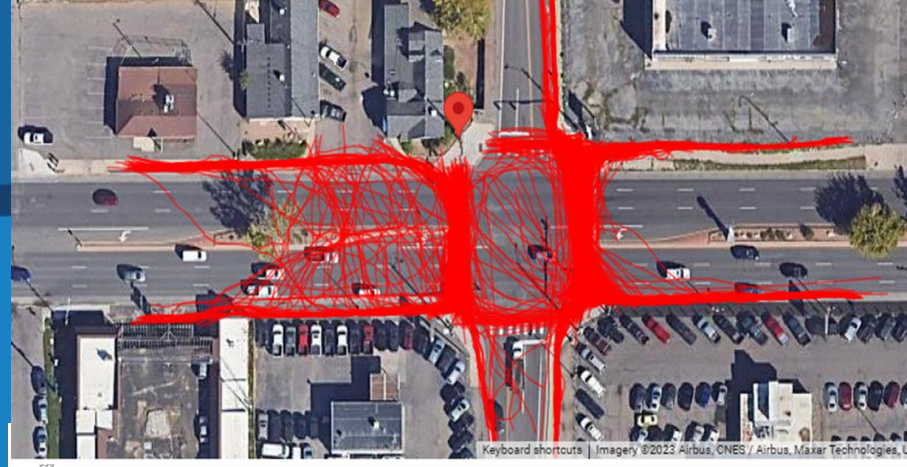
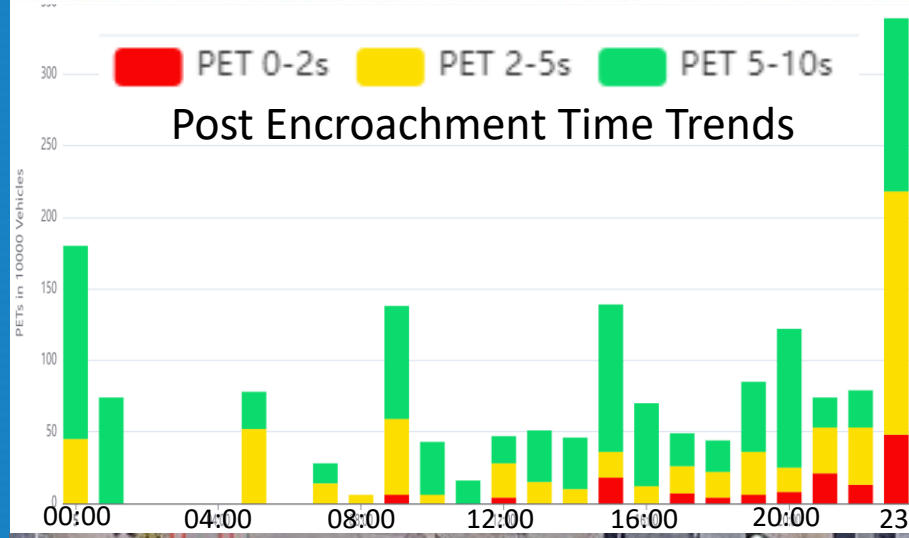
Using Evidence: Signals

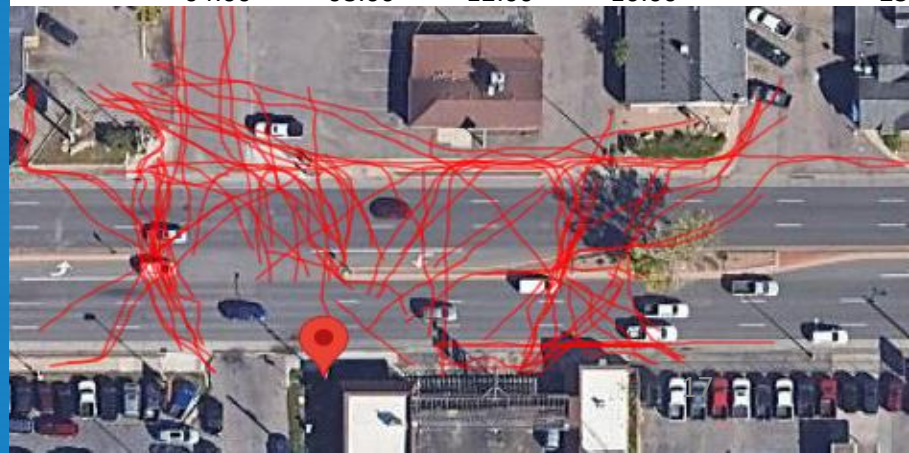
Leveraging Recorded Video, ITS

- To Guide Engineering Design and Decisions
- Measure of Effectiveness for Engineering Decisions
- Using ITS, Analytics for Crash Prevention
  - RIGHT: *Ouster/Velodyne analytics show crossing behavior, location and PET trends by time of day*

"The impact is 1.5 seconds later. The vehicle is so close that the time is the normal perception/ reaction time for the driver and there is no time to avoid the collision."







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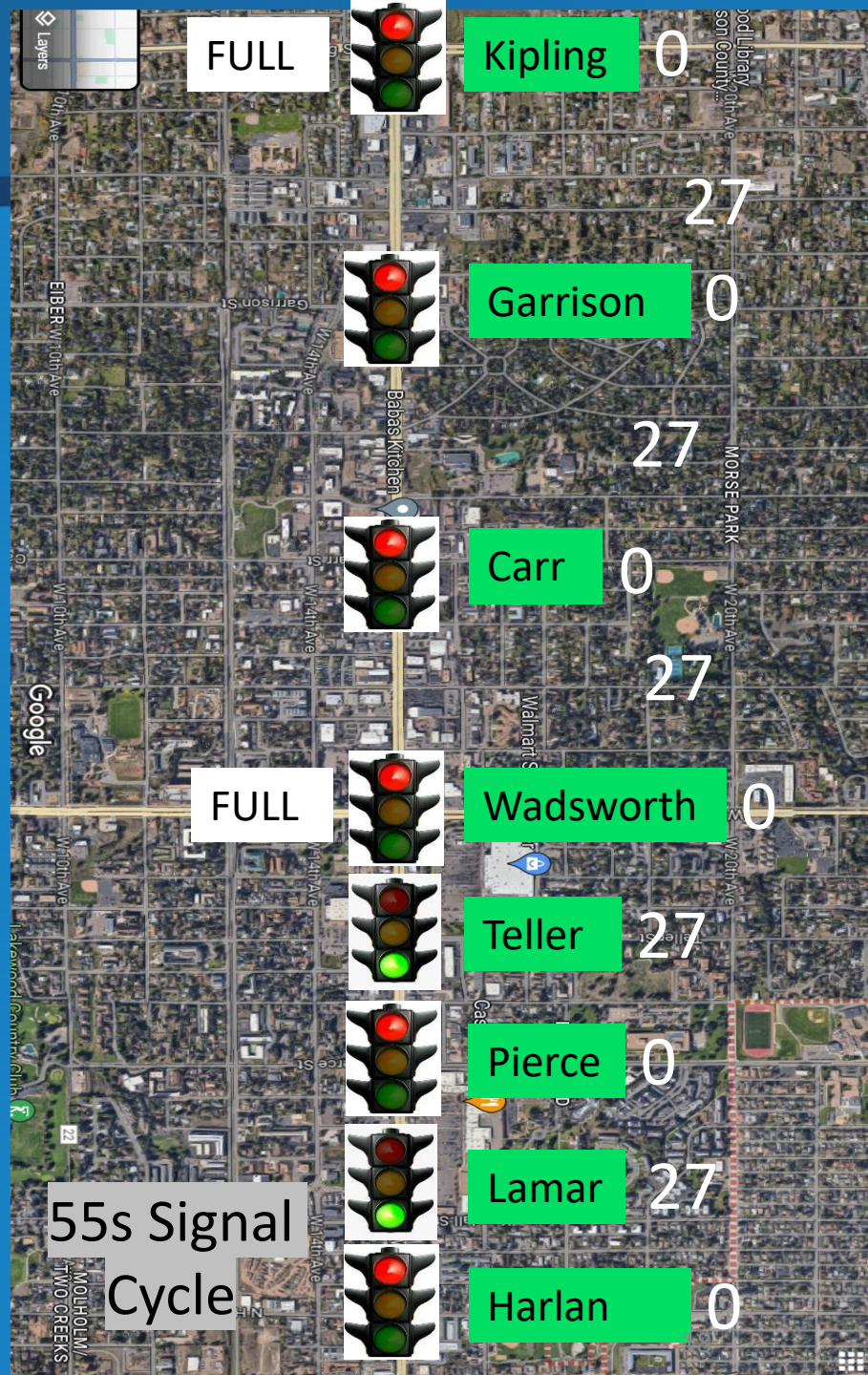
Using Evidence: Signals

Concepts: FHWA Signal Timing on a Shoestring

- Alternate offset formulas for traffic signal cycle lengths
  (single alternate offsets) CL= 2*Distance / Speed
  (double alternate offsets) CL= 4*Distance / Speed
  (triple alternate offsets) CL= 6*Distance / Speed

- Alternate offset is ½ the cycle length

- Single Alternate with ¼-mile spacing at 35 m.p.h.
  *2*1320 ft / 51.333 fps = 51.4 s*
  *55s = 2*1320ft / Speed = 48 fps, or 32.7 mph*



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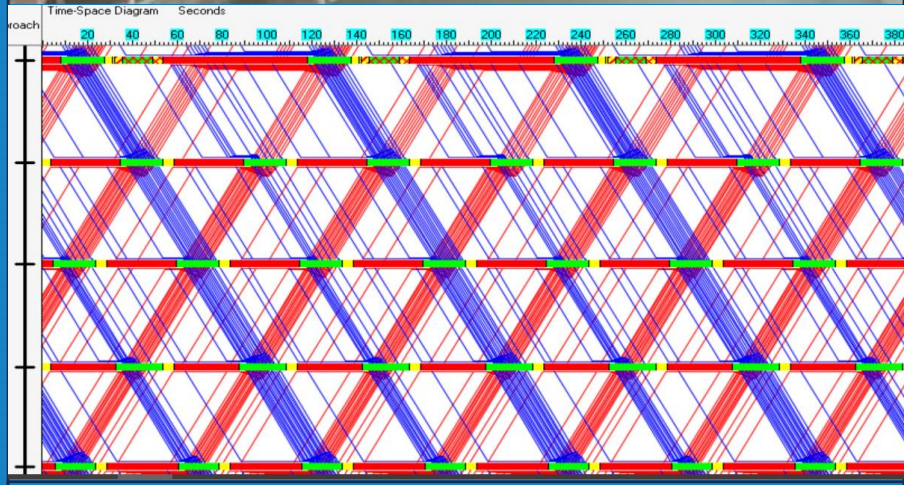
Using Evidence: Signals



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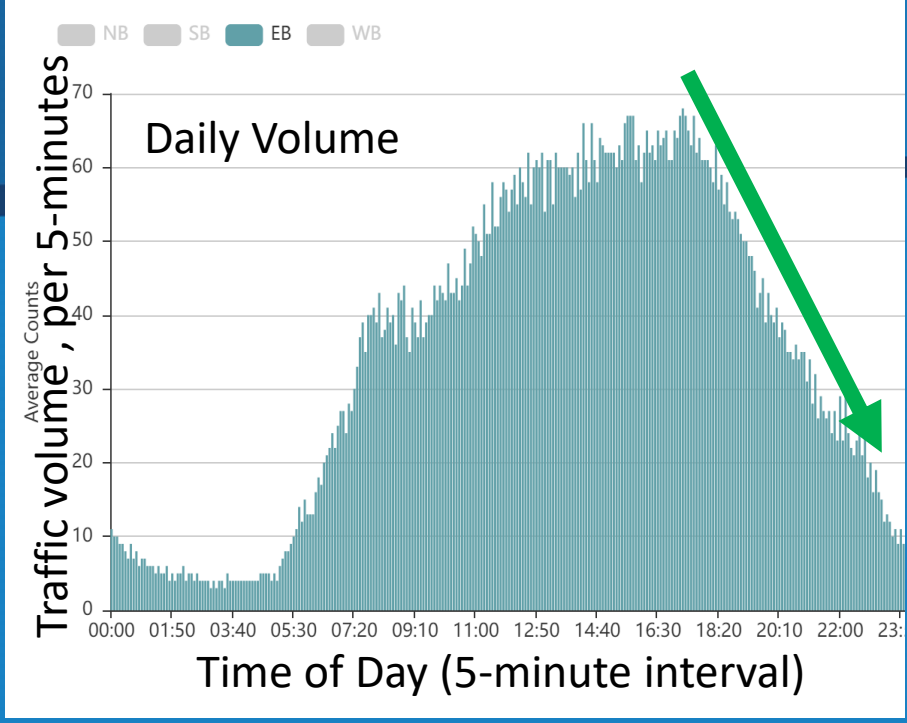
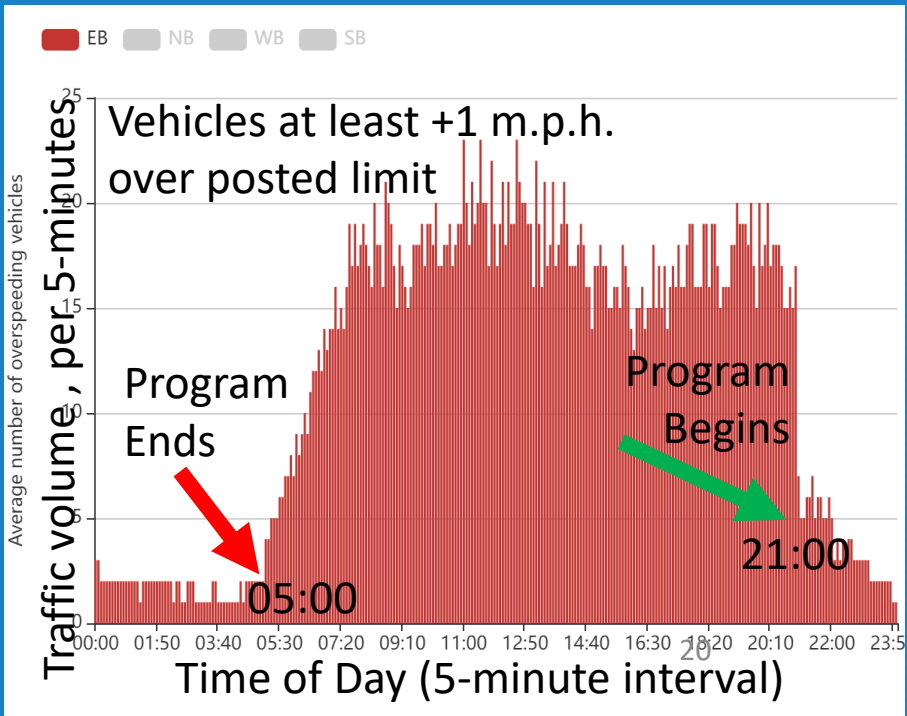
Using Evidence: Signals

Measure of Effectiveness for Fixed-Time Signal Ops

- Top graph, DERQ: Daily volume per 5-minute intervals, showing gradual decline of volumes from PM to overnight period
- Lower graph, DERQ: Vehicles exceeding 35 m.p.h. speed limit per 5-minute interval.
- Fixed time signal operation begins at 21:00, through overnight, and ends at 05:00.





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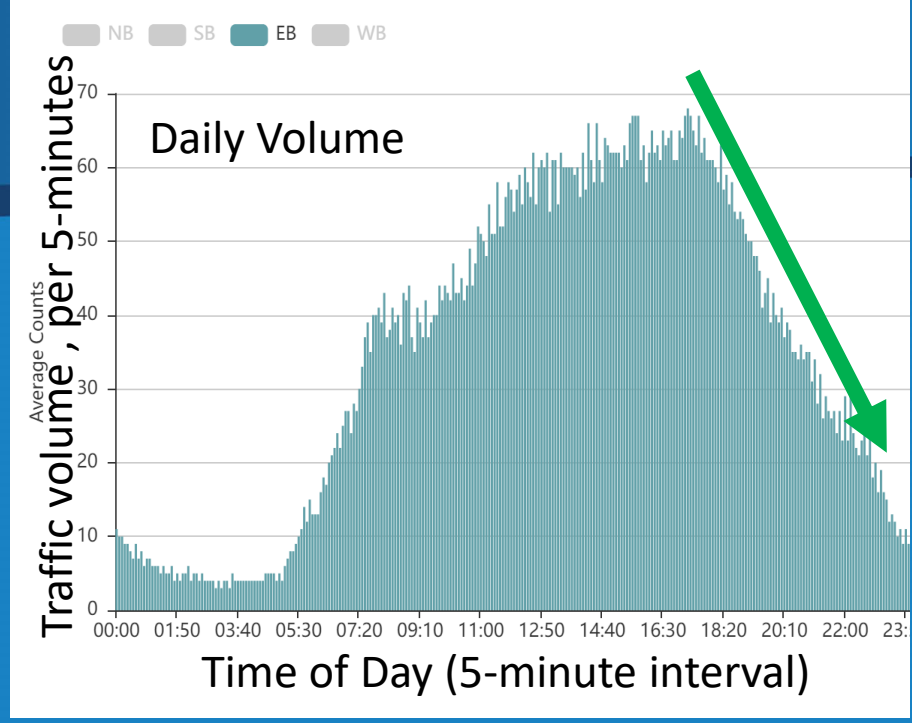
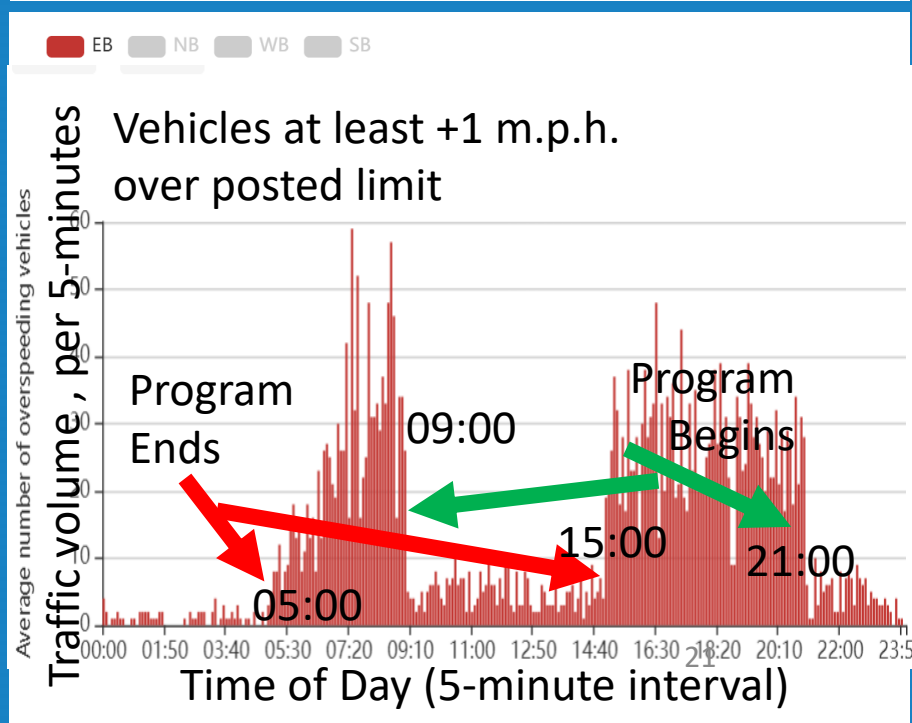
Using Evidence: Signals

Measure of Effectiveness for Fixed-Time Signal Ops

- Top graph, DERQ: Daily volume per 5-minute intervals, showing gradual decline of volumes from PM to overnight period
- Lower graph, DERQ: Vehicles exceeding 35 m.p.h. speed limit per 5-minute interval.
- Fixed time signal operation added 09:00 through 15:00.





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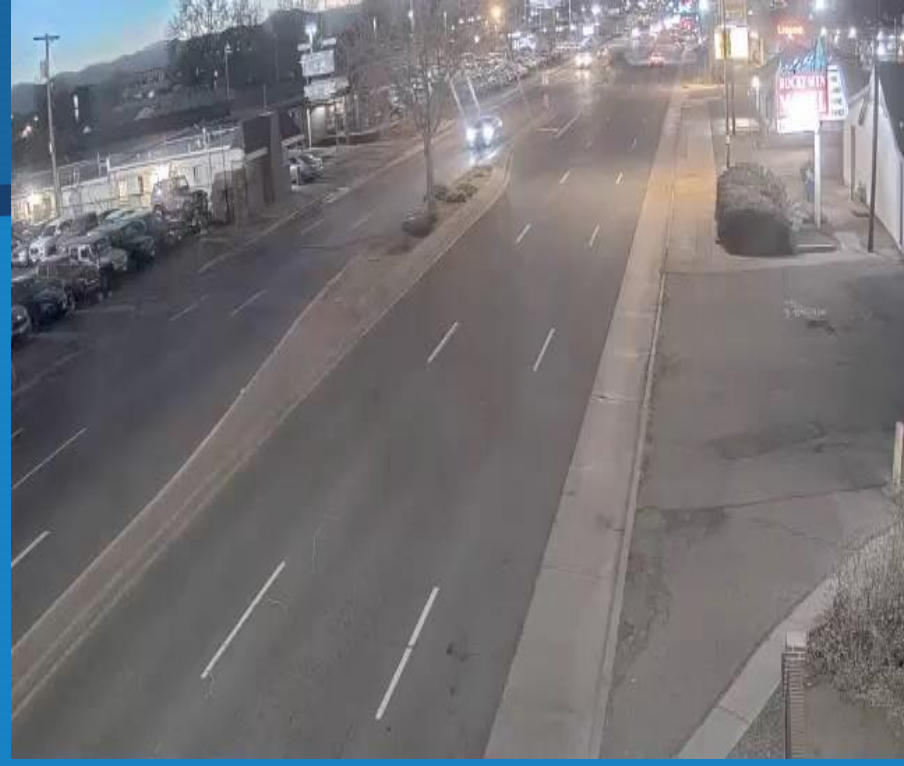
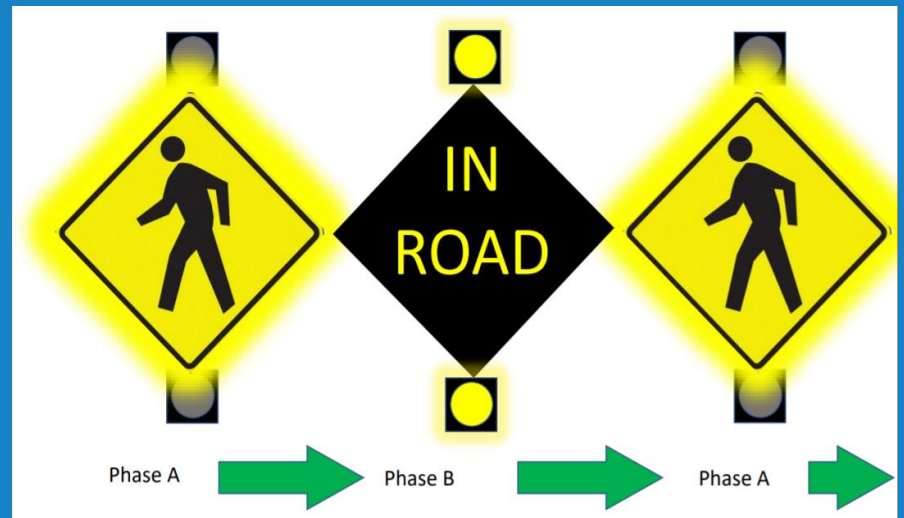
Using Evidence: ITS

Using ITS for Pedestrian Entry Warning System

- Potential use of TTC (Time to Collision) to predict potential of crash, warn approaching motorist
- Clear, concise warning heightens focus to immediate path, real-time hazard
- Potential to enhance perception-reaction time from unexpected to expected, *1.5s reduction in PRT possible*





Matt Duncan, P.E. PTOE

Alternating flash between Phase A and Phase B until object no longer detected within zone.
Rests in "dark", fail-safe in dark to maintain integrity of real-time warning.

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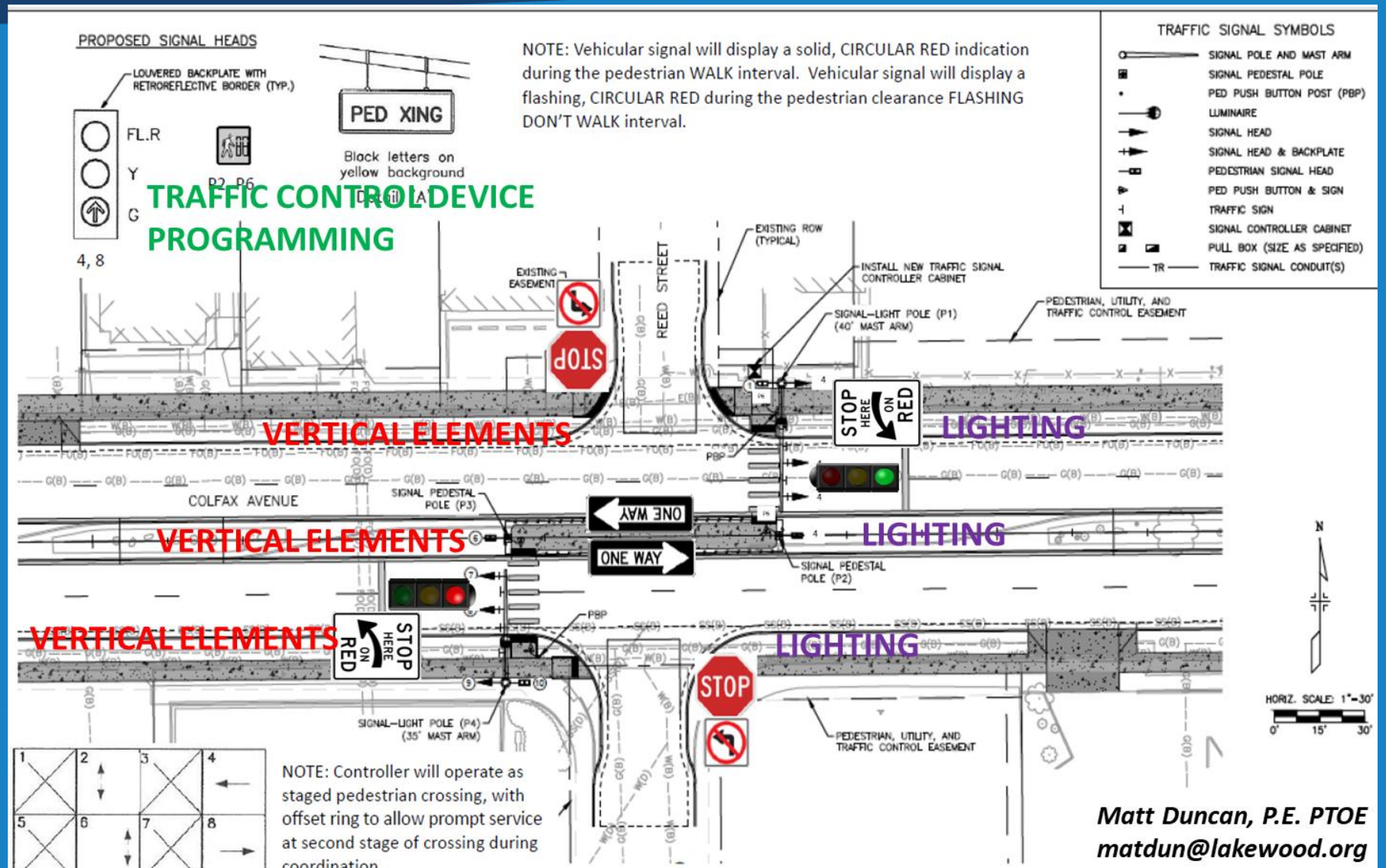
Using Evidence: Policy

Using Licensure, City Codes to address root causes

- Frequent problem-calls, crime motels
- Liquor stores and bars that overserve alcohol
- Warnings, penalties, then revocation of license

Using Evidence: Roadside Design



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Credit Unisson Perth redbubble.com

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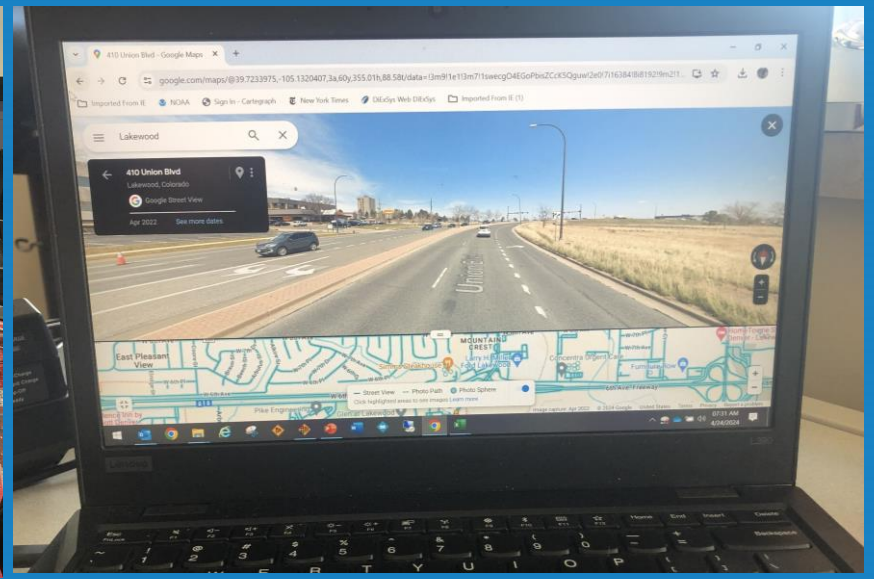
Main takeaway…

More of this…

and this…



Less of that…

Questions?

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Cmdr Lovejoy, Sgt Muller, Sgt Barefoot, Detective Strandberg, Detective Moffat
Lakewood Police
LakewoodPD.org

Engineers shall hold paramount the safety, health, and welfare of the public.
— ITE Canons of Ethics