



Memorandum

To: Honorable Mayor Borowsky and Members of City Council

From: Greg Caton, City Manager
Alison Tymkiw, Senior Director of Transportation and Infrastructure

Date: October 28, 2025

Subject: Traffic Management Center – General Overview

Scottsdale's Traffic Management Center (TMC) opened in 1993 with a single camera and the goal of alleviating congestion during the Phoenix Open. Since then, the TMC has expanded to include an extensive network of cameras, detection systems, traffic signal controllers and communication systems. In 2014 the TMC relocated from One Civic Center to the North Corporation Yard where it is staffed by several full-time employees including traffic engineers, Intelligent Transportation Systems (ITS) analysts and operators, and traffic signal technicians.

The group's responsibilities include:

- Installing and maintaining ITS devices: traffic signals, cameras, detection systems, communication devices, and streetlights.
- Adjusting traffic timing plans for signalized intersections to meet real-time traffic patterns and demands.
- Monitoring and managing live traffic during significant roadway construction, traffic collisions, special events and other road incidents.

The ITS systems include:

- 226 miles of fiber optic cable
- 86 radio communication devices
- 229 video detection systems
- 243 live-feed pan tilt zoom cameras
- 307 signalized intersections
- 14 Pedestrian Hybrid Beacons
- 9,358 Streetlights

Traffic Signal Timing

The TMC develops and maintains traffic signal timing at signalized intersections throughout the city. These plans are developed using traffic engineering modeling software and comply with applicable city, state, and federal regulations. The plans and real-time traffic data determine signal phasing and timing for left-turn arrows, red lights and green lights. Signal timing plans are unique to each intersection and are dependent upon the intersection's traffic volumes, geometric design characteristics and the progression of traffic in a coordinated corridor.

Signal operations like leading or lagging left-turn arrows and yellow and red-light clearance intervals can be adjusted when needed to help improve both traffic progression and road safety. These decisions are made on a case-by-case basis by traffic engineers. A clearance interval that is too short can compromise safety by increasing the risk of a red-light violation collision occurring shortly after a phase change, while a clearance interval that is too long can lead to confusion, long delay, decreased signal efficiency, increased chance of rear end collisions and an increase in risky driving behavior. Making real-time signal changes to address high traffic volumes, road construction or event traffic is standard practice at the city and among other agencies in the valley.

Special Events

During event season the TMC works with Scottsdale's police and fire departments to efficiently improve traffic flow in and outside the road restrictions and closures near the WMPO and WestWorld. Signal timing, surrounding the event venue, is implemented ahead of time to meet anticipated traffic volumes in the area; this includes traffic headed to the event (personal vehicles and ride-share services) as well as the traveling public. The TMC works closely with Scottsdale PD and communications staff to inform the public about planned road restrictions and to promote ride share queuing areas and off-site park and ride transportation to event venues. During special events the TMC is managed by traffic engineers and operators, Scottsdale PD and the department PIO to post traffic updates on social media.



C: Charter Officers
Jeff Walther, Assistant City Manager
Chief of Staff to Mayor Borowsky

Scottsdale's Signal System, Left-Turn Signals, and Red-Light Timing

Work Study Session
11/03/2025

Signal Basics

Leading and Lagging Operations

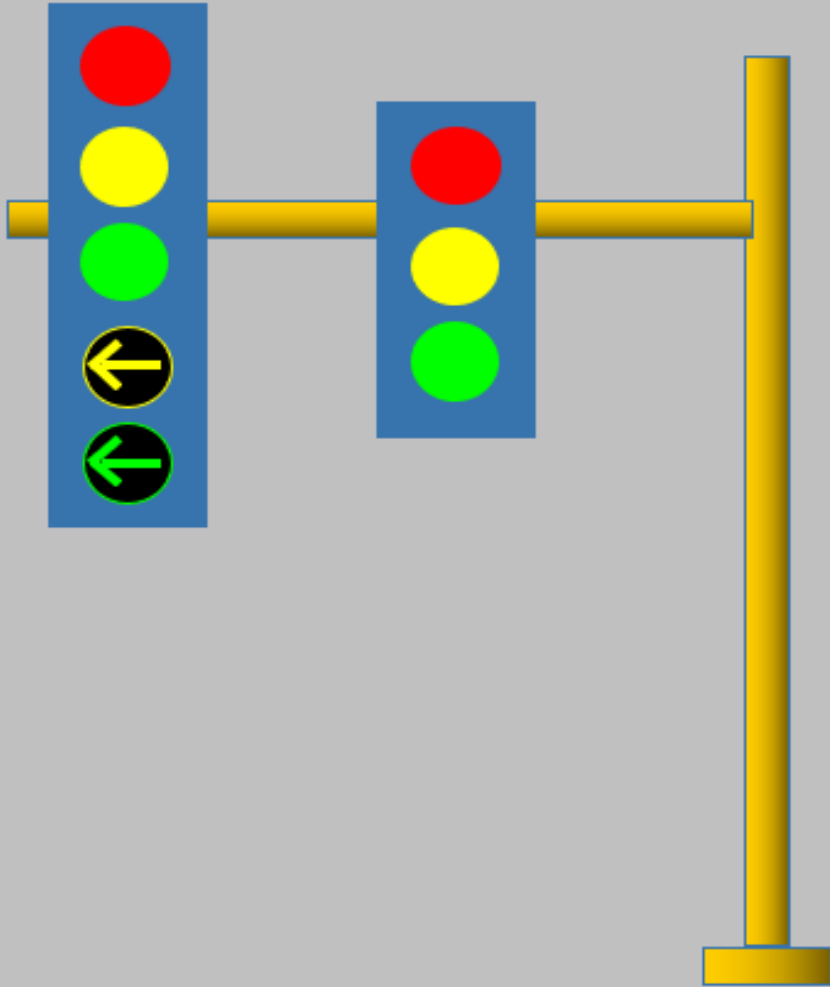
Signal Change and Clearance Intervals

Surrounding Agency Comparison

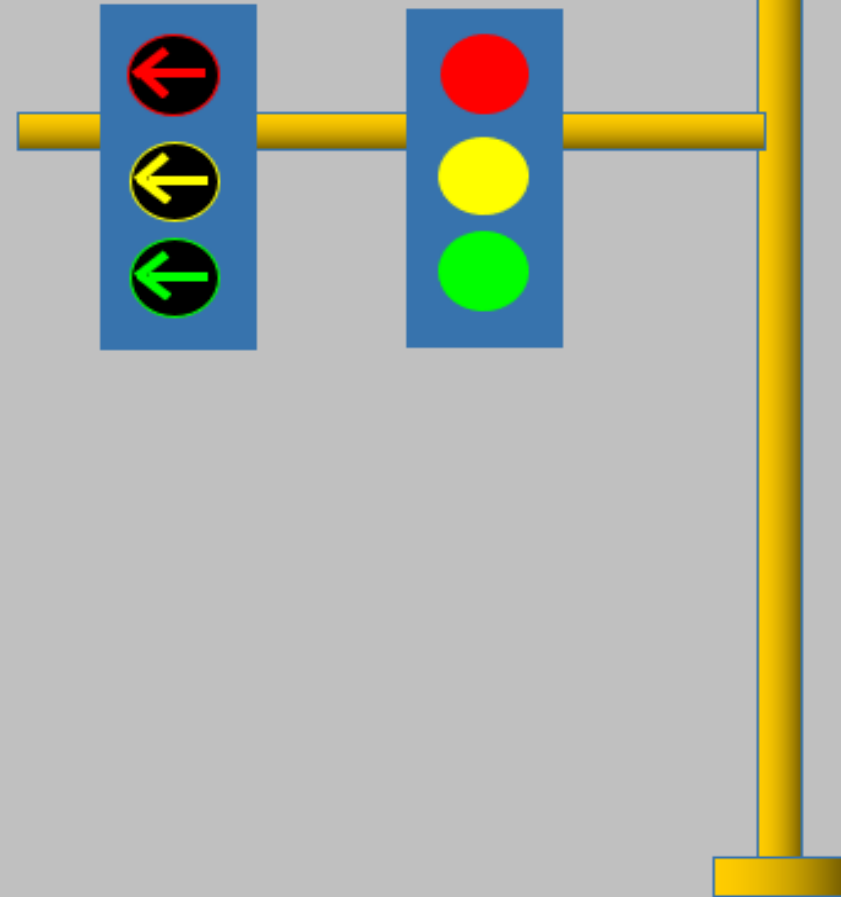
Scottsdale staff recommendations

Signals Basics

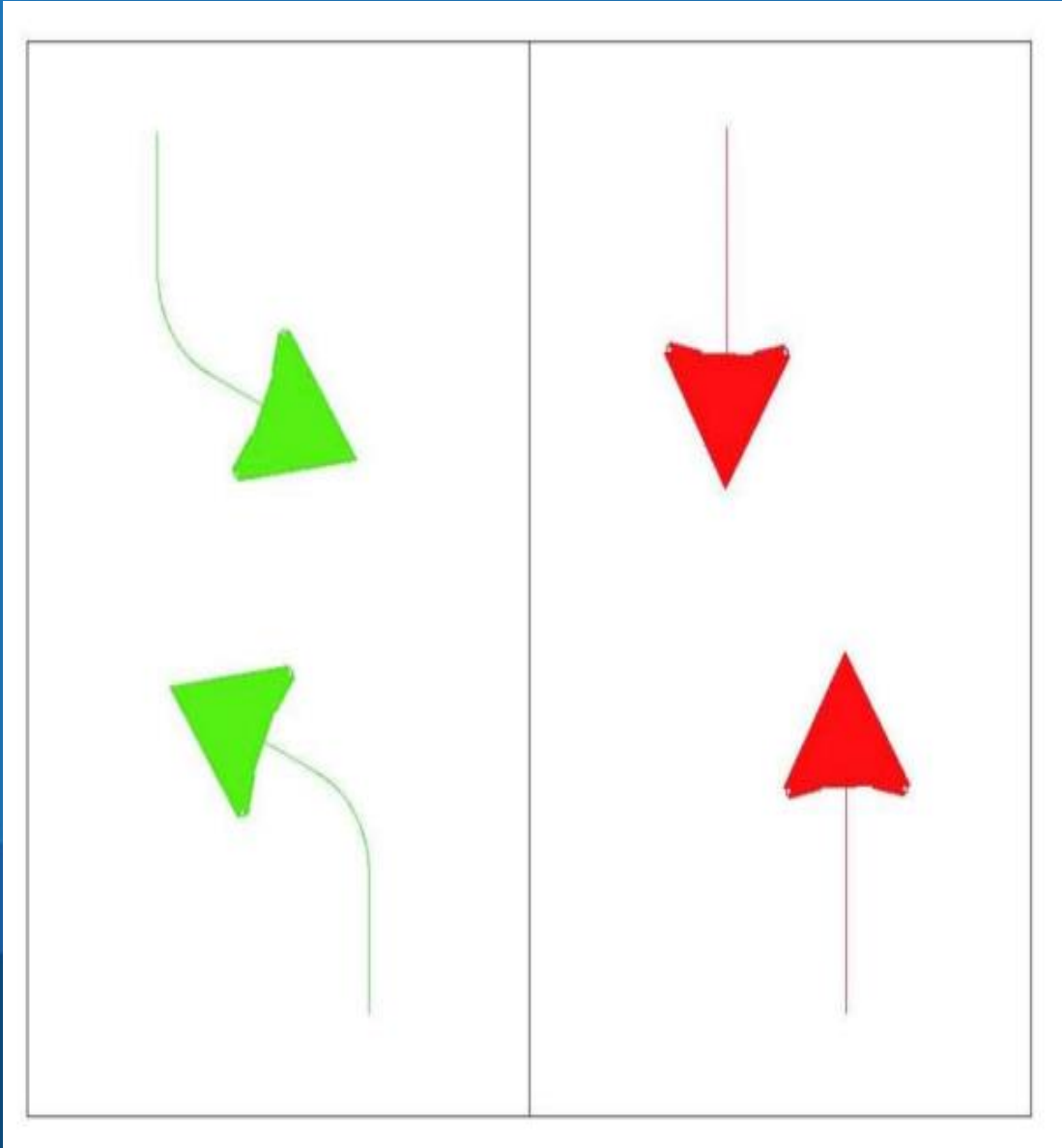
PERMISSIVE/PROTECTED



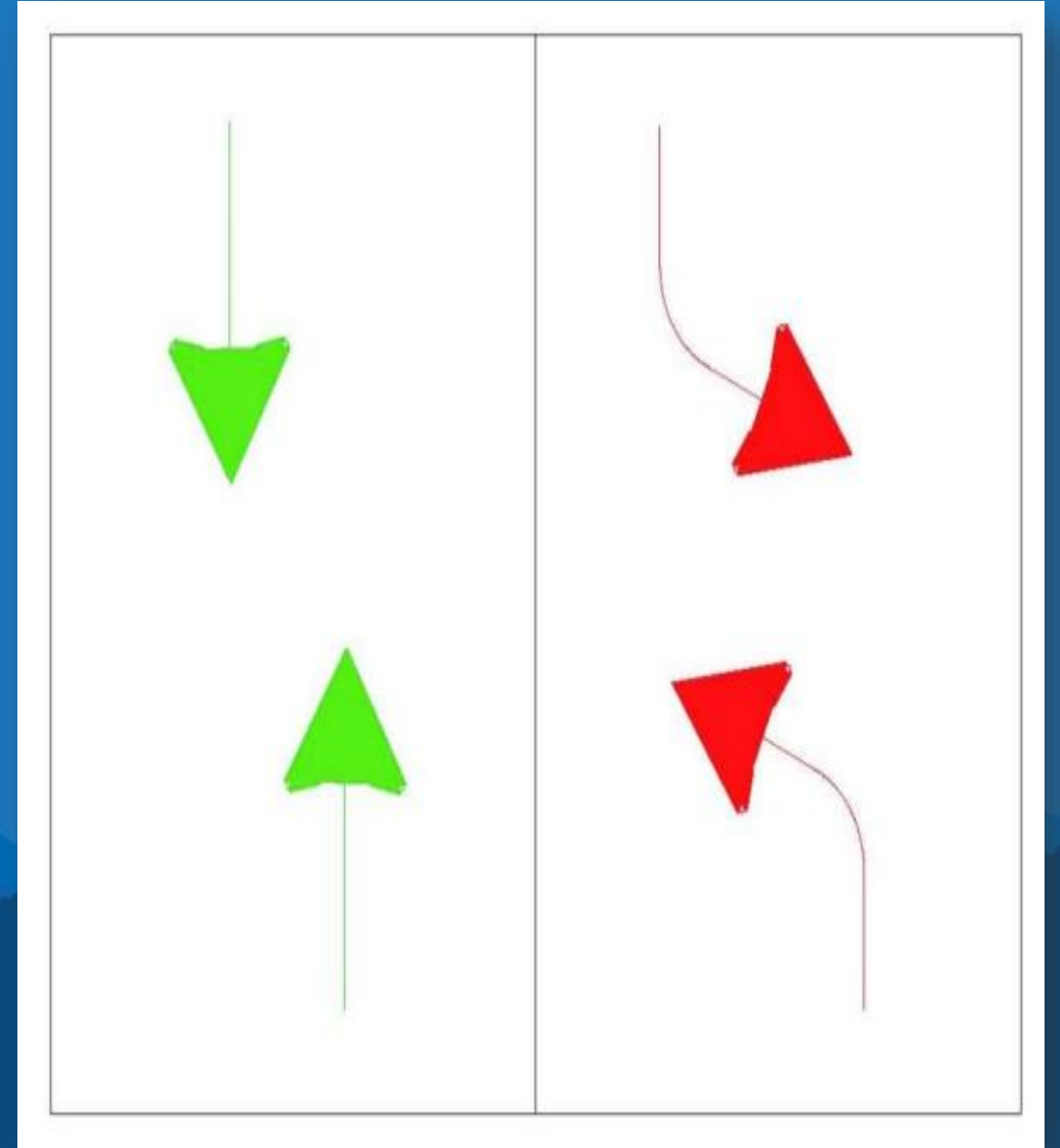
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Leading



Lagging



Left Turn Phasing Options

Exhibit 5-4 Left-Turn Phasing Options

Left-Turn Phasing Option	Description	Advantages	Challenges
Permitted Left-Turn Phase	Served with the adjacent through movement, requiring left-turning vehicles to yield to conflicting vehicle and pedestrian movements	□ Reduced intersection delay □ Efficient green allocation	□ Requires users to choose acceptable gaps in traffic □ Yellow trap can occur if opposing movement is a lagging left turn
Protected Left-Turn Phase	Left-turning vehicles are given the right-of-way without any conflicting movements	□ Reduced delay for left-turning vehicles □ Users always receive exclusive right-of-way; gaps in traffic do not need to be identified	□ Increased intersection delay
Protected-Permitted Left-Turn Phase	Combination of permitted and protected left-turn phasing; users receive a protected interval, but can also make permitted movements as the conflicting through phase receives a green indication	□ Compromise between safety of protected left-turn phase and efficiency of permitted left-turn phase □ No significant increase in delay for other movements	□ Fewer options for maximizing progression of through vehicles during coordination (unless flashing yellow arrow displays are used) □ Yellow trap can occur if opposing movement is a lagging left turn

Decision Making Guide for Traffic Signal Phasing (2020)

NCHRP 284

6.2 Phase Sequence Considerations

Some agencies use the same phasing sequence at all (or most) intersections. A 2003 report indicated that 83 percent of signals with protected-permissive left-turn phase mode used leading left-turn sequence, while 11 percent used lagging and 6 percent used lead-lag (NCHRP 2003). These percentages may have changed somewhat since 2003, but the leading left-turn sequence certainly remains the most common.

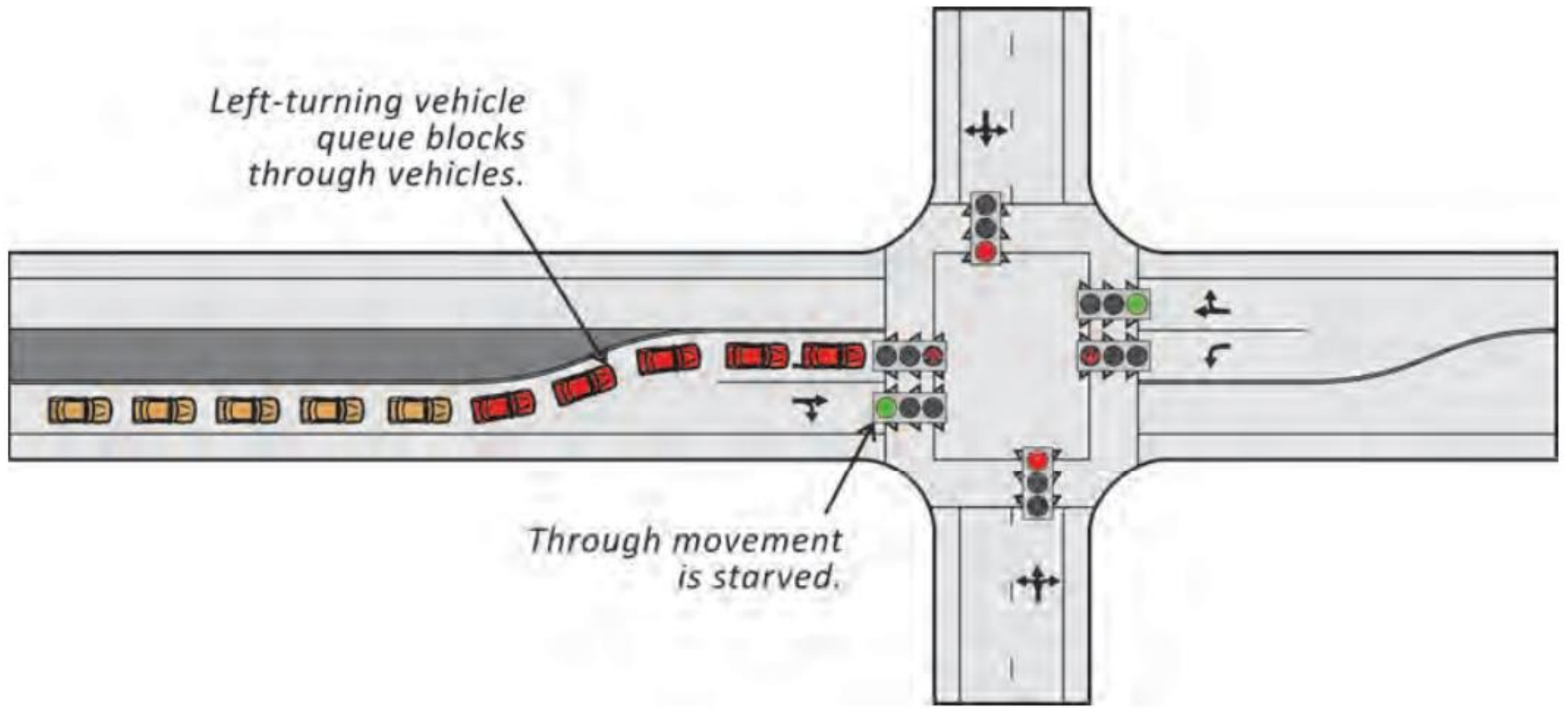
Using a common phase sequence at all intersections is likely not the most efficient, because one phase sequence may be superior on certain approaches and another may be preferable elsewhere. Phase sequence should be considered for each pair of opposing approaches to determine if a certain sequence can provide better operational or safety performance.

- **Crash Modification (CMF) Clearing House (Austin Study 2009)**
- **Comparative Analysis of Leading and Lagging Left Turns Report (Lee Study, August 1991)**
- **Box Study (November 1999)**
- **Valley Traffic Engineers (VATEC) Meeting (November 2000)**
- **Chandler-Gilbert Study (2007)**

**Similar crash rates for leading and lagging
No statistical evidence of difference**

**Consideration should be based on multiple factors such as
safety, efficiency, consistency, and resources.**

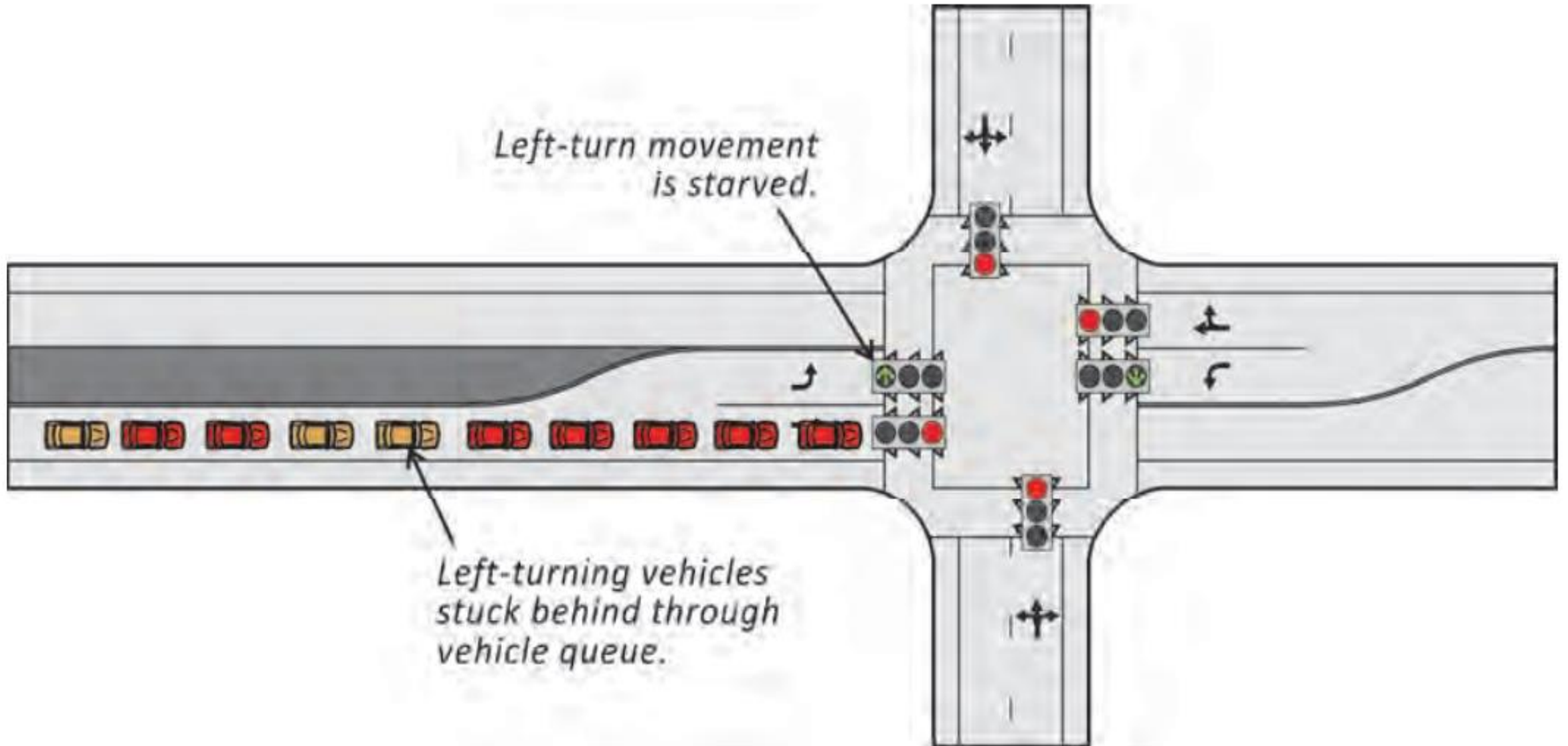
Left Turn Storage Spill Back



Leading Left Turn Operation

- **Provides additional capacity in most cases**
- **Affected by any interrelated factors such as geometrics, traffic volumes, cycle length, phase overlaps, driver habits, speeds, etc.**
- **Optimizing signals provides maximum use of available roadway capacity**

Left Turn Storage Starvation



Lagging Left Turn Operation

- **More Effective in Appropriate Situations:**
 - **Freeway Traffic Interchanges (Tis)**
 - **Unusual Signal Spacing**
 - **Geometric Constraints (Short Left Turn Storage)**
- **Utilization of both Leading and Lagging provides optimal traffic progression depending on location, time of day**

In Summary:

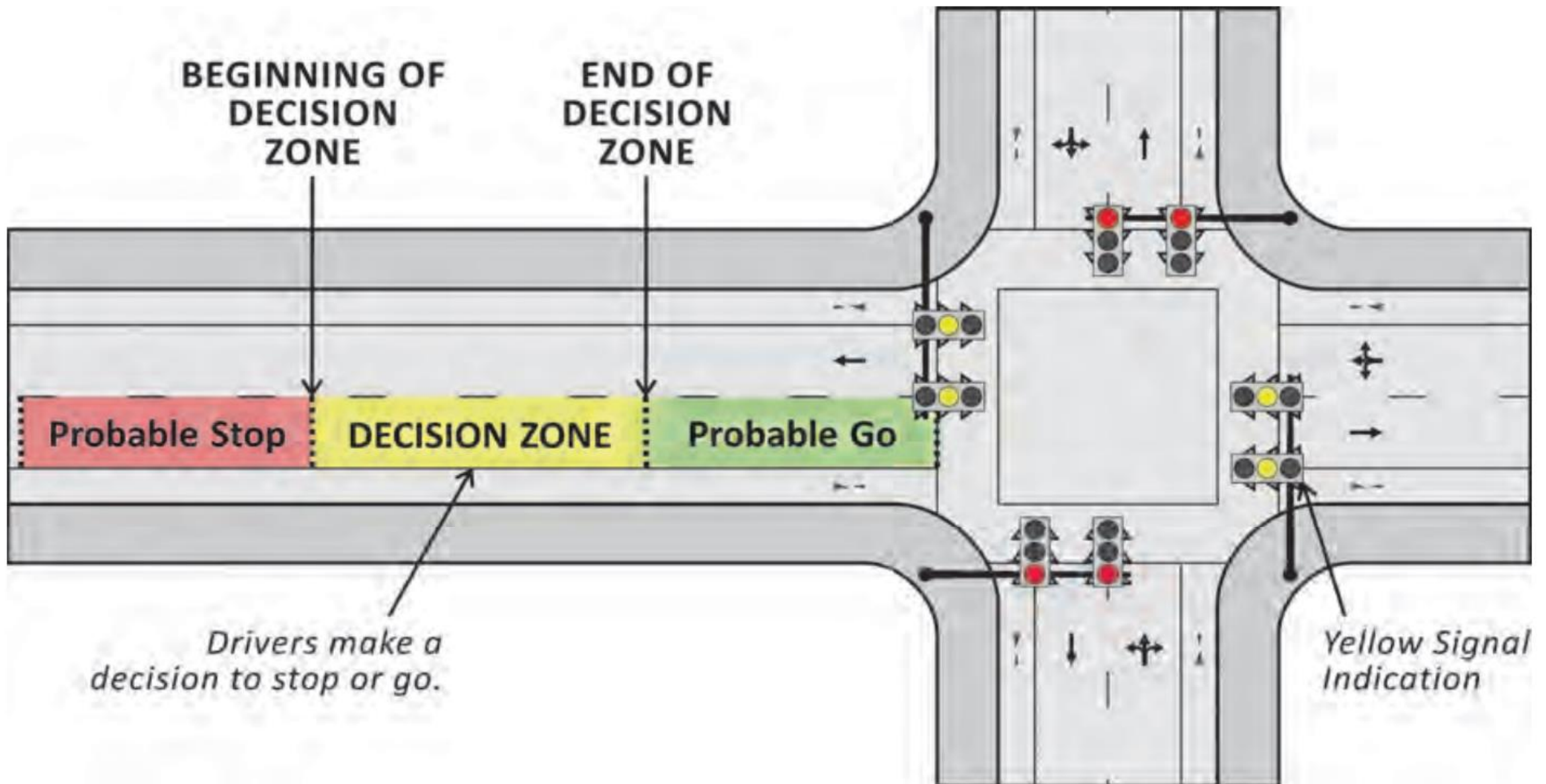
- **Leading or Lagging is not a one size fits all.**
- **Consistency with neighboring agencies**

Traffic Engineers should have the flexibility to implement the appropriate left turn operation based on thorough analysis, optimal throughput, safety and available resources.

Traffic Signal Change and Clearance Intervals



Decision/Dilemma Zone



Limits of Decision Zone

Approach Vehicular Speed (Miles Per Hour)	Beginning of Decision Zone (5.5 Seconds from Stop Bar)	End of Decision Zone (2.5 Seconds from Stop Bar)
35	285 feet	125 feet
40	325 feet	145 feet
45	365 feet	165 feet
50	405 feet	180 feet
55	445 feet	200 feet

Basic Signal Timing Parameter Guidance

	Timing Parameter	Consequence for Too Little Time	Consequence for Too Much Time	Dependent On Variables Including:
Section 6.1.1	Yellow Change	□ May create a dilemma zone (Type I) □ May cause a higher frequency of red-light running	□ May encourage disrespect by familiar drivers	□ Driver perception-reaction time □ Vehicle deceleration rate □ Vehicle approach speed □ Approach grade
Section 6.1.2	Red Clearance	□ Potential conflict after phase begins	□ Wasted time at the intersection	□ Intersection width □ Vehicle length □ Vehicle approach speed

Duration of Minimum Yellow Change Interval

Approach Speed (MPH)	Minimum Yellow Change ¹ (Seconds)
25	3.0*
30	3.2
35	3.6
40	3.9
45	4.3
50	4.7
55	5.0
60	5.4

¹ Based on negligible approach grades. Adjustments are required for upgrades and downgrades.

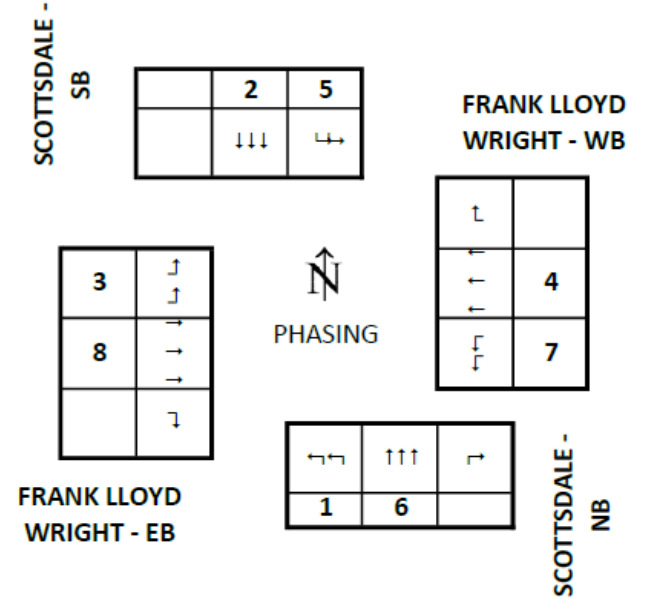
* The MUTCD (2) recommends a minimum duration of 3 seconds for the yellow change interval.

Scottsdale & Frank Lloyd Wright signal timing parameters



SCOTTSDALE & FRANK LLOYD WRIGHT			System # 162
BASIC TIMING PLAN	Section #	I.P. Address	Date Designed
	1617	172.27.11.62	1/15/2021

TIMING PLAN - MM-2-1	Phase	1	2	3	4	5	6	7	8
	Movement	NBL	SBT	EBL	WBT	SBL	NBT	WBL	EBT
	NOTES	L-P	COORD	PROT		PROT	COORD	L-P	
	MIN GRN	5	10	5	10	5	10	5	10
	BK MGRN								
	CS MGRN	5		5		5		5	
	DLY GRN								
	WALK		4		4		4		4
	WALK2								
	WLK MAX								
	PED CLR/FDW		30		26		33		32
	PD CLR2								
	PC MAX								
	PED CO								
	VEH EXT	2	1	2	1	2	1	2	1
	VH EXT2								
	MAX 1	20	45	20	45	20	45	20	45
	MAX 2	40	55	35	45	40	55	30	50
	MAX 3								
	DYM MAX								
	YELLOW	4	4.7	4	4.7	4	4.7	4.0	4.7
	RED CLR	2	2.0	2	2.0	2	2.0	2	2.0
	RED RVT	2	2	2	2	2	2	2	2
	ACT B4								



PHASING SEQUENCES				
TOD: MORNING				
R1	1	2	4	3
R2	6	5	7	8
	B		B	
Use Timing plan:				
TOD: MIDDAY				
R1	1	2	4	3
R2	6	5	7	8

Other Agencies Standard of Practice

- **ITE Guidelines for Determining Traffic Signal Change and Clearance Intervals**
- **Signal Timing Manual 2015 (NCHRP Report 812)**
- **AzTech White Paper**
- **Two agencies in the valley are piloting projects to increase their clearance intervals completion 2026 & 2028**

Study in California found increasing clearance interval greater than ITE Guidelines

Increased number of angle collisions (one of the most severe collision types) –

**While overall collisions slightly decreased,
that decrease was primarily led by decrease in rear
end collisions (one of the least severe collision types)**

MARCH 2020

Guidelines for Determining Traffic Signal Change and Clearance Intervals

A Recommended Practice
of the Institute of
Transportation Engineers

ite
A Community of Transportation Professionals

Signal Timing Manual - Second Edition (2015)



DETAILS

322 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-30888-5 | DOI 10.17226/22097

AZTech White Paper 2020

Clearance Interval Calculation Methodologies (13 Agencies)

YELLOW Interval

Constants and Variables:

Y = Yellow interval (s)

v or V = vehicle or design speed in mph (if not in mph, indicated as such in table below)

t = perception-reaction time, 1.0s

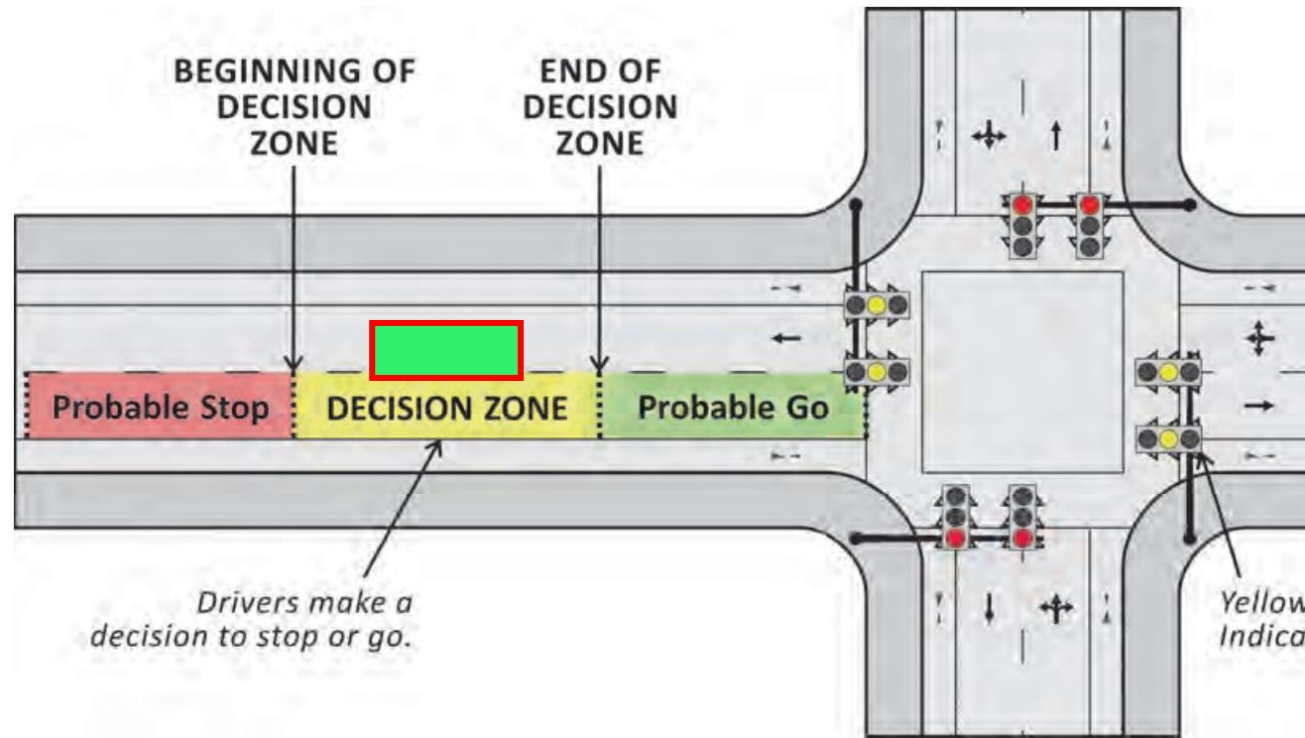
a = deceleration rate, 10 ft/s²

g = % grade (downhill is a negative grade)

G = gravity constant 32.2 ft/s²

Agency	Yellow Interval (s)	Notes/Comments
1	<u>Through phase based on speed:</u> 35 mph or less, 3.5s 40 mph, 4.0s 45 mph, 4.5s <u>Left turn phase based on speed:</u> - Leading arrow, protected/permitted, 3.0s - Leading arrow, protected only, 4.0s - Lagging arrows all operations, same as adjacent through phase	7.0s maximum
2	Y (minimum) = $t_1 + t_2$ $t_1 = 1s$ (perception - reaction time) $t_2 = \frac{1.47v}{(2a + 64.4g)}$	3.0s minimum 6.0s maximum
3	$Y = t + \frac{V}{2a + 64.4g}$ V = approach speed in ft/sec	3.0s minimum 6.0s maximum - If calculated time is longer than 5.0s, the remaining time will go to the all red interval - For protected-only left-turn arrows, 3.0s yellow interval is typically used
4	$Y = t + \frac{1.47v}{2(a + 32.2g)}$	3.0s minimum for all vehicle movements 3.0s for separate left-turn phases - Rounded to the next highest 0.1 seconds - Approach speed (v) assumed to be posted speed
5	$Y = t + \frac{v}{2a + 2Gg}$ v = design speed (ft/s)	
6	$Y = t + \frac{1.47V}{2a + 2Gg}$	

Agency	All Red Interval (s)	Approach Speed (v or V)	Intersection Width (W) (ft)	Notes/Comments
1	R = Vehicle Clearance Interval - Y <u>Left turns:</u> Leading arrow, protected/permitted, 1.0s Leading arrow, protected only, 1.0s Lagging arrow, all operations, same as adjacent through phase	Speed limit in ft/s	Near side stop line to the far edge of the conflicting traffic lane (in feet)	- The all red interval is defined as difference between the vehicle clearance interval and the yellow interval, rounded to the nearest half second - Maximum all red interval is typically 2.5s
2	$t_3 = \frac{W + L}{1.47V}$	Posted speed limit	Stop bar to the farthest conflicting lane	
3	$R = \frac{W}{V}$	Posted speed limit in ft/s	Curb to curb line of the street being crossed	1.0s minimum 1.0s is typically used for protected-only left-turn arrows
4	$R = \frac{W + L}{1.47v}$	Approach speed assumed to be posted speed	Distance from the stop bar to the opposite furthest curb line extended	2.0 s minimum for through movements - Rounded up to the next highest 0.1s 1.0s for separate left turn phases
5	$R = \frac{W + L}{1.47V}$	Design speed in ft/s	Near stop bar to far crossing curb line extension, plus length of a vehicle	
6	$R = \frac{W + L}{1.47V} - t$			
7	Through movements, 2.0s Left turn movements, 1.0s			
8	$R(\text{through}) = \frac{W + L}{1.47(V_T)}$ $R(\text{left turn}) = \frac{W + L}{1.47(V_{LR})} - 1$	V_T (through movement) = Posted Speed Limit V_{LR} (exclusive left turn) = 20 mph	Near-side stop line to the far edge of the conflicting traffic lane along the actual vehicle path	1.0s minimum 2.0s maximum
9	Through movements, 2.0s Left turn movements, 1.0s			
10	$R = \frac{W + L}{1.47(V)} - 1$	V (throughs) = posted speed limit + 7 mph V (left turns) = 20 mph	Stop bar to the curb prolongation of the farthest conflicting movement (including bike lanes). If there is a striped-out lane (unused pavement width) adjoining the curb prolongation, then the intersection width will be measured from the stop bar to the outside edge of the farthest conflicting lane	1.0s minimum 2.0s maximum
11	$t_3 = \frac{W + L}{1.47V}$	Posted speed limit	Stop bar to the farthest conflicting lane	
	R(through)	Saved to V: Drive		Yellow plus all red is equal to 6.0s for



Adaptive detection zone



Staff Recommendation

- **City of Scottsdale currently meet or exceed the minimum yellow change.**
- **Our clearance times are more conservative and consistent with standard practice and requirements.**

Continue to leverage ITS technologies such as adaptive systems to pilot projects with green time extension to increase intersection safety



Questions and Discussion