

A Compendium of Yellow Interval Increase Studies

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Executive Summary

Transportation officials and engineers know that the proper timing of the signal change interval is essential to intersection safety. If the yellow interval is too short, a “dilemma zone” is created. Motorists who are unfortunate enough to be within this section of the roadway when the yellow signal illuminates may neither be able to stop safely nor legally enter the intersection before the onset of the red interval. Dilemma zones virtually assure that some percentage of drivers will be forced to brake suddenly or violate the red, thereby creating the potential for rear end collisions or vehicle conflicts within the intersection.

The safety benefit of longer yellow signal times has been proven in a number of studies. In a 2004 Texas DOT study, traffic engineers Bonneson and Zimmerman noted that when the yellow interval duration is set one second longer than the “minimum time” based on the 85th percentile speed, violations decreased by 53% and crashes decreased by 40%.

As for concerns that drivers will modify their behavior to account for relatively small increases in the yellow interval and still run the red, the available data shows that such an adjustment does not happen.

In the following series of studies, data from various jurisdictions where the yellow interval was increased confirm that a significant safety benefit can be achieved by increasing the yellow interval which consistently results in a reduction in red light running events. The table below summarizes the findings.

Reduction in Red Light Running After Increase in Yellow Interval	
Fremont, CA	77% reduction after 0.7 sec increase
Loma Linda, CA	93% reduction after 1.0 sec increase
Santa Clarita, CA (Left Turn Lanes)	58% reduction after 0.5 sec increase 70% reduction after 1.0 sec increase
Oakland, CA	87% reduction after 1.0 sec increase
Redlands, CA	88% reduction after 0.9 sec increase
West Hollywood, CA	47% - 70% reduction after 0.3 sec increase
Fairfax Co., VA	71% reduction after 0.5 sec increase

All results were compiled using violation data from red light camera installations. The results show that where there is a high number of red light running events, the yellow interval is likely too short for the needs of approaching traffic. Regardless of the yellow interval time that may have previously been calculated, red light running can be reduced simply by increasing the yellow interval. Further, the results show that the incidence of red light running does not “rebound” to previous levels.

A Before and After Study of Violations in Fremont, CA Subsequent to an Increase in the Yellow Duration

By Jay Beeber, Safer Streets L.A., Member ITE

Introduction

Fremont, CA has been using photo enforcement since the early 2000's. In November of 2010, CalTrans officials examined the intersection of Mission Blvd. and Mohave Drive and increased the yellow signal time for the straight through movement by 0.7 second above the minimum time required by state law to a full 5.0 seconds. (See attached email exchanges documenting the change)

On January 31, 2013 we requested violation statistics from Sgt. Mark Dang of the Fremont Police Department. Specifically, we requested the Monthly Redflex Redlight Offender Statistics (RROS) Report (aka Late Time Bar Charts) for the intersection of Mission Blvd. and Mohave Drive for the period April 2010 through December 2012. The reports were received in hard copy format on February 15, 2013. Digital scans of the original reports are available at <http://wp.me/a1mxAG-bz>

The report shows, in chart format, the number of violations recorded in each of the four photo enforced lanes of approach to the intersection. Three charts are provided (by time into red, by hour of the day, and by day of the week) for each lane as well as for all 4 lanes combined.

At the west bound approach to the Mission Blvd. and Mohave Drive intersection there are four lanes, all enforced with red light cameras. On the RROS Report, the lanes are numbered starting from the left hand side of the roadway closest to the center median. Lane 1 is the left turn lane, lanes 2 and 3 serve straight through traffic, and traffic in lane 4 may either proceed straight or turn right.

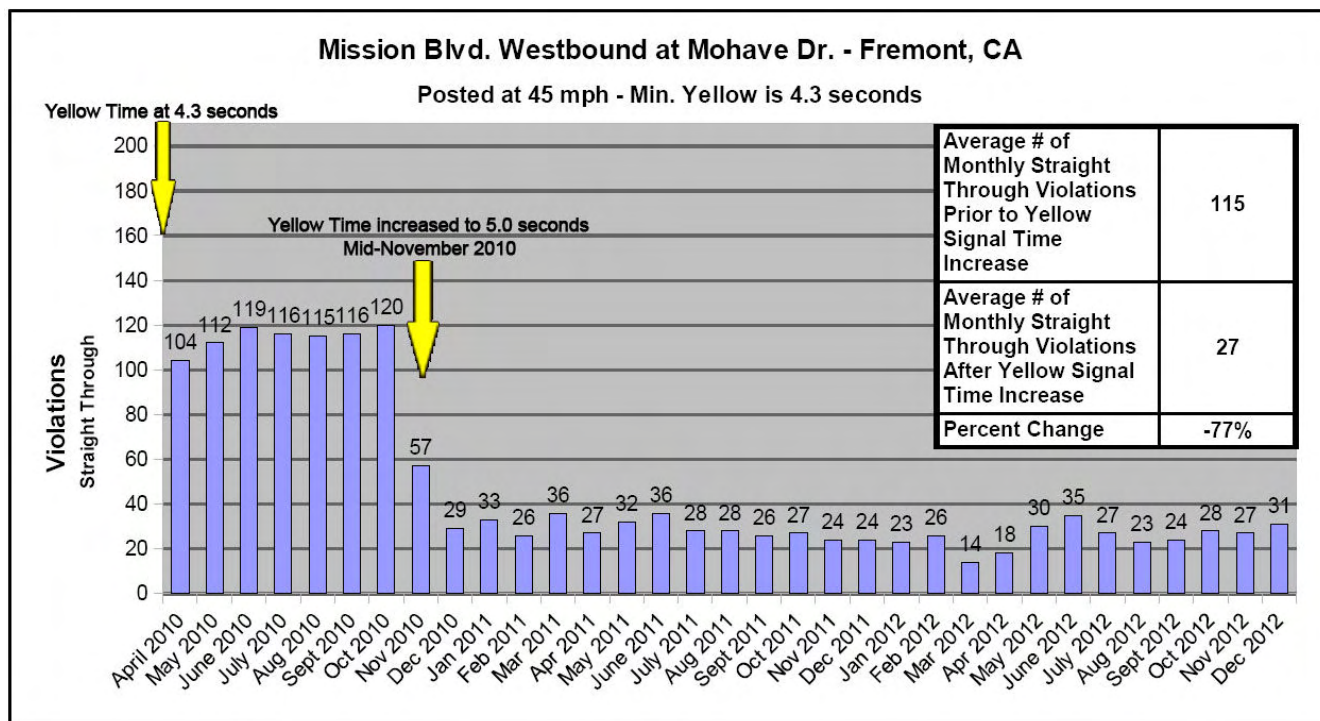


In order to perform the data analysis, we transcribed the data from the hard copy reports into an excel spreadsheet, listing the number of violations in each lane by month. (Spreadsheet available for download at <http://wp.me/a1mxAG-ct>) Since the goal of the analysis was to study the effect of the increase in signal timing for the straight through movement, we did not consider the violations in lane 1 as only left turns are permitted from that lane, nor lane 4 as that lane serves both straight through and right turn movements. We then added together the number of violations in lanes 2 and 3 to arrive at the approximate number of straight through violations occurring each month.

As stated previously, the signal timing was adjusted upwards by 0.7 second in November 2010. We therefore averaged the number of violations occurring in the previous 7 months to obtain the average number of violations in the “before” period. Since the timing change was made in mid-November, we eliminated that month's data from consideration and averaged the subsequent months' violations to obtain the average number of violations in the “after” period.

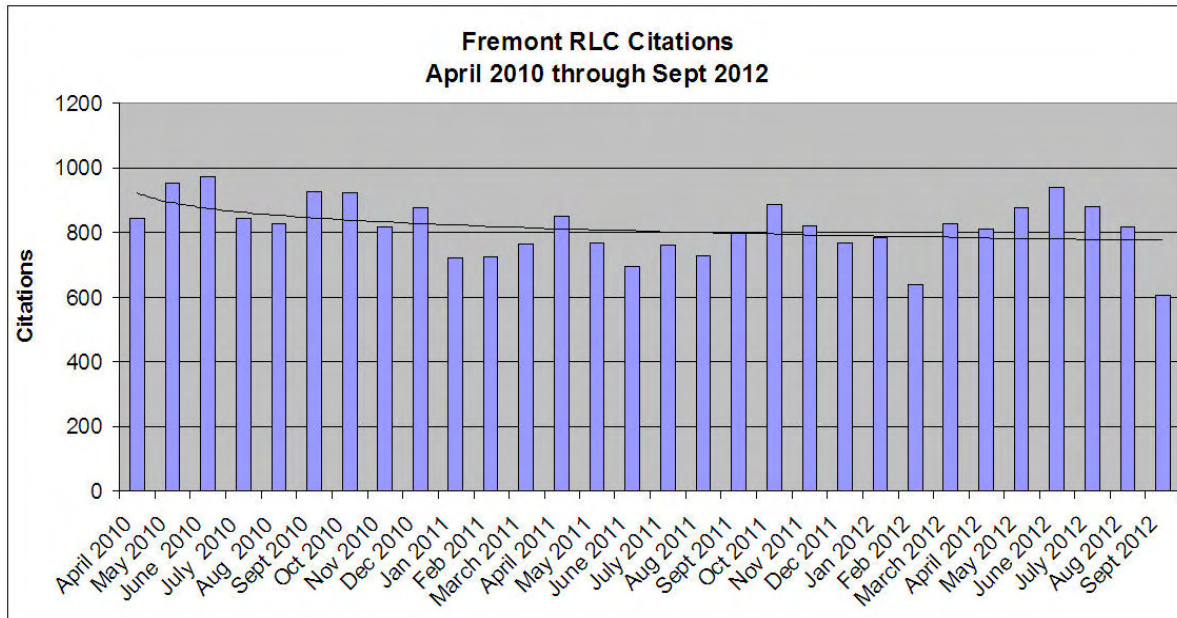
Results

The results appear in the table and chart below.



Immediately after the signal timing increase, the intersection experienced a significant reduction in straight through violations and the lower violation rate has not returned to earlier levels. As can be seen in the above chart, the positive safety results achieved by lengthening the yellow signal time have now remained in place for more than 24 months. Overall, there has been an average 77% decrease in violations during the study period and we have yet to observe any rebound to previous violation levels. In contrast, the violation rate for the left turn movement, where the yellow time remains unchanged at the state minimum of 3.0 seconds, increased approximately 25% during the same period (see spreadsheet). The reason for the increase is undetermined at this time, but regardless, it is almost a certainty that if the left turn yellow time had also been increased, the violation rate for that movement would have been significantly reduced as well.

In addition, since the yellow light time was not increased at any of the other red light camera intersections in Fremont, we analyzed the violation rates at those locations over the same time period to determine if there had been any change in violations over the study period. Using the data available at <http://highwayrobbery.net/redlightcamsdocsFremontMain.html> we charted the total number of monthly violations at all Fremont photo enforced intersections. As the chart below indicates, although the number of violations fluctuates from month to month, there was no overall change in violations at intersections that did not have the signal time increased.



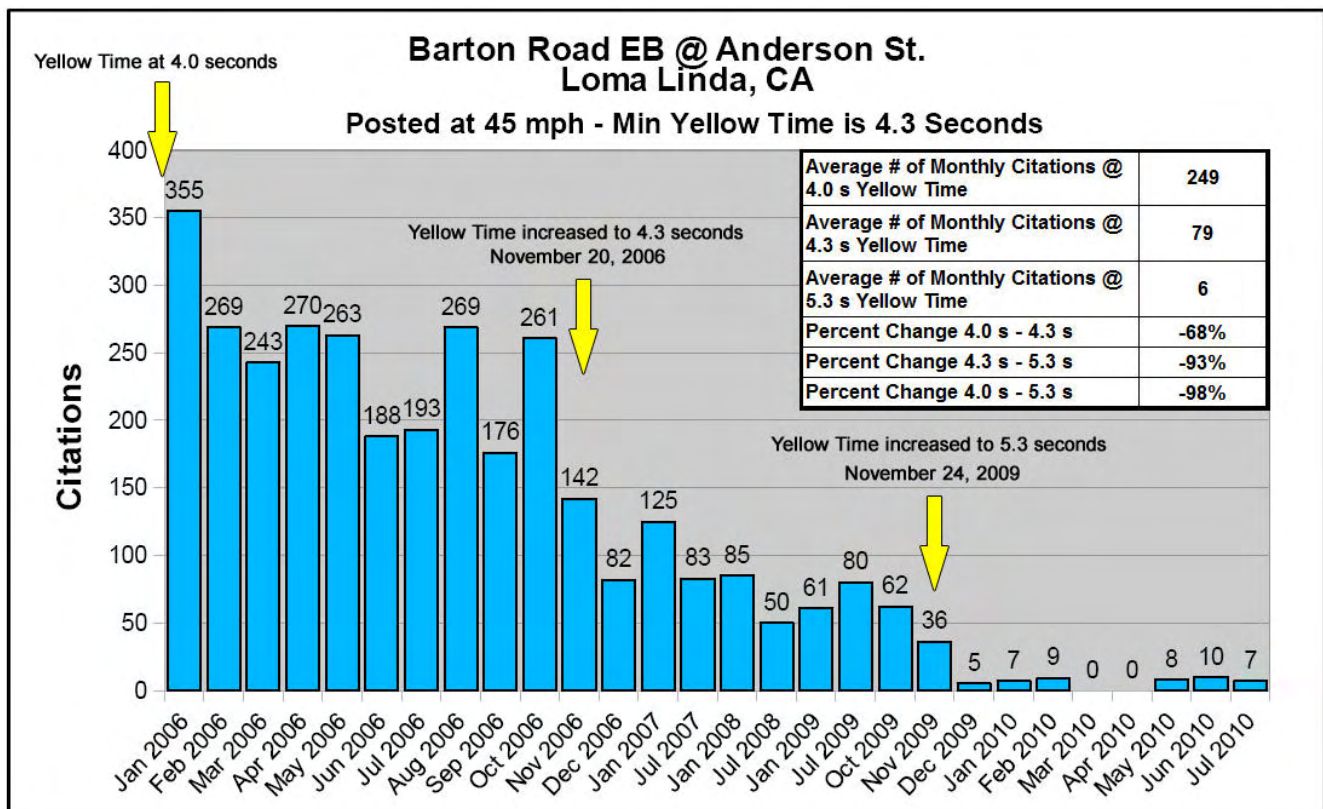
Conclusions

The absence of an increase in red light running violations both at intersections with longer yellow times and at intersections without increases clearly indicates that motorists do not adjust their driving behavior to any large extent to account for longer yellow times, as critics of this safety countermeasure have often claimed. Furthermore, the immediate and lasting reduction in violations which occurred upon lengthening of the yellow signal time strongly suggests that a large majority of the red light running incidents that had been occurring previous to the timing adjustment were inadvertent, not willful. This was likely primarily due to the use of the posted speed limit to calculate the minimum yellow duration rather than the true approach speed of the vehicles on the roadway.

A Before and After Study of Violations in Loma Linda, CA Subsequent to an Increase in the Yellow Duration By Jay Beeber, Safer Streets L.A., Member ITE

In Loma Linda, CA, at the intersection of Barton Road eastbound at Anderson Street, photo enforcement began in January of 2006. The roadway was posted with a 45 mph speed limit with at 4.0 second yellow duration. Per California MUTCD standards, the signal time was deficient by 0.3 seconds. On November 20th 2006, city officials increased the yellow signal time by 0.3 seconds to the statutory minimum of 4.3 seconds. As the chart below indicates, there was an immediate 68% decrease in the number of citations issued from a monthly average of 249 per month to an average of 79 per month. According to city officials, no other engineering or signal timing changes were made.

In the fall of 2009, city officials decided to arbitrarily increase the yellow signal timing an additional 1.0 second. This decision was not based on any engineering study or criteria, simply the will of elected officials to further reduce violations. The timing change was made on November 24, 2009. As before, no other engineering or signal timing changes were made. As the chart below indicates, when the yellow time was increased this additional 1.0 second, citations decreased a further 93% from the previous monthly average of 79 per month to an average of 6 per month. The total decrease in issued citations in Loma Linda was 98% when the yellow time was increased from the originally deficient 4.0 seconds to the arbitrary 5.3 seconds. The data supplied indicates that the reduction in violations was maintained through July 2010 and according to elected officials, through the end of the red light camera program in November of 2010 as well.



Raw data in spreadsheet format compiled from official red light camera monthly reports provided by the City of Loma Linda under the California Public Records Act is attached. Original documents available at <http://highwayrobbery.net/redlightcamsdocsLomaLindaMain.html>.

From: Rigsby, Rhodes
Sent: Tuesday, June 11, 2013 4:35 PM
To: 'Erin.Riches@sen.ca.gov'
Cc: Rigsby, Rhodes
Subject: Yellow Timing Study for Loma Linda

Dear Senate Transportation and Housing Committee:

I have reviewed the attached documents prepared by Jay Bieber of Safer Streets LA. His analysis is correct.

During our 5-year experience with red light cameras from 2005 to 2010, we modified our yellow light durations twice. The first time was after we discovered that our yellow lights did not meet the minimum California standard. At that point, we immediately made the change, which is recorded in Mr. Bieber's analysis as a change from 4.0 to 4.3 seconds. The second time was on my initiative in the fall of 2009, based on my reading of the Texas Highway Institute studies showing that increased yellow durations caused significant decreases in straight-through and left-turn violations. On this arbitrary basis, we added another 1.0 second to each yellow light at each camera-controlled intersection. We made no other engineering changes and made no change in our enforcement. As the chart shows, the violations decreased by another 90% overnight, which more than confirms the Texas experience.

I hope this attestation helps you in your deliberations on this topic.

Sincerely,

Rhodes L. Rigsby, M.D., MBA
Assistant Professor, Loma Linda University School of Medicine
Mayor, City of Loma Linda

**Analysis of Violation Data in Left Turn Lanes at RLC Intersections
in Santa Clarita After Yellow Interval Changes
by Jay Beeber, Executive Director Safer Streets L.A., ITE**

We reviewed the red light camera violation data supplied by the City of Santa Clarita for the ten red light camera monitored intersection approaches. Prior to signal changes, the yellow interval for the protected left turn movement was set at 3.5 seconds at all RLC approaches in the city. Yellow intervals for the left turn movement were increased at seven of the ten approaches. The yellow interval was increased by 1.0 second at both the eastbound and westbound approaches to the intersection of Valencia Blvd and McBean Parkway. The yellow interval was increased by 0.5 second at five additional approaches. The dates of the signal timing changes varied by intersection. Yellow intervals remained at 3.5 seconds at three RLC intersection approaches.

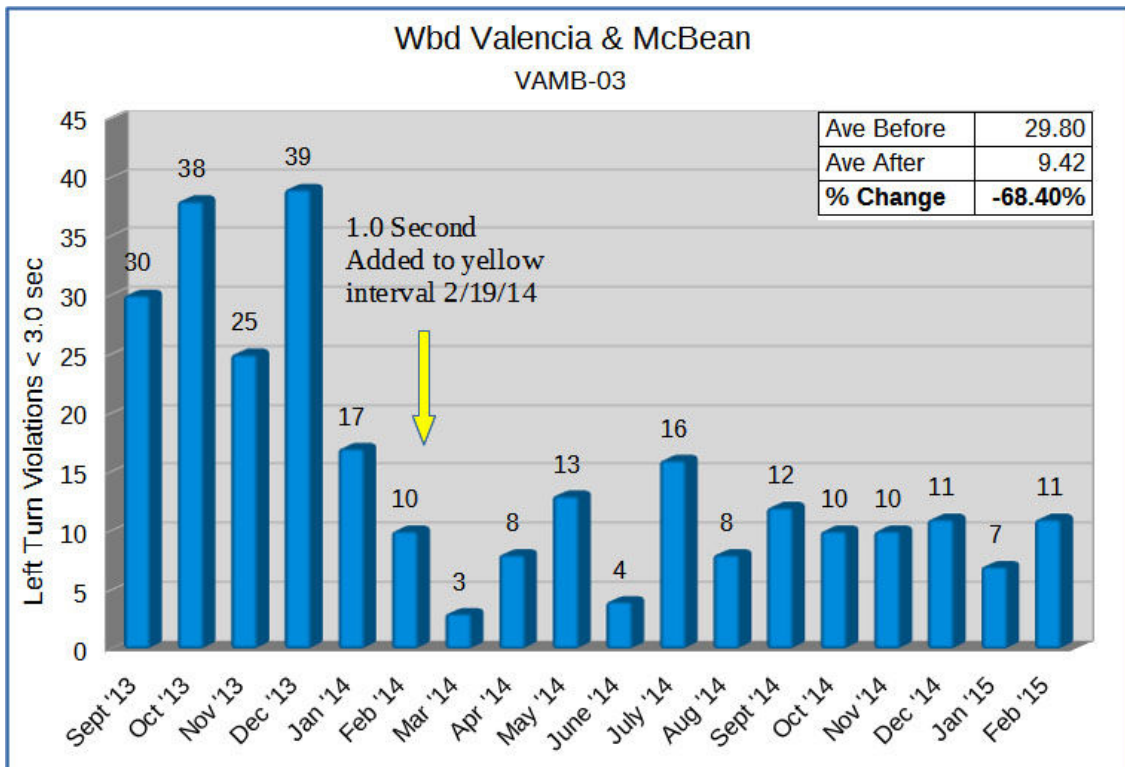
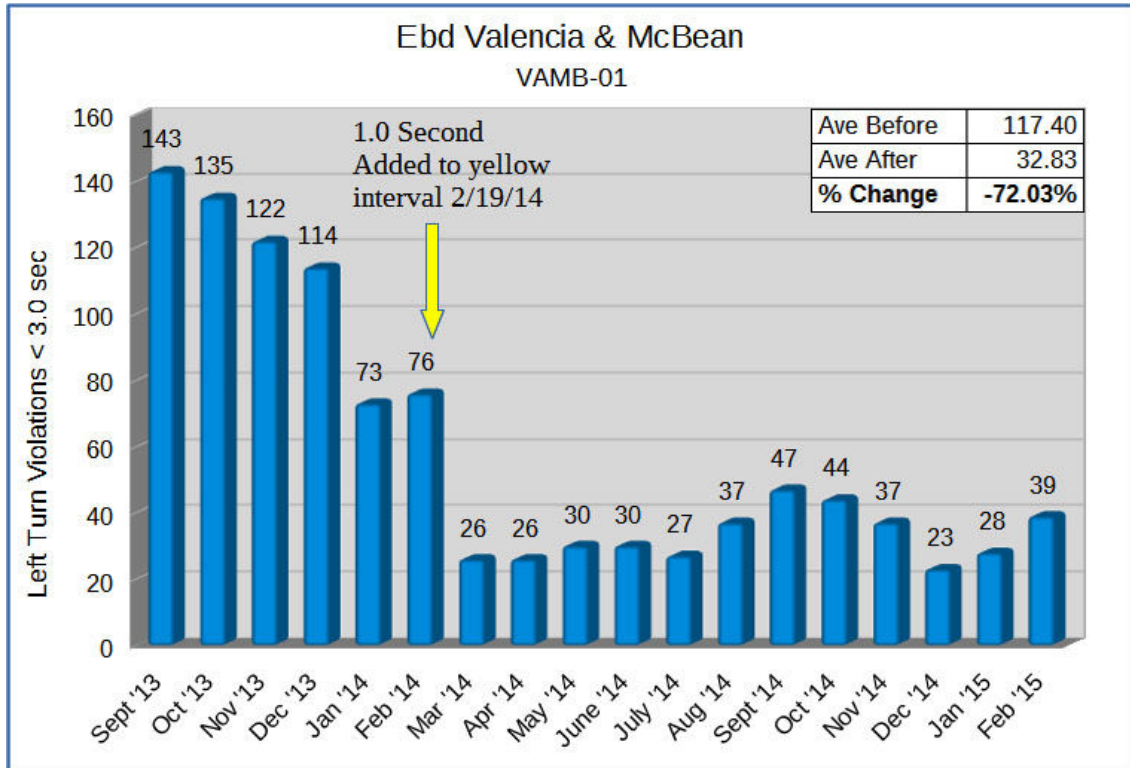
The violation data supplied by the city is broken down by the time-into-red of the violation. Violations occurring within the first 3.0 seconds of the red interval are listed by 0.1 second intervals. All violations over 3.0 seconds are grouped together as one category. The data included all violation events, including those events not deemed to be a citeable offense. Since changes in the yellow interval up to 1.0 second are unlikely to have any effect on violations occurring after 3.0 seconds and many of the late-into-red violations are due to non-citeable offenses such as emergency vehicles, we limited our analysis to violations occurring within 3.0 seconds of the onset of the red interval.

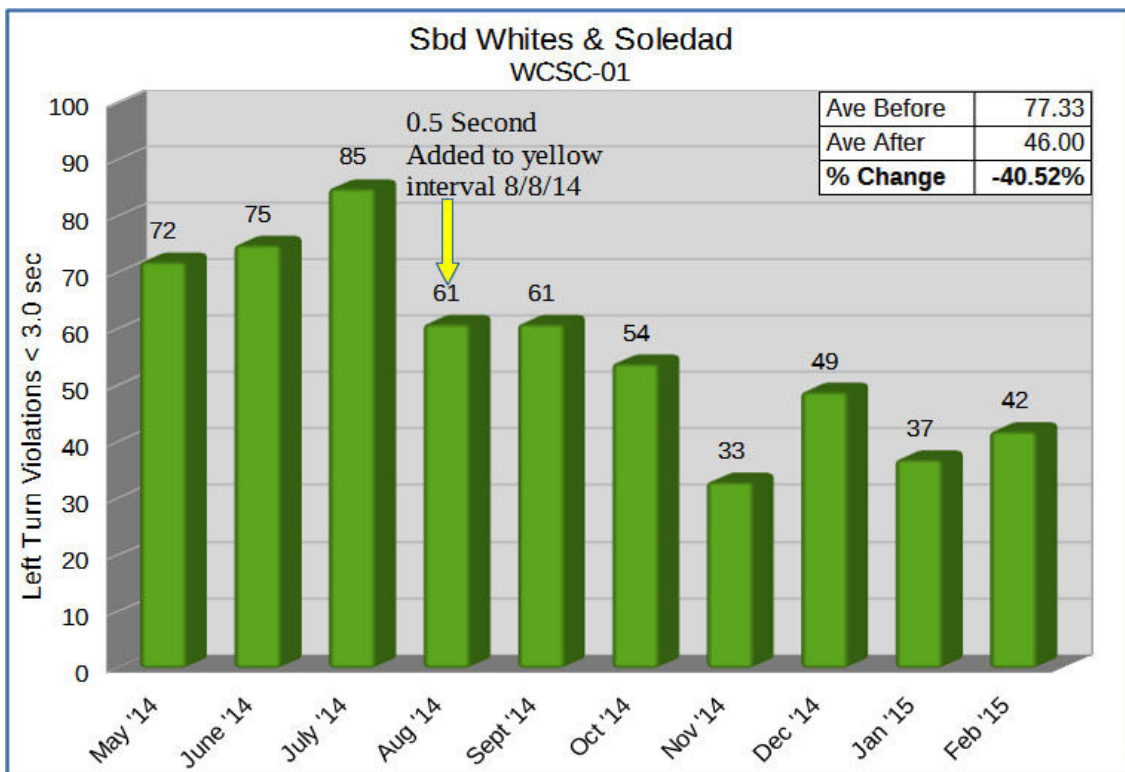
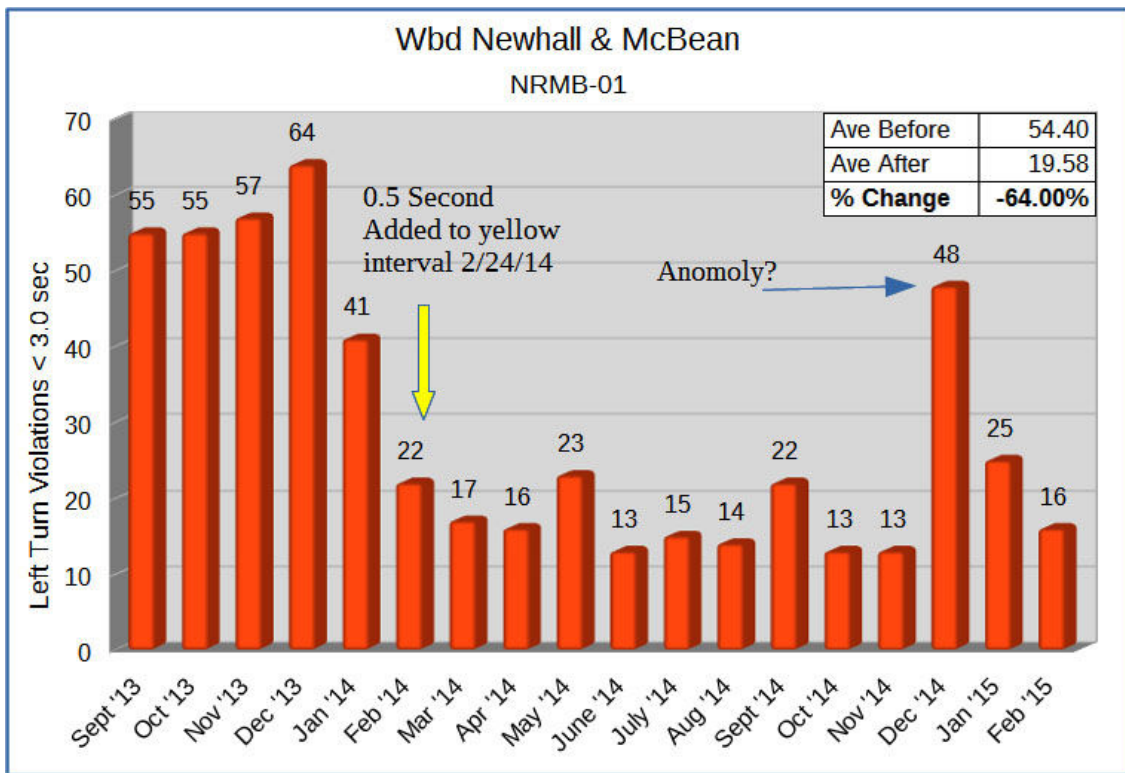
The table below shows the before and after violation numbers and calculated percent change in the average number of monthly violations occurring after the yellow intervals were increased.

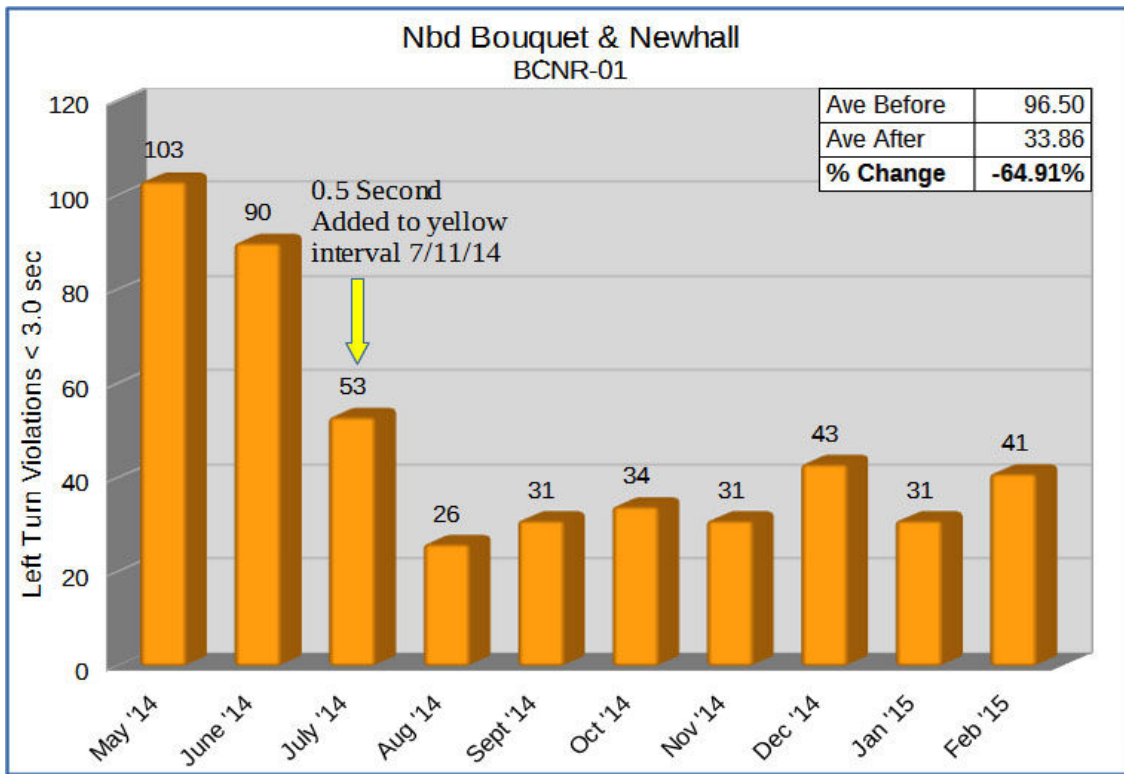
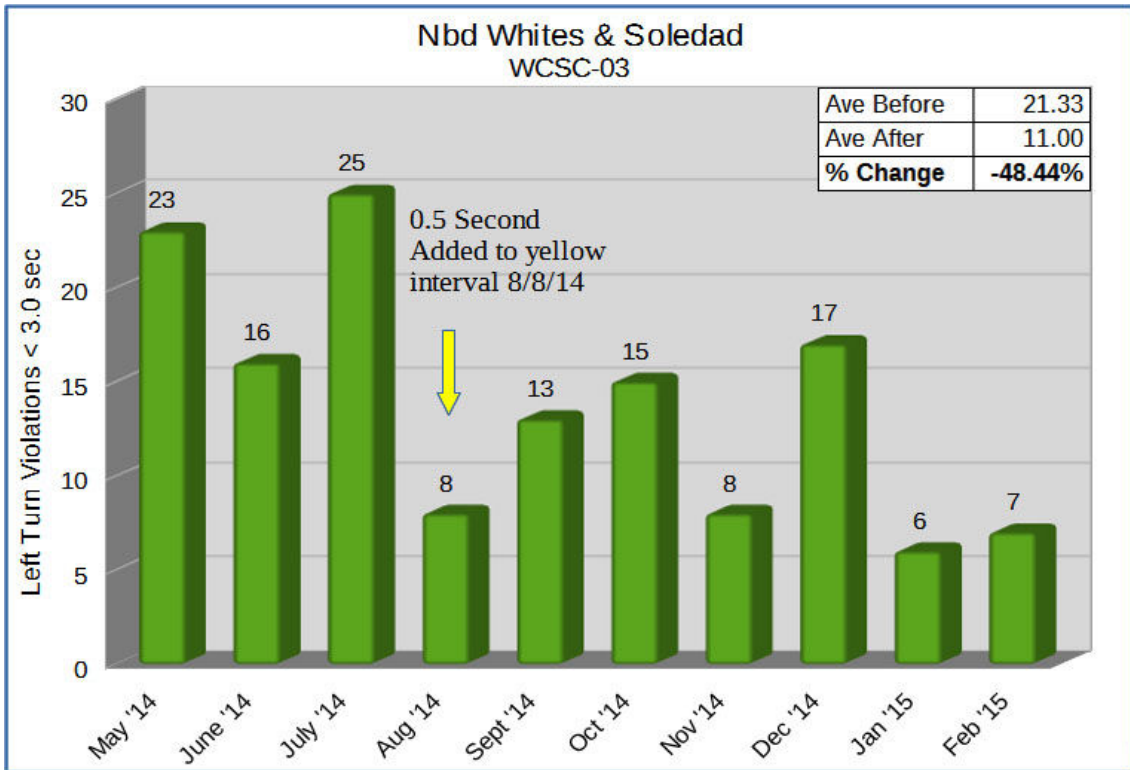
Santa Clarita RLC Violations Left Lanes < 3.0 sec										
Change Date	02/19/14	02/19/14	02/24/14	08/08/14	08/08/14	07/11/14	07/11/14			
Location	VAMB-01	VAMB-03	NRMB-01	WCSC-01	WCSC-03	BCNR-01	NRBC-01*	BCSC-01	MMMB-01	OVLV-01
Sept '13	143	30	55							
Oct '13	135	38	55							
Nov '13	122	25	57							
Dec '13	114	39	64							
Jan '14	73	17	41							
Feb '14	76	10	22							
Mar '14	26	3	17							
Apr '14	26	8	16							
May '14	30	13	23	72	23	103	93	92	73	16
June '14	30	4	13	75	16	90	89	85	100	17
July '14	27	16	15	85	25	53	59	86	67	16
Aug '14	37	8	14	61	8	26	31	105	91	13
Sept '14	47	12	22	61	13	31	24	114	72	24
Oct '14	44	10	13	54	15	34	30	120	82	25
Nov '14	37	10	13	33	8	31	33	91	60	15
Dec '14	23	11	48	49	17	43	41	78	79	24
Jan '15	28	7	25	37	6	31	40	79	68	14
Feb '15	39	11	16	42	7	41	37	78	74	17
Ave Before	117.40	29.80	54.40	77.33	21.33	96.50	91.00	92.80	76.60	18.10
Ave After	32.83	9.42	19.58	46.00	11.00	33.86	33.71			
% Change	-72.03%	-68.40%	-64.00%	-40.52%	-48.44%	-64.91%	-62.95%			

Note that as expected, all intersections where the yellow interval was increased saw significant reductions in red light running violations with the greatest reductions occurring at the two approaches where the yellow was increased by a full 1.0 second. No overall reduction in red light running occurred at the intersections where the yellow interval remained at 3.5 seconds.

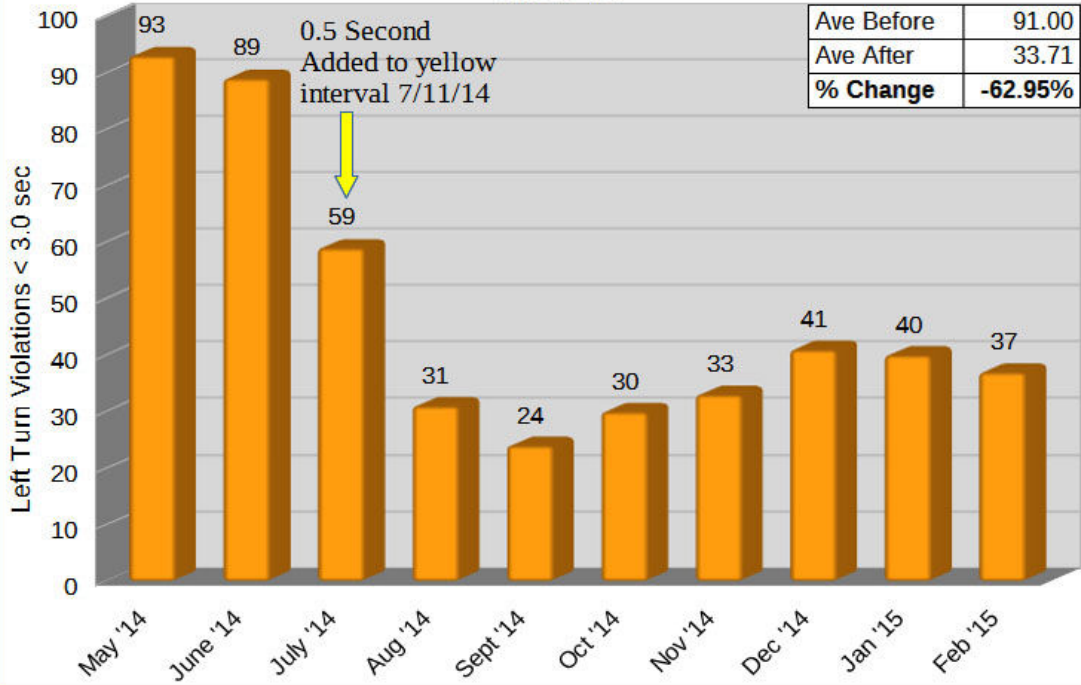
The following charts show the violation changes over time at each intersection approach where the yellow interval was increased. Although violations fluctuate month to month, overall, violations have not rebounded to previous levels.







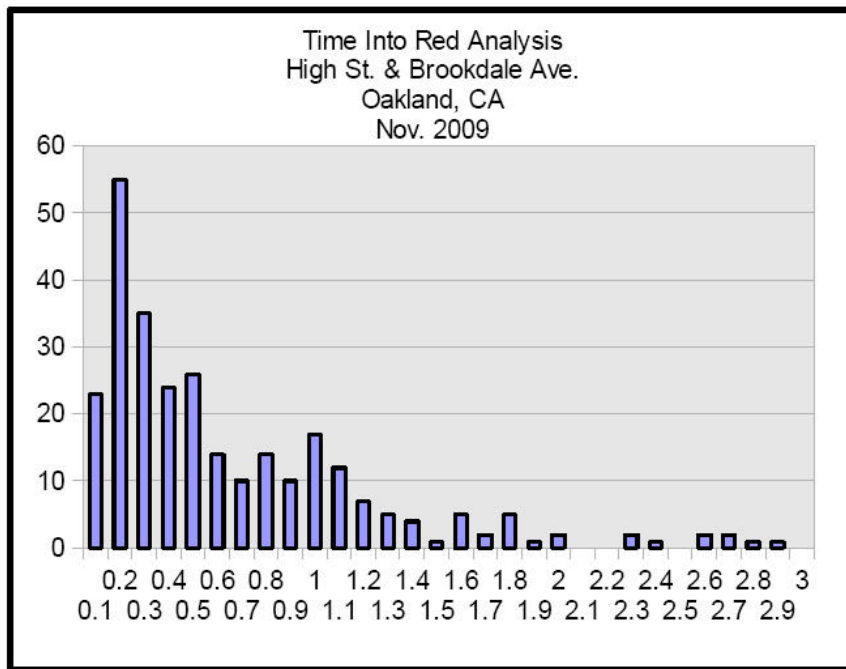
Ebd Newhall & Bouquet
NRBC-01



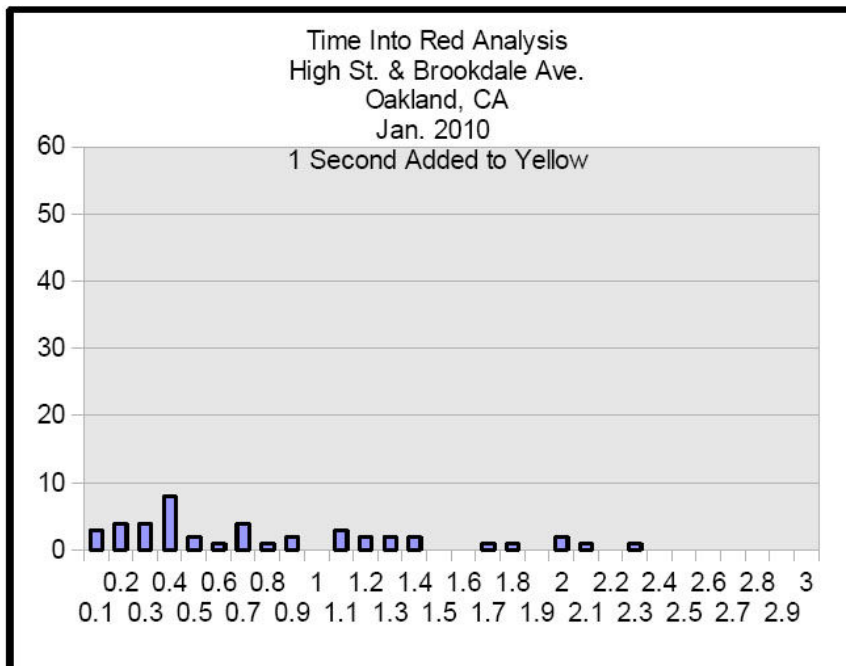
Effect of a One Second Increase in the Yellow Interval - Oakland, CA

By Jay Beeber, Safer Streets L.A., Member ITE

Many jurisdictions set the time of their yellow interval to the absolute minimum permitted by law. Often, this causes numerous drivers to inadvertently run the red light by a fraction of a second. The following chart graphs the violations occurring during the first 3.0 seconds after the traffic light has turned red at one such red light camera monitored intersection, High St. and Brookdale Ave., in Oakland, CA. As can be seen, the vast majority of violations are occurring within the first second of the red interval. This is the typical distribution of straight through violations by time-into-red at locations where the yellow interval is set too short for the needs of approaching traffic.



In December 2009, Oakland DOT increased the yellow signal time at this location by 1.0 second. As shown in the chart below from January, 2010, this immediately resulted in the virtual elimination of these early-into-red violations. Note that the high numbers of violations did not simply shift 1.0 second later, they were eliminated. Overall, there was an 87% reduction in the number of violations within the first second of the red interval.

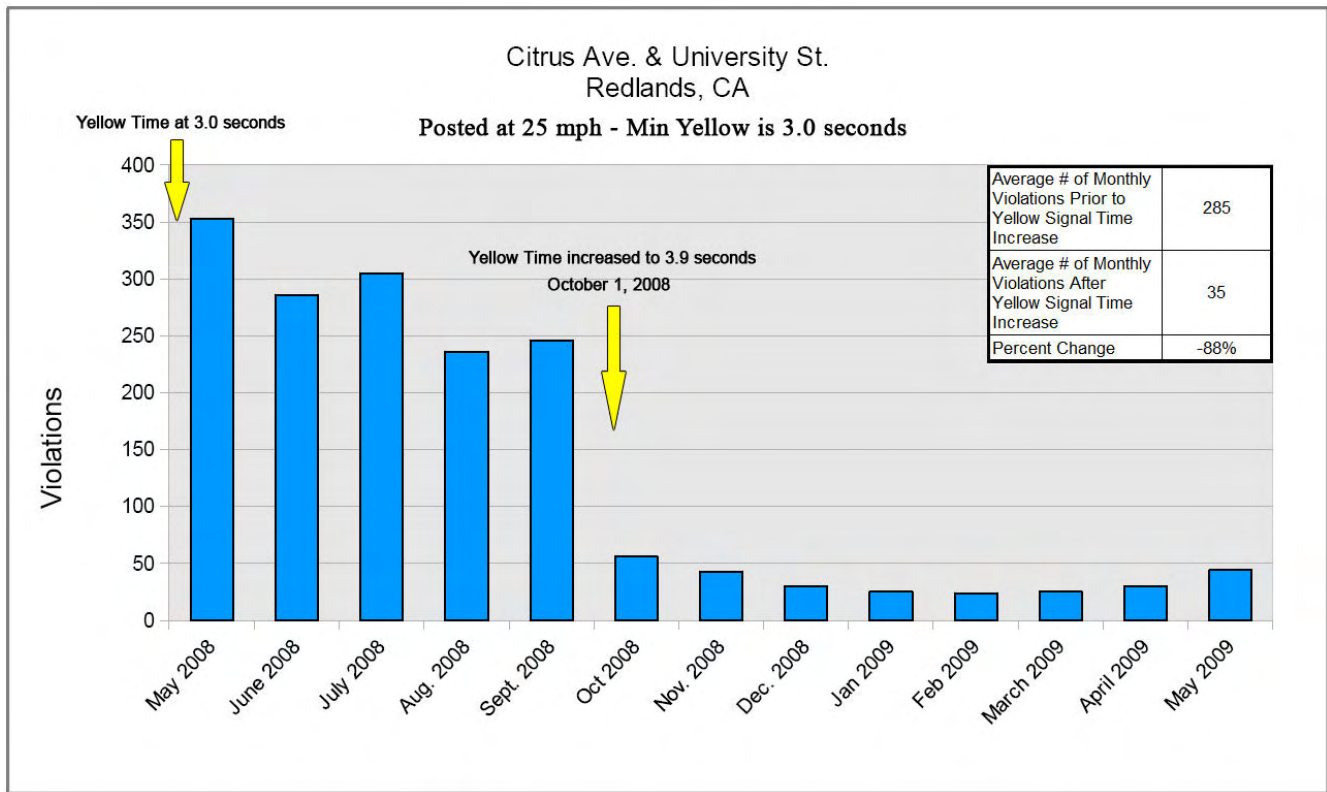


This lower violation level remained constant throughout the first half of 2010. Unfortunately, under pressure from the Oakland Police Department, who complained that the change was “negatively impacting” the red light camera program, after six months of increased safety for motorists, the Oakland DOT was forced to reduce the yellow interval by 1.0 second back to the prior timing. As a result, the early-into-red violations returned to their previous level.

In May 2014, the City of Oakland ended their red light camera program.

A Before and After Study of Violations in Redlands, CA Subsequent to an Increase in the Yellow Duration By Jay Beeber, Safer Streets L.A., Member ITE

The City of Redlands installed one red light camera at the intersection of Citrus Ave. and University St. in May of 2008. The yellow time was set at 3.0 seconds, the minimum duration for a roadway posted at 25 mph. After numerous complaints and a court challenge, the city increased the yellow time by almost a full second to 3.9 seconds on October 1, 2008. Immediately, violations dropped an average of 88% and remained at the lower rate. The program was terminated at the end of May 2009.



Raw data in spreadsheet format compiled from official red light camera monthly reports provided by the City of Redlands under the California Public Records Act is attached. Original documents available at <http://highwayrobbery.net/redlightcamsdocsRedlandsMain.html>.

Case Study: West Hollywood, CA

The City of West Hollywood, CA implemented a red light photo enforcement program in 1999. Currently, 24 approaches at a total of 8 intersections are monitored by red light cameras. Of those, 16 approaches are monitored on a continuous basis. The enforcement systems at the remaining 8 approaches are activated intermittently. Uninterrupted monthly citation figures, therefore, only exist for the 16 approaches where the enforcement cameras are continuously functional.

Until recently, traffic signal yellow intervals in West Hollywood had been set at the absolute minimum time based on the posted speed limit of the roadway. In 2012, the city began implementing a new policy of setting the yellow interval based on the posted speed limit plus an additional 5 mph. This resulted in 0.3 s to 0.4 s of additional time being added to the yellow interval at intersections where the new timing protocol has been employed. The process of re-timing the signals throughout the city has yet to be completed.

The purpose of this analysis is to determine the effect this increase in the yellow interval has had on the citation rate at photo enforced intersection approaches.

The West Hollywood red light camera program provides an ideal test case for this analysis as the city only cites for straight through violations. As a result, all citation data consists only of vehicles proceeding straight through the intersection. At our request, Los Angeles County Sheriff's Deputy Zenon Porche, who administers the city's red light camera program, generated a report detailing the number of monthly citations issued for each intersection approach in the city from the inception of the program through September 2013. In addition, the city's traffic engineering department provided a listing of the months in which the yellow interval was increased at each intersection monitored by red light camera systems. The change dates, along with the before and after yellow interval times, for each red light camera intersection are listed in the table below.

West Hollywood RLC Intersections Yellow Interval Change Dates		NB/SB			EB/WB		
		Previous	Current	Difference	Previous	Current	Difference
Intersection	Date Changed	Yellow Phase	Yellow Phase	YP	Yellow Phase	Yellow Phase	YP
Fountain Av/Crescent Hts Blvd	Oct-12	3.6	3.9	0.3	3.6	3.9	0.3
Fountain Av/Fairfax Av	Nov-12	3.6	3.9	0.3	3.6	3.9	0.3
Fountain Av/La Brea Av	Oct-12	3.6	3.9	0.3	3.5	3.9	0.4
Santa Monica Blvd/ Fairfax Av	Jun-12	3.6	3.9	0.3	3.5	3.6	0.1
Sunset Bl/La Cienega Bl	Jun-13	3.0	3.6	0.6	3.6	3.9	0.3
Santa Monica Blvd/La Brea	N/A	3.6	TBD	TBD	3.5	TBD	TBD
Melrose Av/La Cienega Bl	N/A	3.7	TBD	TBD	3.7	TBD	TBD
Beverly Bl/Robertson Bl	N/A	3.6	TBD	TBD	3.7	TBD	TBD

Of the five intersections where the yellow interval had been increased at the time of this study, one was increased in June 2012, two were increased in October 2012, one was increased in November 2012, and one was increased in June 2013.

Data Analysis and Results

For this study, we compiled the number of citations issued at each photo enforced intersection approach before and after the yellow interval was increased. We eliminated any intersection approach where the enforcement system was not active for all months of the study. Additionally, we eliminated the eastbound and westbound intersection approaches at Sunset Blvd and La Cienega Blvd as the limited after period of three months did not provide sufficient data for a valid analysis. After this data reduction, figures for a total of seven intersection approaches were available for analysis.

For each intersection approach, the average number of monthly citations before and after the signal timing increase was calculated, as was the percent change in the number of citations. The before period for the analysis ran from January 2012 to the month prior to the month in which the signal timing was changed. The after period for the analysis ran from the month after the month in which the signal timing was changed to September 2013, the most recent month for which data was available. The month in which the signal timing was changed was eliminated from the analysis as it contained a mix of before and after data. The results appear in the table below. Months highlighted in yellow represent the months in which the signal timing changes were made.

N/B LaBrea At Fountain Yellow Interval Increase of 0.3 sec in Oct. 2012		S/B LaBrea At Fountain - Yellow Interval Increase of 0.3 sec in Oct. 2012		N/B Fairfax At Fountain - Yellow Interval Increase of 0.3 sec in Nov. 2012		S/B Fairfax At Fountain - Yellow Interval Increase of 0.3 sec in Nov. 2012		N/B Crescent Hts At Fountain - Yellow Interval Increase of 0.3 sec in Oct. 2012		S/B Crescent Hts At Fountain - Yellow Interval Increase of 0.3 sec in Oct. 2012		N/B Fairfax At Santa Monica - Yellow Interval Increase of 0.3 sec in June 2012	
Month	Citations	Month	Citations	Month	Citations	Month	Citations	Month	Citations	Month	Citations	Month	Citations
Jan 2012	217	Jan 2012	109	Jan 2012	108	Jan 2012	33	Jan 2012	46	Jan 2012	51	Jan 2012	43
Feb 2012	148	Feb 2012	135	Feb 2012	89	Feb 2012	27	Feb 2012	35	Feb 2012	50	Feb 2012	45
Mar 2012	160	Mar 2012	134	Mar 2012	93	Mar 2012	35	Mar 2012	49	Mar 2012	59	Mar 2012	48
Apr 2012	165	Apr 2012	129	Apr 2012	101	Apr 2012	34	Apr 2012	47	Apr 2012	53	Apr 2012	40
May 2012	186	May 2012	142	May 2012	120	May 2012	37	May 2012	49	May 2012	42	May 2012	44
Jun 2012	199	Jun 2012	156	Jun 2012	126	Jun 2012	36	Jun 2012	47	Jun 2012	58	Jun 2012	20
Jul 2012	156	Jul 2012	149	Jul 2012	129	Jul 2012	39	Jul 2012	53	Jul 2012	59	Jul 2012	28
Aug 2012	193	Aug 2012	168	Aug 2012	155	Aug 2012	38	Aug 2012	52	Aug 2012	60	Aug 2012	16
Sept 2012	194	Sept 2012	159	Sept 2012	110	Sept 2012	44	Sept 2012	48	Sept 2012	57	Sept 2012	21
Oct 2012	129	Oct 2012	128	Oct 2012	100	Oct 2012	42	Oct 2012	49	Oct 2012	20	Oct 2012	27
Nov 2012	89	Nov 2012	64	Nov 2012	95	Nov 2012	33	Nov 2012	25	Nov 2012	20	Nov 2012	16
Dec 2012	45	Dec 2012	24	Dec 2012	82	Dec 2012	18	Dec 2012	15	Dec 2012	19	Dec 2012	15
Jan 2013	42	Jan 2013	55	Jan 2013	54	Jan 2013	17	Jan 2013	19	Jan 2013	19	Jan 2013	22
Feb 2013	55	Feb 2013	54	Feb 2013	56	Feb 2013	25	Feb 2013	13	Feb 2013	18	Feb 2013	22
Mar 2013	63	Mar 2013	66	Mar 2013	64	Mar 2013	19	Mar 2013	23	Mar 2013	16	Mar 2013	23
Apr 2013	56	Apr 2013	48	Apr 2013	18	Apr 2013	21	Apr 2013	27	Apr 2013	15	Apr 2013	23
May 2013	56	May 2013	41	May 2013	76	May 2013	10	May 2013	19	May 2013	22	May 2013	27
Jun 2013	41	Jun 2013	58	Jun 2013	57	Jun 2013	16	Jun 2013	19	Jun 2013	15	Jun 2013	23
Jul 2013	46	Jul 2013	46	Jul 2013	49	Jul 2013	17	Jul 2013	33	Jul 2013	28	Jul 2013	32
Aug 2013	61	Aug 2013	39	Aug 2013	43	Aug 2013	18	Aug 2013	22	Aug 2013	17	Aug 2013	28
Sept 2013	49	Sept 2013*	38	Sept 2013	13	Sept 2013	17	Sept 2013	29	Sept 2013	24	Sept 2013	23
Average Before Change	180	Average Before Change	142	Average Before Change	113	Average Before Change	37	Average Before Change	47	Average Before Change	54	Average Before Change	44
Average After Change	55	Average After Change	48	Average After Change	51	Average After Change	19	Average After Change	22	Average After Change	19	Average After Change	23
% Change	-69.5%	% Change	-66.0%	% Change	-54.7%	% Change	-47.4%	% Change	-53.1%	% Change	-64.4%	% Change	-47.6%

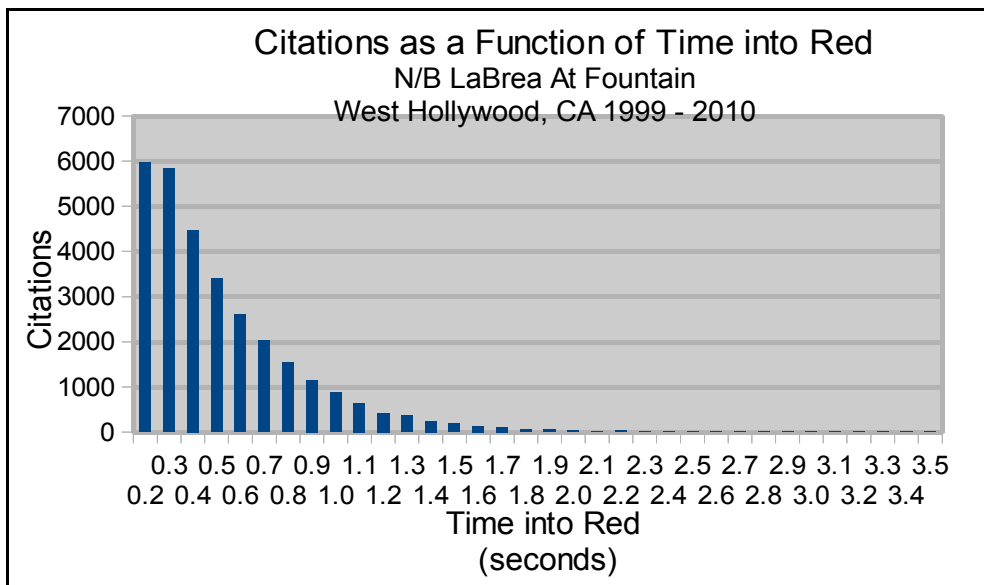
A summary table of the above results including a calculation of the overall rate of change in citations at the seven study locations appears below:

Change in Citations Issued After 0.3 Sec Increase in Yellow Interval West Hollywood, CA			
Location	Average Citations Before Change	Average Citations After Change	% Change
N/B LaBrea At Fountain	180	55	-69.5%
S/B LaBrea At Fountain	142	48	-66.0%
N/B Fairfax At Fountain	113	51	-54.7%
S/B Fairfax At Fountain	37	19	-47.4%
N/B Crescent Hts At Fountain	47	23	-51.3%
S/B Crescent Hts At Fountain	48	19	-59.3%
N/B Fairfax At Santa Monica	44	23	-47.6%
Totals	610	239	-60.9%

Discussion

By increasing the yellow interval by 0.3 s at intersections within the city of West Hollywood, traffic engineers were able to achieve an overall 61% reduction in red light running at the locations analyzed in this study. Individual intersection approaches saw reductions in the range of 48% to 70%, with the greatest percentage reductions occurring at locations with the greatest number of red light violations prior to the yellow time change. This result is to be expected as the number of red light violations at intersections where the yellow interval is set at or near the minimum time based on the posted speed limit is consistently found to be relatively high in the first few fractions of a second after the light turns red and decreases exponentially as the time into red increases.

The chart below illustrates the distribution of citations issued at the photo enforced intersection of LaBrea and Fountain Avenues in West Hollywood from the inception of the program through 2010 as a function of the time into red.



This is the typical distribution of red light running events seen for the straight through movement when the yellow interval is set at or near the minimum time based on the posted speed limit. When the yellow interval is increased, violations occurring during the corresponding time period are eliminated.

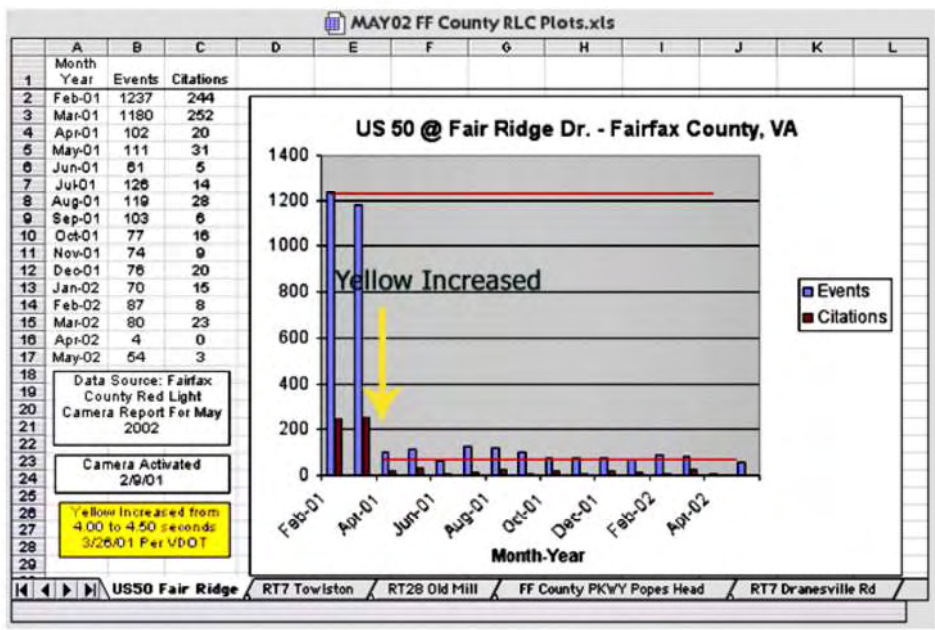
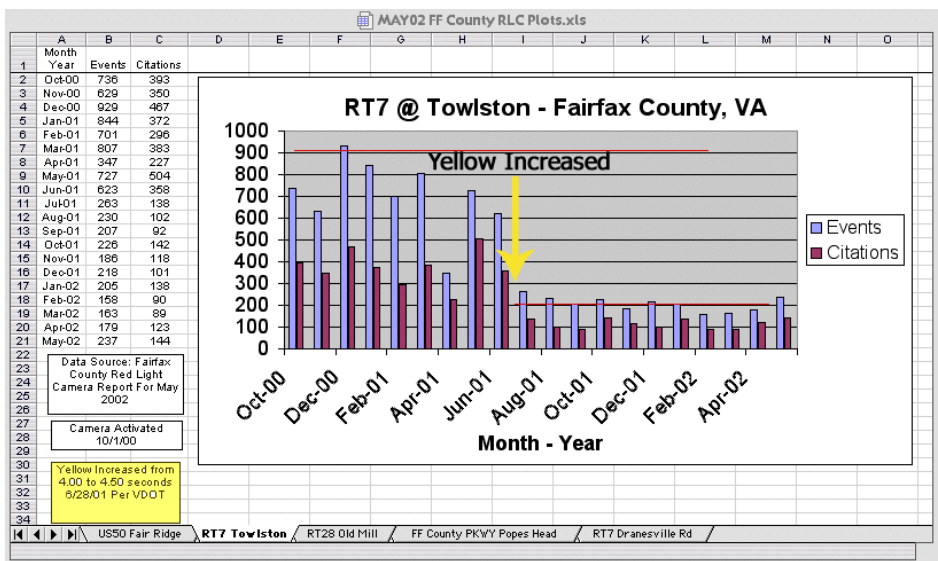
Conclusions

The decreased incidents of red light running brought about by the increase of 0.3 seconds in the yellow interval has likely increased safety at intersections where the change has been made. However, additional reductions in red light running incidents along with additional improvements in safety are achievable through additional increases in the yellow interval and possibly other engineering countermeasures. For example, a very modest 0.3 s increase in the yellow interval at the north and southbound approaches to the intersection of La Brea and Fountain Avenues resulted in an average 68% decrease in red light running from an average of 161 issued citations per month to an average of 52 issued citations per month. By increasing the yellow interval an additional 0.4 s to 0.7 s, red light running incidents would be further reduced. Based on experience at intersections in other jurisdictions where the yellow interval has been increased by 0.7 s to 1.0 s beyond the minimum time and which resulted in an overall 80% to 90% reduction in red light running, West Hollywood could expect to reduce the number of red light running events at this intersection, as well as others throughout the city, to no more than 10 and 20 per month by increasing the yellow interval to a similar extent.

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Fairfax County, VA

The following two figures show how Fairfax County, VA achieved a significant, sustained reduction in violations when the yellow timing was increased by 1/2 second. Note also that although red-light cameras were present at these intersections during the entire review period, a dramatic reduction in violations was seen only after the yellow timing was increased.



San Diego

The chart below shows the 30% to 55% reduction in violations achieved at San Diego red-light camera sites when the yellow interval times were increased, even by as little as 0.2 second.

RESULTS FROM INCREASING YELLOW TIMES AT 6 of 19 SAN DIEGO RED LIGHT CAMERA SITES:

INT #	LOCATION	BEFORE YELLOW (seconds)	BEFORE VIOLATIONS (per 100 hrs)	AFTER YELLOW (seconds)	AFTER VIOLATIONS (per 100 hrs)	YELLOW INCREASE (seconds)	VIOLATION REDUCTION (percent)
1454	WB GARNET AVE @ INGRAHAM ST	3.00	98.8	3.20	55.9	0.20	-43.4%
1504	WB "F" ST @ 16TH ST	4.00	49.4	4.90	22.5	0.90	-54.5%
1534	WB MIRAMAR RD @ CAMINO RUIZ	4.40	42.5	4.80	29.8	0.40	-29.9%
1541	NB MISSION BAY DR TO WB GRAND AVE	3.10	363.4	4.70	42.2	1.60	-88.4%
1542	SB MISSION BLVD @ GARNET AVE	3.00	49.9	3.70	30.3	0.70	-39.3%
1553	EB MIRA MESA BLVD @ SCRANTON RD	3.90	98.7	4.30	52.7	0.40	-46.6%

SOURCE: San Diego Photo Enforcement System Review January 14, 2002

FHWA Recommended Practices

In addition to the ITE, the USDOT and FHWA also provide recommended standards for the setting of yellow signal times. In their presentation regarding countermeasures for red light running, available at http://safety.fhwa.dot.gov/intersection/redlight/outreach/marketing/rlr_pps022509/long/, under the heading "Improve Signal Timing" (slides 27 - 28) are the following guidelines:

- Traffic engineers should make sure that yellow change interval is set properly. This step is covered in the field review checklist that was presented in an earlier slide.
- Research shows that yellow interval duration is a significant factor affecting the frequency of red-light running and that increasing yellow time to meet the needs of traffic can dramatically reduce red-light running.
- When yellow intervals are set too short for the prevailing speed, there is likely to be a higher incidence of red-light running due to drivers being caught in the dilemma zone.
- **If the approach speed is not known, then the speed limit plus 10 mi/h is recommended. Studies show that most speed limits in general are 8-12 mi/h below the prevailing speed.**
- **An additional 0.5 sec of yellow time should be considered for locations with significant truck traffic, significant population of older drivers**
- Yellow times less than recommended by this equation result in more red-light violations and higher crash rates.
- Increasing yellow times that are shorter than recommended by this equation has been show to reduce severe red-light related crashes. A 1.0 sec increase in yellow time results in 40 percent decrease in severe red-light related crashes.

Using an approach speed of 10 mph over the posted speed limit results in an additional 0.7 second yellow time. Adding the recommended 0.5 second for truck traffic and older drivers yields a total of 1.2 seconds of additional yellow.

Drivers Do Not Adapt to Longer Yellow Durations of About 1 Second.

In addition to the evidence presented above from locations where yellow signal times have been increased with no adaptation by drivers, other independent studies have found similar results.

“The data show that the percentage of last-to-cross vehicles clearing the intersection ($T + 0.2$) seconds or more past the yellow onset was not appreciably changed by the extension of the yellow phase.”

The Influence of the Time Duration of Yellow Traffic Signals on Driver Response,
Stimpson/Zador/Tarnoff, ITE Journal (November 1980)

“Research has consistently shown that drivers do not, in fact, adapt to the length of the yellow.”

Determining Vehicle Change Intervals – A Proposed Recommended Practice, Institute of
Transportation Engineers (1985)

“Drivers do adapt to the increase in yellow duration[†]; however, this adaptation does not undo the benefit of an increase in yellow duration.”*

Effect of Yellow-Interval Timing on Red-Light-Violation Frequency at Urban Intersections,
Bonneson/Zimmerman, Texas Transportation Institute (January 2004)

*Note, however, that the adaptation found was minor, shifting the statistical curve about 0.2 of a second. Most other studies at photo enforced intersections over long periods of time show no increase in red light running after the initial reduction in violations. This suggests that drivers do *not* adapt to the increase in yellow duration in any meaningful way. Yet even in this one study that suggested that drivers may adapt to a longer yellow time, the evidence showed that the safety benefit of a 53% decrease in violations and 40% decrease in crashes far outweighed any driver adaptation.

Conclusions

If the yellow signal time was increased at red light camera locations, violations would be greatly reduced resulting in a significant increase in safety as well as eliminating the needless ticketing of tens of thousands of otherwise law-abiding motorists every year. The lack of a rebound in violations or collisions, even after a number of years of motorists experiencing longer signal times, belies the notion that motorists can perceive this change and will adjust their driving behavior. All the evidence to date indicates that this does not happen. In fact, the evidence shows just the opposite, that once the yellow light time is increased, violations and collisions are significantly reduced, never to return.