

**Evaluation of the City of Houston
Digital Automated Red Light Camera Program**

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Selection Process

1. Intersections with a high number of crashes were selected for the installation of a red light camera (RLC) based on crashes reported for the years 2000 thru 2005.
2. One approach per intersection was selected for the installation of a red light camera. From an 8-hour trial period, the selected approach was determined to have the highest rate of red light camera violations.
3. Between September, 2006 and August, 2008, red light cameras were installed at 50 intersections and 70 approaches in five groups of ten approaches and one group of twenty. Group 1 began operating in September, 2006, with a new group coming online approximately every two months. From September, 2006 to September, 2007 cameras were in operation at only one approach per intersection. Since September, 2007 20 additional cameras (installation Group 6) have been installed at several intersections in Groups 1 through 5 on different approaches.

Previous Research Findings

Current literature on red light camera programs in other cities reveals inconsistent results. One synthesis of these studies points to inconsistent data collection, faulty analytical procedure, and poor intersection sampling as the primary causes of the ambiguous conclusions surrounding red light cameras.¹ Based upon the general trends in the research literature and evaluations of other camera programs, the following outcomes were hypothesized for Houston's red light camera program.

1. The effect of red light cameras should be observed most strongly in the approaches where there are cameras. There may also be some "spillover" effect on other approaches in the intersection or other nearby intersections.
2. The incidence of crashes is expected to increase in the first several months after the installation of red light cameras and then decline.
3. The incidence of rear end crashes is expected to rise in the first several months after the installation of red light cameras and then decline.
4. The incidence of side-impact crashes is expected to decline after installation of red light cameras.

¹ National Cooperative Highway Research Program, "Synthesis 310: Impact of Red Light Camera Enforcement on Crash Experience" 2003. http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_syn_310.pdf

Evaluation Design

1. Information on all vehicle collisions since January 2004 was collected for the 50 camera-monitored intersections. At present, we have 12 or more months of crash data after the installation of red light cameras at 50 approaches. Data continues to be collected on crashes at all intersections where red light cameras have been installed.
2. In the course of our research, we settled on a methodology comparing crashes between approaches with and without red light cameras for the two year period preceding installation and for a minimum of 12 months following installation.² This approach has a number of advantages:
 - a) Although monitored and non-monitored approaches are close to “representative” study groups, with the non-monitored approaches acting as a control and the monitored approaches as an “experimental” group.
 - b) The large number of approaches (50 monitored and 150 non-monitored) is a sufficiently large sample size allowing for statistically significant conclusions.
 - c) The staggered implementation of the cameras, conducted in groups of 10 cameras every other month beginning in September 2006, provides additional controls in the evaluation. In this methodology, the precise effect of the treatment, in this case a red light camera, can be substantially isolated from seasonal effects by viewing all approaches on a pre-RLC/post-RLC timeline instead of by calendar month. The available data did not allow us to study the effect of changes in traffic volume at specific intersections.
3. To evaluate our hypotheses, we looked not only at the raw number of collisions both pre- and post-RLC, but also at each type of collision before and after the installation of camera enforcement.

Findings

The Appendix to this report includes the number of collisions for installation groups 1 through 5 at both the red light camera approach as well as the approaches without cameras. Data on collisions by type and by individual approaches is also included (Appendix A).

The comparison of data between monitored and non-monitored approaches supports the conclusion that red light cameras are mitigating a general, more severe increase in collisions.

Comparing non-monitored to monitored approaches before and after camera implementation, we see that non-monitored approaches have observed an increase in collisions after the installation of red light cameras that is not observed at the monitored approaches.³ Monitored

² Collisions occurring at the monitored approaches were defined using the four rules of coding:

1) One more or more vehicle in the camera-monitored approach is cited [Included].

2) No vehicle cited, but one or more vehicles are in the camera-monitored approach [Included].

3) Vehicle cited is not in the camera-monitored approach [Not Included].

4) Neither vehicle in camera-monitored approach (i.e. not within 500 ft. of the intersection) [Not Included].

While these rules are in no way a perfect definition of “monitored collision”, they do represent the best available definition based upon available data. The rules have been consistently applied to both the pre- and post-implementation datasets.

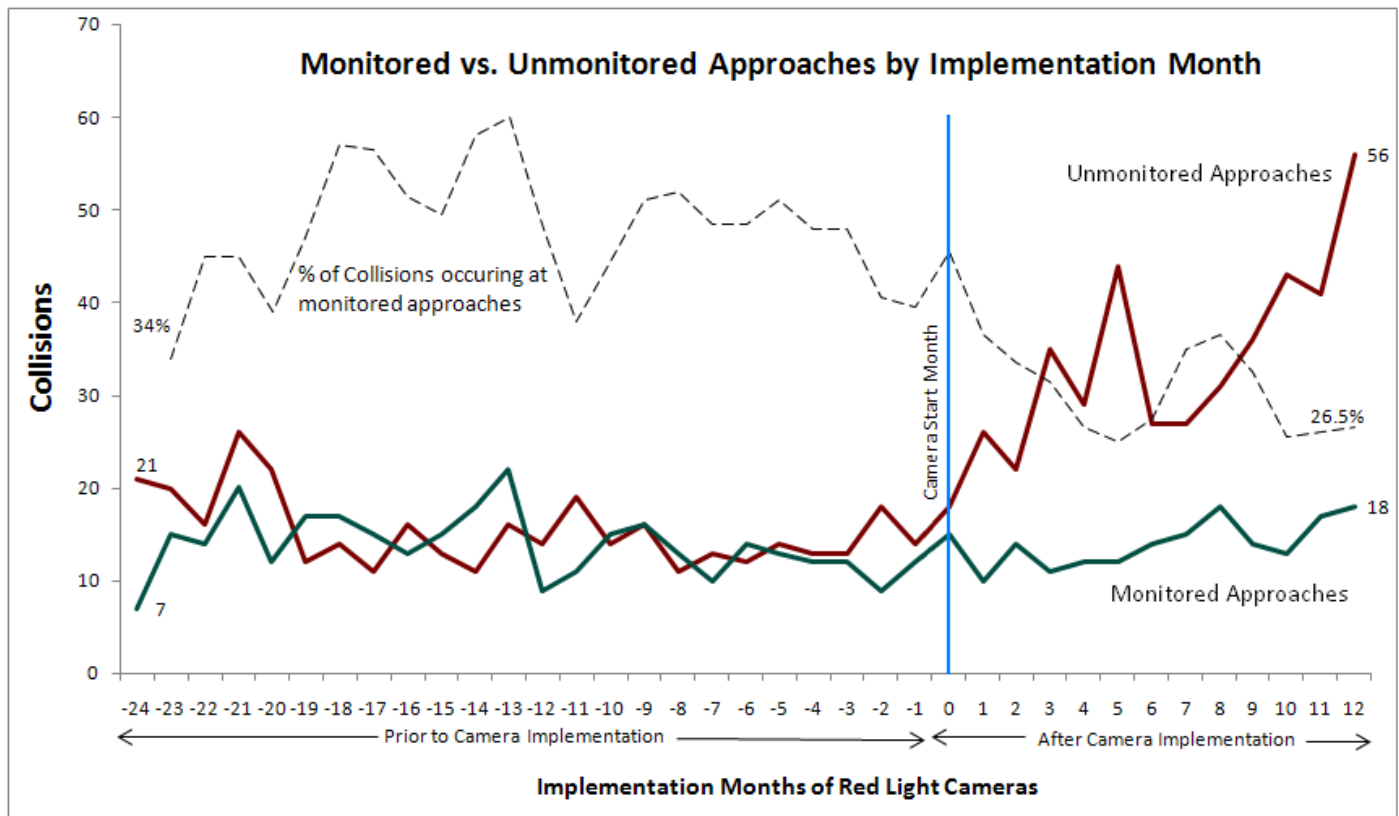
³ 13 months of pre-camera implementation data was compared to 13 months of post-camera implementation data.

approaches saw no significant increase or decrease in total number accidents; whereas a 133% increase was observed at the non-monitored approaches (see Appendix B). Significant increases in side-impact, rear-impact, and swipe-impact collisions were all observed at non-monitored approaches. Conversely, monitored approaches experienced a significant increase only with regards to swipe-impacts. This observed increase in swipe collisions (collisions on turns) at monitored approaches could still support the efficacy of the red light cameras in that the cameras are least likely to prevent these types of collisions, which have little to do with the running of red lights.

Red light camera-monitored approaches are further differentiated from non-monitored approaches through direct comparisons of average collisions per month both prior to and after the installation of red light cameras. Prior to camera implementation, the number of collisions at monitored and non-monitored approaches did not significantly differ. After the implementation of red light cameras, the two groups varied greatly, especially with regards to side-impact collisions.

Another point of comparison between monitored and non-monitored approaches is crash severity. Derived from a combination of vehicle damages and occupant injuries, our measure of crash severity differed significantly prior to the implementation of red light cameras, with collisions at monitored approaches classified as more severe. Post-implementation, no significant difference in crash severity at monitored and non-monitored approaches was observed.

Finally, the proportion of collisions occurring at monitored approaches decreased significantly relative to the non-monitored approaches (see dashed line in figure below).



When individual approach data is analyzed, a more detailed picture of the red light camera program emerges (see appendix C). On this level of analysis, comparing collision rates of individual approaches before and after camera implementation, the effect of the program appears to be bimodal. The large number of approaches increasing in collisions and a similar number of approaches decreasing in collisions seem to be offsetting each other, with only a small number of approaches experiencing minor changes in collision rates. Intersections increasing in collisions per year include:

- Brazos at Elgin, #6 HO03
- FM 1960 at Tomball Parkway, #13 HO17
- Hollister at Northwest Freeway, #25 HO28
- West Sam Houston S at Bellaire, #31 HO31
- Westpark at West Sam Houston S, #45 HO45

Intersections where the expected reduction in collision rate was observed include:

- Pease at LaBranch, #10 HO07
- Chimney Rock at Southwest Freeway, #14 HO18
- West Loop S at San Felipe, #21 HO21
- Antoine at Northwest Freeway, #40 HO39
- Northwest Freeway at Mangum, #48 HO48

Data on the effect of red light cameras at individual approaches serves as a starting point for determining the context best suited to the success of the camera program. Light timing, intersection design, and approach speed may all play roles in the success of red light cameras.

Although analyzing at the level of individual approaches may allow for the selection of “winning” and “losing” approaches, the absolute number of collisions at camera-monitored approaches is not decreasing. There are several possible reasons why we have not observed the expected changes in incidence of crashes. These include:

- Red light cameras are not effective. We do not believe this is true, but there may be some locations where the cameras are more effective than at other locations. Previous studies are not definitive.
- Crashes are relatively infrequent events and changes in the number or pattern of crashes over a one-year period can be affected by many events that are not affected by red light camera installation.
- There may be other physical conditions or construction activity at individual intersections that affect the efficacy of the red light camera program.
- Changes in traffic volume may have increased traffic levels (i.e. chances for crashes). There are few traffic counts available at the subject intersections to explore this factor.
- Expectations for the red light camera program may have been too optimistic. We reexamined the research literature and analytical procedures used to study red light camera programs in other cities. We find the evaluation procedures used in these studies differ from the procedure we have used to evaluate the Houston program.

In general, the absence of an expected decrease in collisions could point to two explanations: 1) The cameras have not been effective across this group of 50 approaches; 2) The cameras are effective in reducing collisions, but this affect is a relative decrease, with the absolute number of collisions staying constant or even increasing due to other factors. We believe that this second explanation, as evidenced in decrease in the proportion of crashes occurring on camera-monitored approached, is the more accurate.

Questions for Future Investigation

Although this study supports the idea that that red light cameras have a positive effect in reducing collisions at monitored approaches in comparison with non-monitored approaches, several questions have been raised by these findings. The most important of these is “Why have accidents at non-monitored approaches increased so dramatically in the past year?” As suggested above, these results could be evidence of an increase in collisions across the city. The selection in 2006 of intersections with high rates of collisions could be serving to magnify this effect.

Currently, conclusions on a general increase in collisions across the city are not supportable with available data. Population growth and congestion stand out as possible factors behind slower traffic flow and increased collisions on a citywide level. However, this hypothesis is beyond the scope of this report and will have to be tested with specific data and rigorous analysis.

Actions for Future Research

To evaluate and definitively support the findings observed in this study, a further course of action is necessary. Fortunately, the tools for such an analysis are readily available. First, a comparison between the 50 camera-monitored intersections and a group of roughly comparable intersections should be conducted. In this process, we would test the trends seen in the pre- and post-RLC periods against the general trends of the outside group. Using this methodology, the new analysis could reveal if, in fact, the red light cameras mitigated a general increase in accidents citywide. This observation, if found, would both confirm the public safety benefit of the red light cameras in Houston as well as advocate the expansion of the program.

A second point of future research would be to evaluate the effect of multiple camera-monitored approaches at the same intersection. This research, supported by the collection of new data on installation group 6 (a group of 20 cameras installed at intersections already possessing a camera), could serve to guide future installation of RLCs on two, three, or all approaches to a given intersection. Throughout this process, similarities in approach characteristics, such as engineering design, signal timings, and surface conditions would be used to gain greater insight into the nature of red light running collisions. Building on this preliminary study, which has only investigated a year’s worth of post-camera implementation data, is not an option, but rather a necessity for understanding the effect of red light cameras and improving safety on the streets of Houston.

**Appendix A: Collisions by Group and Type at
Monitored (Appr) and Non-Monitored (Other) Approaches**

Group 1

	04-05			05-06			06-07			07-08		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Sep	1	4	5	1	1	2	1	3	3	0	3	3
Oct	4	2	6	0	2	2	0	2	3	3	1	4
Nov	3	3	6	1	3	4	4	2	6	5	5	10
Dec	2	4	6	4	4	8	1	2	3	1	4	5
Jan	4	2	6	2	2	4	1	2	3	2	4	6
Feb	1	1	2	2	1	3	0	0	0	2	1	3
Mar	3	1	4	0	1	1	2	0	2	3	2	5
Apr	1	0	1	2	2	4	1	3	4	4	1	5
May	0	4	4	0	1	1	3	4	7	1	4	5
Jun	2	2	4	0	1	1	5	3	8			
Jul	3	3	6	2	1	3	1	1	2			
Aug	1	0	1	1	3	4	0	3	3			
Total	25	26	51	15	22	37	19	25	44	21	25	46

Group 2

	04-05			05-06			06-07			07-08		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Nov	0	6	6	3	3	6	6	5	11	6	9	15
Dec	4	5	9	4	5	9	1	10	11	9	8	17
Jan	2	4	6	3	2	5	2	4	6	5	12	17
Feb	6	11	17	2	6	8	2	8	10	7	17	24
Mar	0	6	6	4	2	6	0	3	3	14	17	31
Apr	1	4	5	2	5	7	3	11	14	1	6	7
May	3	4	7	3	4	7	3	4	7	5	3	8
Jun	3	3	6	3	3	6	2	5	7			
Jul	4	5	9	1	5	6	2	0	2			
Aug	2	2	4	5	4	9	2	4	6			
Sep	2	1	3	2	6	8	2	8	10			
Oct	5	5	10	2	3	5	2	9	11			
Total	25	50	75	30	39	69	23	54	77	47	72	119

Group 3

	2005			2006			2007			2008		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Jan	2	8	10	2	5	7	2	3	5	5	6	11
Feb	1	4	5	2	6	8	3	3	6	5	8	13
Mar	4	5	9	8	3	11	2	3	5	8	7	15
Apr	4	5	9	4	1	5	2	3	5	4	5	9
May	4	4	8	3	2	5	1	8	9	2	8	10
Jun	8	1	9	3	3	6	5	6	11			
Jul	9	5	14	3	2	5	2	7	9			
Aug	1	1	2	4	2	6	4	6	10			
Sep	4	3	7	2	0	2	5	2	7			
Oct	4	2	6	2	1	3	3	8	11			
Nov	8	4	12	3	5	8	3	9	12			
Dec	9	4	13	4	7	11	3	8	11			
Total	58	46	104	40	37	77	35	66	101	24	34	58

Group 4

	05-06			06-07			07-08			08-09		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Mar	2	3	5	2	3	5	3	6	9	5	22	27
Apr	3	3	6	3	4	7	5	7	12	7	16	23
May	4	3	7	2	3	5	4	10	14	6	8	14
Jun	7	2	9	3	3	6	5	14	19			
Jul	3	7	10	0	1	1	7	12	19			
Aug	5	3	8	3	2	5	3	16	19			
Sep	2	4	6	6	4	10	6	12	18			
Oct	5	3	8	1	4	5	3	11	14			
Nov	4	2	6	5	5	10	5	21	26			
Dec	5	5	10	5	6	11	3	14	17			
Jan	2	2	4	1	2	3	5	13	18			
Feb	6	2	8	2	1	3	10	11	21			
Total	48	39	87	33	38	71	59	147	206	18	46	64

Group 5

	05-06			06-07			07-08			08-09		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Tot
May	2	0	2	1	2	3	4	1	5	2	16	18
Jun	3	6	9	2	2	4	2	4	4			
Jul	1	1	2	1	3	4	0	3	5			
Aug	1	4	5	3	2	5	1	8	9			
Sep	1	3	4	4	4	8	3	4	7			
Oct	2	3	5	0	2	2	1	11	12			
Nov	0	0	5	2	1	3	1	4	5			
Dec	5	4	9	3	3	6	5	2	7			
Jan	1	2	3	4	2	6	3	4	7			
Feb	2	2	4	1	1	1	1	7	8			
Mar	3	1	4	0	4	5	2	12	14			
Apr	1	5	6	3	0	3	2	10	12			
Total	22	31	53	24	26	50	25	70	95	2	16	18

Rear-End Collisions

	2004-2005			2005-2006			2006-2007			2007-2008		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Jun	2	2	4	4	0	4	1	4	5	0	6	6
Jul	1	1	2	3	3	6	2	3	5	0	2	2
Aug	1	6	7	0	2	2	2	1	3	2	5	7
Sep	1	6	7	1	2	3	1	0	1	1	4	5
Oct	0	4	4	1	2	3	0	4	4	2	3	5
Nov	2	6	8	3	0	3	2	3	5	7	9	16
Dec	4	4	8	2	3	5	3	6	9	3	10	13
Jan	4	4	8	2	1	3	1	2	3	3	6	9
Feb	1	4	5	0	3	3	2	2	4	1	5	6
Mar	3	1	4	1	3	4	0	2	2	1	5	6
Apr	2	1	3	3	1	4	2	4	6	2	6	8
May	0	4	4	0	6	6	2	6	8	1	6	7
Total	21	43	64	20	26	46	18	37	55	23	67	90

Side Collisions

	2004-2005			2005-2006			2006-2007			2007-2008		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Jun	10	20	30	16	12	28	9	5	14	14	20	34
Jul	6	13	19	15	14	29	3	5	8	11	19	30
Aug	9	14	23	9	5	14	8	10	18	6	28	34
Sep	9	13	22	8	9	17	9	12	21	10	19	29
Oct	12	17	29	12	9	21	5	7	12	8	21	29
Nov	7	8	15	11	9	20	15	12	27	12	28	40
Dec	9	8	17	22	14	36	9	17	26	15	16	31
Jan	10	13	23	7	8	15	5	9	14	16	19	35
Feb	11	11	22	12	12	24	4	10	14	20	24	44
Mar	5	9	14	15	2	17	6	10	16	23	38	61
Apr	7	10	17	8	10	18	9	14	23	9	22	31
May	10	7	17	8	2	10	9	18	27	11	18	29
Total	105	143	248	143	106	249	91	129	220	155	272	427

Swipe Collisions

	2004-2005			2005-2006			2006-2007			2007-2008		
	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total	Appr	Other	Total
Jun	3	1	4	3	2	5	1	3	4	3	6	9
Jul	4	5	9	2	4	6	2	4	6	3	2	5
Aug	0	4	4	1	3	4	6	2	8	2	4	6
Sep	5	8	13	1	1	2	4	5	9	5	6	11
Oct	3	9	12	3	4	7	1	1	2	2	16	18
Nov	1	7	8	2	3	5	3	3	6	1	11	12
Dec	3	6	9	3	5	8	2	5	7	3	10	13
Jan	1	2	3	1	4	5	4	2	6	1	13	14
Feb	1	5	6	2	2	4	1	1	2	4	14	18
Mar	3	6	9	1	5	6	2	4	6	8	17	25
Apr	1	3	4	1	6	7	3	6	9	7	10	17
May	3	4	7	1	4	5	4	3	7	4	15	19
Total	28	60	88	21	43	64	33	39	72	43	124	167

Appendix B: Mean Comparison of Monitored and Non-Monitored Approaches

Implementation	Rear-Impact			Side-Impact			Swipe-Impact			TOTALS		
	Pre-	Post-	Change	Pre-	Post-	Change	Pre-	Post-	Change	Pre-	Post-	Change
Monitored	1.54	1.38	-0.16	9.38	9.69	+0.31	2.00	3.00	+1.00*	12.92	14.08	+1.16
Non-Monitored	2.77	5.62	+2.85**	7.85	19.38	+11.53**	3.77	8.38	+4.61*	14.38	33.46	+19.08**
Mean Difference	1.23**	4.24**	_____	1.53	9.69**	_____	1.77**	5.32**	_____	1.46	19.38**	_____

* Statistically significant with 95% confidence ($p < .05$)

** Statistically significant with 99% confidence ($p < .01$)

Appendix C: Rate Changes at Individual Approaches

The charts in this section show rate changes on an intersection by intersection basis. In the charts, **red** indicates an increase while **green** is indicative of a decrease. This information, the difference between the “Pre-RLC” period and “Post-RLC” period, is also found in the “Change” column.

The first chart (C1) shows the mean monthly number of collisions at each monitored approach for the 24 months “Pre-RLC” (the months before cameras were installed) and for the months “Post-RLC” (the months after cameras were installed).

The second chart (C2) shows the number of collisions at the monitored approach as a proportion of the total number of collisions at the monitored intersection for the period “Pre-RLC” (the months before cameras were installed) and for the period “Post-RLC” (the months after cameras were installed).

Group	Location Name	Rice_ID	HPD_ID	Pre-RLC	Post-RLC	Change	% Change
1	Harwin at Hillcroft	1	HO04	0	0	0.00	0%
	Milam at Elgin	2	HO08	1.13	1.14	0.02	2%
	Richmond at Dunvale	3	HO09	2.25	4.57	2.32	103%
	Bellaire at Wilcrest	4	HO02	1.13	2.29	1.16	103%
	Richmond at Hillcroft	5	HO05	1.88	1.14	-0.73	-39%
	Brazos at Elgin	6	HO03	0.38	1.71	1.34	357%
	Travis at Webster	7	HO10	4.13	1.71	-2.41	-58%
	John F. Kennedy at Greens Rd.	8	HO06	3.75	8.00	4.25	113%
	Bay Area Blvd at El Camino Real	9	HO01	2.25	1.14	-1.11	-49%
	Pease at LaBranch	10	HO07	5.63	1.14	-4.48	-80%
2	Hillcroft at Southwest Fwy	11	HO20	3.18	3.16	-0.02	-1%
	Bissonnet at West Sam Houston S	12	HO16	8.47	11.37	2.90	34%
	FM 1960 W at Tomball Pkwy	13	HO17	3.88	15.79	11.91	307%
	Chimney Rock at Southwest Fwy	14	HO18	3.88	0.63	-3.25	-84%
	Westpark at Southwest Fwy	15	HO11	5.29	3.79	-1.50	-28%
	Westheimer at West Loop S	16	HO13	2.82	3.16	0.33	12%
	West Sam Houston S at Beechnut	17	HO15	1.76	0.63	-1.13	-64%
	Gessner at Beechnut	18	HO19	3.53	5.05	1.52	43%
	East Fwy at Uvalde	19	HO14	2.82	1.26	-1.56	-55%
	Southwest Fwy at Fountain View	20	HO12	2.82	1.26	-1.56	-55%
3	West Loop S at San Felipe	21	HO21	3.00	0	-3.00	-100%
	Southwest Fwy at Bellaire	22	HO22	8.00	5.65	-2.35	-29%
	El Dorado at Gulf Fwy	23	HO27	9.33	9.18	-0.16	-2%
	West Rd at North Fwy	24	HO29	5.00	5.65	0.65	13%
	Hollister at Northwest Fwy	25	HO28	0.33	2.82	2.49	747%
	North Wayside at East Fwy	26	HO30	2.67	5.65	2.98	112%
	Chartres at St. Joseph Pkwy	27	HO25	6.33	3.53	-2.80	-44%
	Southwest Fwy at Beechnut	28	HO23	3.00	2.12	-0.88	-29%
	Southwest Fwy at Fondren	29	HO24	3.67	4.24	0.57	16%
	Bissonnet at Southwest Fwy	30	HO26	3.67	1.41	-2.25	-61%
4	West Sam Houston S at Bellaire	31	HO31	0.63	6.40	5.77	913%
	Greens Road at North Fwy	32	HO32	6.32	3.20	-3.12	-49%
	North Shepherd at North Loop W	33	HO33	7.58	4.80	-2.78	-37%
	Southwest Fwy at Wilcrest	34	HO34	12.32	17.60	5.28	43%
	Main St at South Loop W	35	HO35	3.79	10.40	6.61	174%
	North Fwy at Rankin	36	HO40	4.74	5.60	0.86	18%
	East Fwy at Normandy	37	HO36	3.16	4.80	1.64	52%
	Monroe at Gulf Fwy	38	HO37	0.32	3.20	2.88	913%
	Scott at South Loop E	39	HO38	1.26	4.00	2.74	217%
	Antoine at Northwest Fwy	40	HO39	0.95	0	-0.95	-100%
5	Gulf Fwy at South Wayside	41	HO41	3.00	2.77	-0.23	-8%
	Gulf Fwy at Woodridge	42	HO42	4.50	0.92	-3.58	-79%
	West Bellfort at Southwest Fwy	43	HO43	2.10	0.92	-1.18	-56%
	NW Fwy at Fairbanks N. Houston	44	HO44	3.00	0.92	-2.08	-69%
	Westpark at West Sam Houston S	45	HO45	2.40	10.15	7.75	323%
	Gulf Fwy at FM 2351	46	HO46	0.60	0.92	0.32	54%
	West Loop S at Post Oak Blvd	47	HO47	3.00	0.92	-2.08	-69%
	Northwest Fwy at Mangum	48	HO48	1.50	0.00	-1.50	-100%
	S Sam Houston Fwy at Telephone	49	HO49	2.10	5.54	3.44	164%
	South Loop West at Stella Link	50	HO50	1.20	0.00	-1.20	-100%

Group	Location Name	Rice_ID	HPD_ID	Pre-RLC	Post-RLC	Change
1	Harwin at Hillcroft	1	HO04	0.00%	0.00%	0.00%
	Milam at Elgin	2	HO08	50.00%	50.00%	0.00%
	Richmond at Dunvale	3	HO09	42.86%	61.54%	18.68%
	Bellaire at Wilcrest	4	HO02	16.67%	57.14%	40.48%
	Richmond at Hillcroft	5	HO05	38.46%	40.00%	1.54%
	Brazos at Elgin	6	HO03	100.00%	60.00%	-40.00%
	Travis at Webster	7	HO10	100.00%	75.00%	-25.00%
	John F. Kennedy at Greens Rd.	8	HO06	66.67%	53.85%	-12.82%
	Bay Area Blvd at El Camino Real	9	HO01	50.00%	10.53%	-39.47%
	Pease at LaBranch	10	HO07	83.33%	66.67%	-16.67%
2	Hillcroft at Southwest Fwy	11	HO20	25.71%	31.25%	5.54%
	Bissonnet at West Sam Houston S	12	HO16	30.77%	26.87%	-3.90%
	FM 1960 W at Tomball Pkwy	13	HO17	43.48%	44.83%	1.35%
	Chimney Rock at Southwest Fwy	14	HO18	40.00%	22.22%	-17.78%
	Westpark at Southwest Fwy	15	HO11	51.72%	42.86%	-8.87%
	Westheimer at West Loop S	16	HO13	66.67%	62.50%	-4.17%
	West Sam Houston S at Beechnut	17	HO15	31.25%	12.50%	-18.75%
	Gessner at Beechnut	18	HO19	71.43%	40.00%	-31.43%
	East Fwy at Uvalde	19	HO14	44.44%	18.18%	-26.26%
	Southwest Fwy at Fountain View	20	HO12	23.53%	28.57%	5.04%
3	West Loop S at San Felipe	21	HO21	50.00%	0.00%	-50.00%
	Southwest Fwy at Bellaire	22	HO22	55.81%	38.10%	-17.72%
	El Dorado at Gulf Fwy	23	HO27	72.97%	51.85%	-21.12%
	West Rd at North Fwy	24	HO29	60.87%	52.94%	-7.93%
	Hollister at Northwest Fwy	25	HO28	10.00%	23.53%	13.53%
	North Wayside at East Fwy	26	HO30	23.53%	40.00%	16.47%
	Chartres at St. Joseph Pkwy	27	HO25	90.48%	83.33%	-7.14%
	Southwest Fwy at Beechnut	28	HO23	36.00%	18.75%	-17.25%
	Southwest Fwy at Fondren	29	HO24	44.00%	42.86%	-1.14%
	Bissonnet at Southwest Fwy	30	HO26	47.83%	15.38%	-32.44%
4	West Sam Houston S at Bellaire	31	HO31	15.38%	15.38%	0.00%
	Greens Road at North Fwy	32	HO32	55.56%	20.00%	-35.56%
	North Shepherd at North Loop W	33	HO33	70.59%	46.15%	-24.43%
	Southwest Fwy at Wilcrest	34	HO34	86.36%	79.31%	-7.05%
	Main St at South Loop W	35	HO35	37.50%	26.00%	-11.50%
	North Fwy at Rankin	36	HO40	35.90%	20.51%	-15.38%
	East Fwy at Normandy	37	HO36	41.67%	26.09%	-15.58%
	Monroe at Gulf Fwy	38	HO37	10.00%	20.00%	10.00%
	Scott at South Loop E	39	HO38	20.00%	31.25%	11.25%
	Antoine at Northwest Fwy	40	HO39	23.08%	0.00%	-23.08%
5	Gulf Fwy at South Wayside	41	HO41	34.48%	23.08%	-11.41%
	Gulf Fwy at Woodridge	42	HO42	38.46%	11.11%	-27.35%
	West Bellfort at Southwest Fwy	43	HO43	50.00%	6.25%	-43.75%
	NW Fwy at Fairbanks N. Houston	44	HO44	45.45%	9.09%	-36.36%
	Westpark at West Sam Houston S	45	HO45	47.06%	44.00%	-3.06%
	Gulf Fwy at FM 2351	46	HO46	33.33%	20.00%	-13.33%
	West Loop S at Post Oak Blvd	47	HO47	41.67%	25.00%	-16.67%
	Northwest Fwy at Mangum	48	HO48	50.00%	25.00%	-25.00%
	S Sam Houston Fwy at Telephone	49	HO49	40.00%	30.43%	-9.57%
	South Loop West at Stella Link	50	HO50	33.33%	0.00%	-33.33%

Appendix D: Statistical Significance of Divergence in Collisions by Approach Type (Monitored vs. Non Monitored) Post-Implementation

The tables below show the statistical results of a regression model for both unmonitored and monitored collisions after camera implementation. The coefficient of the IMP_MONTH variable can be interpreted as the mean slope of the two groups from Graph 1, post-implementation (i.e. Unmonitored Approaches compared to Monitored Approaches from Month 0, the first month of implementation, onwards).

From a comparison of the slopes and their confidence intervals, both statistically significant to a high degree, one sees that unmonitored collisions are increasing at a higher rate than those that are monitored.

Unmonitored Collisions post camera implementation

Coefficients^{a,b}

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	21.033	3.639		5.779	.000	13.023	29.043
IMP_MONTH	2.071	.515	.772	4.025	.002	.939	3.204

a. Dependent Variable: N_Collisions

b. Selecting only cases for which MONITORED = .00

Monitored Collisions post camera implementation

Coefficients^{a,b}

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	11.670	1.091		10.699	.000	9.269	14.071
IMP_MONTH	.401	.154	.617	2.600	.025	.062	.741

a. Dependent Variable: N_Collisions

b. Selecting only cases for which MONITORED = 1.00

Appendix E: Analysis Years for Each Group of Red-Light Camera Installations

Groups and Intersections	Year 1	Year 2	Year 3 (Post-Installation)
Group 1 – Intersections #1 to #10	September 1, 2004 to August 31, 2005	September 1, 2005 to August 31, 2006	September 1, 2006 to August 31, 2007
Group 2 – Intersections #11 to #20	November 11, 2004 to November 10, 2005	November 11, 2005 to November 10, 2006	November 11, 2006 to November 10, 2007
Group 3 – Intersections #21 to #30	January 20, 2005 to January 19, 2006	January 20, 2006 to January 19, 2007	January 20, 2007 to January 19, 2008
Group 4 – Intersections #31 to #40	March 19, 2005 to March 18, 2006	March 19, 2006 to March 18, 2007	March 19, 2007 to March 18, 2008
Group 5 – Intersections #41 to #50	May 15, 2005 to May 14, 2006	May 15, 2006 to May 14, 2007	May 15, 2007 to May 14, 2008
Group 6 – Intersections #51 to #70	September, 2005 to August, 2006	September, 2006 to August, 2007	September, 2007 to August, 2008

Note: See intersection listing for location and approach of red-light camera installations. Group 6 is not included in this report as a result of less than 12 months of post-camera implementation collision data.