

November 27th, 2017

To: Mike Carroll, Chris Puchalsky

CC: Kelley Yemen

Re: ARLE Summary Document and Findings v3

This document a condensed summary of research and findings on ARLE on a national scale, as well as Philadelphia-specific information and evaluation. The information in this report will be pared down and simplified to create a smaller document like the New York City Red Light Camera *Program Review 1994-2015* report, published by the New York Department of Transportation in 2016.

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This summary report draws heavily upon the findings of the Pennsylvania Transportation Advisory Committee (PTAC), which published an updated ARLE Evaluation report in June 2017. This document also cites the AAA Foundation for Traffic Safety (AAA), the National Cooperative Highway Research Program (NCHRP), the Transportation Research Board (TRB), the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), the Centers for Disease Control and Prevention (CDC), the Insurance Institute for Highway Safety (IIHS), and multiple peer-reviewed academic research papers in addition to data provided by the Pennsylvania Department of Transportation (PennDOT) and the Philadelphia Parking Authority (PPA).

1.0 SUMMARY OF KEY FINDINGS:

1. From 2012 to 2016:
 - a. 57% of all reportable crashes in Philadelphia occurred at intersections;
 - b. 40% of all reportable crashes in Philadelphia were at least partially attributed to red-light-running (RLR);
 - c. 0.5% of all reportable RLR crashes resulted in a fatality;
 - d. 16% of all reportable RLR crashes resulted in a fatality or serious injury;
 - e. 2.6% of all reportable RLR crashes involved a pedestrian, and
 - f. 18.2% of all reportable RLR crashes involving a pedestrian resulted in a fatality or a serious injury.
2. National Highway Traffic Safety Administration (NHTSA) research indicates that angle crashes are some of the deadliest crashes that occur in the United States, with strikingly-higher rates of fatalities and serious injuries than rear-end crashes.
3. The most common type crash at Philadelphia intersections are angle crashes, which account for 50% of all crashes (followed by rear-end crashes, which account for 15% of all crashes).
 - a. 2.28% of reportable angle crashes at intersections resulted in KSI, versus 1.3% of rear-end crashes, a difference of 55%.
 - b. Angle crashes are the second most fatal type of intersection crashes in Philadelphia, accounting for 35% of all fatal crashes behind crashes in which a vehicle hit a pedestrian.
4. The National Cooperative Highway research program (NCHRP), Centers for Disease Control (CDC), (Federal highways Administration (FHWA), and Texas Transportation Institute (TTI) are among the organizations that have published reports indicating that Automated Red-Light Enforcement (ARLE) implementation increases overall intersection safety.
5. The Pennsylvania Transportation Advisory Committee's 2017 ARLE Program Evaluation report found that cumulative red-light violations decreased by 64% in 24 months post ARLE implementation.
6. The Pennsylvania Transportation Advisory Committee (PTAC)'s 2017 ARLE Program Evaluation report found evidence that ARLE has safety benefits in Philadelphia in the form of reduced injuries in crashes attributed to running red lights.
7. ARLE pays for itself in Philadelphia and has made a net profit every year since its implementation in 2005.
8. All net revenue from ARLE violations is channeled into statewide roadways safety improvement projects through the ARLE Funding Program.

2.0 DANGERS OF RED-LIGHT RUNNING

As natural points of vehicle interaction, intersections are the sites of most traffic crashes in the United States. The AAA Foundation for Traffic Safety (AAA) reported that motor vehicle crashes were the leading cause of death for people aged 16-24 for each year from 2012 through 2014,ⁱ and that 6.3 million traffic crashes were reported across the United States in 2015, involving 11.3 million vehicles,ⁱⁱ almost 50% of which occurred at intersections.ⁱⁱⁱ This underscores the importance of safety controls and enforcement at intersections throughout the roadway system. Philadelphia is not an exception to this rule: between 2012 and 2016, 57% of all reportable crashes in Philadelphia County occurred at intersections.^{iv}

From 2012 to 2016, 857 crashes at Philadelphia intersections resulted in a fatality or major injury, accounting for 44% of all crash fatalities in Philadelphia. Broken down by mode, intersection crashes in Philadelphia accounted for 53% of all pedestrian fatalities, 41% of bicycle rider fatalities, and 40% of vehicle occupant fatalities. In all, 218 pedestrians, 7 bicycle riders, and 115 vehicle occupants were killed in crashes at Philadelphia intersections between 2012 and 2016. Table 1 provides a detailed breakdown of Intersection Crashes by Crash Type and Crash Severity in Philadelphia from 2012 to 2016.

Table 1: Intersection Crashes by Crash Type and Crash Severity

Crash Type	All Crashes at Intersections in Philadelphia		Fatal Crashes at intersections in Philadelphia	
	Number	Percent	Number	Percent
Non-Collision	142	0.4	4	1.9
Rear-end	5,295	16.5	8	3.8
Head-on	669	2.1	8	3.8
Rear-to-rear	116	0.4	0	0.0
Angle	15,909	49.6	73	35.1
Sideswipe [same dir.]	1,805	5.6	1	0.5
Sideswipe [opposite dir.]	593	1.8	1	0.5
Hit fixed object	1,875	5.8	23	11.1
Hit pedestrian	5,611	17.5	90	43.3
Other or unknown	88	0.3	0	0.0
Total	32,103	100.0	208	100.0

Source: PennDOT Crash Report database

During that same period, 40% of all reportable crashes in Philadelphia County were at least partially attributable to one or more drivers running a red light.^v AAA's 2016 Traffic Safety Culture Index reports that most drivers (82.8% of those surveyed) consider it unacceptable for a driver to run a red light, but more than 1 in 3 drivers (35.5%) admitted to having done so in the past 30 days when they could have

stopped safely.^{vi} This indicates that in the absence of enforcement, red light running remains an acceptable option for many drivers.

Intersections, therefore, are some of the most dangerous places to be a pedestrian in Philadelphia, and are almost as dangerous for vehicle occupants and bicycle riders. PennDOT's 2012-2016 indicates that over 6,000 reportable crashes in Philadelphia (11% of all reportable crashes) were at least partially attributable to a driver running a red light. 16% of those crashes resulted in KSI, and 18% of all RLR crashes resulting in KSI involved a pedestrian fatality or major injury. Red-light running (RLR), therefore, remains a dangerous practice within Philadelphia.

2.1 Angle Crashes vs. Rear-End Crashes

One argument against ARLE implementation states that red light cameras increase the number of crashes at intersections and are therefore detrimental to safety. Proponents of this argument state that the presence of red light cameras will cause drivers to stop short, which will result in an increase in rear-end collisions great enough to offset any crash reduction caused by the presence of cameras. What this argument fails to address is that not all types of crashes are equal in severity; ARLE implementation can result in a simultaneous increase in raw number of crashes and decrease in fatalities/serious injuries if it results in fewer serious crashes, specifically fewer angle crashes.

Angle crashes are defined as crashes in which vehicles on opposite roadways collide at a point of junction, such as a road intersection, driveway, or entrance ramp. These include "T-bone" crashes as well as right-turn and left-turn crashes. A large body of research undertaken by national policy organizations, think-tanks, academic researchers, and agencies indicates that angle crashes are some of the most severe, deadly crashes in the United States, especially compared to rear-end collisions.

NHTA's 2015 Traffic Safety Facts FARS/GES Annual Report indicates that 14.9% of all fatal Passenger car crashes in 2015 were either left side or right-side angle crashes, while only 1.7% of all fatal crashes were rear collisions. For light trucks (which includes SUVs and pickups), 10.9% of all fatal crashes were right or left side angle crashes, while rear collisions accounted for 1.4% of all fatal crashes. For large trucks (tractor-trailers), 12.8% of fatal crashes were left or right-angle crashes, and 5.0% of crashes were rear-end collisions. For motorcycles, 24.5% of fatal crashes in 2015 were the result of right or left angled collisions, and only 0.4% of all fatal crashes were the result of rear collisions.^{vii}

The same report also indicated that in 2015, angle crashes resulted in more fatalities than any other type of crash involving two vehicles, and resulted in the second-highest number of injuries from crashes. This data indicates that while rear-end crashes resulted in more property damage and injury than angle crashes, angle crashes were generally more severe: 6,275 vehicle occupants died in left or right-side angle crashes in 2015 compared to 1,480 vehicle occupants killed in rear collisions in the same year.^{viii} Another 450,000 vehicle occupants were injured in angle crashes in 2015, compared to 650,000 vehicle occupants injured in rear collisions.^{ix}

The most common type crash at Philadelphia intersections are angle crashes, which account for 50% of all reportable crashes at intersections (followed by rear-end crashes, which account for 16% of all reportable crashes at intersections). From 2012 to 2016, angle crashes accounted for 42% of all KSI at intersections, followed by crashes in which a vehicle hit a pedestrian (33%), crashes in which a vehicle hit a fixed object (8.5%), and then rear-end crashes (8.05%). Angle crashes are also the second most fatal type of intersection crashes, accounting for 35% of all fatal crashes behind crashes in which a vehicle hit a pedestrian (43%). Given these statistics, ARLE implementation has the potential to increase safety on Philadelphia streets if it decreases the number of angle crashes that occur at intersections, even if the number of overall crashes increases.

3.0 ARLE AND INTERSECTION SAFETY

A robust body of literature exists on the efficacy of red-light cameras as safety enhancement tools at intersections. Most these studies present evidence that red-light cameras make intersections safer. The NCHRP, CDC, FHWA, and TTI^x are among the organizations that have published reports indicating that ARLE implementation increases overall intersection safety.

One study, sponsored by the Insurance Institute for Highway Safety (IIHS) and published in the Journal of Safety Research in 2017, examined the effects of red-light cameras on the incidence of fatal crashes. Researchers looked at the 57 cities of 200,000 or more people that activated cameras between 1992 and 2014 without interruption. They compared the trends in annual per capita fatal crash rates in those cities with the trends in 33 cities that never had cameras. After accounting for the effects of population density and unemployment rates, the researchers found that there were 21 percent fewer fatal RLR crashes per-capita in cities with cameras than would have occurred without cameras, and 14 percent fewer fatal crashes of all types at signalized intersections.^{xi}

The IIHS study also reviewed 14 cities that ended their camera programs between 2010 and 2014. The researchers compared trends in annual crash rates in those cities with trends in crash rates in 29 cities in the same regions that continued their camera programs. The fatal RLR crash rate was 30 percent higher in cities that turned cameras off than it would have been if the cameras had remained on.^{xii} Further, the rate of crashes with fatalities at signalized intersections was 16 percent higher.^{xiii}

Several other studies isolated different types of collisions and estimated ARLE's effects on angle crashes, rear-end crashes, and the combined total of all crashes. All the studies that isolated right-angle crashes found reductions in those types of crashes. Many studies found increases in rear-end crashes following ARLE implementation. For example, Walden, et al. (2011) studied 39 Texas communities and found that, on average over all the communities, right-angle crashes decreased 19 percent while rear-end crashes increased 44 percent, and all crashes combined (right-angle, rear-end, and other) decreased 26 percent, with all changes statistically significant at the 5 percent significance level.^{xiv}

Despite the overall evidence on safety benefits, studies have also found that not every intersection appears to reap safety benefits from ARLE. In other words: ARLE does not work the same way at all intersections, and potential ARLE sites must be selected carefully to maximize the likelihood of yielding safety benefits.

A 2013 Transportation research Board (TRB) study conducted by the TTI evaluated the effectiveness of ARLE systems in reducing red-light-running vehicle crashes at signalized intersections. The study reviewed 254 signalized intersections in 32 Texas jurisdictions. The study results suggest that a significant safety benefit for RLR cameras is achieved if intersections have four or more RLR crashes per year or have two or more RLR crashes per 10,000 vehicles.

4.0 PHILADELPHIA: INTERSECTION VIOLATION DATA

As of November 2017, there are 30 intersections with operational and enforceable ARLE cameras in Philadelphia County. The most mature of these cameras have been in use since 2003, and the least mature have been in effect since 2015.

In its 2017 summary report, the Pennsylvania Transportation Advisory Committee examined violation numbers from each ARLE intersection in Philadelphia to determine whether ARLE appears to have a sustained effect on driver behavior. The report noted that because the number of violations at each intersection prior to ARLE installation is unknown, their analysis presents only a partial picture of ARLE effects on red light violations.

If an ARLE program is having its desired effect, violation data should show an overall decline in red-light violations over time at each intersection, with an eventual stabilization. Since 27 of the existing 30 ARLE intersections in Philadelphia can be considered mature, with no significant decline in violations expected, violations going forward should be stable assuming no change in outside factors. The 2017 PTAC report aggregated violation data over 21 ARLE intersections that were in place as of 2012. All violation counts were aligned per the number of months from when the cameras were installed at the intersection.

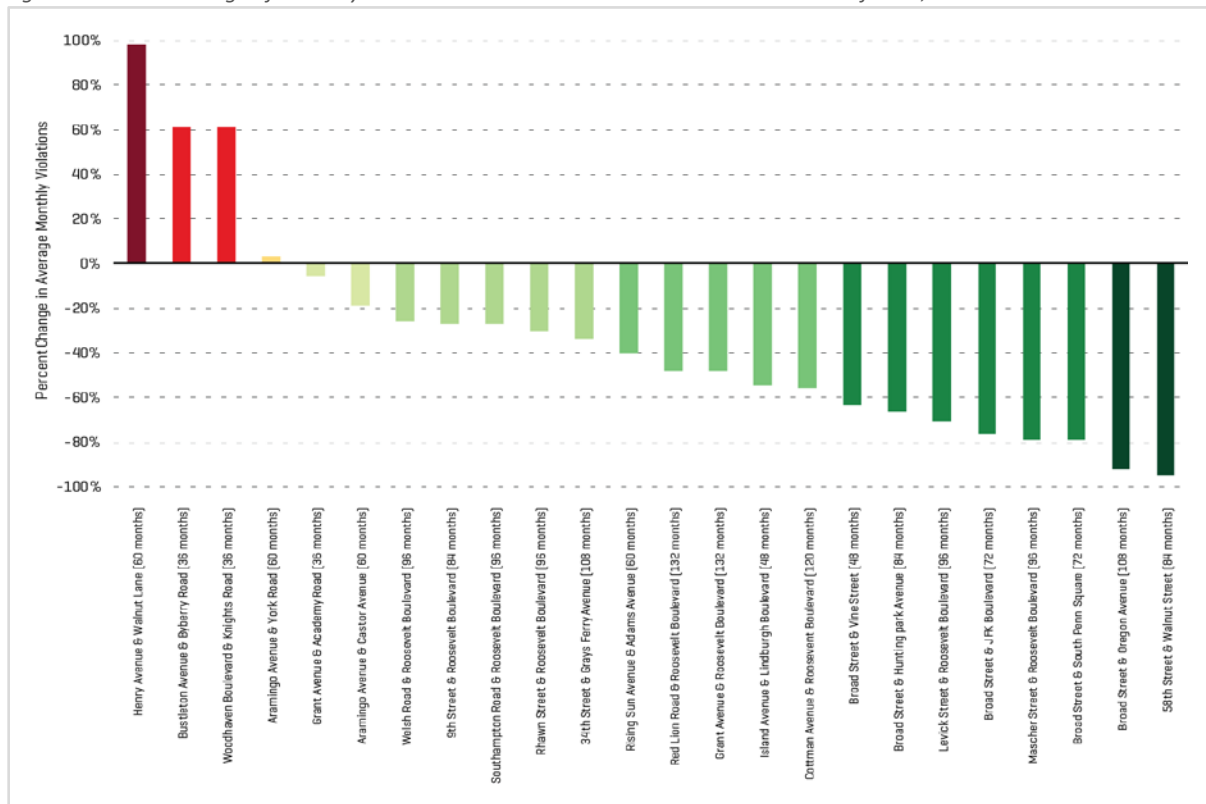
The report looked at violations that occurred within the first two months of monitoring, when warnings were issued but no fines. The data in the PTAC report shows a peak of 29,692 total violations during the second month of the 60-day warning period,¹ then a sharp decrease to 24,878 during the first month of enforcement.^{xv} Within one year of ARLE implementation, the number of monthly violations decreased to 23,013.^{xvi} By month 24, violations decreased to approximately half the pre-ARLE level at 15,145.^{xvii}

¹ 75 Pa. C.S. §3116 (d)(1) requires a minimum 60-day warning period prior to fines being issued.



Individual intersections have considerable fluctuation in trends, but most experience a decline over the long term. Figure 1 shows the percent change in monthly violations at 24 ARLE stations with at least 36 months of data as of January 1, 2016, where Year 1 is the first full year of ARLE implementation, and Year N is the most recent full year of available data. Years in which fewer than 12 months of data were available were not included in the analysis. Average monthly violations were calculated for each intersection using data provided by the PPA, and the percent change between the average monthly violations in Year 1 and Year N was calculated.

Figure 1: Percent Change of Monthly Violations at ARLE Intersections with 36+ Months of Data, Year 1 to Year N



Source: PPA Red-Light Camera Yearly Report, 2016

As Figure 1 shows, 4 of the 24 intersections in the analysis had a positive percent change, indicating that they had more average monthly violations in Year N than in Year 1. Two of those intersections, Bustleton Avenue & Byberry Road and Woodhaven Boulevard & Knights Road, have relatively recent ARLE installations and only 36 months of data for analysis, so those trends may change over time.

The 20 other intersections examined showed a decrease in average monthly violations between Year 1 and Year N, with the highest percent change at 58th Street and Walnut Street, which experienced a 95%

decrease in average monthly violations over 84 months. The average percent change for all 24 intersections analyzed was -34%, and the median percent change was -44% over the lifetime of the program.

The general trend is clearly towards a decrease in red light violations at ARLE intersections, though the amount of the decrease in violations varies widely by intersection. Additionally, because red light violation data is not available for intersections without ARLE implementation, it is not possible to compare the decreases at ARLE intersections to the decreases at non-ARLE intersections to control for general trends throughout Philadelphia.

5.0 PHILADELPHIA: INTERSECTION CRASH DATA

In addition to examining violations at ARLE intersections in Philadelphia, the 2017 PTAC report includes an analysis of crash data to evaluate the safety effects of Philadelphia's ARLE program.² Various measures of safety were considered for examination. The reported number of injuries was selected as the measure for detailed analysis because it most closely captures safety effects. Other potential measures are the number of crashes in which there was an injury or fatality and the number of overall crashes (both injury crashes and property-damage only crashes).

5.1 Analysis of Effects on Number of Injuries

Using the PennDOT Crash report database, PTAC collected data on the number of injuries in crashes at each of the ARLE intersections for each year from 2000 to 2015 (the most recent available). Non-reportable crashes involve no injuries, fatalities, or towing, and are not included in PennDOT's crash statistics. Because the Commission's analysis focuses on injuries and injury accidents, the absence of non-reportable crashes from the data is not a concern.

To examine the impact of ARLE implementation on crash-related injuries in Philadelphia, individual crash-related injuries for each ARLE intersection were totaled for the five years before and five years after ARLE implementation. The percent change from the before to the after period was calculated. The number of injuries from crashes in the year that ARLE was implemented was not included because monthly violation data that that period is typically one of transition.

The percent change in the number of injuries from crashes was calculated for four sets of ARLE intersections: those added in 2005, 2007, 2009, and 2010. These intersections were chosen because there were at least three intersections added in the same year and there were five years of post-ARLE implementation crash data available. To account for the possibility that more general trends were affecting the crash incidences, the number of all crashes in all signal-controlled intersections without

² This analysis, presented in the Commission's 2017 ARLE program evaluation report, was not intended to meet all the requirements for a rigorous statistical study. Several more sophisticated analyses of ARLE safety effects in other communities and their findings were summarized under the Benefits and Costs discussion in Section 5 of the report.

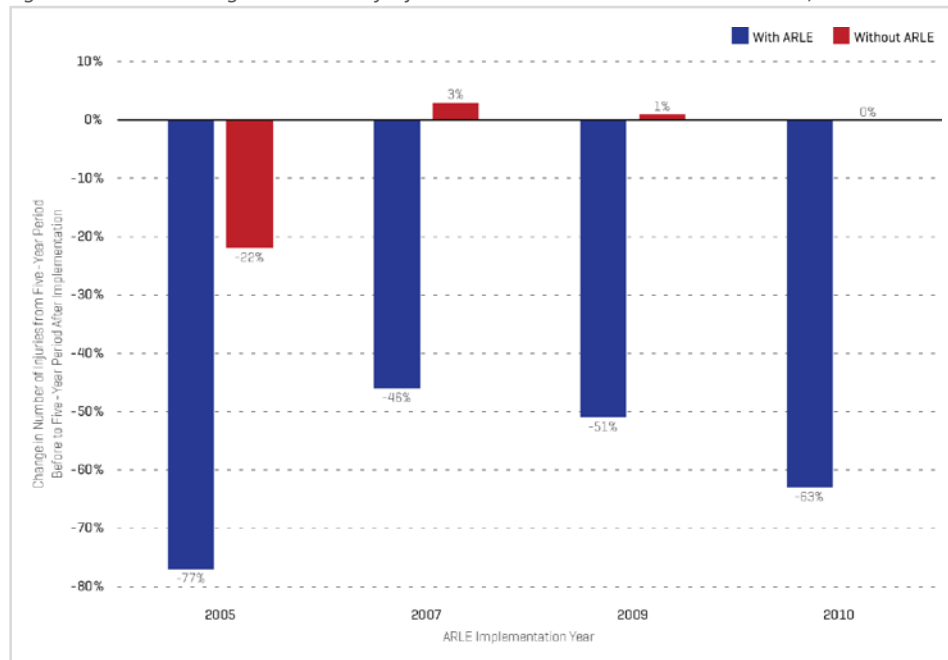


ARLE was also tallied for the same five-year periods for comparison to the changes at the ARLE intersections.

5.2 Injuries in Crashes with Red-Light Running

Figure 2, reproduced from the Pennsylvania Transportation Commission’s 2017 ARLE Evaluation Report, displays the percentage change in number of injuries occurring in crashes at intersections with red-light signals for crashes at least partially attributed to RLR. As shown in Figure 2, injuries caused by RLR crashes were lower after ARLE implementation in all the groupings. For example, at the three intersections implementing ARLE in 2005, there were a total of 132 injuries reported in the five years before implementation and 30 injuries in the five years after, for a total decrease of 77 percent.^{xviii} During this period, injuries from RLR crashes also decreased at non-ARLE intersections, but not to as great an extent as at the ARLE intersections. The results shown in Figure 2 strongly suggest that ARLE has safety benefits in Philadelphia in the form of reduced injuries in crashes attributed to running red lights.

Figure 2: Percent Change in Number of injuries at ARLE and non-ARLE intersections, RLR crashes



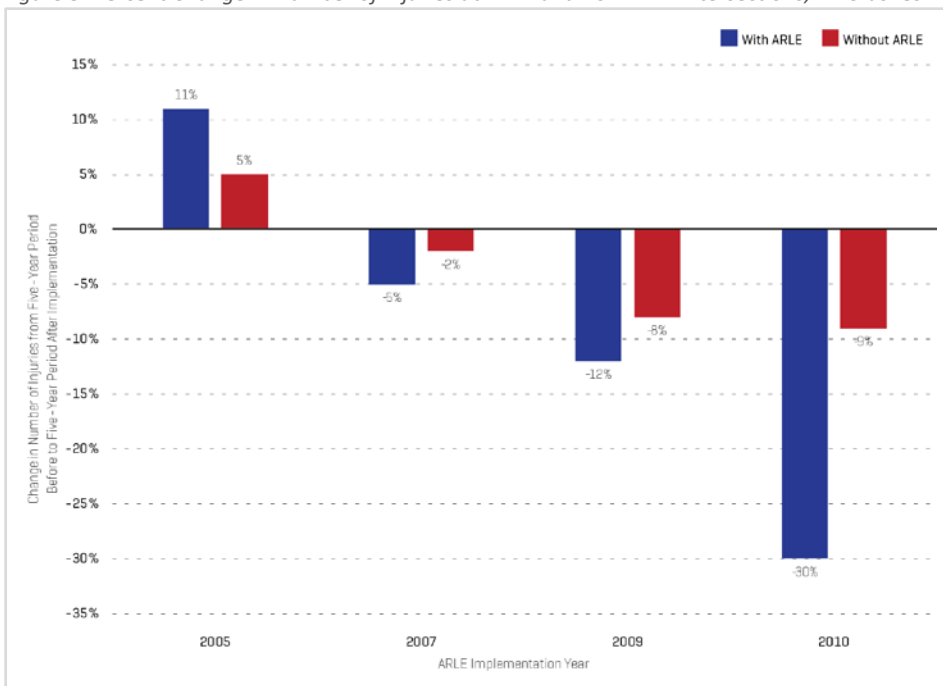
Source: PennDOT Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation

5.3 Injuries in All Crashes

Evaluating the safety effects of ARLE requires measuring the injuries from all crashes, not only from those crashes caused by RLR. An increase in other crashes, particularly rear-end crashes, could potentially outweigh the benefits in a decrease in RLR crashes. The Pennsylvania Transportation Advisory Committee’s analysis focused on the number of injuries because it allows us to capture the expected difference in crash severity. As previously noted, RLR crashes are typically angle crashes, which are generally more severe than rear-end collisions. Even if rear-end crash rates are not affected by ARLE, the percentage injury reduction due to ARLE would be lower when all crashes are counted.

Figure 3, also reproduced from the Pennsylvania Transportation Commission’s 2017 ARLE Evaluation Report, examines the changes in the number of injuries caused by *all* crashes. It shows that for the intersections added in 2005, injuries in all crashes *increased* after ARLE. The PTAC report addressed this result by applying a statistical significance test to the data (the Wilcoxon signed-rank test) and determined that the increase was not significant at either a 5 percent or 10 percent level.^{xix} The report found that 16 of the 27 intersections exhibited a statistically significant *reduction* in injury crashes when data was limited to injury-only crashes (excluding property-damage crashes).^{xx}

Figure 3: Percent Change in Number of Injuries at ARLE and non-ARLE intersections, All Crashes



Source: PennDOT Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation



Only 3 intersections were operating ARLE in 2005, and only one of those intersections drove the negative result: Roosevelt Boulevard and Red Lion Road. Injuries there increased from 44 to 76, a 73 percent increase (shown in Table 2). The Committee’s report notes that this result indicates that ARLE is not the solution to this intersection’s safety challenges, and that other measures are required.

Table 2: Crash Statistics for Red Lion Road and Roosevelt Boulevard

Red Lion Road and Roosevelt Boulevard - Crash Statistics: 2002 to 2016							
Crash Year	Total Crash Count	Total Fatality Count	Total Injury Count	Major Injury Count	Moderate Injury Count	Minor Injury Count	Unknown Injury Count
2002	9	0	8	0	0	7	1
2003	16	1	21	0	1	17	3
2004	15	0	15	0	3	6	6
2005 A*	24	1	39	1	2	25	11
2005 B†	6	0	12	0	0	4	8
2006	15	0	16	0	3	8	5
2007	20	0	28	0	3	13	12
2008	18	0	32	0	1	23	8
2009	20	0	19	0	1	9	9
2010	29	0	35	2	2	14	17
2011	14	0	17	0	1	6	10
2012‡	-	-	-	-	-	-	-
2013	15	0	18	0	1	6	11
2014	13	0	21	0	2	8	11
2015	17	0	17	1	1	9	6
2016	28	0	34	0	12	13	9
% Change 2002-2008§	+ 33%	- 100%	+ 73%	0%	+ 75%	+ 47%	+ 150%

* 2005 A = crashes in 2005 prior to ARLE implementation
 † 2005 B = crashes in 2005 after ARLE implementation
 ‡ There were no reportable crashes at this intersection in 2012, but there could have been non-reportable crashes
 § This excludes 2005, which PTAC identified as transitional

Source: PennDOT Crash Report database

The other intersection groupings showed a modest safety benefit as measured by comparing percentage injury reduction at intersections with ARLE to injuries at intersections without ARLE. The most substantial percentage reduction was for the three intersections added in 2010. There were 74 injuries in the five years before implementation versus 52 in the five years following, for a 30 percent reduction.^{xxi} In comparison, injuries declined 9 percent at intersections without ARLE.^{xxii}

5.4 Effects on Fatalities

Due to the low number of fatalities both before and after ARLE implementation, the Pennsylvania Transportation Advisory Committee was unable to draw a statistically definitive conclusion about ARLE's effects on fatalities. The 24 ARLE intersections for which sufficient years of crash reporting were available showed a total of six fatalities in the five years before ARLE implementation and three fatalities in the five years afterward.^{xxiii}

5.5 Effects on Number of Injuries in All Crashes

Crash data on all crashes, regardless of cause or type, were compiled at each of the ARLE intersections. Of the 27 intersections with at least three years of post-implementation crash data, 16 exhibited an *increase* in the number of injuries from all crashes after ARLE implementation.^{xxiv} However, the Committee's 2017 evaluation notes that when a statistical significance test³ was applied to the data, the increase was not significant to the five percent level. When limited to injury crashes (excluding property-damage-only crashes), 16 of the intersections exhibited a *reduction* in crashes after ARLE implementation, and this decrease was found to be significant to the 5 percent level.

6.0 PHILADELPHIA: FINE REVENUES

The Pennsylvania ARLE program's primary purpose is improved road safety, not revenue generation.^{xxv} To this end, every recorded violation is individually reviewed and validated by appropriate enforcement officials prior to any citation being written or delivered to a registered vehicle owner. Because there is no per-violation commission for the vendor, there is no financial incentive for the vendor or the state to erroneously flag violations. The ARLE program is also limited to red-light enforcement – motorists are not fined for having an expired registration, faulty tags, etc., and registered vehicle owner information obtained because of a violation does not become the property of the vendor or PPA. Legislation further mandates that the program's cameras may not be used for surveillance purposes.

One common argument against ARLE implementation is the cost of the program. The 2017 PTAC report offers an in-depth examination of ARLE costs and revenues for Philadelphia from 2005 to 2016.

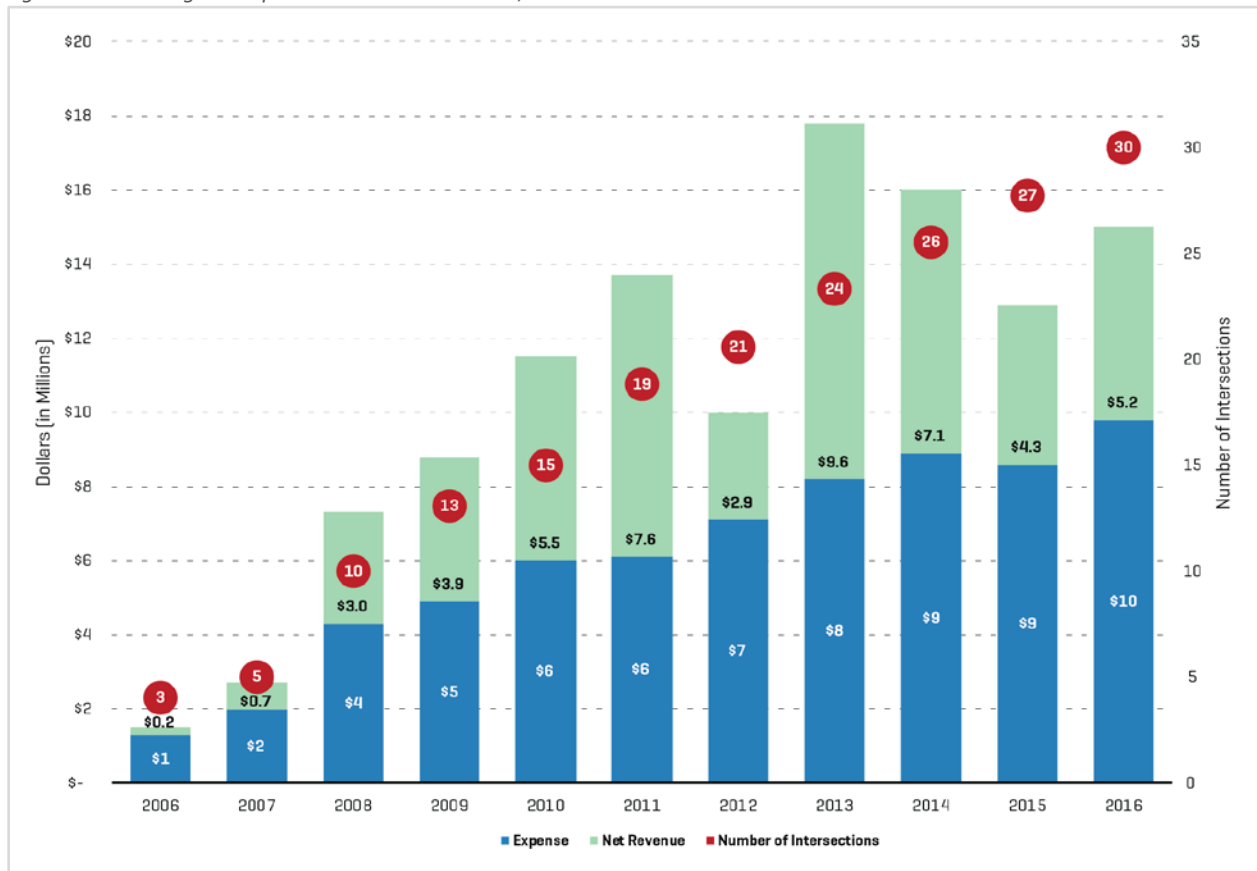
The report notes that despite increasing cumulative unpaid fines and penalties from Fiscal year 2005-06 to Fiscal year 2015-2016 (amounting to 18.9million dollars in Fiscal year 2016-16), the number of ARLE violations in the Philadelphia ARLE program is sufficiently large that the revenue collected from the violation fees exceeds the expense of operating the system. The PPA reported a cumulative total net income of approximately \$50million for the ARLE program from inception in 2005 to March 31st, 2016, and because the ARLE Funding Program was established to use any net revenue generated from automated enforcement for safety improvements throughout the commonwealth of Pennsylvania, this revenue is directly channeled back into statewide road safety improvements.

³ The Wilcoxon signed-rank test. The increase in crashes was also not significant at the less demanding 10% significance level.



Figure 4 displays a consistently increasing trend in expenses and number of intersections since FY 2006. Total program revenue, reflected by the height of the bars, increases from the first full year (FY 2006) through FY 2011, and then becomes erratic. Per the Pennsylvania Transportation Advisory Committee’s 2017 ARLE Evaluation, the PPA attributes at least part of the dip in 2012 revenues to an error in implementing a new ARLE intersection.^{xxvi} The report attributed the 2015 dip in revenues (and a corresponding dip in the cumulative number of violations in that same year) to a change in vendors.^{xxvii}

Figure 4: ARLE Program Expenses and New Revenues, FY 2005-06 to FY 2015-16



Source: PennDOT Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation



Table 3, reproduced from the Committee’s 2017 report using data from PPA Annual Reports, provides a breakdown of the ARLE program’s financial history.

Table 3: ARLE Financial History, Fiscal Years 2011-12 to 2015-16

	Fiscal Years	For the Fiscal Year Ending March 31,					Totals
	2005-2009	2012	2013	2014	2015	2016	
Total Program Revenue	\$ 45,544,632	\$ 10,057,700	\$ 17,763,697	\$ 16,091,899	\$ 12,925,384	\$ 15,004,869	\$ 117,388,181
PPA Program Expenses	\$ 24,656,251	\$ 7,150,041	\$ 8,228,672	\$ 8,984,625	\$ 8,640,618	\$ 9,833,120	\$ 67,493,327
Net Income	\$ 20,888,381	\$ 2,907,659	\$ 9,535,025	\$ 7,107,274	\$ 4,284,766	\$ 5,171,749	\$ 49,894,854

Source: PennDOT Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation

7.0 VALUING SAFETY BENEFITS

The US Department of Transportation provides guidance on valuing crash reduction benefits. Table 4, reproduced from the Pennsylvania Transportation Advisory Committee’s report, displays what the USDOT recommends for crash reduction values, updated from 2014 to 2017 dollars using the U.S. CPI.

Table 4: US DOT Guidance on Valuing Crash Reduction Benefits

Item	Statistical Cost or Value in 2017 Dollars
Value of statistical life	\$9,870,000.00
Critical Injury	\$5,852,910.00
Severe Injury	\$2,625,420.00
Serious Injury	\$1,036,350.00
Moderate Injury	\$463,890.00
Minor Injury	\$29,610.00
Property damage per vehicle	\$4,123.00

Source: PennDOT Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation

Based on these numbers, a camera enforcement program that avoids just one serious injury every five years yields an average annual benefit of more than \$207,000 (\$1,036,350/5) in avoided injury costs. This underscores an extremely important point regarding ARLE evaluation either on a statewide level or for a municipality considering ARLE: reduction of fatalities and injuries represents a major benefit. The cost of implementing and maintaining ARLE must be considered in relation to these benefits, which can accumulate to a very large extent even when the numbers of fatalities and injuries are seemingly few.

This is especially relevant in Pennsylvania: per the Centers for Disease Control and Prevention, Pennsylvania bears the 6th highest costs from Motor Vehicle Crash deaths in the country, behind Texas (1), California (2), Florida (3), North Carolina (4), and Georgia (5).^{xxviii}

8.0 NEXT STEPS

Per Mike's request, I assembled and cleaned data for each ARLE intersection with crashes for 3 years before and 3 years after ARLE implementation. This data set contains 1,244 crash events ranging in year from 2002 to 2016.

Using correlation tests, fisher's test, and logistic regression and anova analysis: it is safe to conclude that crash relationship to ARLE differs from intersection to intersection n; there is a general decrease in injury crashes at intersections with ARLE; and the estimated decrease is not large but it is significantly different from injury crashes previous to ARLE implementation.

Using this analysis and the research undertaken by PTAC and others in this report, the Office of Complete Streets will put together a basic report on ARLE's use and effect in Philadelphia. While the PTAC report contains valuable information and analysis, it is too long and complicated for the average resident. The OCS report will be public-facing, and will resemble New York City's 2016 Red Light Camera Program Review, found [here](#). The goal of this report will be to answer basic questions about ARLE in Philadelphia in basic language that the public can understand, dispelling misunderstandings and reporting on the program's intended results and actual results in a condensed, accessible document.

NOTES

ⁱ AAA Foundation for Traffic Safety, “2016 Traffic Safety Culture Index” (Washington DC: AAA Foundation for Traffic Safety, February 2017), 1,

https://www.aaafoundation.org/sites/default/files/2016TrafficSafetyCultureIndexReportandCover_0.pdf.

ⁱⁱ US Department of Transportation National Highway Traffic Safety Administration, “TRAFFIC SAFETY FACTS 2015,” 78.

ⁱⁱⁱ Ibid.

^{iv} “PennDOT Crash Download Map” (Harrisburg, PA: Pennsylvania Department of Transportation), accessed September 20, 2017,

<https://pennshare.maps.arcgis.com/apps/webappviewer/index.html?id=8fdbf046e36e41649bbfd9d7dd7c7e7e>.

^v “PennDOT Reportable Crash Statistics,” Technical (Harrisburg, PA: Pennsylvania Department of Transportation, 2017), <https://www.dotcrashinfo.pa.gov/PCIT/welcome.html>.

^{vi} AAA Foundation for Traffic Safety, “2016 Traffic Safety Culture Index,” 5.

^{vii} US Department of Transportation National Highway Traffic Safety Administration, “TRAFFIC SAFETY FACTS 2015,” 92–100.

^{viii} Ibid., 70.

^{ix} Ibid., 125.

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^{xii} Ibid.

^{xiii} Ibid.

^{xiv} “Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation,” 57.

^{xv} “Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation,” 29.

^{xvi} Ibid.

^{xvii} Ibid.

^{xviii} Ibid., 33.

^{xix} “Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation,” 34.

^{xx} “Pennsylvania Automated Red-Light Enforcement 2017 Program Evaluation,” 34.

^{xxi} Ibid.

^{xxii} Ibid.

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