Reducing Late-Night/ Early-Morning Intersection Crashes By Providing Lighting

This case study is one in a series documenting successful intersection safety treatments and the crash reductions that were experienced. Traffic engineers and other transportation professionals can use the information contained in this case study to answer the following questions:

- What are some low-cost countermeasures that can reduce late-night/early-morning crashes (many with injuries) at urban and rural intersections?
- How many crashes did the treatments reduce?
- Are there any implementation issues associated with lighting, and if so, how can they be overcome?

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U.S. Department of Transportation
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Safe Roads for a Safer Future
Investment in roadway safety saves lives

Introduction

More than 40 percent of intersection fatalities occur during the late-night/early-morning hours. Further, the probability of being killed in a crash during late-night/early-morning hours is as much as three times greater than during the day[1]. A primary reason for this difference in crashes is poor intersection visibility, where drivers are not able to see conflicting traffic and other road users. Increasing the luminance levels of existing lighting systems, or providing overhead lighting where necessary, can reduce late-night/early-morning crashes at intersections.

Objective

The following case study showcases the results of three studies which examined lighting enhancements at more than 50 intersections in Minnesota and Kentucky, installed to reduce crashes associated with poor visibility at intersections during late-night/early-morning hours.

Treatment Summary

This case study examines the application of street lights to intersections in rural and urban areas[1]. While the type of lamp and wattage varied for some of the intersections, a single 250 watt, high pressure sodium (HPS) luminaire street light was installed at a majority of the intersections evaluated in these studies [3, 5][2].

Evaluation Methodology

This case study reviews results from three studies that examined intersections in Minnesota and Kentucky with a high incidence of crashes due to poor visibility during late-night and early-morning hours. Crash reductions were based on a review of "before and after" data at these intersections during a minimum of six years, between 1996–2004[3]. (The "before" and "after" observation periods ranged between 36-48 months, depending on the study).

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Results

Problem: Drivers were violating traffic controls at intersections due to poor visibility, leading to a high number of crashes at these intersections.

Solution: The States sought to reduce late-night/early-morning intersection crashes through improved lighting. *The enhanced lighting reduced overall late-night/early-morning crashes across these intersections by a weighted average of 35 percent.*

[1] *Both of the Minnesota studies examined stop-controlled intersections. The Kentucky study did not specify the type of intersection control used.*

[2] *The studies did not provide any additional specifications on the types of lighting used, nor whether the lighting met American Association of State Highway and Transportation Officials (AASHTO) standards. The Kentucky study did not specify the type of lighting used.*

[3] *Note that crash reduction averages in this report reflect the percent reduction per year based on the difference between the total number of "before" and "after" crashes. Injury reductions per year are noted where supporting data were available.*

Increasing the luminance levels of existing lighting systems, or providing overhead lighting where necessary, can reduce late-night/early-morning crashes at intersections.

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Location	Study Year	Number of Intersections	Analysis Period in Years		Reduction in Overall Late-night/ Early-morning Crashes	Reduction in Late-night/Early-morning Injury Crashes
			Before	After		
Minnesota (Study 1)	2004	34[b]	3	3	27%	41%
Kentucky (Study 2)	2003	9[a]	4	3	45%	NA
Minnesota (Study 3)	1999	12[b]	3	3	25-40%	8-26%

Table 1: Summary of lighting studies
[a]Rural and urban intersections [b]Rural intersections

Study 1

Isebrand and McDonald (2004) analyzed the effects of street lighting on crashes at 34 rural Minnesota intersections before and after installing lighting[3]. The lighting installation dates ranged from 1985 to 2000. The "before and after" analysis showed a 27 percent reduction in night crash frequency, a 32 percent reduction for the ratio of night to total crashes, and a 35 percent reduction in the night crash rate[4]. Late-night/early-morning injury crashes decreased by 41 percent after the lighting was installed. **Late-night/early-morning crash severity (ratio of nighttime injury and fatal crashes to total crashes) decreased by 20 percent in the after period.**

Study 2

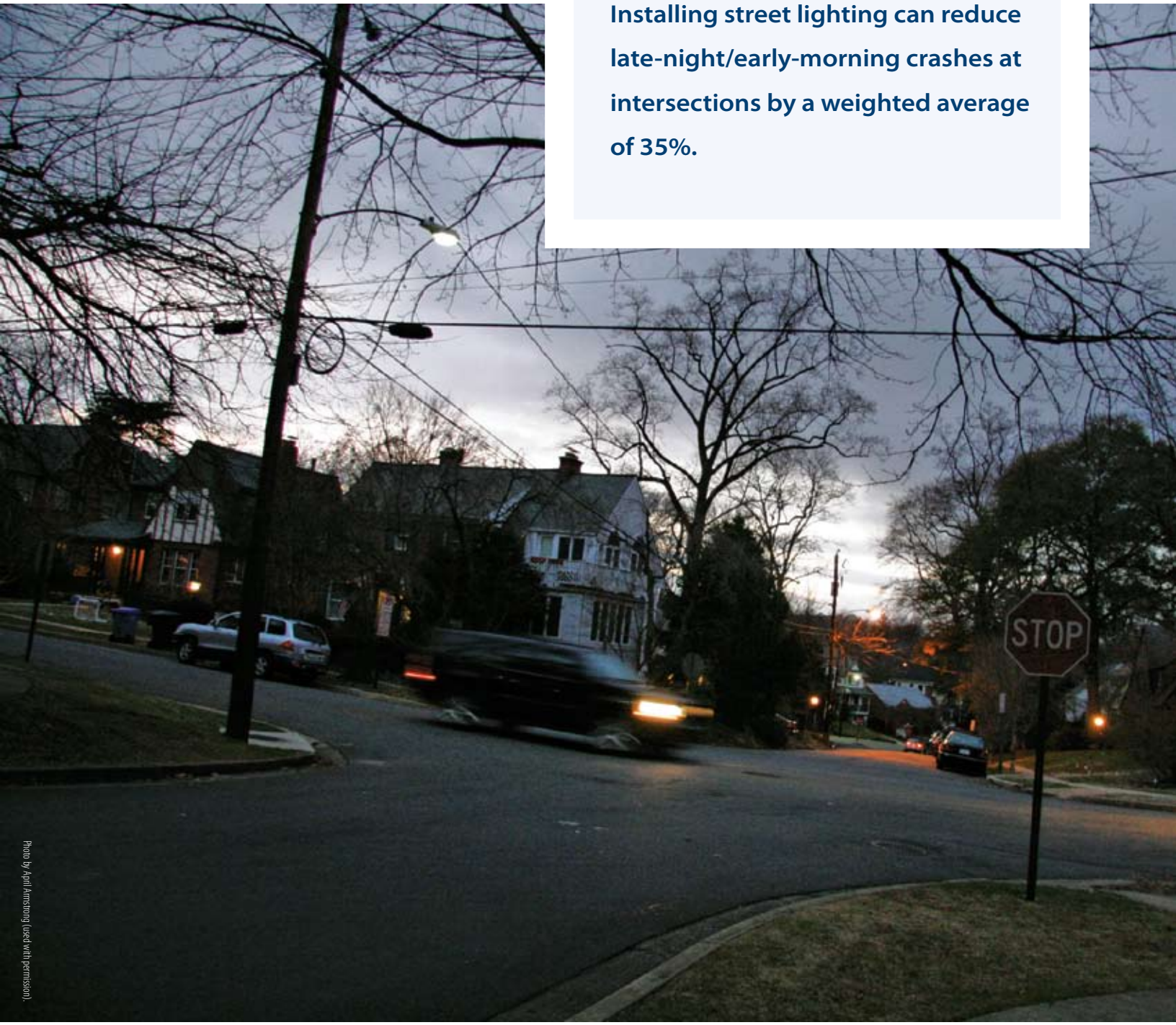
A "before and after" study in Kentucky conducted by Green et al. (2003) analyzed the safety benefits associated with roadway lighting at nine intersections[4]. The lighting installation dates varied between 1998 and 2000. A significant number of the locations identified were rural; however, some urban sites were also included. The number of crashes per year was obtained for up to 4 years prior to the lighting installation and 3 years after installation. **The analysis found that late-night/early-morning crashes were reduced by 45 percent after installing the lighting.**

Study 3

Preston and Schoenecker (1999) conducted a "before and after" analysis for a sample of 12 intersections selected by Minnesota DOT[5]. At intersections where street lighting was installed (between 1987 and 1994), researchers observed an overall decrease in the late-night/early-morning crash rate from 1.41 crashes per million vehicles entering before lighting to 0.84 after lighting — a decrease of approximately 40 percent in the late-night/early-morning crash rate. After installing street lighting, the late-night/early-morning multiple-vehicle crash rates declined from 0.48 before lighting to 0.18 after lighting, a 63 percent reduction. The late-night/early-morning single-vehicle crash rate also declined from 1.55 before lighting to 1.03 after lighting, a 33 percent reduction. **The results of this study concluded that installing street lighting at rural intersections resulted in a 25–40 percent reduction in the overall nighttime crashes, as well as an 8–26 percent reduction in the nighttime injury crashes.**

[4] Note that crash rate is defined by the authors as crashes per million vehicles entering the intersection.

Installing street lighting can reduce late-night/early-morning crashes at intersections by a weighted average of 35%.



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Discussion

Implementation Issues

The studies suggested that the states experienced no implementation issues with these countermeasures.

Cost

The studies did not provide any information on the costs to install lighting at the treated intersections. Providing lighting involves both fixed costs for lighting installation and ongoing maintenance costs. Lighting upgrades (installation of higher wattage bulbs) can typically cost up to $1,500-2,500 including labor and equipment per intersection. The installation of a new pole can vary from $3,000 to $12,000, depending on fixture type and conduit costs (not high mast).

Time Frame

The studies did not provide any information on the time needed to install lighting at the treated intersections. Upgrades to replace existing bulbs with higher wattage bulbs can take up to two hours per intersection. A new lighting installation generally requires a minimum 6- to 12-month implementation period. The lighting system must be designed, permits approved, and onsite electrical power obtained. The installation itself can usually be completed in less than 90 days.

Effectiveness

The enhanced lighting reduced overall late-night/early-morning crashes across these intersections. Analysis conducted for the application of the lighting to the 12 (Study 3) intersections selected by Minnesota DOT determined a benefit-cost ratio of 11:1. Previously published research reports further confirm that installing intersection lighting is effective in reducing late-night/early-morning crashes[8].

Summary of Results

The studies referenced here demonstrate that installing street lighting can reduce late-night/early-morning crashes by a weighted average of 35 percent. The average reductions in crashes achieved by the treatments is consistent with the overall crash reductions for lighting installations of 17-47 percent and 50 percent reduction of nighttime crashes as mentioned in the Desktop Reference for Crash Reduction Factors (September 2007), published by the United States Department of Transportation (USDOT) FHWA[6].

References

1) Traffic Safety Facts Annual FARS, National Highway Traffic Safety Administration, 2008.

2) Opiela, Kenneth S., Andersen, Carl K., and Schertz, Greg. "Driving After Dark," *Public Roads Magazine,* Vol. 66. No 4, January/February 2003.

3) Isebrand and McDonald. "Safety Impacts of Street Lighting at Isolated Rural Intersections, Part II, Year 1 Report," MN/RC-2006-35, Minnesota Department of Transportation, December 2004. (Study 1).

4) Green, E.R., Agent, K.R., Barrett, M.L., and Pigman, J.G., "Roadway Lighting and Driver Safety," KTC-03-12/ SPR247-02-IF, Kentucky Transportation Center, University of Kentucky and Federal Highway Administration, May 2003. (Study 2).

5) Preston, H. and Schoenecker, T., "Safety Impacts of Street Lighting at Isolated Rural Intersections," MN/RC-1999-17, Minnesota Department of Transportation, April 1999. (Study 3).

6) Federal Highway Administration. *Desktop Reference for Crash Reduction Factors,* FHWA-SA-07-015 (Washington, DC: September 2007), p. 43.

7) Elvik, R. "Meta-Analysis of Evaluations of Public Lighting as Accident Countermeasure," *Transportation Research Record,* Transportation Research Board, The National Academies, 1485, pp. 112-124, 1995.

8) Neuman, T.R., et al. "Strategy 17.1 E2—Improve Visibility of the Intersection by Providing Lighting (P)," *NCHRP Report 500,Volume 5: A Guide for Addressing Unsignalized Intersection Collisions,* Transportation Research Board, The National Academies, pp V-70–V-71, Washington, DC, 2003.

For More Information

Ed Rice

Intersection Safety Team Leader,
FHWA Office of Safety

202.366.9064

ed.rice@dot.gov

Eric Green

Research Engineer,
Kentucky Transportation Center

859.257.2680

egreen@engr.uky.edu

Susan Zarling

Office of Traffic Safety,
Minnesota Department of Transportation

651.234.7052

susan.zarling@state.mn.us

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