**4. Safety, Security and Crime Prevention**

The resources listed below discuss how outdoor lighting can help promote safety as well as perceptions of personal security. The widely varying impacts of outdoor lighting on crime are also described. All links below are up-to-date as of January 2020.

Boyce, P. R., Eklund, N. H., Hamilton, B. J., & Bruno, L. D. (2000). Perceptions of safety at night under different lighting conditions. Lighting Research and Technology, 32(2), 79–91. Retrieved from <https://doi.org/10.1177/096032710003200205> This paper presents the results of a series of studies on the perception of safety and security in parking lots in Albany, NY and New York City. The authors found that an average horizontal illuminance on a parking lot surface or street sidewalk of about 30 Iux provides enough light to ensure that perceptions of safety are close to what they are in daylight. The light spectrum is a minor factor relative to illuminance.

Bullough, J. D. (2014). Roadway Lighting and Safety : An Integrated Approach. Lighting Research Center. Retrieved from <http://www.lrc.rpi.edu/programs/transportation/lightingsafety.asp> This web page provides links to articles on roadway lighting and safety. Specific topics include safety, visibility, synthesis, and cost benefits.

Bullough, J. D. et al. (2019). Integrating research on safety perceptions under parking lot illumination. CIE 29th Session, Washington. Retrieved from <http://doi.org/10.25039/x46.2019.OP60> This paper describes the impacts of light levels, light source spectra (color) and uniformity of illumination on pedestrians’ perceptions of safety and personal security. Uniformity is one of the most important factors in reinforcing a sense of safety.

Bullough, J. D., Donnell, E. T., & Rea, M. S. (2013). To illuminate or not to illuminate: roadway lighting as it affects traffic safety at intersections. Accident Analysis & Prevention, 53, 65–77. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/23377085> This study correlated the lighting with crash frequency at intersections in Minnesota. A model of relative visual performance was used to characterize the lighting at the intersections. The results allow engineers to quantify the expected safety improvements at an intersection from installing a particular lighting system. Overall, the presence of roadway intersection lighting was found to be associated with an approximately 12% lower night-to-day crash ratio than unlighted intersections.

Clarke, R. V. (2008). Problem-Oriented Guides for Police Improving Street Lighting to Reduce Crime in Residential Areas. Retrieved from <https://cops.usdoj.gov/RIC/Publications/cops-p156-pub.pdf> This guide provides insights to communities wishing to use improved outdoor street lighting as a method of reducing crime. Lighting techniques are suggested and the costs and benefits of improved lighting are weighed and considered. Some benefits include improved perception of safety, less actual crime and disorder and the overall improvement of appearance of outdoor areas.

Donnell, E. T., Porter, R. J., & Shankar, V. N. (2010). A framework for estimating the safety effects of roadway lighting at intersections. Safety Science, 48(10), 1436–1444. Retrieved from <https://doi.org/10.1016/j.ssci.2010.06.008> The methods for evaluating the safety effects of intersection lighting are proposed. The methods are used to evaluate Minnesota intersection crash data; benefits were found to be lower than previously published research suggested, but consistent with estimates in Highway Safety Manual research.

Hanford, D.J. (2011). Exterior Lighting: Use Best, Not Brightest. Building Operating Management. Retrieved from <http://www.facilitiesnet.com/lighting/article/Outdoor-Lighting-Strategy-Can-Balance-Safety-Security-andEnvironmental-Stewardship-Facilities-Management-Lighting-Feature--12857> This article discusses lighting for safety vs. security, appropriate light levels, and lighting controls. It also provides a case study from Walmart.

Illuminating Engineering Society. (2016). Guide for Security Lighting for People, Property, and Critical Infrastructure, G-1-16. New York: Illuminating Engineering Society. Retrieved from <https://www.techstreet.com/standards/ies-g-1-16?product_id=1949694> This guide discussed how to deploy outdoor lighting to maximize security of people and property in safety-critical situations.

Illuminating Engineering Society (2015). The Value Proposition: At the Crossroads of Intersections. LD+A e-report. Retrieved from <https://www.lrc.rpi.edu/resources/newsroom/LDAvalue5.pdf> This brief article discusses recent research on the value of lighting roadway intersections and how the results might be used to decide when and where to light intersections.

Rea, M. S., Bullough, J. D., Fay, C. R., Brons, J. A., Van Derlofske, J., & Donnell, E. T. (2009). Review of the safety benefits and other effects of roadway lighting (pp. 1–61). Retrieved from <http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP05-19_LitReview.pdf> A summarization of studies performed as part of the National Cooperative Highway Research Program (NCHRP) is provided to take an in-depth look at the effects of nighttime lighting on roadway crashes, pedestrian perceptions of safety and security, street crime, economic development and light pollution. Wide variations in findings likely stemming from biases and analysis techniques are seen to exist, however, there is nevertheless a connection found to exist between effective outdoor lighting and the reduction of street crime and roadway accidents.

Tien, J. M. et al. (1979). Street Lighting Projects, National Evaluation Program Phase I Report. Washington, U.S. Department of Justice. Retrieved from <https://popcenter.asu.edu/sites/default/files/Responses/street_lighting/PDFs/Tien_1979.pdf> This report summarizes numerous street lighting improvement projects across the United States. The authors concluded that the effects of street lighting on crime are mixed with no consistent effects, but improved lighting reduces the fear of crime.