LIGHTING DESIGN GUIDELINES

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I. INTRODUCTION

The Maryland Department of Transportation's State Highway Administration (SHA) lighting guidelines as described herein take into consideration factors such as traffic safety, pedestrian safety, light pollution, energy conservation, and maintenance. The proper selection of lighting equipment and the location of street lighting will provide sufficient visibility, increased safety, and improved security for motorists and pedestrians while maximizing energy efficiency and minimizing expenditure. Lighting also has adverse effects that include glare, light trespass and sky glow that should be considered when deciding to install roadway lighting. The Local Jurisdiction's commitment to participate in the design, construction, operation and maintenance of the lighting system should also be a consideration.

All new low level lighting such as interchange and intersection, underpass and sign lighting shall be designed using light emitting diode (LED) fixtures. The LED fixtures should also be considered for pedestrian lighting. The LED roadway fixtures shall be selected from the Qualified Products List (QPL).

The following guideline is separated into three sections:

- The ***Criteria for Eligibility*** section defines the circumstances which qualify a roadway to be considered for the installation of lighting.
- The ***Typical Lighting Applications*** section describes the common applications of lighting installations.
- The ***Special Lighting Applications*** section describes the various applications in relation to the roadways in which lighting shall be considered.

II. CRITERIA FOR ELIGIBILITY

To determine the eligibility for lighting installations, the SHA requires an engineering study of local conditions considering such factors as crash data, roadway characteristics, speed (posted and prevailing) and ambient light to support lighting installation decisions and to promote road user safety (motorists, pedestrian, cyclists, etc.). When there is a history of crashes, the type and circumstances of the crashes should also be considered in a study. Engineering judgment should be used in instances where an operational or safety concern is not indicated by the crash data. Traffic volumes can also be used as a supplemental measure in evaluating lighting eligibility. Furthermore, The American Association of State Highway and Transportation Officials (AASHTO) minimum conditions for when to consider lighting shall be used when determining eligibility for all lighting installations.

The conditions for eligibility for specific facility types are described in the following sections. Meeting these conditions does not obligate the SHA to provide lighting nor is it a requirement for installation of lighting in special circumstances.

III. TYPICAL LIGHTING APPLICATIONS

A. Interchange Lighting

Partial Interchange Lighting will be installed on all approaches at new and reconstructed grade separated interchanges across the state. At existing grade separated interchanges without interchange lighting; lighting will be installed based on an established need including night time crash history, site specific conditions and engineering judgement. Secondary ramp merges and diverges will be treated in the same manner as mainline exits. **Figure III-A.1** in the Appendix should be used as a reference for lighting placements. The installation of additional lights is at the discretion of the SHA. For all lighting placements, the entering and/or exiting lane(s) and one (1) adjacent mainline travel lane shall be analyzed when determining proper spacing as shown in **Figures III-A.2** and **Figure III-A.3** of the Appendix.

When new lighting, installed to meet these guidelines, results in less than 600 feet between any two light poles, additional lighting shall be installed to fill in this gap and to provide uniform levels in that section. Additional interchange lighting shall be considered on facilities with one or more of the following characteristics:

1. Ramps, interchange alignments, or grades which are complex or unusual. This includes ramps with substandard deceleration or acceleration lanes, full loops, compound curves, lane reductions and/or multi-lane ramps.
2. Locations with significant pedestrian or bicycle activities during times of darkness.
3. Important decision point(s) or existing roadside hazard areas that would not be covered with partial interchange lighting.
4. An operational analysis indicates the need for lighting. Traffic volume and crash data should be used to support the analysis.

Refer to **Table III-A.4** of the Appendix for recommended illuminance lighting values for interchanges. High mast lighting will not be installed along state roadways unless required lighting levels cannot be achieved with low level lighting and justified by an engineering study. In addition to light trespass and photometric analysis, the engineering study should consider the presence of any rural historic districts, National Parks, National Historic Landmarks or other relevant historic properties in the vicinity of the proposed high-mast lighting.

B. Intersection Lighting

Partial Intersection lighting will be installed at all locations meeting the following criteria:

1. All signalized intersections will have partial intersection lighting.

2. All roundabouts will have lighting (refer to Appendix **Section III-B.1** for the SHA Roundabout Guidelines for placement and illuminance requirements).
3. All non-signalized intersections for which a need is determined based on the SHA Evaluation Form for Intersection Lighting. Refer to **Table III-B.2** of the Appendix for the SHA Evaluation Form for Intersection and Mid-Block Pedestrian Crossing Lighting.

Lighting should be located on the downstream side of an intersection and coverage may include channelized (free) right turn lanes. See **Figure III-A.1** of the Appendix for example lighting configurations. Where possible, the placement of the luminaire on a signal pole is preferred at signalized intersections. The conduit system for intersection lighting shall be dedicated for lighting only and shall not be shared with the signal cable unless the luminaire is mounted on the signal pole or otherwise directed by the SHA. Further, service pedestals may be shared for lighting and signals at the discretion of the SHA. Refer to **Table III-B.3** of the Appendix for recommended lighting values for intersections other than roundabouts. Refer to **Table III-B.4** of the Appendix for recommended lighting values for intersections of continuously lit roadways.

C. Continuous Roadway Lighting

Continuous roadway lighting will not be installed along any state highway unless justified by an engineering study and approved in advance by the Director of the Office of Traffic and Safety (OOTS) through the Design Request process.

Refer to **Table III-C.1** of Appendix for recommended luminance lighting values for straight continuously lit roadways. Illuminance values in accordance with **Table III-A.4** may be used when sufficient curvature exists on the roadway such that utilizing the luminance method for lighting design is not feasible.

The installation of continuous roadway lighting may be justified when pedestrian/ bicycle/vulnerable road user lighting is warranted along a state highway to improve safety. Most walkways and bike lanes are located adjacent to roadways. The light spillover from pedestrian lighting onto the roadway must be evaluated and designed to ensure roadway and pedestrian lighting meet acceptable levels. Refer to **Section IV-E** for additional information.

Continuous lighting installed along a state highway shall meet the target values in this guideline regardless of ownership and maintenance requirements for the system (County, City, etc.).

D. Sign Lighting

Overhead signs shall be installed with ASTM Type XI sheeting and shall not be illuminated with sign lighting, except under the following conditions:

1. All overhead signs with unencumbered sight distance of less than 1,000 feet. Unencumbered sight distance exists if all portions of every overhead sign panel on that structure is visible to motorists in all approaching lanes.
2. Additional lighting may be considered and requested as part of the Design Request based on engineering judgement to address site specific conditions.

Sight distance as noted above should be considered when selecting locations for new structures.

When sign lighting is provided:

1. Lighting shall consist of LED luminaires.
2. Individual supports for each luminaire is the preferred mounting method; sign lighting maintenance systems should only be used at the discretion of the OOTS.
3. All overhead sign panels mounted on a structure shall be illuminated. Lighting only select panels is not permitted.

Existing sign lighting, where required, will be upgraded to LED lighting as part of each project. When existing signs are replaced with new signs fabricated from Type XI sheeting, the need for sign lighting will be determined per the above criteria. If any overhead sign does not require lighting it shall use Type XI sheeting which shall be specified on the sign detail sheets.

E. Mid-Block Pedestrian Crossing Lighting

Partial lighting will be installed at all locations meeting the following criteria:

1. All signalized mid-block pedestrian crossings will have partial lighting. Pedestrian Hybrid Beacons qualify for partial lighting under this warrant.
2. All mid-block pedestrian crossings with flashing beacons or Rectangular Rapid-Flashing Beacons will have partial lighting.
3. All non-signalized mid-block pedestrian crossings for which a need is determined based on the SHA Evaluation Form for Intersection Lighting. Refer to **Table III-B.2** of the Appendix for the SHA Evaluation Form for Intersection and Mid-Block Pedestrian Crossing Lighting.

Refer to **Table III-E.1** of the Appendix for recommended vertical illuminance values for mid-block pedestrian crossings. The vertical illuminance values in **Table III-E.1** of the Appendix shall be met for isolated mid-block pedestrian crossing (partial lighting) or when the mid-block pedestrian crossing is along a continuously lit roadway. If the approach

roadway is continuously lit, the luminance values in **Table III-C.1** shall be used for the approach roadway.

At mid-block pedestrian crosswalk locations, consideration should be given to placing lights in advance of the crossings on both approaches to illuminate the front of the pedestrian and avoid creating silhouettes. Where possible, the placement of the luminaire on a signal pole is preferred at signalized mid-block pedestrian crossings. The conduit system for lighting shall be dedicated for lighting only and shall not be shared with the signal cable unless the luminaire is mounted on the signal pole or otherwise directed by the SHA. Further, service pedestals may be shared for lighting and signals at the discretion of the SHA.

IV. SPECIAL LIGHTING APPLICATIONS

A. Bridge Lighting

Bridge lighting will be evaluated using the Roadway Lighting criteria provided above, particularly the approach transition areas, with the following exceptions:

1. Existing bridge lighting which will not be impacted by a roadway project may remain in place.
2. Existing continuous roadway lighting not required to light the existing roadway at the approach of and along bridges should be removed.
3. Pedestrian Lighting on bridges will be installed in accordance with the SHA Pedestrian Lighting Policy (Application Guideline 11-X9).
4. Decorative lighting should not be installed on bridges without sidewalks. When a sidewalk is present, the installation of lighting should be in accordance with the SHA Pedestrian Lighting Policy. Decorative lighting should not be installed without a Memorandum of Understanding (MOU) which assigns responsibility for maintenance to Local Jurisdictions or utility companies.
5. All other lighting applications shall be determined as per the discretion of the OOTS.
6. Lighting on historic bridges warrants coordination with Office of Structures and Office of Planning and Preliminary Engineering to ensure the work is performed in a manner that protects the historic fabric of the bridge.

B. Rest Area or Park-and-Ride Lots

Sufficient illumination shall be provided for public safety purposes at both rest areas and park-and-ride lots. Refer to **Table IV-B.1** of the Appendix for recommended Illuminance Levels for Roadway Rest Areas and **Table IV-B.2** of the Appendix for recommended Illuminance Levels for Parking Areas. Access ramps to and from the facility should be

treated as interchange ramps and illuminance values as defined in **Section III-A** of this document.

C. Underpass Lighting

Underpass lighting shall be designed, for nighttime hours, in accordance with **Table IV-C.1** of the Appendix where sidewalks are present. The need for daytime lights will be based on an Engineering Study, which includes consideration of existing light levels. Underpass lighting on historic structures warrants coordination with Office of Structures and Office of Planning and Preliminary Engineering to ensure the work is performed in a manner that protects the historic fabric of the structure.

D. Tunnel Lighting

Tunnel lighting shall be designed in accordance with the Illuminating Engineering Society RP-8-21, Chapter 14: Tunnel Lighting. Tunnel lighting on historic structures warrants coordination with Office of Structures and Office of Planning and Preliminary Engineering to ensure the work is performed in a manner that protects the historic fabric of the structure.

E. Pedestrian Lighting

In Maryland and throughout the Country, approximately 75% of all pedestrian fatalities occur during periods of darkness. According to the Crash Modification Factor Clearinghouse, the number of vehicle-pedestrian crashes may be reduced by 42% to 81% with the proper design and installation of lighting. The design and installation of pedestrian lighting is directed by the Maryland Department of Transportation State Highway Administration's Pedestrian Lighting Policy (Application Guideline No. 11-X9). For Recommended Values for High, Medium and Low Pedestrian Conflict Areas see **Table IV-E.2, Table IV-E.3 and Table IV-E.4** of the Appendix. Where pedestrian lighting is installed along a roadway the veiling luminance along the roadway, per **Table III-A.4** and **Table III-C.1** of the Appendix, shall not be exceeded.

Pedestrian lighting needs are documented by the approved Design Request. The SHA Evaluation Form for Pedestrian Lighting may be used to support the decision to install pedestrian lighting. Refer to **Table IV-E.1** of the Appendix for the SHA Evaluation Form for Pedestrian Lighting.

The installation of continuous roadway lighting may be justified when pedestrian/ bicycle/vulnerable road user lighting is warranted along a state highway to improve safety. The light spillover from pedestrian lighting onto the roadway must be evaluated and designed to ensure roadway and pedestrian lighting meet acceptable levels. Refer to **Section III-C** for additional information.

Modification or installation of lighting in historic districts or on historic structures should be coordinated with Office of Planning and Preliminary Engineering.

F. Knock Downs

When a light pole is knocked down, maintenance forces should verify with the OOTS if the pole shall be replaced. If replacement of the pole is necessary, the existing fixture shall be upgraded with an LED fixture.

G. District Initiated Lighting Reductions

Districts are encouraged to review their existing lighting systems and consult with the OOTS to determine if reductions are possible. Funding for such reduction projects may be provided by the OOTS. Examples of reductions include replacement of continuous freeway lighting with partial interchange lighting.

H. Temporary Lighting

During construction, temporary lighting should be provided for decision points. During design of the project, it should be determined if existing/proposed light poles will sufficiently illuminate conflict points, otherwise, temporary light poles (typically wood poles with overhead feeds) should be provided. Wood poles or other non-breakaway temporary lighting structures must be protected from vehicular traffic.

Revision Date	Revision Description:
6/27/2013	Original
5/16/2018	Updated
11/13/2023	Updated - Added new criteria and considerations for addressing pedestrian crashes

Approved Cedric Ward 12/7/2023

Director, Office of Traffic and Safety — Date

LIST OF APPENDICES

Section I-A.1
Maryland State Highway Administration Light Emitting Diode (LED) Roadway Lighting Specifications and Approved Luminaires Memo

Martin O'Malley, *Governor*
Anthony G. Brown, *Lt. Governor*

SHA
State Highway Administration
Maryland Department of Transportation

Darrell B. Mobley, *Acting Secretary*
Melinda B. Peters, *Administrator*

MEMORANDUM

TO: All District Engineers

Mr. Earle Freedman, Director
Office of Structures

Mr. Kirk McClelland, Director
Office of Highway Development

Mr. Russell Yurek, Director
Office of Maintenance

FROM: Gregory D. Welker
Deputy Administrator/Chief Engineer for Operations

DATE: December 7, 2012

SUBJECT: Light Emitting Diode (LED) Roadway Lighting
Specifications and Approved Luminaires

The State Highway Administration (SHA) is working to reduce energy usage in our agency by 20% from our 2011 levels by the year 2015. With advances in technology, the efficiency and compatibility of newer light sources has significantly improved. The use of light emitting diodes (LED's) as a source for roadway lighting can offer energy savings as compared to conventional high intensity discharge (HID) light sources, such as high pressure sodium (HPS) or metal halide (MH).

The SHA's Office of Traffic and Safety (OOTS) initiated an LED Roadway Lighting Pilot Study in October 2011 at the I-83/Warren Road Interchange. The purpose of the study was to research, analyze and document the energy efficiency and operational performance of LED roadway lighting. The study concluded that the LED roadway lighting technology has adequately evolved and can provide energy savings for lighting performance similar to conventional HID light sources. In addition, LED roadway lighting offers advantages such as cooler/natural light output, faster lamp start up time and less maintenance needs as compared to conventional HID light sources.

In view of these benefits, LED luminaires will be required on all future roadway lighting projects. Special Provision Inserts (SPI) 806 and 950.12 shall be included in the information for bid (IFB) package for all future roadway lighting projects. SPI's 806 and 950.12 cover the performance and materials aspect of LED luminaires, respectively.

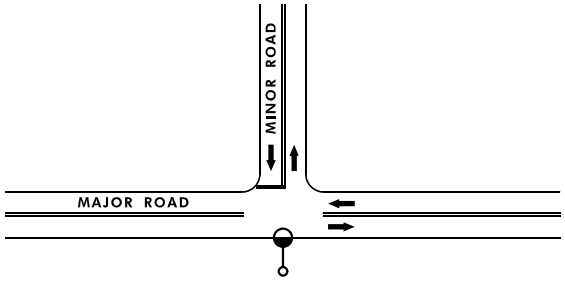
All projects currently in design that include non-LED roadway lighting should incorporate LED luminaires.

LED luminaire bid items will be required on all future roadway lighting maintenance projects. These should include items for repair/replacement of LEDs, and for replacing damaged conventional lighting with LED lighting. For existing lighting maintenance contracts, the respective District Offices may negotiate change orders for the contractors, to furnish and install LED luminaires. LED luminaires shall be used for all maintenance replacements. Maintenance of existing lighting shall be in accordance with SHA standards and any removal of existing, unwarranted lighting shall be coordinated with the OOTS.

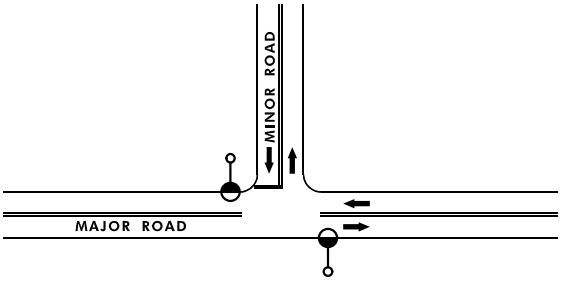
All approved LED roadway luminaires will be included on the Office of Traffic and Safety's Qualified Product's List (QPL). Only LED roadway luminaire models selected from the QPL shall be used on roadway lighting projects.

If you have any questions or require additional information, please do not hesitate to contact Mr. Michael L. Paylor, P.E., Chief, Traffic Engineering Design Division at 410-787-4027 or mpaylor@sha.state.md.us.

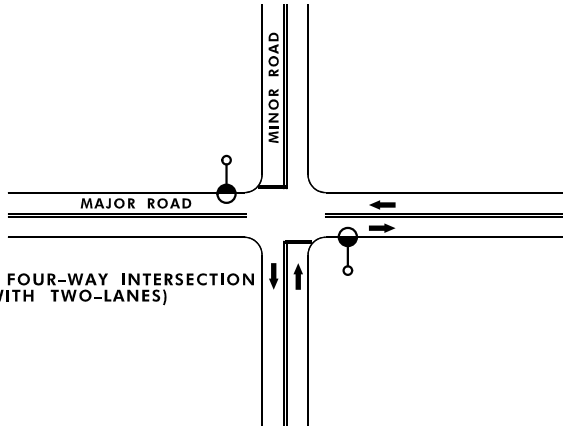
cc: Mr. Steven Marciszewski, Director, Office of Construction, SHA
Mr. Michael L. Paylor, P.E., Chief, TEDD, SHA
Mrs. Melinda Peters, Administrator, SHA
Mr. Douglas Simmons, Deputy Administrator/Chief Engineer for Planning, Engineering, Real Estate & Environment
Mr. Cedric Ward, P.E., Director, Office of Traffic and Safety, SHA



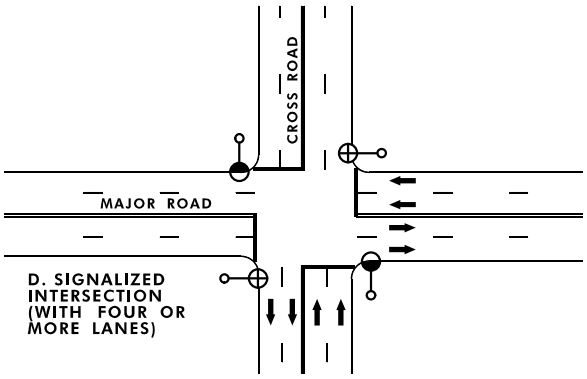
A. T–INTERSECTION



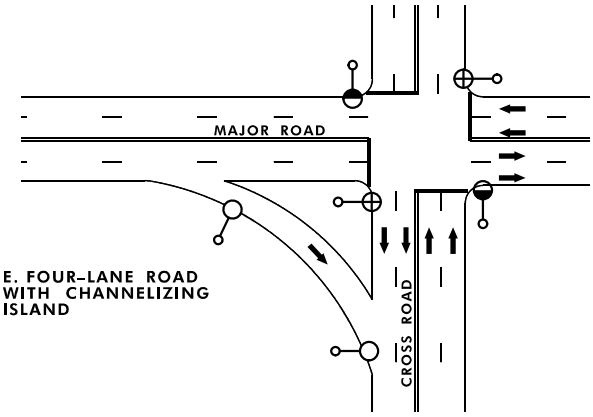
B. T–INTERSECTION (ALTERNATE)



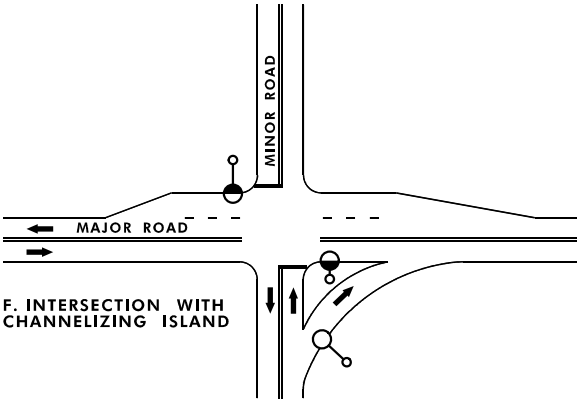
C. FOUR–WAY INTERSECTION (WITH TWO–LANES)



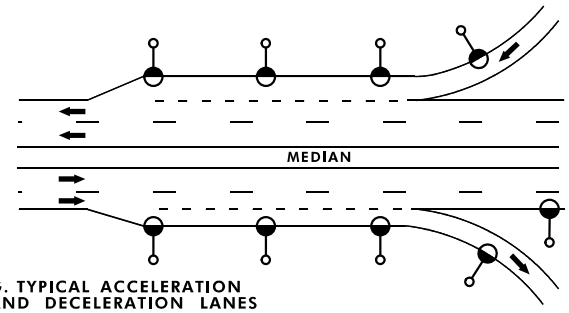
D. SIGNALIZED INTERSECTION (WITH FOUR OR MORE LANES)



E. FOUR–LANE ROAD WITH CHANNELIZING ISLAND



F. INTERSECTION WITH CHANNELIZING ISLAND



G. TYPICAL ACCELERATION AND DECELERATION LANES AT ON AND OFF RAMPS

LEGEND

- UNIT REQUIRED
- UNIT RECOMMENDED
- UNIT OPTIONAL

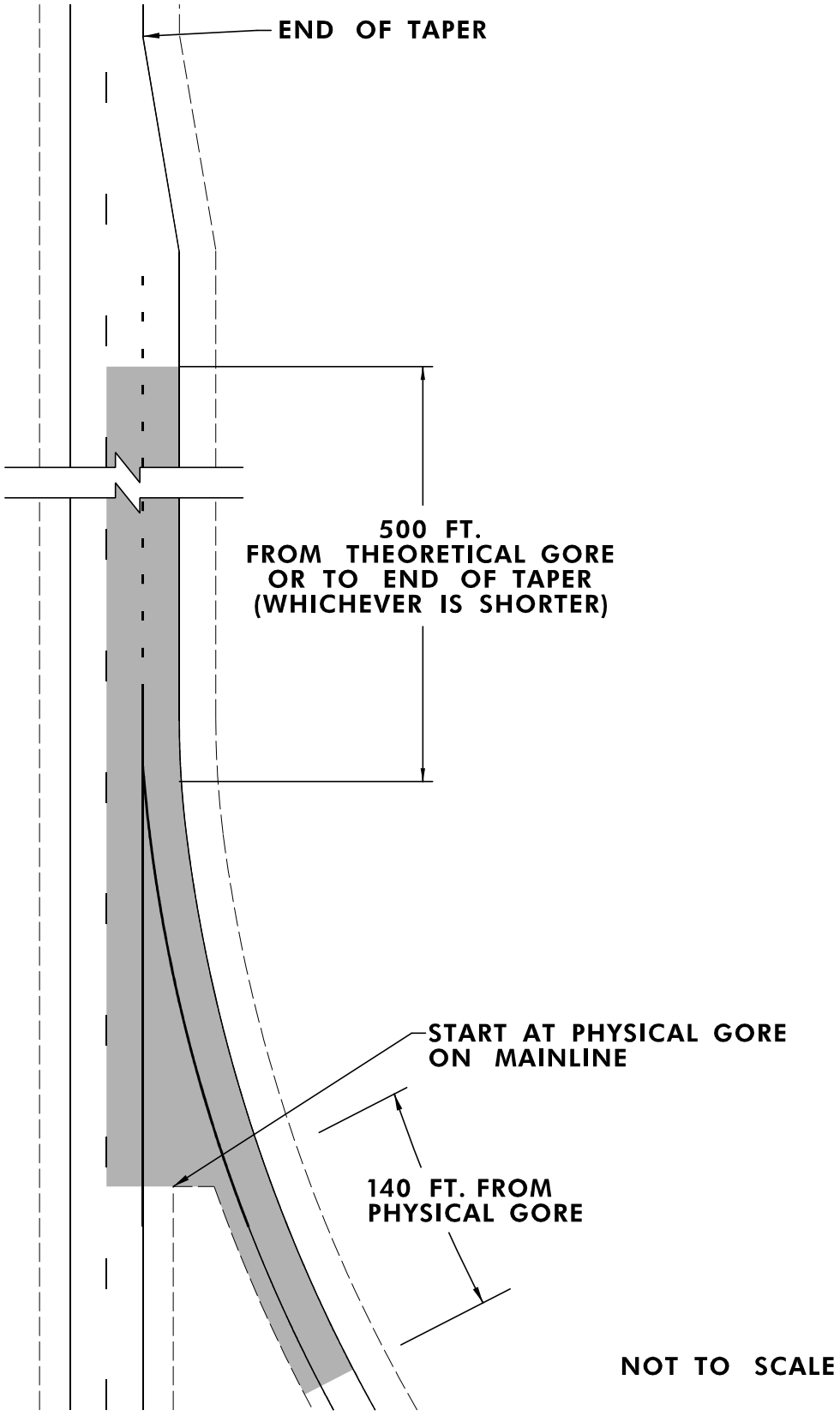
NOTE: DRAWINGS ARE NOT TO SCALE AND THE LIGHT LOCATIONS SHOWN ARE NOT TO BE CONSIDERED COMPLETE IN NUMBER OR BETTER THAN APPROXIMATE IN POSITION

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

LIGHTING DESIGN GUIDELINES
EXAMPLES OF LIGHTING CONFIGURATIONS

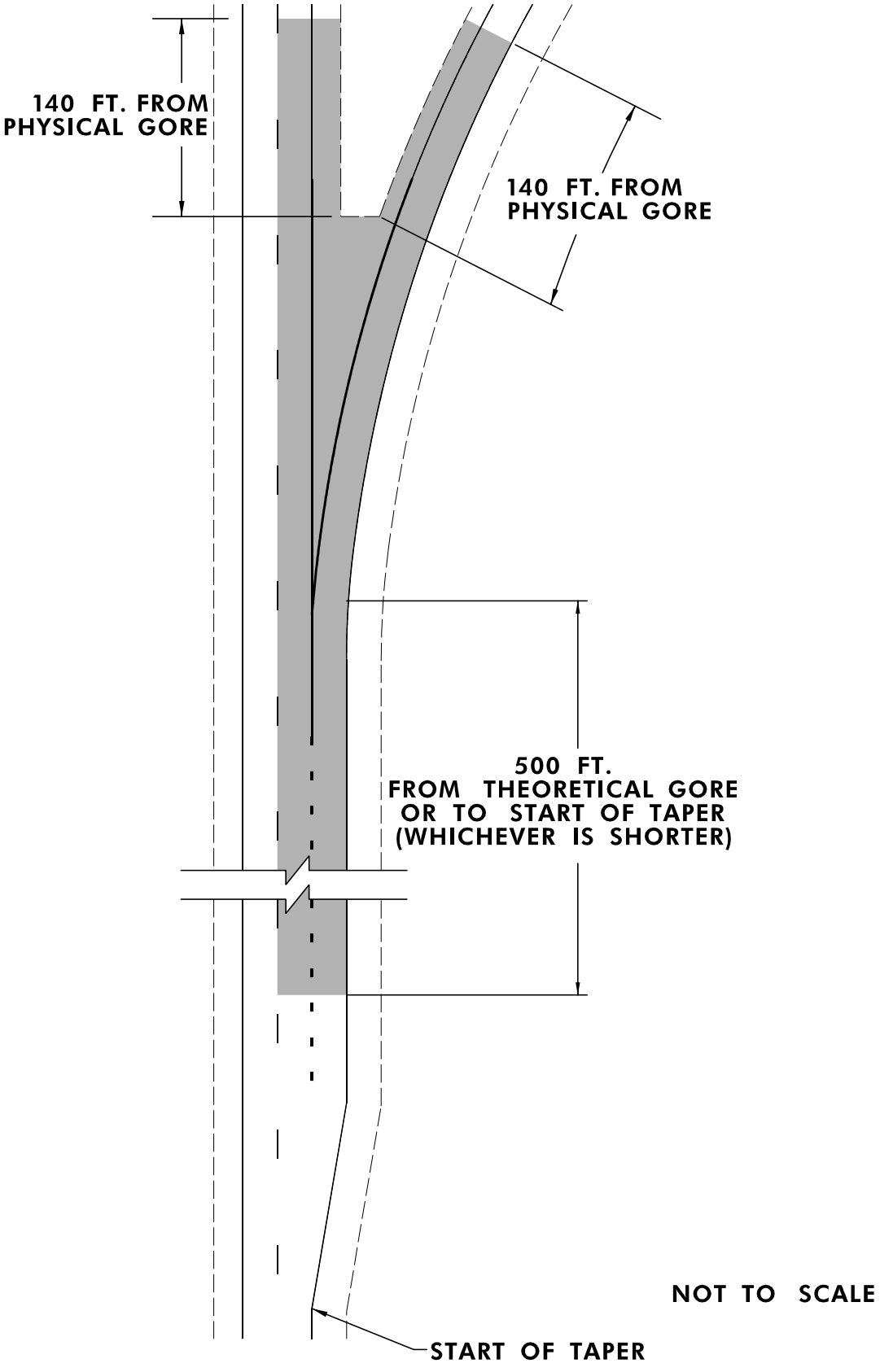
FIGURE NO. III–A.1



MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

LIGHTING DESIGN GUIDELINES
LIGHTING ANALYSIS AREA FOR ENTRANCE RAMPS

FIGURE NO. III–A.2



MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

LIGHTING DESIGN GUIDELINES
LIGHTING ANALYSIS AREA FOR EXIT RAMPS

FIGURE NO. III–A.3

Table III-A.4:

Recommended Illuminance Lighting Values for Interchanges

Road and Pedestrian Conflict Area[1]		Pavement Classification[2] (Minimum Maintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 (fc)	R2 & R3 (fc)	R4 (fc)	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Freeway Class A		0.6	0.9	0.8	3.0	0.3
Freeway Class B		0.4	0.6	0.5	3.0	0.3
Expressway	High	1.0	1.4	1.3	3.0	0.3
	Medium	0.8	1.2	1.0	3.0	0.3
	Low	0.6	0.9	0.8	3.0	0.3
Major	High	1.2	1.7	1.5	3.0	0.3
	Medium	0.9	1.3	1.1	3.0	0.3
	Low	0.6	0.9	0.8	3.0	0.3
Collector	High	0.8	1.2	1.0	4.0	0.4
	Medium	0.6	0.9	0.8	4.0	0.4
	Low	0.4	0.6	0.5	4.0	0.4
Local	High	0.6	0.9	0.8	6.0	0.4
	Medium	0.5	0.7	0.6	6.0	0.4
	Low	0.3	0.4	0.4	6.0	0.4

[1] Road and Pedestrian Conflict Area (Pedestrian Activity Classifications) per IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.
Excerpt from IES RP-8-00, Section 2.2 Pedestrian Conflict Area Classifications:
High – Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals. Typically over 100 pedestrians per hour[3].
Medium – Areas with lesser numbers of pedestrians utilizing the streets at night. Examples are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, older city areas, and streets with transit lines. Typically 11 to 99 pedestrians per hour[3].
Low – Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets, very low density residential developments, and rural or semi-rural areas. Typically 10 or fewer pedestrians per hour[3].

[2] Pavement Classifications per IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.

[3] These volumes represent the total number of pedestrians walking on both sides of the street plus those crossing the street at non-intersection locations in a typical block or 656 foot section.

Section III-B.1
Maryland State Highway Administration Roundabout Design Guidelines (Chapter 3)

Chapter 3 - Lighting Guidelines

This section presents recommended guidelines for lighting of roundabouts on facilities within Maryland. The information in this section is based on the following sources:

- FHWA, *NCHRP Report 672: Roundabouts: An Informational Guide - Second Edition,* 2010.
- ANSI / IESNA RP-8-00, *American National Standard Practice for Roadway Lighting*, 2000.
- AS/NZS 1158.1.3:1997, *Road lighting*, Australian/New Zealand Standard, 1997.
- Centre d'Etudes sur les Réseaux les Transports, l'Urbanisme et les constructions publiques (CERTU), *L'Éclairage des Carrefours à Sens Giratoire (The Illumination of Roundabout Intersections),* Lyon, France: CERTU, 1991.

General Requirements

Lighting should be provided at all roundabouts, whether in rural or urban settings. The specific lighting requirements for each setting are discussed below. Lighting is required for roundabouts on the Maryland state highway system.

Lighting should be installed and operational before the roundabout is open to traffic. If a portion of the roundabout will be opened to accommodate traffic on a temporary basis, lighting should be provided. If permanent lighting cannot be installed to meet construction schedules, temporary lighting will be allowed, with the approval of the engineer.

Lighting in Urban and Suburban Areas

The recommended practice for determining proper roadway illumination is provided in ANSI/IESNA RP-8-00, published by the Illuminating Engineering Society of North America. The discussion in this section focuses on the illuminance method, which is commonly used for illumination design at roundabouts. RP-8-00 discusses other methods such as luminance and small target visibility; the reader is encouraged to refer to that document for discussion of those methods, as well as discussion on the proper method to calculate the critical values for each criterion.

The basic principle behind the lighting of roundabouts in urban and suburban areas is that the amount of light on the roundabout should be equal to the sum of the lighting of the two brightest approach roads. This increases nighttime visibility of the intersection by making it stand out from the approach roadways.

Exhibit 3-1 presents the recommended illuminance for roundabouts located on continuously illuminated streets. Separate values have been provided for portland cement concrete road surfaces (RP-8-00 Road Surface Classification R1) and typical asphalt road surfaces (RP-8-00 Road Surface Classification R2/R3). Exhibit 3-2 presents the roadway and pedestrian area classifications used for determining the appropriate illuminance levels in Exhibit 3-1. RP-8-00

clarifies that although the definitions given in Exhibit 3-2 may be used and defined differently by other documents, zoning by-laws, and agencies, the area or roadway used for illumination calculations should best fit the descriptions contained in Exhibit 3-2 and not how classified by others (RP-8-00, Section 2.0, p.3). Note that the predominant surface type should be used for illumination calculations; for example, a roundabout with an asphalt concrete circulatory roadway and portland cement concrete truck apron should be designed using a surface type of R2/R3.

Exhibit 3-1
Recommended Illuminance for the Intersection of Continuously Lighted Urban and Suburban Streets

Pavement Classification[1]	Roadway Classification	Average Maintained Illuminance at Pavement[2]			Uniformity Ratio (E_{avg}/E_{min})	Veiling Luminance Ratio (L_{vmax}/L_{avg})
		Pedestrian/Area Classification				
		High (fc (lux)	Medium (fc (lux)	Low (fc (lux)		
R1	Major/Major	2.4 (24.0)	1.8 (18.0)	1.2 (12.0)	3.0	0.3
	Major/Collector	2.0 (20.0)	1.5 (15.0)	1.0 (10.0)	3.0	0.3
	Major/Local	1.8 (18.0)	1.4 (14.0)	0.9 (9.0)	3.0	0.3
	Collector/Collector	1.6 (16.0)	1.2 (12.0)	0.8 (8.0)	4.0	0.4
	Collector/Local	1.4 (14.0)	1.1 (11.0)	0.7 (7.0)	4.0	0.4
	Local/Local	1.2 (12.0)	1.0 (10.0)	0.6 (6.0)	6.0	0.4
R2/R3	Major/Major	3.4 (34.0)	2.6 (26.0)	1.8 (18.0)	3.0	0.3
	Major/Collector	2.9 (29.0)	2.2 (22.0)	1.5 (15.0)	3.0	0.3
	Major/Local	2.6 (26.0)	2.0 (20.0)	1.3 (13.0)	3.0	0.3
	Collector/Collector	2.4 (24.0)	1.8 (18.0)	1.2 (12.0)	4.0	0.4
	Collector/Local	2.1 (21.0)	1.6 (16.0)	1.0 (10.0)	4.0	0.4
	Local/Local	1.8 (18.0)	1.4 (14.0)	0.8 (8.0)	6.0	0.4

Notes: [1] R1 is typical for portland cement concrete surface; R2/R3 is typical for asphalt surface

[2] fc = footcandles

Source: ANSI / IESNA RP-8-00 Table 9 (for R2/R3 values); R1 values adapted from Table 2

Exhibit 3-2
ANSI / IESNA RP-8-00 Guidance for Roadway and Pedestrian/Area Classification for Purposes of Determining Intersection Illumination Levels

Roadway Classification	Description	Daily Vehicular Traffic Volumes[1]
Major	That part of the roadway system that serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation and important rural roadways leaving the city. Also often known as "arterials," thoroughfares," or "preferentials."	over 3,500 ADT
Collector	Roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. They do not handle long, through trips.	1,500 to 3,500 ADT
Local	Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property.	100 to 1,500 ADT
Pedestrian Conflict Area Classification	**Description**	**Guidance on Pedestrian Traffic Volumes[2]**
High	Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals.	over 100 pedestrians/hour
Medium	Areas where lesser numbers of pedestrians use the streets at night. Typical are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, older city areas, and streets with transit lines.	11 to 100 pedestrians/hour
Low	Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets, very low density residential developments, and rural or semi-rural areas.	10 or fewer pedestrians/hour

Notes: [1] For purposes of intersection lighting levels only

[2] Pedestrian volumes during the average annual first hour of darkness (typically 18:00-19:00), representing the total number of pedestrians walking on both sides of the street plus those crossing the street at non-intersection locations in a typical block or 656 ft (200 m) section. RP-8-00 clearly specifies that the pedestrian volume thresholds presented here are a local option and should not be construed as a fixed warrant.

Source: ANSI / IESNA RP-8-00 Sections 2.1, 2.2, and 3.6

Lighting in Rural Areas

Exhibit 3-3 provides recommended illuminance levels for rural isolated intersections with unlit approaches.

Exhibit 3-3
Recommended Illuminance for the Intersection of Unlit Rural Roadways

Pavement Classification[1]	Average Maintained Illuminance at Pavement[2] (fc (lux)	Uniformity Ratio (E_{avg}/E_{min})	Veiling Luminance Ratio (L_{vmax}/L_{avg})
R1	0.6 (6.0)	4.0	0.3
R2/R3	0.9 (9.0)	4.0	0.3

Notes: [1] R1 is typical for Portland cement concrete surface; R2/R3 is typical for asphalt surface
[2] fc = footcandles

Source: ANSI / IESNA RP-8-00 Table D1

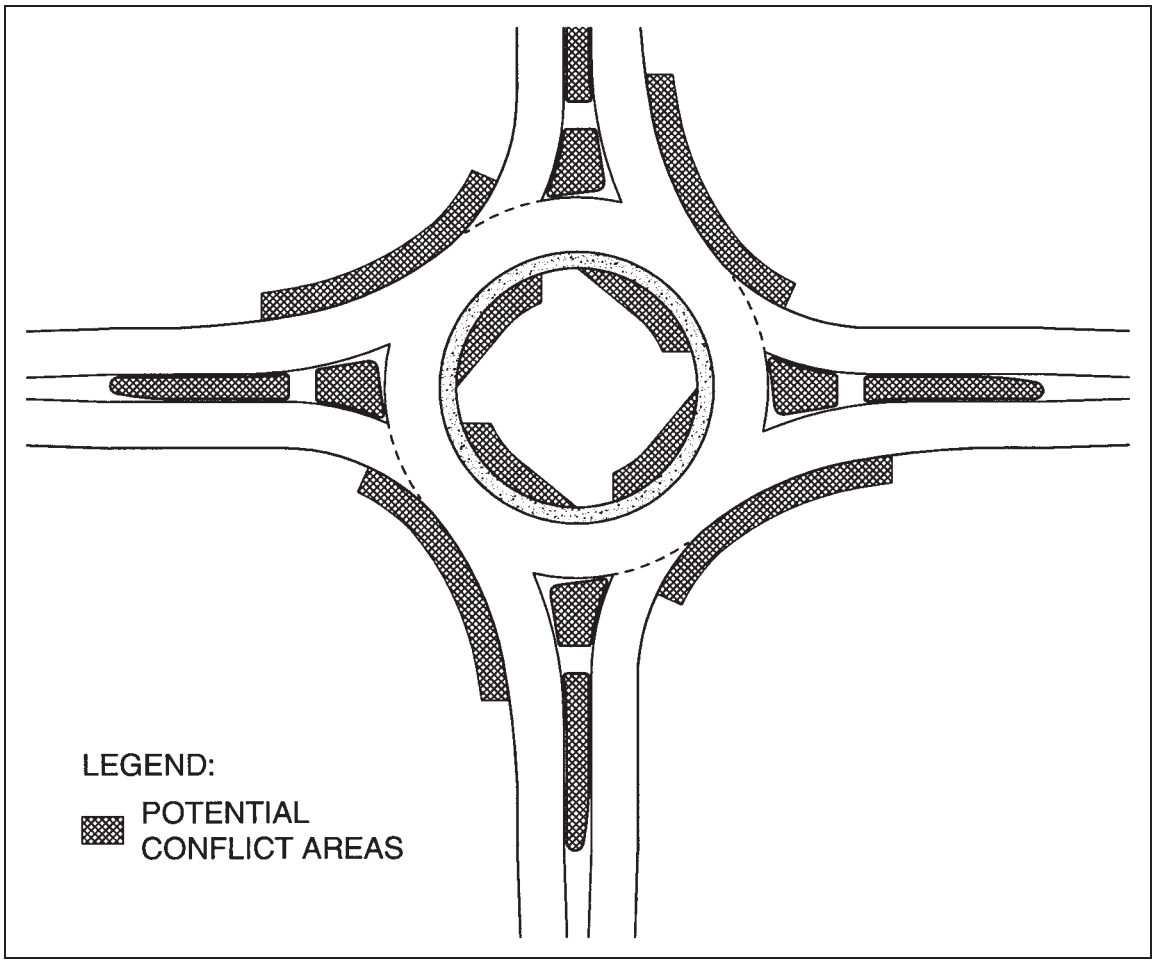
Equipment Type and Location

A photometric analysis is required to determine luminaire wattage, mounting height, luminaire arm length, and pole placement at a roundabout. In general, the use of fewer luminaires with higher wattage mounted on traditional luminaire arms ("cobra-style") is preferable to minimize the number of fixed objects in the public right-of-way, provided that the IES illuminance requirements are met. However, in urban areas where high pedestrian activity is expected or desirable, pedestrian-level illumination at lower mounting heights is often more consistent with urban design goals and should be considered. These types of luminaires may need to be supplemented by strategically located traditional cobra-style luminaires to provide adequate lighting at key conflict areas.

Lighting on SHA facilities should be installed using SHA standard equipment. Generally, this will involve the use of 40-foot poles with 250-W high-pressure sodium (HPS) "cobra-style" luminaires. If light trespass may be an issue, the designer should consider using 30-foot poles. In some instances, it may be necessary to install lease lighting on utility poles to avoid conflicts with utility lines. If the roundabout is to be installed as part of a community revitalization project or streetscape project, then the type of lighting installed should be complimentary to the lighting being installed throughout the rest of the project.

Exhibit 3-4 suggests critical conflict areas where run-off-the-road crashes are most prevalent at roundabouts. In these areas, lighting poles should be placed as far back from the curb face as practical, and no closer than 3 feet beyond the edge of the traveled roadway. In rural areas where pedestrian activity is low, breakaway pole bases are required for poles located in these critical areas. The placing of lighting in the central island should be avoided; instead, lighting should be placed on the periphery of the roundabout.

Exhibit 3-4
Critical Conflict Areas Affecting Lighting Pole Placement



Source: Adapted from AS/NZS 1158.1.3:1997, Road lighting, Australian/New Zealand Standard, 1997, Figure 8.2, p. 39.

Sample Illumination Layouts

The following three exhibits present some sample illumination plans demonstrating layouts using various types of luminaires. Each illumination plan has been customized to the specific geometry of the roundabout, photometric requirements, equipment options, and site constraints. Therefore, the reader is urged to exercise considerable caution if attempting to adapt one or more of these plans to another location.

Exhibit 3-5
Example of Illumination Using Cobra-Style Luminaires

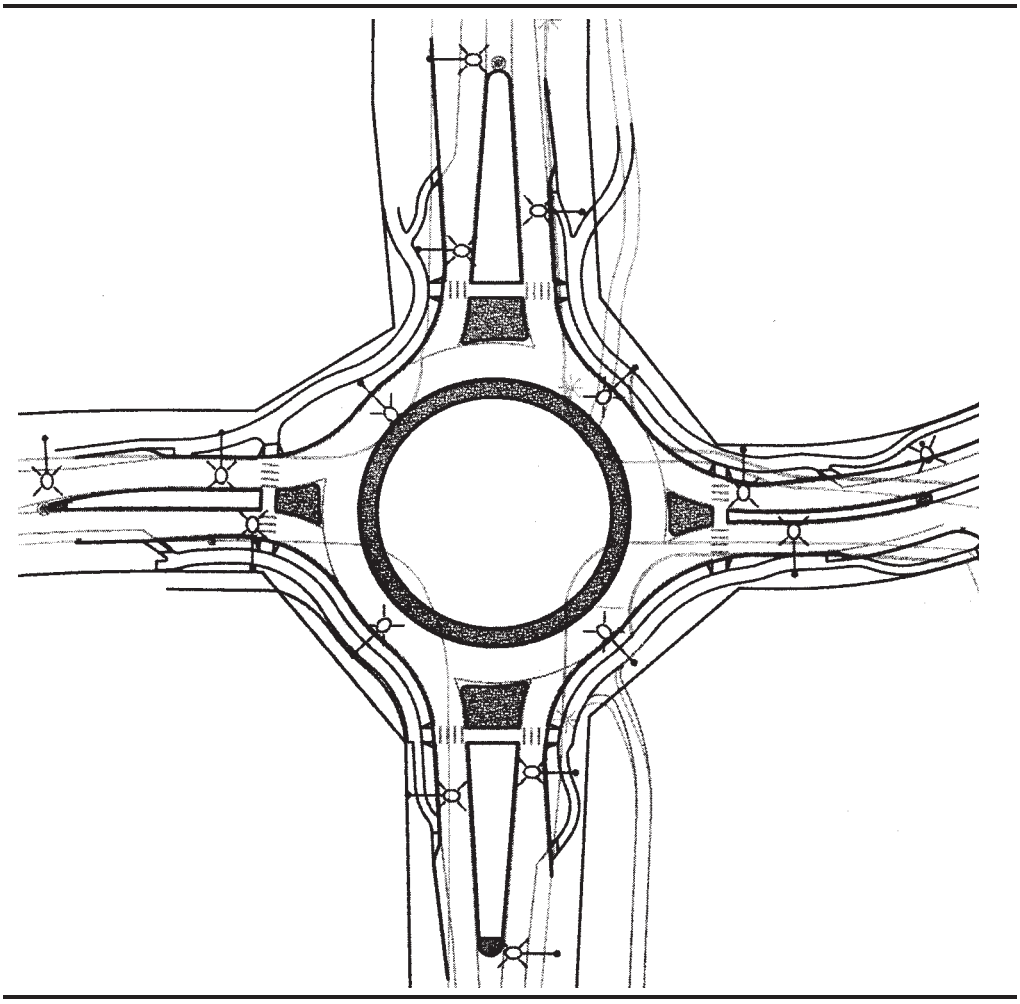


Exhibit 3-6
Example of Illumination Using Pedestrian-Level Luminaires

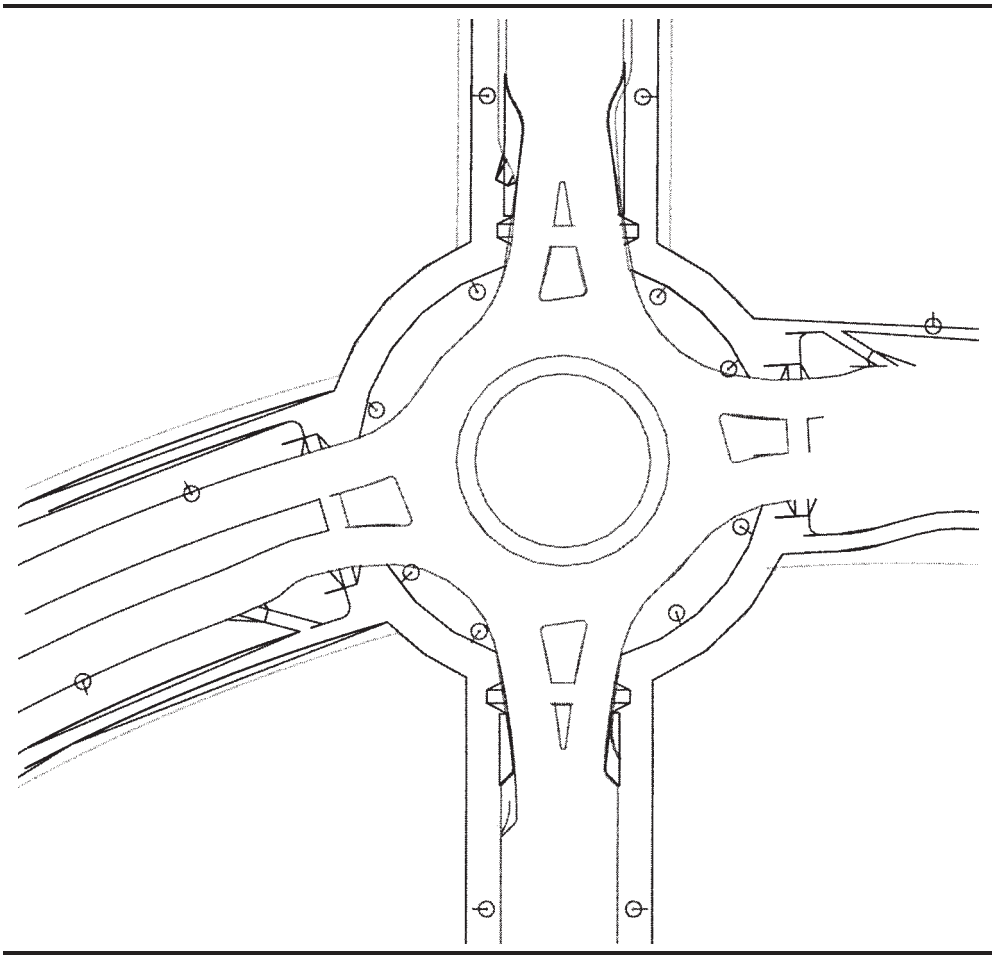


Exhibit 3-7
Example of Illumination Using a Mix of Cobra-Style and Pedestrian-Level Luminaires

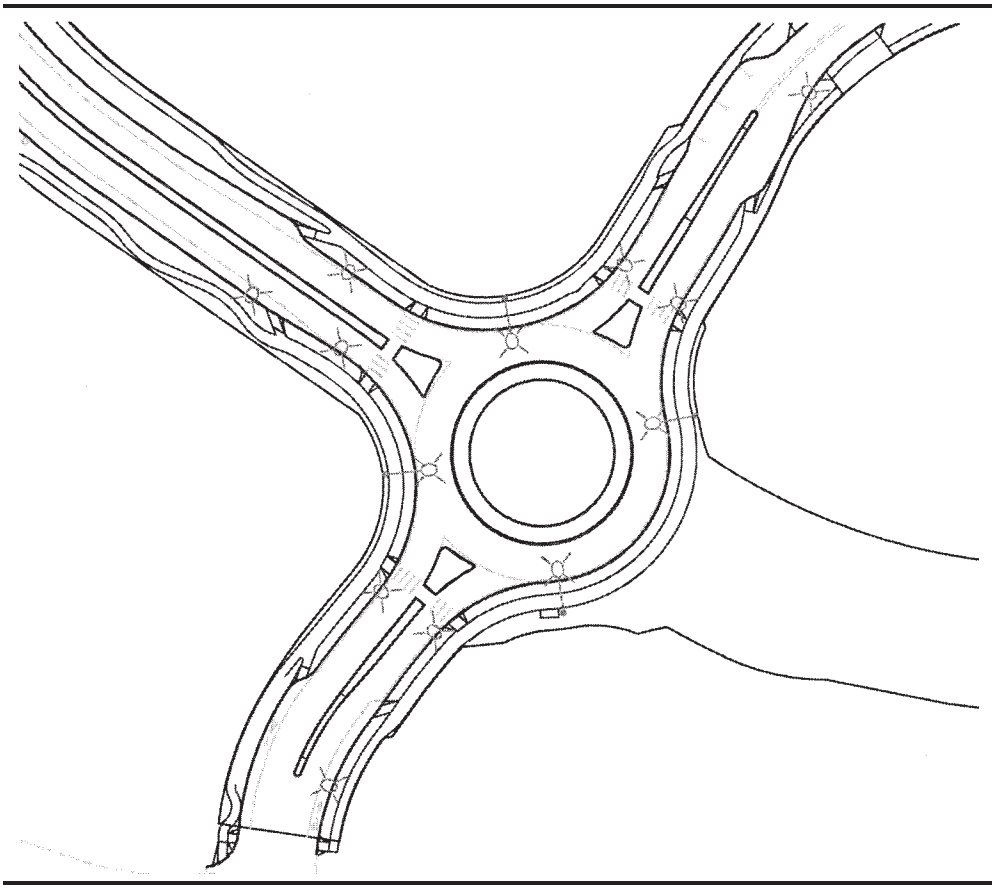


Table III-B.2:

MARYLAND STATE HIGHWAY ADMINISTRATION
EVALUATION FORM FOR INTERSECTION AND MID-BLOCK PEDESTRIAN CROSSING LIGHTING

Location:
Evaluation

	Criteria		Score Met = 1 Not Met = 0 (a)	Weight (b)	Total (a x b)
a.	Is intersection signalized?		0	5	0
b.	Does intersection have medians on any approach?		0	4	0
c.	Does intersection have left turn bays and /or other auxiliary lanes?		0	3	0
d.	Is intersection a freeway ramp terminal?		0	4	0
e.	Is there significant pedestrian volume after dark?		0	3	0
f.	Does intersection involve two or more state maintained highways?		0	1	0
g.	Does ADT of state highway exceed 15,000?		0	2	0
h.	Ratio of Night to total crashes	0.35-0.40	0	1	0
		0.40-0.45	0	3	0
		0.45-0.50	0	5	0
	(Min 5 crashes)	> 0.50	0	8	0
i.	Is intersection at school entrance or children walking to school?		0	3	0
j.	Is operating speed on any road approach greater than 50 MPH?		0	4	0
k.	Is intersection sight distance restricted?		0	5	0
l.	Are there any brightly lighted areas, i.e., parking lots, commercial area, etc. within 300 feet of the intersection?		0	4	0
m.	Are any of the road approaches continuously lighted?		0	4	0
Total					0

1) Intersection lighting is to be considered by a score of 13 or more.
2) Potential for intersection lighting will be prioritized based on score.
3) Mid-block crossing lighting is to be considered by a score of 7 or more.

Table III-B.3:

Recommended Maintained Illuminance Values for Intersections other than Roundabouts

Road Classification	Pavement Classification[1]			Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
	R1 *(fc)*	R2 & R3 *(fc)*	R4 *(fc)*	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Intersection Lighting	0.6	0.9	0.8	4.0	0.3

[1] Pavement Classifications as IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.

Table III-B.4:

Recommended Illuminance Values for Intersections of Continuously Lit Roadways[3]

Functional Classification	Average Maintained Illuminance (fc)			Maximum Uniformity Ratio E_{avg}/E_{min}
	High[2]	Medium[2]	Low[2]	
Major/Major	3.4	2.6	1.8	3.0
Major/Collector	2.9	2.2	1.5	3.0
Major/Local	2.6	2.0	1.3	3.0
Collector/Collector	2.4	1.8	1.2	4.0
Collector/Local	2.1	1.6	1.0	4.0
Local/Local	1.8	1.4	0.8	6.0

[2] Pedestrian Conflict Areas (Pedestrian Activity Classifications) as defined in IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.
[3] Based on R2/R3 Pavement Classification defined in IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.

Table III-C.1:

Recommended Luminance Values for Straight Continuously Lit Roadways

Road and Pedestrian Conflict Area[1]		Average Luminance	Uniformity Ratio	Uniformity Ratio	Veiling Luminance Ratio
Road	**Pedestrian Conflict Area[1]**	L_{avg} (cd/m²)	L_{avg}/L_{min}	L_{max}/L_{min}	L_{vmax}/L_{avg}
Freeway Class A		0.6	3.5	6.0	0.3
Freeway Class B		0.4	3.5	6.0	0.3
Expressway	High	1.0	3.0	5.0	0.3
	Medium	0.8	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

[1] Pedestrian Conflict Areas (Pedestrian Activity Classifications) as defined in IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.

Table III-C.2 - SHA Evaluation Form for Continuous Freeway Lighting

Consideration No.	Consideration Description	Sub-Category	Score Met = 1 Not Met = 0 (a)	Weight (b)	Sub-Total (a) X (b)
1	Three or more successive interchanges are located with an average spacing of 1.5 mi or less and adjacent areas outside the right-of-way are substantially urban in character.			5	0
2	Sections of two miles or more passing through a substantially developed suburban or urban area in which local traffic operates on a complete street grid having some form of street lighting, parts of which are visible from the freeway.			5	0
3	Sections of two miles or more passing through a substantially developed suburban or urban area in which the freeway passes through a series of developments-such as residential, commercial, industrial and civic areas, colleges, parks, terminals, etc. that include lighted roads, streets, parking areas, yards, etc. that are lighted.			3	0
4	Sections of two miles or more passing through a substantially developed suburban or urban area in which separate cross streets, both with and without connecting ramps, occur with an average spacing of 0.5 mi or less, some of which are lighted as part of the local street system.			3	0
5	Sections of two miles or more passing through a substantially developed suburban or urban area in which the freeway cross section elements, such as median and shoulders, are substantially reduced in width below desirable sections used in relatively open country.			4	0
6	The ratio of nighttime to daytime crashes is at least 2.0 times the statewide average for similar roadways, and a study indicates that lighting may be expected to result in a significant reduction in the night crash rate.			10	0
7	Nighttime fatalities within analyzed segment in past 3 years	0		0	0
		1		2	0
		2		4	0
		3 or more		5	0
8	Average Daily Traffic (ADT)	49,999 or less		0	0
		50,000-79,999		1	0
		80,000-149,999		2	0
		150,000-199,999		3	0
		200,000 or more		5	0
9	Context Zone	A) Urban Core		4	0
		B) Urban Center		3	0
		C) Suburban Activity Center / Traditional Town Center		2	0
		D) Suburban		1	0
		E) Rural		0	0
Total					**0**

Continuous freeway lighting may be considered by a score of 24 or more

Table III-E.1:

Recommended Vertical Illuminance Values for Mid-Block Pedestrian Crossings

Pedestrian Conflict Area[1]	E_{vmin} (fc) [2]
High	3.7
Medium	2.8
Low	1.9

[1] Pedestrian Conflict Areas (Pedestrian Activity Classifications) as defined in IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.

E_{vmin} = Minimum vertical illumination at 1.5 m (4.9 ft) above crosswalk measured in both directions parallel to vehicle flow.

Table IV-B.1:

Recommended Illuminance Levels for Roadway Rest Areas[1]

Rest Area	Average Horizontal Illuminance (fc)	Uniformity Ratio (AVG:MIN)
Entrance and Exit		
Access Lanes	*Refer to Table III-A.4*	
Gores		
Interior Roadways	0.6	3:1
Activity Areas[2]		
Major	1.0	3:1
Minor	0.5	6:1

[1] The illuminance values recommended represent the condition just prior to cleaning and/or group relamping as calculated and planned in the design procedure.
[2] Activity Areas are not a focus of the SHA OOTS lighting design, however if provided shall meet these values.

Table IV-B.2:

Recommended Maintained Illuminance Values for Parking Areas

Rest Area	Minimum Horizontal Illuminance[1] *(fc)*	Uniformity Ratio[2] *(MAX:MIN)*	Minimum Vertical Illuminance[3] *(fc)*
Basic	0.2	20:1	0.1
Enhanced Security[4]	0.5	15:1	0.25

[1] For preliminary design, an average value of 1 hfc for basic illuminance and 2.5 horizontal footcandles (hfc) for enhanced illuminance may be calculated. The minimum points and maximum point are then calculated and the uniformity ratio checked for compliance with the table's values.

[2] The highest horizontal illuminance point divided by the lowest horizontal illuminance point or area should not be greater than the values shown.

[3] Facial recognition can be made at levels as low as 0.25fc. The IESNA Security Lighting committee recommends that for facial identification, the minimum vertical illuminance should be 0.5fc. This should be measured at 5ft above the surface in various directions.

[4] If personal security or vandalism is a likely and/or severe problem, a significant increase of the Basic level may be appropriate.

Table IV-C.1:

Recommended Lighting Values for Pedestrian Portion of Underpasses with Walkways/Bikeways

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min}[1]
Night	4.0	2.0	3.0
Day[2]	10.0	5.0	3.0

E_H = Average horizontal illumination at walkway/bikeway
E_{vmin} = Minimum vertical illumination at 1.5 m (4.9 ft) above walkway/bikeway measured in both directions parallel to the main pedestrian flow.

[1] Horizontal only
[2] Use only when an engineering study indicates that enhanced security lighting is required.

Table IV-E.1 - SHA Evaluation Form for Pedestrian Lighting

Considerations for Continuous and Non-Continuous (Conflict Area) Pedestrian Lighting

Consideration No.	Consideration Description	Sub-Category	Score Met = 1 Not Met = 0 (a)	Weight (b)	Sub-Total (a) X (b)
1	The system is within ½ mile of a transit center or ¼ mile of a major transit stop or is along a connection between two or more transit centers.			5	0
2	The system falls within a designated Priority Funding Area.			1	0
3	The system is within ½ mile of an educational or similar facility that generates significant pedestrian and/or bicyclist traffic during hours of darkness.			5	0
4	The total number of pedestrians and/or bicyclists within any one-hour period of darkness is greater than 100.			7	0
5	The system is within a commercial area with significant nighttime activities.			4	0
6	Pedestrian and/or bicyclist safety issues have been documented after dark.			4	0
7	Context Zone	A) Urban Core		0	0
		B) Urban Center		0	0
		C) Suburban Activity Center / Traditional Town Center		3	0
		D) Suburban		4	0
		E) Rural		1	0
8	Located in areas with high ambient light levels (parking lots, transit centers, etc.)			3	0
9	Average Daily Traffic (ADT) Exceed 15,000			3	0
10	Facility Type	Non-Divided, 2 or 3 Lanes		0	0
		Non-Divided, 4+ Lanes		1	0
		Divided, 4+ Lanes		2	0
11	Speed Limit *Per ANSI/IES RP-8-18, continuous roadway lighting may not be necessary when the posted speed limit is less than 30 mph. At lower speeds, low beam headlights extend the entire stopping sight distance which provides enough time for drivers to identify and react to obstacles in the roadway.*	Less than 30 MPH		0	0
		30 MPH to 45 MPH		2	0
		Greater Than 45 MPH		3	0
12	Spacing of crossings or intersections is greater than 800 feet. *Along roadways with intersection or crosswalk spacing less than 800 feet, isolated crosswalk lighting might be feasible instead of continuous pedestrian lighting.* (Refer to Table III-B.2)			3	0
13	Nighttime Pedestrian Fatality Has Occurred Within Past 5 Years	None		0	0
		1		6	0
		2		8	0
		3		10	0
		4		12	0
		5 or Greater		14	0
14	Sidewalk Buffer from Roadway Less Than 5 Feet or No Buffer			3	0
15	No barrier between sidewalk or bicycle way and travel lanes			3	0
16	Functional Classification	Interstate/OPA Freeway and Expressway		0	0
		Principal Arterial Other		3	0
		Minor Arterial		2	0
		Collector (Major or Minor)		2	0
		Local		1	0
Total					**0**

Pedestrian lighting may be considered by a score of 18 or more

Table IV-E.2:

Recommended Maintained Illuminance Values for High Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Mixed Vehicle and Pedestrian**	2.0	1.0	4.0
Pedestrian	1.0	0.5	4.0

Table IV-E.3:

Recommended Maintained Illuminance Values for Medium Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Pedestrian	0.5	0.2	4.0

Table IV-E.4:

Recommended Maintained Illuminance Values for Low Pedestrian Conflict Areas[1]

	E_H (fc)	E_{vmin} (fc)	E_{avg}/E_{min} *
Rural/Semi-Rural Areas	0.2	0.06	10.0
Low Density Residential	0.3	0.08	6.0
Medium Density Residential	0.4	0.1	4.0

* Horizontal

**Mixed vehicle and pedestrian refers to those areas where the pedestrians are immediately adjacent to vehicular traffic without barriers or separation. Does not apply to mid-block crossings.

E_H=Average horizontal illuminance at walkway/bikeway

E_{vmin} = Minimum vertical illumination at 1.5 m (4.9 ft) above walkway/bikeway measured in both directions parallel to the main pedestrian flow.

[1] Pedestrian Conflict Areas (Pedestrian Activity Classifications) as defined in IES RP-8 Recommended Practice: Lighting Roadway and Parking Facilities.