11-3-1 Preliminary Design Considerations and Parameters – Roadway Lighting April 2024

POLICY

Unless described otherwise, all roadway lighting designed for the State Trunk highway system that is owned and maintained by WisDOT **shall** follow the preliminary design guidelines described in this section.

TYPES OF ROADWAY LIGHTING

There are several different types of roadways and facilities involving the consideration of lighting, most all of which are covered in more detail in the ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide. In general, the following categories are covered in this document:

- Continuous lighting systems, including continuous (corridor) freeway lighting; complete interchange lighting; partial interchange lighting; and rural interchanges.
- Streets and highways other than freeways, including expressways and urban streets, and rural highways, including spot locations involving special considerations.
- Intersections, including isolated (standalone) intersections; signalized intersections; and roundabouts. These could include transition lighting and/or coordination with a continuous segment lighting system.
- Non-standard interchanges and intersections

Continuous lighting is defined as a lighting system incorporating lighting units with overlapping distribution patterns that meet average and uniformity levels as defined by IES for the appropriate roadway area classification and use.

Isolated lighting is defined as lighting at the intersections of non-illuminated roadways or periodic lighting along a roadway where IES defined light level standards for average and uniformity are not applicable.

Transition lighting is defined as a gradual increase or reduction in lighting levels when entering or leaving a lighting system, most typically at freeway ramps, isolated systems, and roundabouts, when the roadway is not continuously illuminated.

PRELIMINARY DESIGN PARAMETERS AND CALCULATIONS

The following design parameters pertain to all “standard” roadway lighting systems:

1. Lighting systems **shall** be designed in accordance with ANSI/IES RP-8-22 and AASHTO’s Roadway Lighting Design Guide, October 2018.
2. Pavement classifications of R1 (concrete) or R3 (asphalt) *should* be used depending upon the permanent roadway surface.

The most restrictive and/or applicable policy, code, standard, or guide **shall** govern. Bureau of Traffic Operations will make the final decision on the interpretation of conflicting policies, codes, or standards.

ROADWAY AND LAND USE (AREA) CLASSIFICATIONS

There are numerous documents that define roadway classifications. Roadway classifications used to determine lighting standards **shall** reference the applicable section(s) of the following guidelines:

- ANSI/IES RP-8-22 (Lighting Roadway and Parking Facilities)
- AASHTO Policy on Geometric Design of Highways and Streets (Green Book)
- WisDOT Facilities Development Manual (FDM) 4-1-15
- FHWA Highway Functional Classifications

WisDOT policy specifies using the ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide. However, it is the responsibility of the designer to use the available resources to evaluate the section of roadway where the proposed lighting system will be installed. The functional classifications used to design the road do not necessarily address the issues that are important for lighting. Evaluation metrics include:

- Is this section of roadway primarily used for through traffic or access, or more to local properties?
- What is the speed limit and volume of traffic?
- What is the level of development and access to the surrounding area?
- What is the pedestrian conflict?
- Any unique roadway geometry or complex intersections/interchanges?

This type of basic evaluation will help determine which of the IES Table classifications provides the best fit for the project.

Table 1 below contains some of the key points from the ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide as an example to the designer. AASHTO utilizes similar roadway classification nomenclature under varying parameters. The designer **shall** refer to the appropriate reference manual as selected for use with the project.

Table 1. Classification Descriptions

Highway Classifications	**Description**
Freeway	A divided highway with full control of access. *Freeway Class A:* Roadways with great visual complexity and high trafic volumes. This type of freeway will usually be found in major metropolitan areas in or near the central core, and will operate at or near design capacity through some of the early morning or evening hours of darkness. *Freeway Class B:* All other divided roadways with full conrol of access.
Expressway	A divided highway with partial control of access.
Roadway Classifications	**Description**
Major (Arterial) Street	That part of the roadway system that serves as the principal network for through-traffic flow. These routes connect areas of principal traffic generation and important roadways entering and leaving the city. They are sometimes subdivided into primary and secondary classications; however, such distinctions are not necessary for the purpose of street lighting. These routes primarily serve through-traffic and secondarily provide access to abutting property.
Collector Street	A road servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. Collector streets may be used for truck or bus movements and give direct service to abutting properties.
Local Street	Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property. They make up a large percentage of the total street system but carry a small proportion of vehicular traffic.
Pedestrian Activity Classifications	**Description**
High Pedestrian Activity Areas	More than 100 pedestrians during the highest nightly average one-hour volume period. For example, this would include downtown areas with dense urban development (typically over 3,000 pedestrians per square kilometer), areas around major arenas.
Medium Pedestrian Activity Areas	Between 11 and 99 pedestrians during the highest nightly average one-hour volume period.
Low Pedestrian Activity Areas	10 or fewer pedestrians during the highest nightly average one-hour volume period. In low activity areas, it is recommended that the jurisdiction define whether sidewalk lighting is required, as lighting will typically have lower value in this application.

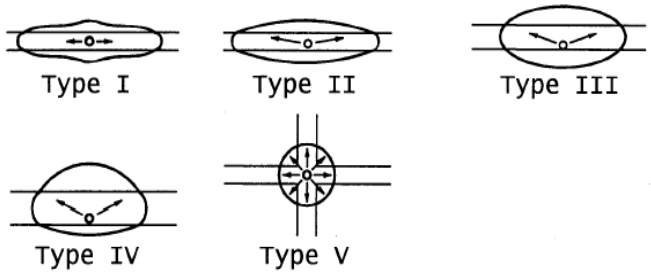
GENERAL REQUIREMENTS FOR LUMINAIRES

LED Luminaires **shall** be used for WisDOT maintained lighting systems and **shall** be selected from the

Department's Electrical Qualified Product List (QPL) whenever possible. The QPL provides products that contain a Type 3 light distribution only. Any other distribution types would need to be approved before use and require a modification to the standard specification.

Understanding the characteristics of the luminaires used on the project is critical when laying out lighting to ensure proper coverage is provided while maintaining a cost-effective approach. For permitted locally maintained systems, the luminaires **shall** be selected based on their distribution characteristics as they apply to the roadway geometry to ensure adequate illumination and minimum glare. They **shall** meet the roadway illumination requirements specified in this document. Type 2 or 3 roadway lighting distribution patterns **shall** be used for all standard applications. See typical distribution patterns in Figure 1.

Figure 1. Standard Luminaire Distributions



WisDOT QPL approved luminaires also adhere to predetermined criteria for control of light trespass for **B**ack-light, **U**p-light, and **G**lare (B.U.G). For permitted locally maintained systems, the luminaires *should* be selected based on their B.U.G. rating performing within the limits specified by the WisDOT LED Luminaire Material Specification. B.U.G. ratings are a required performance metric specified by the manufacturer for nearly all modern luminaires. These metrics are calculated based on the different distribution of light within each zone.

WisDOT currently permits the use of 4K luminaires. Luminaires with significantly different color temperatures **shall** be approved before use. For permitted locally maintained systems, the color temperature **shall** be selected based on coordination with the local agency. For example, urban districts will often utilize lower color temperatures to maintain a warmer and less stark setting.

No luminaire **shall** be proposed for use on the State Trunk Highway System that cannot meet the Illuminance and/or Luminance criteria or the Veiling Luminance Ratio required for the lighting system unless approved by the Regional and State Lighting Engineer.

A Light Loss Factor (LLF) **shall** be applied to initial lamp lumen output to calculate maintained illumination as prescribed in this section.

- The LLF for Luminaires on WisDOT's QPL **shall** be the value indicated on the List. This value includes an adjustment for luminaire dirt depreciation.
- When luminaires other than those identified on the QPL are specified for permitted locally maintained systems, the designer **shall** identify the proposed LLF and furnish justification for it with the permit application.

POLICY REVISIONS

The requirements of this policy *may* be updated to reflect changing technology or other conditions appropriate at the time. Such additions, revisions, and modifications will not be made retroactive to lighting installations covered by existing permits.

WisDOT *may* require the updating of all or part of an existing installation to conform to the latest criteria in the event damage to an installation, highway reconstruction, or other reasons requiring the replacement or relocation of all, or part of an existing lighting installation offers an opportunity to upgrade the installation.

CURFEWS

Curfews are defined as the switching off or dimming of lights during certain off-peak hours. WisDOT does not currently utilize curfews of lighting systems on WisDOT maintained lighting installations. The Department will consider allowing curfews of a permitted lighting system if the maintaining agency can demonstrate that it will not violate the AASHTO table lighting levels. This would include:

- Evaluation of the conditions during the proposed curfew hours showing that the roadway/area is different than the normal hours such that a reduction in illumination is justified if dimming is proposed. Such an evaluation typically would include such items as reductions in traffic volume and/or pedestrians.
- A statement from the local agency supporting that full illumination is not necessary during the proposed curfew hours.

11-3-2 Photometrics and Illumination Modeling April 2024

PHOTOMETRIC MODELING

The calculation of roadway lighting levels for WisDOT projects *should* be performed using Lighting Analysts AGI32 software. This will enable the designer to share the design files generated by the software with the Department for in-depth review when necessary. Unless indicated otherwise, the following methods of calculation **shall** be used:

- The Luminance Method of calculation **shall** be used to determine the average maintained luminance (in candelas per meter squared), the average-to-minimum (average uniformity), and the maximum-to-minimum (maximum uniformity) lighting levels for straight roadway segments with continuous lighting.
- The Illuminance Method of calculation **shall** be used to determine the average maintained illumination (in footcandles) and the average-to-minimum (uniformity) lighting levels for intersections and roundabouts. This can also be used on curved roadway segments with continuous lighting, but the luminance method **shall** govern when applicable.
- The designer/engineer **shall** also perform the Maximum Veiling Luminance Ratio calculation for all continuous lighting systems. The specified Maximum Veiling Luminance Ratio *should not* exceed that

defined in the ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide.

The designer *should* be prepared to provide the WisDOT Regional Lighting Engineer with a technical summary of the photometric modeling, including:

- Classification of all lighting segments within the project limits according to ANSI/IES guide RP-8-22 and/or AASHTO's Roadway Lighting Design Guide
- Other lighting design criteria according to the specified classifications and roadway characteristics
- Luminaires used in modeling and their defining characteristics:
    - Mounting height
    - Arm length
    - Maximum wattage
    - Lumen output
    - Light Loss Factor
- Photometric output and performance results for all segments of a project.

11-3-3 Standard Overhead Roadway Lighting (Intersections and Continuous Segments) April 2024

POLICY

Unless described otherwise, all standard overhead lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

Standard overhead lighting **shall** be installed at all locations as specified in FDM 11-50-60, and as approved according to TEOpS Chapters 11-1 and 11-2. Exceptions include alternative systems as described in the following subchapters and decorative lighting as requested by the local maintaining authority.

MATERIALS

Designers **shall** refer to the QPL for a list of multiple luminaires that are pre-approved for use on WisDOT facilities. Designers *should* also consider which QPL luminaire to use for photometric design, and they *should* consult with the Regional Lighting Engineer to confirm whether specific luminaire(s) from the QPL are preferred. Designers *should* select the luminaire model and distribution type based on the WisDOT Region's typical practices and the type that is most efficient and best performing overall to provide the necessary lighting levels with the fewest number of poles.

Table 2. Lighting Infrastructure Compatibility

Concrete Base	Compatible Poles	Compatible Luminaire Arms	Compatible Luminaire Types	Typical Applications
Type 2	Type 3 (30-Ft) Type 4 (30-Ft)	Truss Type 4-Inch Clamp 10-15 FT Single Member 4-Inch Clamp 6-8 FT	A, B, C	Traffic Signals - Standard
Type 5	Type 5 (30-Ft)	*Aluminum:* Single Member 4 ½-Inch Clamp 4-8 FT Truss Type 4 ½-Inch Clamp 10-15 FT	A, B, C	Intersections / Continuous
		Steel: Single Member 4-Inch Clamp 6-8FT Truss Type 4-Inch Clamp 10-15 FT		Intersections / Continuous
Type 6	Type 6 (35-Ft)	*Aluminum:* Single Member 4 ½-Inch Clamp 4-8 FT Truss Type 4 ½-Inch Clamp 10-15 FT	B, C, D	Intersections / Continuous
		Steel: Single Member 4-Inch Clamp 6-8 FT Truss Type 4-Inch Clamp 10-15 FT		Intersections / Continuous
Type 7	Type 17 (40-Ft)	*Aluminum and Steel:* Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10-20 FT	B, C, D	Milwaukee Freeway
Type 10 Type 10 Special	Type 10 Type 10 Special Type 10-Over Height	Steel 6-15 FT Steel Type 10 Pole Clamp 15 FT*	A, B, C	Traffic Signals - Monotube
Type 11	Lighting Units Walkway	NA – Post top style unit		Rest Areas / Waysides / Pedestrian Areas
Type 13	Type 13 Type 13-Over Height	Luminaire Arms Steel 6-15 FT Steel Type 13 Pole Clamp 15 FT*	A, B, C	Traffic Signals - Monotube
Freeway Median Barriers & Structural Parapets	Type 7 (35'-10")	Single Member 6-Inch Clamp 4-10 FT Truss Type 6-Inch Clamp 10-20 FT	B, C, D	STH Median / Side Mount
Freeway Median Barriers & Structural Parapets	Type A (47'-6")	Single Member 6-Inch Clamp 4-10 FT Truss Type 6-Inch Clamp 10 FT	C, D	Freeway Median Ground / Structure Mount
Freeway Median Barriers & Structural Parapets	Type E (49'-0")	Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10 FT	C, D	Freeway on/off Ramp; Slope Mount
Freeway Median Barriers & Structural Parapets	Type F (46'-0")	Single Member 6-Inch Clamp 4-15 FT Truss Type 6-Inch Clamp 10-20 FT	C, D	Freeway Barrier Wall Median Mount
** This luminaire arm type is only intended for use with traffic signal detectors and cameras*				

Lighting units and compatible infrastructure **shall** be verified with the WisDOT standard specifications and Standard Detail Drawings (SDD's) to ensure compatibility.

Specification of lighting infrastructure **shall** be verified with the respective WisDOT Regional Lighting Engineer. Acceptable mounting heights are generally dictated by the reach of available maintenance equipment in the respective Region. In general, a taller pole height provides greater coverage and a more efficient design than shorter poles. The luminaire arm length *should* be as short as possible, except when the offset to the roadway requires a longer arm to aim the light where needed. Evaluating the performance of twin luminaires and single luminaires *should* be compared when lighting a divided roadway and for intersections with channelizing islands. Twin luminaires are rotated 180 degrees from each other and cannot be adjusted.

WisDOT's list of standard bid items and QPL include both aluminum and steel pole types for some categories. Aluminum poles **shall** be used as standard practice with exceptions for steel in cases where a more rigid pole type is required. Poles combined with freeway ramp gates are one example.

Refer to Table 2 above for multiple potential combinations of concrete bases, poles, and luminaire arms available for use on WisDOT projects.

LOCATING LIGHTING UNITS

The following criteria **shall** be used to ensure that the placement of poles and other lighting appurtenances adjacent to the roadway will provide an acceptable degree of safety to the public and comply with good

illumination practices. The selection of pole types and their offsets from the traveled portions of the roadway is of considerable importance in minimizing the number and severity of fixed object collisions by errant vehicles. Light poles installed along curves *should* be located on the inside of the radius of curvature unless not possible due to unique circumstances. As much as possible, the number of poles *should* be as limited as possible to decrease impact on roadway operations, potential "run-ins", and maintenance purposes. The TEOPS Chapter 4 and TEOpS 11-4 herein give additional information related to pole locations and co-locations for luminaires, etc.

Lighting poles *should* be located to minimize conflict with utilities, including both underground and overhead. Special consideration *should* be given to overhead lines, as the survey is not always accurate to the actual envelope created by multiple lines stacked horizontally. Furthermore, utility companies will have minimum offsets that must be maintained from their lines to ensure stray voltage does not become a safety concern for installation or maintenance crews. Establishing safe offsets to high voltage transmission lines is especially critical.

Where lighting projects are being considered near an active airfield or airport, consider the impact the height of the light tower has on navigable airspace during and after construction. Any need for aviation obstruction warning luminaires on highway structures will be coordinated with the Federal Aviation Administration (FAA).

POLE BREAKAWAY REQUIREMENTS

Poles permitted on the rights-of-way of the State Trunk Highway System for the sole purpose of roadway lighting fall into one of two categories:

1. *Breakaway Poles:* This type of lighting support is defined as a pole and/or foundation which when struck by a vehicle will fracture or slip away under the conditions prescribed by the current edition of AASHTO Standard Specifications for Structural Supports for Highway Luminaires. No portion of the concrete footing **shall** be allowed to protrude above the ground level more than 4 inches.
2. *Non-Breakaway Poles:* Rigid lighting standards are defined as those poles and mountings which under impact conditions do not break away within the criteria specified for breakaway poles. Under normal conditions, the use of lighting pole designs conforming to the breakaway requirements above is required for all lighting installations except in certain circumstances:
    - Salvaging and reinstalling existing non-breakaway poles
    - Poles located on concrete barrier or parapets
    - Where direct bury poles are necessitated by the project
    - High pedestrian traffic areas, such as school zones

MINIMUM LATERAL OFFSET

Table 3 below is attached as a reference for the minimum lateral offset for lighting poles on the State Trunk highway system. The values indicated in Table 3 are based upon the current policy related to objects in clear zones as specified in FDM 11-15-1. All designs **shall** comply with the FDM. Offsets greater than those prescribed *should* be provided where feasible and where special traffic and highway conditions warrant. The designer **shall** coordinate with the Project Manager regarding all pole placement considerations.

Table 3. Minimum Lateral Offsets

Facility Type	Speed Limit (MPH)	Traffic Volume (ADT**)	Minimum Rigid (FEET)	Offset Breakaway (FEET)
Rural				SHOULDER width plus
	35 or less	ALL	12	2
	40	0 - 1,500	14	2
		1,500 - 6,000	16	2
		over 6,000	18	2
	45-50	0 - 1,500	20	2
		1,500 - 6,000	26	2
		over 6,000	28	2
	55	0 - 1,500	24	2
		1,500 - 6,000	30	2
		over 6,000	30	2
Urban				
	40 or less	ALL	2 from face of curb	2 from face of curb
	45 and higher	ALL	Offsets same as rural section	(Measured from the edge of thru lane) the greater of 12 or 2 from face of curb

Offset distances are in feet, from edge of the adjacent through traffic lane to the face of the pole; or as indicated for urban sections.

1. The preceding table is based upon pole location in a flat area or without fill slope steeper than 4:1. If rigid poles are contemplated on a slope of greater steepness and significant width, advice *should* be sought from Bureau of Traffic Operations. Placement of rigid poles in this situation is discouraged.
2. Where the offsets given in the above table would place rigid poles off the highway right-of-way, they *may* be permitted at or as near the right-of-way line as practical if it would not result in a significant added hazard to the public.
3. Where the offsets given in the above table require a pole to be in a ditch line, the pole *should* be located beyond the ditch line, but *may* be permitted in front of the ditch line if it would not result in significantly increased hazard.
4. Where the offsets given in the above table would require a pole to be within a sidewalk area, poles *should*, if conditions permit, be located behind the sidewalk. Locations between the sidewalk and roadway *may* be permitted in the event no other alternative is feasible.
5. Where a tree line exists closer to the roadway than permitted by Table 2 above, lighting poles *may* be placed in that tree line if such poles will not constitute significant additional hazards to the public.
6. Rigid poles *may* be permitted inside the limits shown in the table where they are adequately protected by barriers such as guardrails or retaining walls erected for other purposes. There *should* be at least 4 feet clearance between the guardrail and the pole to allow for deflection at higher speed locations. Designers **shall** avoid placing poles within guardrail end terminal sections.
7. Offset requirements for poles in the medians of divided highways along added left turn lanes **shall** be measured from the edge of the through traffic lane. A right turn lane is not considered a through lane.
8. For pole installation locations where there is a pronounced backslope rising directly from the shoulder, a reduction in minimum offset requirement from the preceding table by as much as 1/3 *may* be followed, no value **shall** be less than 24 feet for 40 mph or more.

11-3-4 High Mast Roadway Lighting April 2024

POLICY

Unless described otherwise, all high mast lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

This section is used to differentiate between standard overhead mounting heights (50 feet or less) and high mast lighting (80 feet or more). When deciding whether to use conventional lighting or high mast towers, the following sections **shall** be taken into consideration to compare the advantages and disadvantages of conventional and high mast lighting.:

1. *Installation Cost:* Depending on the application, the cost comparisons between high mast and conventional lighting systems can vary widely. High mast towers to illuminate interchanges are often less expensive to install than conventional lighting. This is due to reducing the installation cost associated with conduit, wiring, and considerably fewer poles required.
2. *Maintenance Cost:* Conventional lighting requires the use of a bucket truck and can require traffic control, such as signs, cones, and lane closures. When poles are mounted on concrete traffic barriers or single slope concrete barriers, the inside lane usually must be closed, resulting in significant traffic disruptions. High mast towers are generally located outside of the roadway footprint and require one or two persons with a pickup truck who can usually perform maintenance on a high mast lighting system.
3. *Safety Considerations:* High mast lighting *may* eliminate the risks involved with having personnel working near high-speed traffic. Generally high mast towers will not require lane closures for maintenance. High mast lighting also removes the opportunity for vehicle collisions with light poles placed within the clear zone.
4. *Accessibility:* High mast poles are commonly located within interchange infield areas. This can become difficult for maintenance vehicles to access the lighting systems. Constructing separate maintenance routes is often required for staff to access high mast towers.

5. *Utility Service:* High mast lighting systems are commonly located far from utility connections. Consideration *should* be given to the proximity of utility connections and the ability to access and connect to the lighting systems.
6. *Land-Use Considerations: Light Trespass can be a disadvantage when considering High Mast Lighting with adjacent residential areas.*

MATERIALS

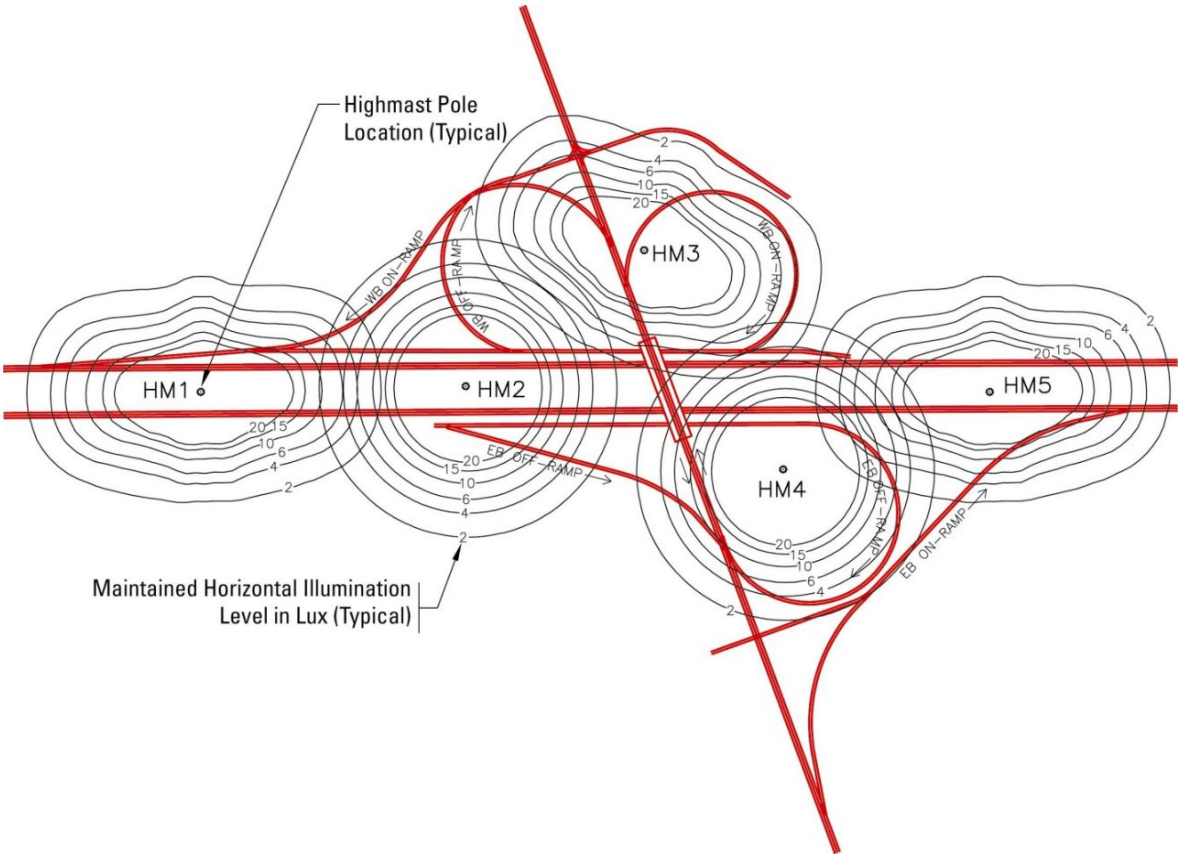
Designers **shall** refer to the QPL for multiple pre-approved luminaires. The number of luminaires required will be determined by the area to be lighted. As a general starting point, for new installations it can be assumed that up to four (4) luminaires will be used at each high mast tower location.

LOCATING LIGHTING UNITS

In determining the location of light towers, review the plan and profile view of the area to determine the critical areas requiring lighting. In selecting tower locations, consider the following:

1. *Critical Areas:* Locate light towers so that the highest localized levels of illumination fall within the critical traffic areas (e.g., freeway/ramp junctions, ramp terminals, merge points).
2. *Roadside Safety:* Locate light towers outside the roadside clear zone and a sufficient distance from the roadway so that the probability of a collision is virtually eliminated.
3. *Signs:* Locate light towers so that they are not within the driver's direct line of sight to highway signs.
4. Where lighting projects are being considered near an active airfield or airport, consider the impact the height of the light tower has on navigable airspace during and after construction. Any need for aviation obstruction warning luminaires on highway structures will be coordinated with the Federal Aviation Administration (FAA).
5. Where lighting projects are being considered near residential land uses, consider the impact of light trespass into the residential areas.
6. For interchange areas, use the typical interchange high mast tower layout shown in Figure 4.

Figure 4. Typical Interchange High Mast Tower Layout



DESIGN CONSIDERATIONS

Mounting heights in high-mast lighting applications range from 80 ft to 160 ft. Heights typically ranging between 100 ft to 150 ft provide the most practical designs. Greater mounting heights generally require more luminaires to maintain illumination levels. However, greater heights will provide a broader light distribution and better light uniformity resulting in fewer towers. As a general starting point, it is a good practice to identify optimal tower height and location to illuminate critical areas before adding additional poles and greater heights to cover the same area.

11-3-5 Underdeck Roadway Lighting April 2024

POLICY

Unless described otherwise, all underdeck lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

The decision of whether to include underdeck lighting with a design is typically based on engineering judgement. Generally, these installations are included to maintain continuous lighting throughout a corridor. Other factors to consider include pedestrian utilization and public security.

MATERIALS

WisDOT currently permits the use of 4K wall mounted luminaires for underdeck installations. Designers **shall** refer to the QPL for multiple pre-approved luminaires. Designers *should* also consider which QPL luminaire to use for photometric design, and they *should* consult with the Regional Lighting Engineer. Designers *should* select the luminaire type based on the WisDOT Region's typical practices and the type that is most efficient overall to provide the necessary lighting levels.

Current WisDOT standards and practices are not based on using overhead or ceiling mounted luminaires. Circumstances which require luminaires to be mounted overhead from the ceiling require a special provision for contractor procurement of a unique product. The Regional Lighting Engineer **shall** approve all model(s) of ceiling mounted luminaires specified for projects.

Lighting units and compatible infrastructure **shall** be verified with the WisDOT standard specifications and detail drawings to ensure constructability. Structural characteristics govern the lighting system design and whether the infrastructure will be surface mounted or embedded.

Conduit type for underdeck lighting systems will vary depending on application and **shall** be sized as necessary for wire fill capacity of proposed conductors according to the National Electrical Code.

1. Reinforced Thermosetting Rigid Conduit (RTRC) or Rigid Galvanized Steel (RGS) Conduit are typically used when infrastructure is surface mounted.
2. PVC conduit is typically utilized when the infrastructure is to be embedded in concrete. Schedule 80 *should* be considered where conduit transitions from structure to ground for added strength.

Underdeck bid items are quantified under a single bid item, accounting for all conduit, junction boxes, joints, elbows, brackets, and other miscellaneous items as necessary to complete the installation. Underdeck luminaires and conductors are not included with underdeck lighting bid item. The limits dictating where this quantification begins, and ends **shall** be specified in the plans to ensure accurate estimating and bidding of the completed installation.

LOCATING LIGHTING UNITS

Exact location and orientation for mounting underdeck luminaires will be governed inherently by structure type and ability to route infrastructure to the location. Luminaires *should* be mounted as high as practical for the structure to optimize light dispersion and minimize glare. Luminaires are typically mounted on the abutment of the bridge or on a pier cap for each direction of travel on the roadway. If such mounting would lower light levels to a non-acceptable level, then the luminaire is typically mounted on the bottom of the diaphragm. If luminaire mounting is restricted to overhead, the designer **shall** consult with BOS and BTO to determine the optimal mounting position and electrical routing.

DESIGN CONSIDERATIONS

Luminaires positioned adjacent to the underdeck can often provide adequate lighting without supplemental underdeck lighting. As a rule, for continuously lit roadways, underdeck lighting *should* be installed for structures

greater than 50 feet in length. For underpasses that exceed 200 feet in length, the underdeck lighting *should* be on continuously, day and night.

To the best of the designer's ability, the lighting level of the underdeck **shall** match the lighting levels on the adjacent roadways in accordance with ANSI/IES guide RP-8-22 and AASHTO Roadway Lighting Design Guide. Higher lighting levels *may* result due to luminaire mounting height and spacing limitations. The underdeck lighting **shall not** exceed twice the lighting level of roadway adjacent to the underdeck.

Luminaires attached to the structure along the roadside **shall** be wall mounted in a manner that minimizes glare to the drivers. To reduce the amount of glare, the use of several lower output luminaires is generally better than providing one or two high output luminaires. The use of lower output luminaires tends to improve the uniformity of lighting while maintaining lighting levels. Wall mounted luminaires are generally easier to maintain and are less affected by structure vibration. Additional considerations to mounting locations include susceptibility to vandalism and bird nesting.

All underdeck lighting locations are typically unique in design and **shall** require separate installation details. Details **shall** include plan view, elevation views, installation notes and critical dimensions. Details **shall** clearly indicate all conduit, junction box, and luminaire locations. For new underdeck locations, the conduit and junction boxes *should* be embedded in the concrete structures. Lighting installations for existing underpasses **shall** be surface mounted.

11-3-6 Tunnel Roadway Lighting April 2024

POLICY

Unless described otherwise, all tunnel lighting installations on the State Trunk highway system **shall** follow the design guidelines described in this section.

REFERENCE TO STANDARDS

Tunnel lighting design **shall** comply with the requirements of the latest edition of the following:

- ANSI/IES RP-8-22 (Lighting Roadway and Parking Facilities)
- AASHTO Roadway Lighting Design Guide

FEASIBILITY CONSIDERATIONS

Warranting criteria for the implementation of tunnel lighting is provided in ANSI/IES RP-8-22 and AASHTO Roadway Lighting Design Guide. The decision of whether to include lighting with tunnel structures is unique to each location. Warranting criteria *should* be based on engineering judgement according to the traffic volumes, posted speeds, proposed users, and geometric features of the tunnel. Lighting control technology and managing energy usage **shall** be carefully evaluated when designing tunnel lighting installations. The State Lighting Engineer **shall** approve the design criteria for any tunnel lighting systems.

MATERIALS

The WisDOT QPL does not specify pre-approved luminaires for tunnel lighting. Tunnel lighting installations **shall** require a special provision for contractor procurement of a unique product. Designers *should* select the luminaire based on the WisDOT's typical practices and the type that is most efficient overall to provide the necessary lighting levels while minimizing glare for drivers.

11-3-7 Pedestrian Scale Lighting April 2024

POLICY

Unless described otherwise, all pedestrian scale lighting installations on State Trunk highway rights-of-way **shall** follow the design guidelines described in this section.

FEASIBILITY CONSIDERATIONS

Pedestrian scale lighting is most often installed for roadside facilities, i.e., rest areas and weight enforcement areas, to illuminate areas accessible to pedestrians. The decision of whether to include pedestrian lighting *should* be based on coordination with the respective WisDOT Regional Lighting Engineer, the respective Bureau of Highway Maintenance (BHM) official, and engineering judgement according to the proposed users and unique features of the site.

MATERIALS

WisDOT currently permits the use of 4K post-top mounted luminaires for pedestrian scale lighting. Designers *should* refer to the QPL for pre-approved luminaires and consider which QPL luminaire to use for photometric design. Designers *should* select the luminaire type based on the WisDOT Region's typical practices and the type that is most efficient overall to provide the necessary lighting levels. Designers **shall** confirm luminaire model(s) with the BHM project manager and Regional Lighting Engineer.

11-3-8 Aesthetic Lighting on Structures April 2024

DEFINITION

This policy applies to decorative lighting on structures for aesthetic purposes using a dynamic lighting system that can be operated and controlled by a central computer using fiber optic and data cable lines and software that can project a variety of colors and patterns on bridges and other transportation structures. The colors can be changed at an interval or remain constant. The intensity of the lighting fixtures can be controlled from 0 to 100 percent. Typical systems have the capability to be pre-programmed so that the lighting color selections and color schemes can be approved and controlled. These systems do not provide roadway lighting and **shall not** negatively impact the illumination level of the roadway.

POLICY

Aesthetic lighting *may* be installed only under conditions referenced in the WisDOT Bridge Manual and Division of Transportation Investment Management cost-share policies in the Program Management Manual 3-25-15. The provisions of this policy **shall** apply to all cities, villages, counties, and towns (i.e., local agencies) which desire to use or occupy rights-of-way of the State Trunk Highway System for locally owned and maintained lighting and electrical facilities. Public, private, and municipal utilities, cooperatives, and private citizens who desire to use or occupy rights-of-way of the State Trunk Highway System for roadway lighting **shall** apply to the city, village, county, or town in which the State Trunk Highway is located.

FEASIBILITY CONSIDERATIONS

Aesthetic lighting is not typically installed or maintained by WisDOT and would be completely at the discretion/desire of the project sponsor with agreement from the Department. The decision of whether to include aesthetic lighting **shall** be based on coordination with the WisDOT State Lighting Engineer and engineering judgement according to the proposed aesthetic function and features of the site.

MATERIALS

The installation, including all wiring, supports, equipment, and roadway clearance **shall** be in accordance with pertinent statutes, codes, and regulations as well as good trade and engineering practice and **shall** be properly maintained.

DESIGN CONSIDERATIONS

All electrical components of the system, including conduit, cabling, and pedestals, **shall** be separate physically from WisDOT electrical system infrastructure. All electrical systems **shall** be designed under the oversight of the State Lighting Engineer and **shall** be documented as under the operational control of WisDOT Bureau of Traffic Operations.

The operation and maintenance of the lighting system **shall** be at the expense of the maintaining agency. Removal of the system or alterations in any part of the installation that are required at any time by WisDOT **shall** be made by the maintaining agency at no expense to the Department. Immediate action will be required if a hazardous aspect to the lighting system arises.

Construction and maintenance operations **shall** be performed without closing the highway to traffic except as *may* be specifically authorized by authorized representatives of the agency maintaining the highway. A work on right-of-way permit will be required from the appropriate regional office prior to any work being done on the right-of-way.

Aesthetic lighting schemes **shall not** present a distraction to the traveling public. The lighting system **shall** be designed to minimize light trespass. When programmed to do so, the colors will remain fixed for no less than 10 seconds. When lighting is near the traveling public, certain colors (i.e., red, blue, amber), text, or images *may* be prohibited. At no time **shall** the lights or colors flash or blink. WisDOT will require field testing and validation prior to securing full approval to operate the lighting system.

Any requests from the public for change in operation of the aesthetic lighting system **shall** be approved by

WisDOT's Bureau of Traffic Operations.

WisDOT *may* require the aesthetic lighting be turned off under conditions or circumstances of adverse weather like heavy snow, fog or accidents which could have a negative impact on the traveling public.

11-3-9 Navigation Lighting April 2024

POLICY

Bridge navigation lighting systems **shall** be installed under State Trunk highway system bridges over navigable waters to delineate the structure and provide guidance for vessels traversing the waterway. Unless described otherwise, all navigation lighting installations **shall** follow the US Coast Guard standards and the design guidelines at the following path https://www.ecfr.gov/current/title-33/chapter-I/subchapter-J/part-118

MATERIALS

The installation, including all wiring, supports, equipment, clearance, etc. **shall** be in accordance with pertinent statutes, codes, and regulations, as well as good trade and engineering practice and **shall** be properly maintained. All bridge navigational lighting system materials **shall** follow and be approved by the US Coast Guard Bridge Lighting and Other Signals as included in the following path https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5pw/Office%20of%20Bridge%20Programs/Lighting.pdf

DESIGN CONSIDERATIONS

The bridge navigational lighting system installation **shall** conform to all standards and requirements set forth by the US Coast Guard, Office of Bridge Administration.

11-3-10 Roadway Lighting Equipment Installed Near Airports April 2024

State Trunk highway system roadway lighting equipment installed near airports **shall** be installed per the Federal Aviation Administration (FAA) Advisory Circular for Obstruction Marking and Lighting - AC_70_7460-1L located at the following path. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_-_Obstuction_Marking_and_Lighting_-_Change_2.pdf