Chapter 1040 Illumination

1040.01 General

Illumination serves multiple functions along highways, in parking lots, and at other facilities, such as improving safety and enhancing security during hours of darkness. Lighting can highlight objects or locations that would not be illuminated by headlights, draw attention to a specific location or feature, or improve the visibility of approaching people or objects.

Lighting design needs to balance the function of the lighting with its potential adverse effects, including light pollution and other environmental effects, energy consumption, maintenance impacts, and potentially less cautious user behavior.

Lighting is not required to be addressed for WSDOT Q Program Low-Cost Enhancement projects (Q2/QE projects) unless the project is specifically to address lighting.

1040.01(1) System Ownership and Management

The Washington State Department of Transportation (WSDOT) is generally responsible for illumination on state highways except within the limits of an incorporated city or town. Ownership and maintenance responsibility for highway lighting is defined by RCW 47.24.020, with clarification provided by WAC 468-18-050 (commonly referred to as the "City Streets as Part of State Highways Guidelines"). In unincorporated areas, WSDOT is responsible for all highway lighting. In incorporated areas, WSDOT is responsible for the lighting on limited access facilities (typically freeways and expressways) and interchanges, but not for local crossroads or non-limited-access state highways.

Local roadway lighting shall be designed to local agency standards and use local agency standard equipment such as luminaires and poles.

For design and construction, the agency responsible for the construction project will provide the required illumination as part of the project, regardless of which agency will own any particular illumination system upon project completion. Systems shall be electrically separated by owning jurisdiction, starting from the electrical service cabinet and metering point. Two jurisdictions cannot jointly own, operate, and maintain separate parts of the same electrical system.

1040.01(1)(a) Conventional Roadways

For the purposes of this Chapter, all state highways that are not freeways or expressways are considered Conventional Roadways.

Lighting responsibility for conventional state highways depends on the type of access control. WSDOT is responsible for lighting the following types of state highways:

- Any state highway outside of city limits.
- Any segment of state highway within city limits that is designated limited access. This does not include the cross street at a freeway interchange unless the cross street is still designated as limited access outside of the freeway limited access limits.

Cities are responsible for the lighting of state highways within city limits that are not designated limited access, including state highways that are cross-streets at freeway interchanges except those noted above. Refer to the WSDOT Highway Access Requests and Training web page to determine the access control level for any segment of state highway. Ownership of lighting for conventional (non-freeway) state highways may be different if a formal agreement is established between WSDOT and the local agency.

Where WSDOT is responsible for lighting, provide basic lighting as required by the lighting design areas described in this chapter, with the lighting designed and constructed to WSDOT standards. If additional lighting is desired, the requesting local agency will need to take responsibility for any additional lighting beyond the basic required, at a minimum, and may choose to take responsibility for all lighting within the area of interest. WSDOT may agree to maintain colored (powder-coated) poles. If any other decorative pole features (arm style, base covers, etc.) or non-WSDOT-standard luminaires are desired, the agency requesting the decorative features must take responsibility for the lighting system.

1040.01(1)(b) Freeways and Expressways

WSDOT is responsible for the illumination of all freeways and their interchanges.

At interchanges, WSDOT is responsible for the lighting of the ramp itself and the ramp intersection outside of cities, and the city is responsible for the lighting at the ramp intersection (see Exhibit 1040-1 and Exhibit 1040-2) inside cities. Where a ramp intersection is within city limits, but there is no additional city lighting in the area, WSDOT may take ownership of the ramp intersection lighting, particularly if the intersection includes a traffic signal.

Exhibit 1040-1 Interchange Lighting Responsibility – Basic Interchange

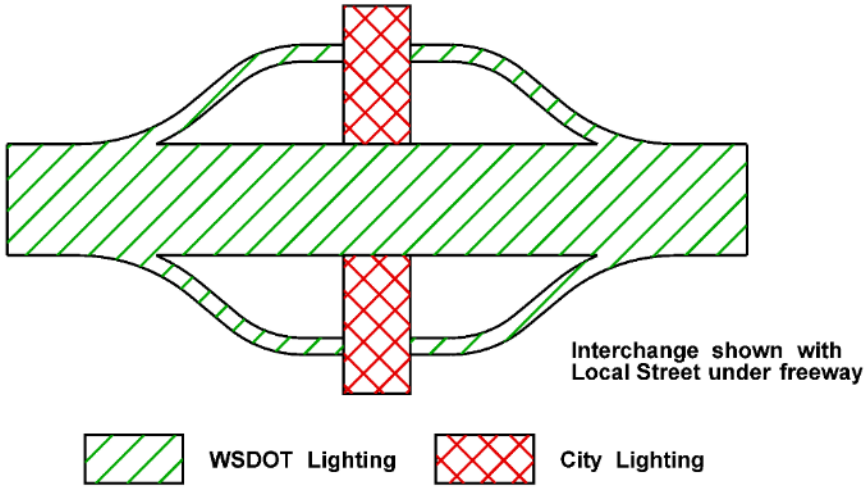
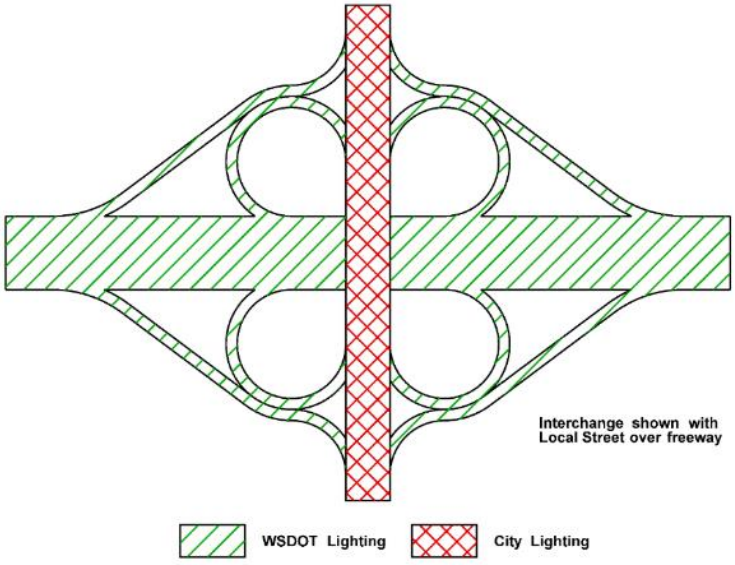
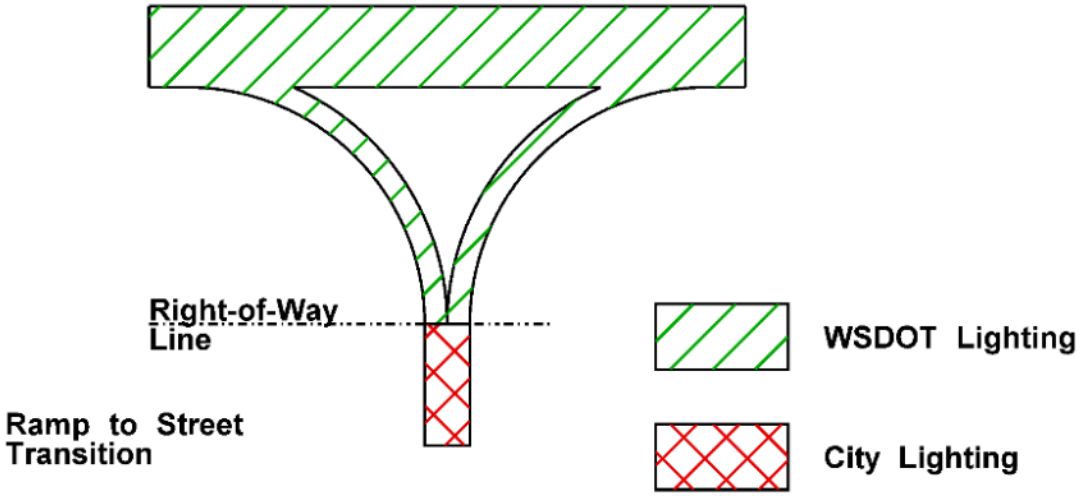


Exhibit 1040-2 Interchange Lighting Responsibility – Complex Interchange



If a ramp is a continuation of a street (ramp becomes a street or street becomes a ramp, no intersection), then WSDOT's responsibility for lighting stops at the WSDOT right-of-way line (see Exhibit 1040-3).

Exhibit 1040-3 Ramp to Street Transition Lighting Responsibility

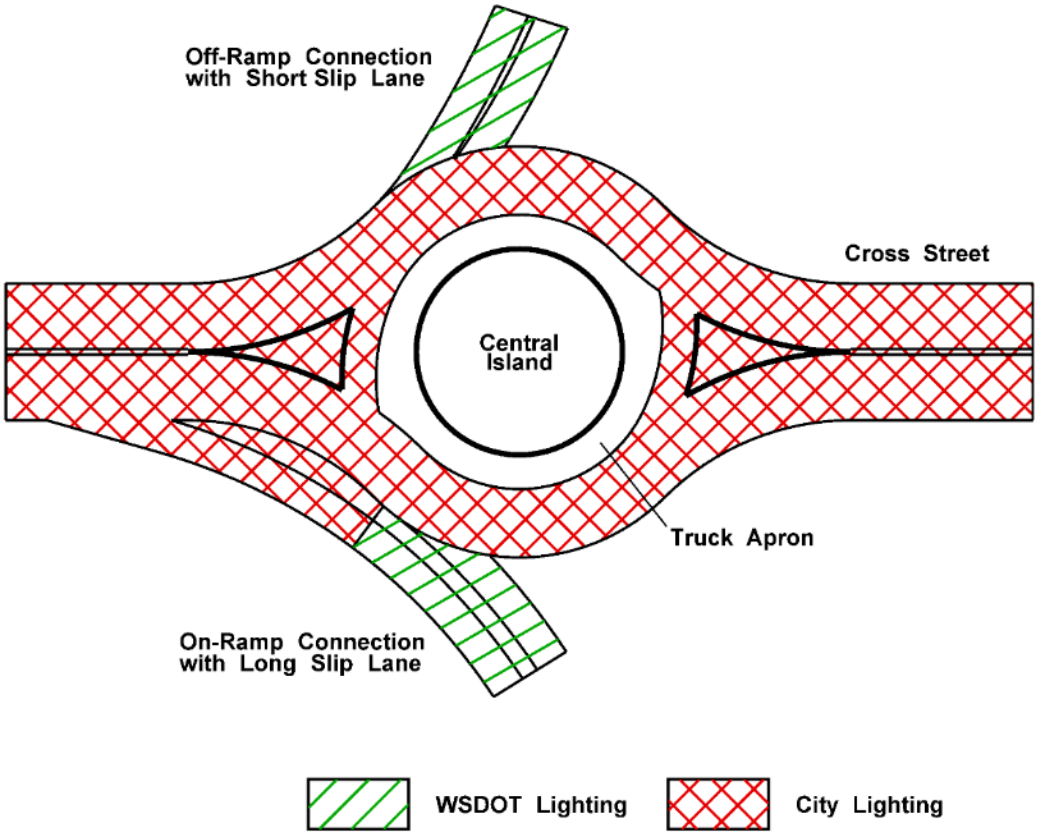


Where a ramp terminal ends at a roundabout, and the cross street is within city limits, WSDOT responsibility for lighting stops at the end of each ramp where it meets the circulating roadway (see Exhibit 1040-5). When there is a right-turn slip lane for a corner of the roundabout, lighting of the right-turn slip lane is divided dependent on the type of right-turn slip lane:

- If the right-turn slip lane stops near the edge of the circulating roadway (short slip lane), responsibility for lighting the right-turn slip lane falls under the same jurisdiction as the approach roadway that the right-turn slip lane is connected to.
- If the right-turn slip lane connects two approach roadways (long slip lane), responsibility for lighting the right-turn slip lane is split between the owners of the two connected approach roadways. The split point is approximately along a line from the center of the roundabout and perpendicular to the outside edge line of the right-turn slip lane.

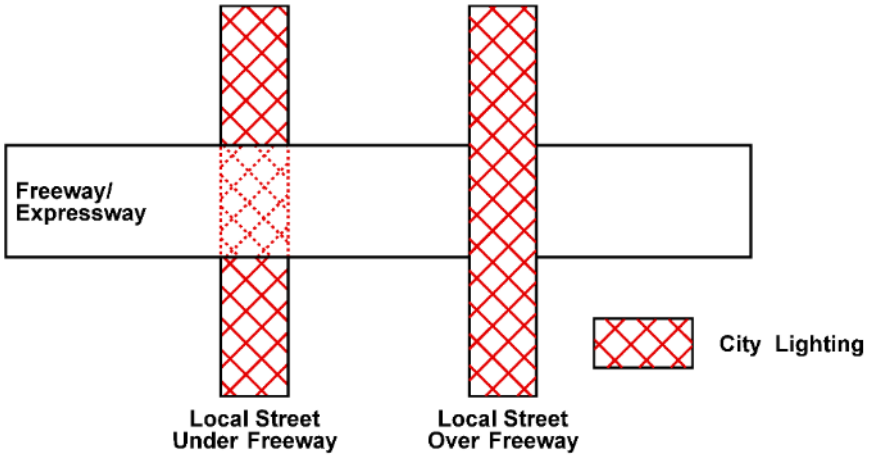
For a roundabout ramp terminal in particular, it is expected that lighting from both WSDOT and City systems will be needed to meet required intersection light levels. The ownership limits shown in Exhibit 1040-5 are more applicable to which poles will belong to which agency, with the orientation of the luminaire arm and the roadway over which the luminaire is placed determining ownership of the luminaire (and related equipment). For example, poles along the ramp lanes would belong to WSDOT, even though some of the light output will contribute to the lighting of the circulating roadway if they are close enough to the intersection.

Exhibit 1040-4 Roundabout Ramp Terminal Street Lighting Responsibility



Where a local street goes over or under a freeway or expressway, the local agency (city or county) is responsible for any local street lighting – even when attached to a WSDOT owned structure (see Exhibit 1040-5). Structure mounted local agency lighting may be attached to traffic barrier (local street above freeway), suspended underneath the bridge, or attached to bridge pier columns or crossbeams.

Exhibit 1040-5 Local Street Lighting Responsibility – No Interchange



1040.02 Conventional Roadways – Required Illumination

Lighting for conventional roadways is typically focused around interaction areas such as intersections and pedestrian crossings. Local agency lighting design areas or pole placement standards may be different.

For curved roadways, measurements for lighting design areas are always taken from the inside lane edge of a curve.

Lighting design areas extend to the roadway edge line or face of curb unless otherwise noted here.

1040.02(1) Stop and Signal Controlled Intersections

A minimum of two lights are required at all stop and signal-controlled highway intersections where any of the following are true:

- A left or right turn lane (channelization) is present on the highway
- The intersection has sidewalks and curb ramps
- The intersection has a marked crosswalk
- The intersection has a traffic signal
- The intersection has paired transit stops nearby – pedestrians will cross the roadway to reach the stop for the opposite direction. Applies only to the intersection that is part of the shortest path between opposing stops.
- The intersection has raised channelization or traffic barrier
- The intersection is on a divided highway

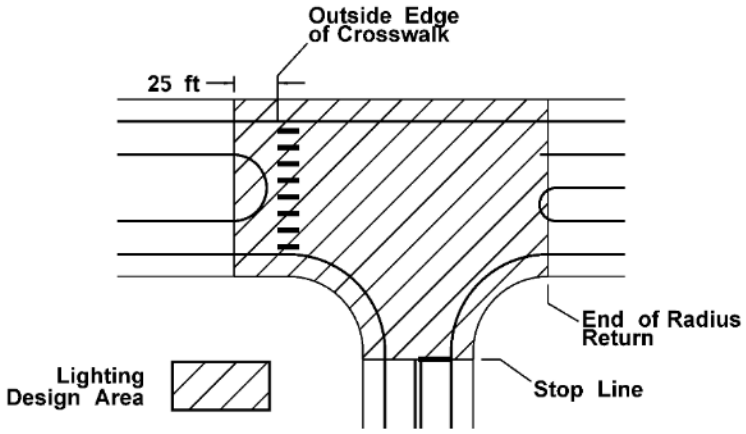
For intersections where none of these items are present, it may still be desirable to provide lighting as either a wayfinding device or in response to nighttime collisions where lighting may have a positive impact. This may be accomplished by requesting a single roadway luminaire be installed by a local electrical utility on a utility pole in the immediate vicinity of the intersection.

Lighting Design Area

Lighting is required for the entirety of the intersection area, including paved shoulders, extending back to one of the following on each approach, in order of precedence (see Exhibit 1040-6):

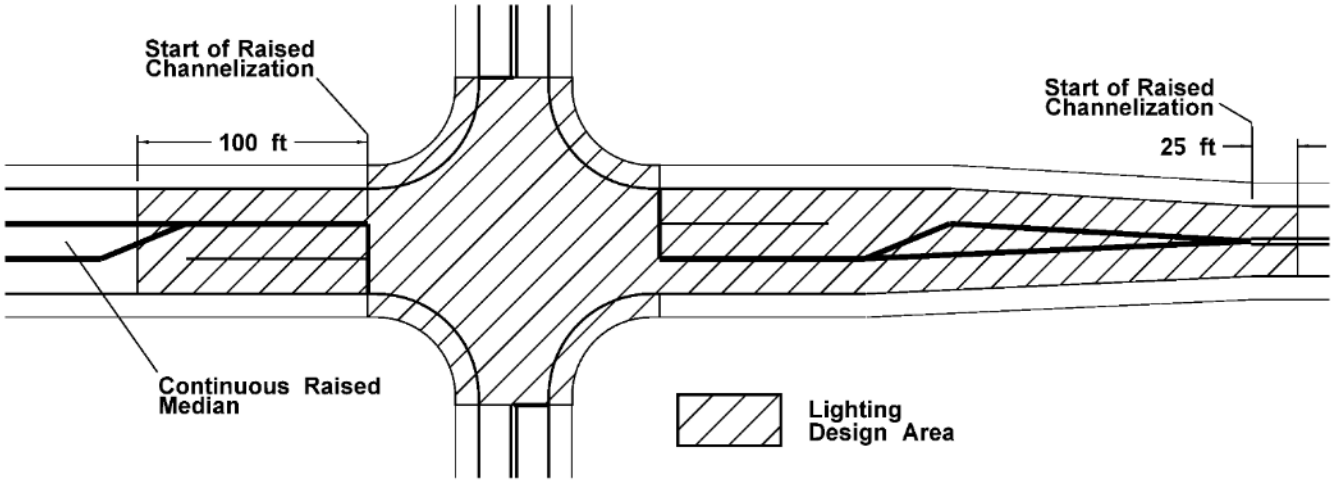
1. To the stop line for the approach.
2. To 25 feet before the outside edge (edge away from intersection core) of the marked crosswalk.
3. To the leading end of the edge line radius return.

Exhibit 1040-6 Basic Intersection Lighting Design Area



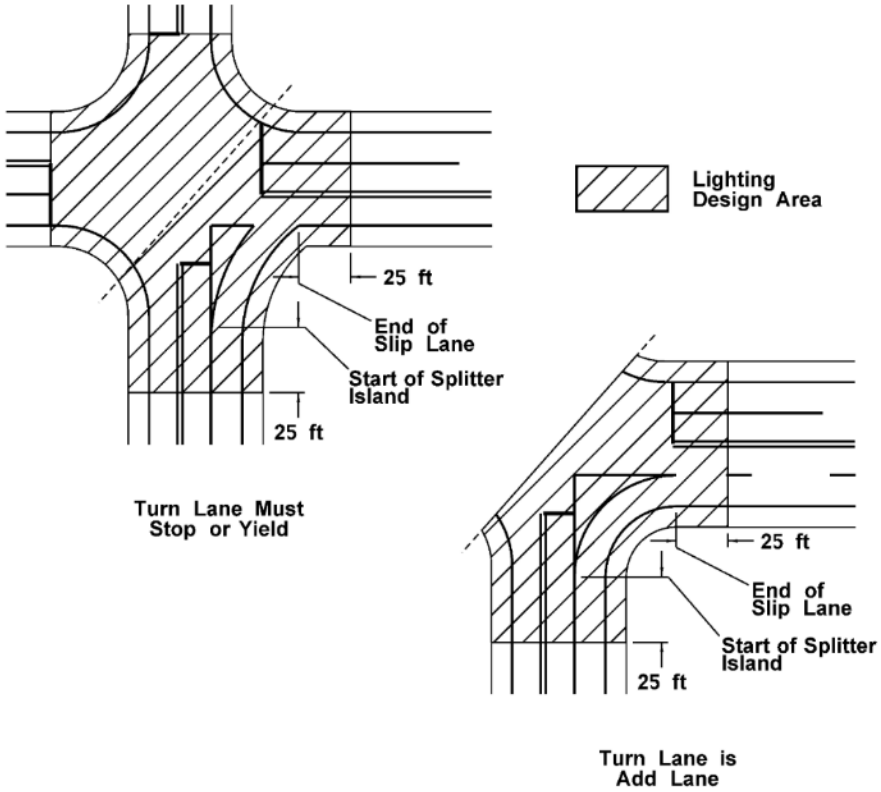
Where there is raised channelization, the lighting design area extends to 25 feet before the beginning of the raised channelization area. Where the raised channelization extends beyond the intersection channelization, or there is median traffic barrier, only the first 100 feet of the raised channelization or median barrier needs to be included (see Exhibit 1040-7). Paved shoulders do not need to be included outside the intersection core area.

Exhibit 1040-7 Basic Intersection with Raised Channelization Lighting Design Area



Where there is a traffic island for a turning movement (see Section 1310.02(14)), the entire traffic island must be included. The lighting design area extends 25 feet in advance of the island (painted gore point) on the entry approach and extends 25 feet beyond where the right edge line meets the exit approach roadway edge line (see Exhibit 1040-8).

Exhibit 1040-8 Basic Intersection with Traffic Island



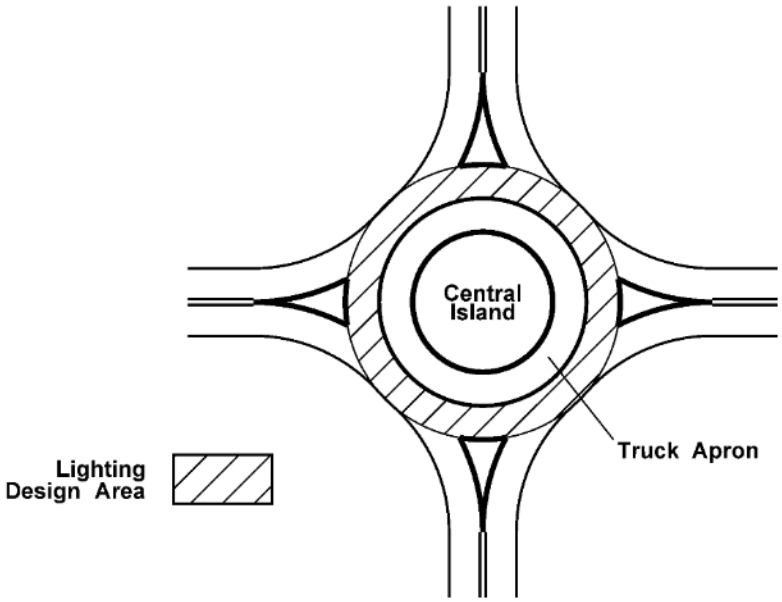
1040.02(2) Roundabouts

Roundabout lighting is dependent on the configuration of the roundabout. Roundabout lighting needs to address conflict areas, raised channelization, and pedestrian interaction points. A minimum of two lights are required for all roundabouts.

Lighting Design Areas

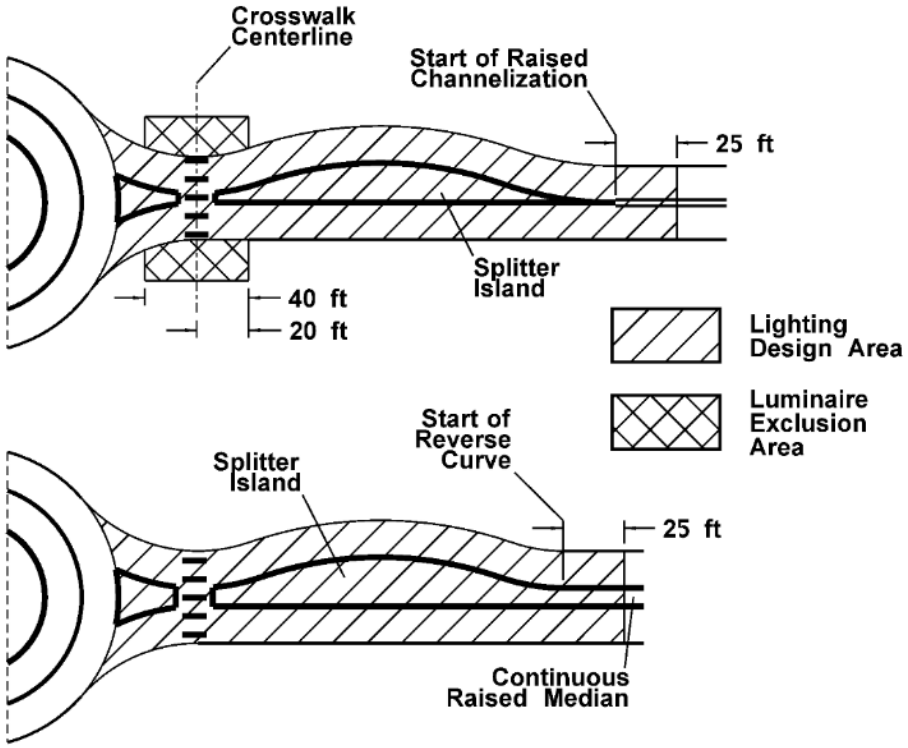
Roundabout lighting covers the intersection core, not including the central island and central island truck apron (see Exhibit 1040-9), and out each approach. The area where lighting is required on the approach depends on the features of the approach. Light standards shall not be placed within 20 feet of the centerline of any crosswalk, if possible, to avoid placing lighting directly above a pedestrian (see Exhibit 1040-10 for an example pole/luminaire exclusion area).

Exhibit 1040-9 Roundabout Core Lighting Design Area



For complex approaches with reverse curves, the lighting is required out to 25 feet before the start of either the raised channelization or the start of the reverse curve (see Exhibit 1040-10).

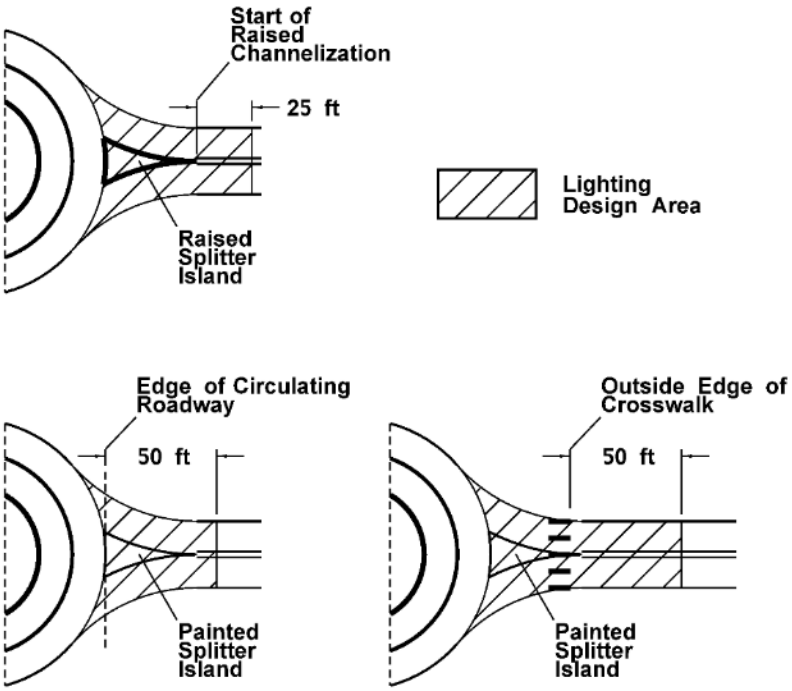
Exhibit 1040-10 Roundabout Approach Lighting Design Areas – Simple Approaches



For simple approaches, lighting is required to extend out to one of the following – whichever extends the design area farthest away from the intersection:

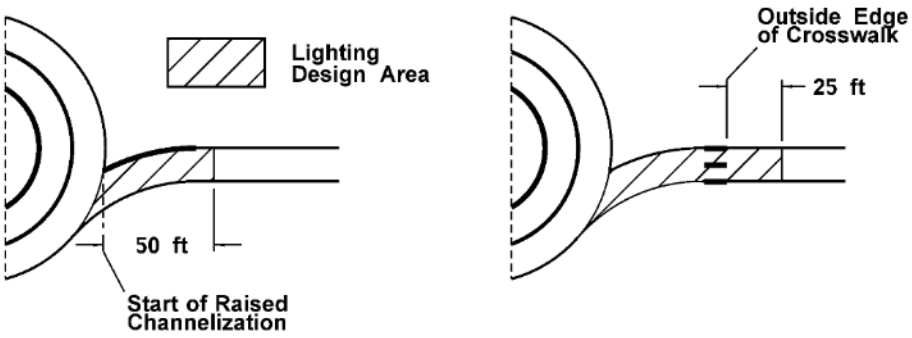
- 50 feet before the outside edge of the crosswalk
- 25 feet before the start of raised channelization (does not apply when raised channelization continues beyond the intersection area, such as continuous raised medians)
- 50 feet away from the edge of the circulating roadway

Exhibit 1040-11 Roundabout Approach Lighting Design Areas – Reverse Curves



For single direction approaches (entry only or exit only), the lighting design areas are the same as those required for simple approaches described above. For exit only approaches, the start of raised channelization is at the circulating roadway rather than at the end of the approach. Where a crosswalk is present, the lighting only needs to extend 25 feet beyond the outside edge of the crosswalk (see Exhibit 1040-12).

Exhibit 1040-12 Roundabout Approach Lighting Design Area – Exit Only Approach



1040.02(3) Midblock Crossings

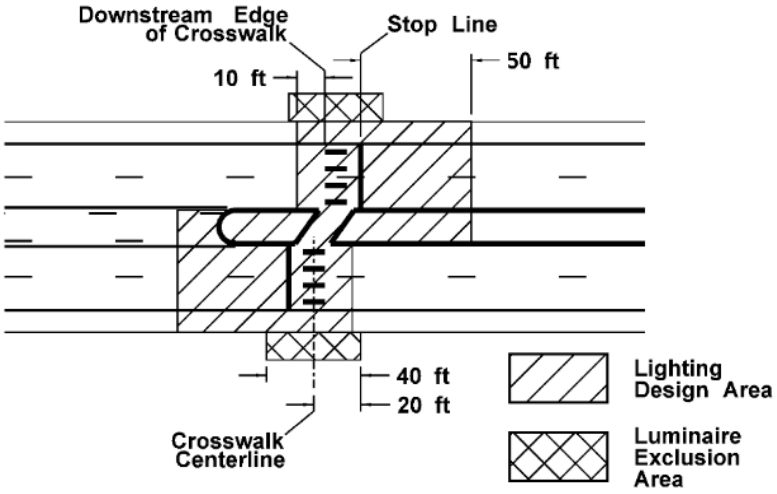
Midblock crossings include any marked crossing not at an intersection, regardless of control type (such as uncontrolled, flashing beacon controlled, or traffic signal controlled). A minimum of two lights are required.

Lighting Design Areas (Exhibit 1040-13)

Midblock crossings require lighting out to 50 feet in advance of the stop line for the crosswalk and 10 feet beyond the downstream edge of the crosswalk for each approach direction. Where any type of median is present, the full width of the median shall be illuminated out to the upstream limits for each approach direction. The lighting design area should be extended to the nose of the splitter island for islands specifically installed for the midblock crossing. Shoulders and sidewalks shall be included in the lighting design area.

Lights shall be installed upstream of the crossing on each side of the roadway, such that there is positive lighting of any pedestrian in the crosswalk. Light standards shall not be placed within 20 feet of the centerline of any crosswalk, if possible, to avoid placing lighting directly above a pedestrian. Type III Signal Standards (mast arm with luminaire arm) should not be used for midblock crossing lighting since they are required to be downstream of the crosswalk.

Exhibit 1040-13 Midblock Crossing Lighting Design Areas



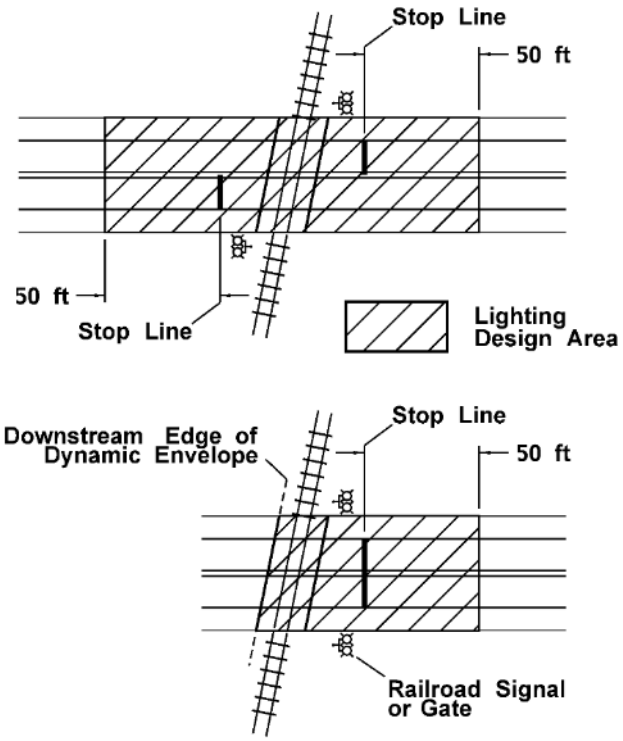
1040.02(4) Railroad Crossings

A minimum of two light standards are required for any railroad crossing where rail crossing warning lights or gates are operational. Lighting should be considered at any railroad crossing without rail crossing warning lights or signals and there is a high volume of nighttime rail activity, a known nighttime crash history involving any mode of transportation (rail, vehicle, bicycle, or pedestrian), or the crossing is blocked by trains for extended periods of time during hours of darkness.

Lighting Design Area (Exhibit 1040-7)

Railroad crossings require lighting out to 50 feet in advance of the stop line for the approach for the full roadway width in both directions. For a one-way roadway, lighting may stop at the downstream rail dynamic envelope marking (10 feet beyond the center of the far rail, where no markings are provided). Shoulders and sidewalks shall be included in the lighting design area.

Exhibit 1040-14 Railroad Crossing Lighting Design Areas

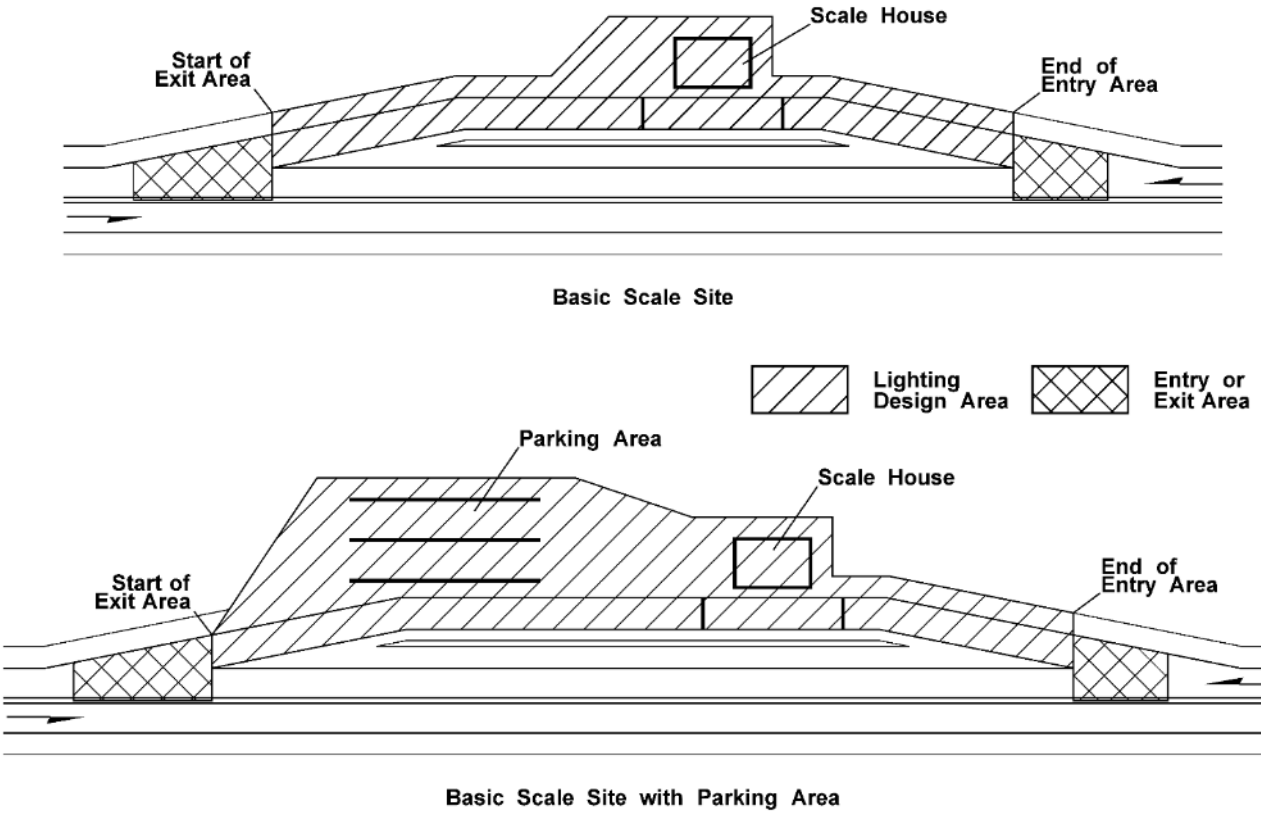


1040.02(5) Non-Freeway Weigh Sites

Truck weighing and inspection sites (weigh stations) involve both slow moving large vehicles trying to maneuver and users on foot either inspecting vehicles or walking to and from the scale facility. To improve the safety of all users of the site, weigh sites are illuminated during hours of darkness when operational or open for nighttime truck parking.

Lighting is required for the entrance and exit ramps for the weigh station, and for the entirety of the weigh station itself. Entrances and exits shall be illuminated as required for freeway off-ramps and on-ramps as described in Section 1040.04(1). Where a weigh station serves both directions of traffic, the stop controlled entrances and exits shall be illuminated with design areas as shown in Section 1040.02(1) and ramp type entrances and exits shall be illuminated as shown for on-ramp areas at both ends. The remainder of the weigh station shall be illuminated from the end of the entrance area to the start of the exit area, using a minimum of two lights, and include any parking areas (see Exhibit 1040-15).

Exhibit 1040-15 Weigh Station Lighting Design Areas



1040.02(6) Safety Rest Areas

Safety rest areas on non-freeway state highways shall be illuminated as required for safety rest areas for freeways in accordance with Section 1040.04(5), with any connection to the state highway illuminated as required for stop or signal controlled intersections in accordance with Section 1040.02(1).

1040.02(7) Chain Installation and Removal Areas

Chain installation and removal areas for conventional roadways shall follow the same requirements for freeways as described in Section 1040.04(6).

1040.03 Conventional Roadways – Additional Illumination

Lighting of the following locations may be appropriate or required under certain conditions, such as utilization or collision history.

Where collision history is used for justification of a lighting system, all the following must be true:

- During the last five full calendar years, the site has experienced nighttime collisions that are correctable with illumination.
- The benefit-cost analysis for the proposed illumination exceeds 1.
- Alternative lower-cost countermeasures have been evaluated and did not address the particular nighttime collision history issue.

Nighttime collisions are defined as collisions occurring between one-half hour after sunset and one-half hour before sunrise. Correctible nighttime collisions are collisions that:

- Meet the nighttime definition of this chapter
- Have contributing factors related to a lack of lighting
- Where lighting, if installed, would directly address the contributing factors to the collisions

Collision reporting forms and the collision data are not sufficient to distinguish between daytime and nighttime conditions; the collision location, reported time, and hours of darkness for the date of the collision are also needed to determine which collisions are nighttime collisions. Additionally, for sites where the number of nighttime collisions is equal to or greater than the number of daytime collisions, the above-mentioned collision and benefit-cost ratio analysis should be performed.

For locations where nighttime vehicle-pedestrian collisions occur, the type of collision and the pedestrian utilization needs to be considered. A location where a pedestrian is not normally expected to be present or crossing a roadway may not be correctable with lighting, while a location with regular nighttime pedestrian activity such as an unmarked crosswalk may be an appropriate location for lighting.

1040.03(1) Transit Stops

Lighting of a transit stop depends on the type of stop and facilities provided.

Transit stops with a dedicated bus pullout lane, serving a large number of routes, or serving as a transfer point should be illuminated. Transit stops with shelters should be considered for illumination as a shelter typically indicates heavier use. Smaller transit stops may be appropriate to illuminate when there is significant use.

Lighting of transit stops is the responsibility of the transit agency. Early engagement with the transit agency is required to determine funding, maintenance, and operation of the lighting system. It is recommended that a Memorandum of Understanding (MOU) be established with each transit agency across their entire system, rather than location by location negotiations.

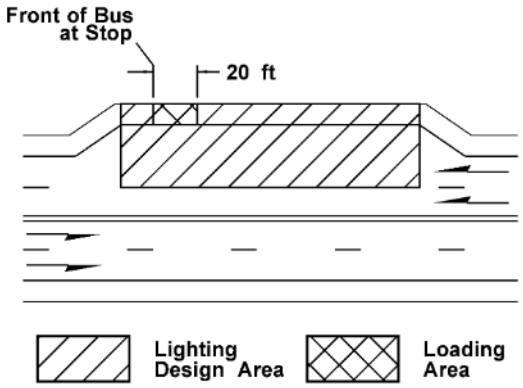
Normally, two lights shall be provided for transit stops with a dedicated bus pullout. Where a bus is required to stop in the travel lane, a single light may be provided at the loading area. Where a transit agency is unable or unwilling to participate in funding and maintenance of transit stop lighting, and there is no other adjacent or overlapping lighting system (such as for an intersection), consider requesting a utility owned and maintained light installed on a nearby utility pole for minimum utility lighting of the transit stop.

Lighting Design Area

For all transit stop types, an overlapping area shall be evaluated on the sidewalk or shoulder at the loading area for the front 20 feet of the bus. This smaller area has a higher light level requirement to accommodate loading and unloading of passengers.

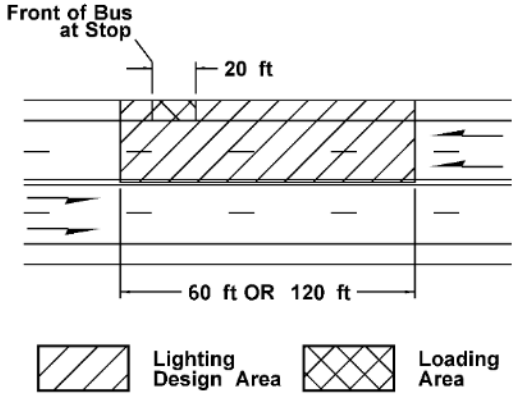
For transit stops with a dedicated bus pullout, lighting shall extend for the full length of the full-width pullout lane and include the adjacent lane and sidewalk (see Exhibit 1040-16).

Exhibit 1040-16 Pullout Transit Stop Lighting Design Areas



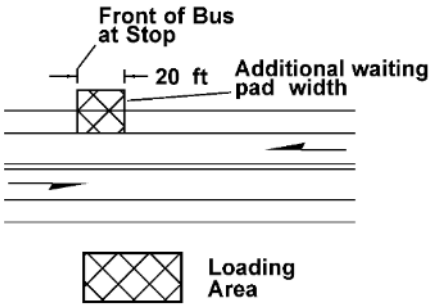
For transit stops in a dedicated bus lane, lighting shall cover the lane for 60 feet (single bus stop) or 120 feet (articulated or two bus stop) as measured from the head of the stop (usually where the route sign is located) and include the adjacent lane and sidewalk (see Exhibit 1040-17).

Exhibit 1040-17 In-Lane Transit Stop Lighting Design Areas



For rural or limited service transit stops where only one light will be provided (does not apply to utility provided lighting), lighting is only required for the loading area – extend to include any waiting area or pad (see Exhibit 1040-18).

Exhibit 1040-18 Rural Transit Stop Lighting Design Areas



1040.03(2) Continuous Lighting

Continuous lighting is the illumination of the entirety of the roadway outside of required lighting design areas, usually connecting multiple lighting design areas together. WSDOT does not provide continuous lighting of conventional highways.

Continuous lighting may be desirable in areas with regular nighttime pedestrian or other non-motorized use, such as commercial areas, residential areas, or connections between the two. Where continuous lighting is desired by the local agency, the local agency is required to take ownership of the additional lighting beyond any required lighting required unless an agreement is established with WSDOT.

Continuous lighting shall be installed at the back of sidewalk to ensure adequate sidewalk lighting and minimize off-roadway light pollution. Continuous lighting areas are evaluated separately from required lighting areas, such that the lighting analysis areas overlap when being evaluated.

1040.04 Freeways and Expressways

Lighting for freeways and expressways focuses primarily on decision points, conflict points, and unusual highway features that may not be adequately illuminated by headlights.

For curved roadways, measurements for lighting design areas are always taken from the inside lane edge of a curve.

Lighting design areas extend to the roadway edge line unless otherwise described here.

1040.04(1) Interchanges

Lighting is required for the following locations at all interchanges:

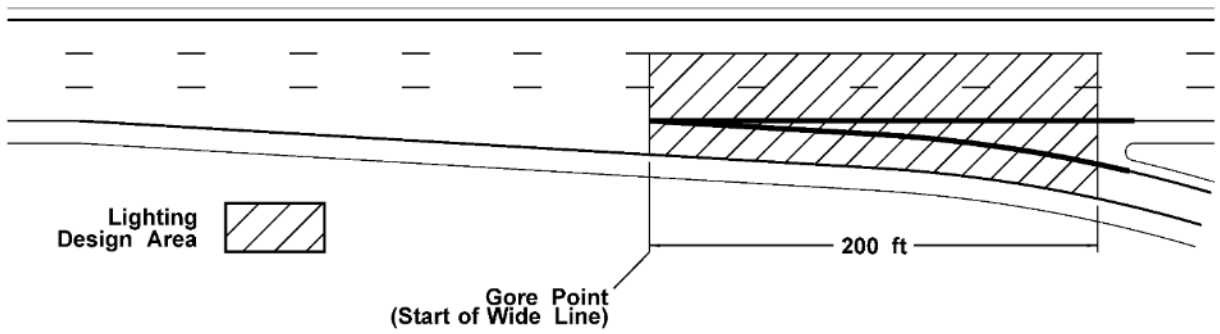
- Where an off-ramp departs the freeway
- Where an on-ramp connects to the freeway
- Ramp terminal intersections
- Loop ramps

A minimum of two lights are required for each lighting design area, with the exception of ramp terminal intersections where none of the items listed in Section 1040.02(1) are listed are present, in which case only one light needs to be provided.

1040.04(1)(a) Off-Ramps

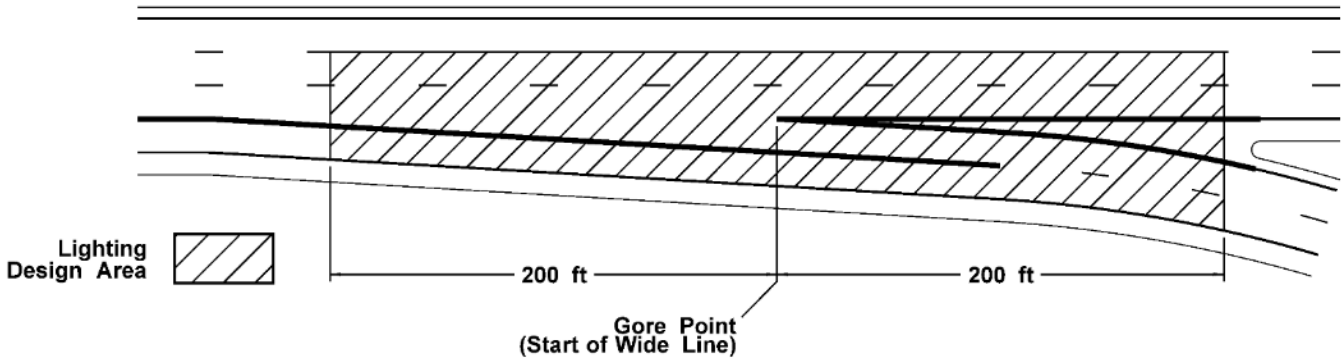
Where a single lane off-ramp departs the freeway, lighting is required for 200 feet starting from the painted gore point, as measured along the mainline freeway, and include both the off-ramp lane(s) and the two adjacent freeway lanes (see Exhibit 1040-19).

Exhibit 1040-19 Single Lane Off-Ramp Lighting Design Area



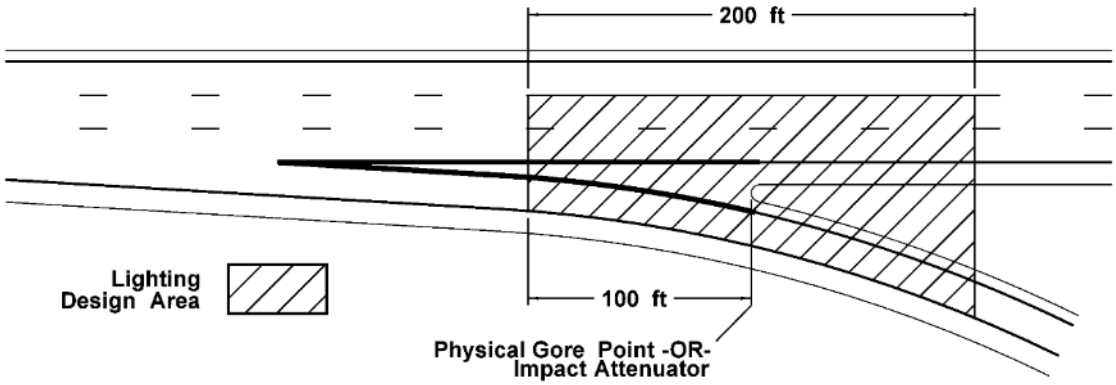
Where a multi-lane off-ramp departs the freeway, lighting is required for 400 feet. The area starts 200 feet in advance of the painted gore point and continues 200 feet beyond this point as measured along the mainline freeway, including all off-ramp lanes and the two adjacent freeway lanes (see Exhibit 1040-20).

Exhibit 1040-20 Multi-Lane Off-Ramp Lighting Design Area



Lighting design areas for off-ramps may be shifted up to 100 feet downstream, provided that the shifted design area starts at least 100 feet in advance of the physical gore point or impact attenuator (see Exhibit 1040-21). The design area may only be shifted to avoid light foundation obstructions or to avoid the need to add new light poles to existing bridges.

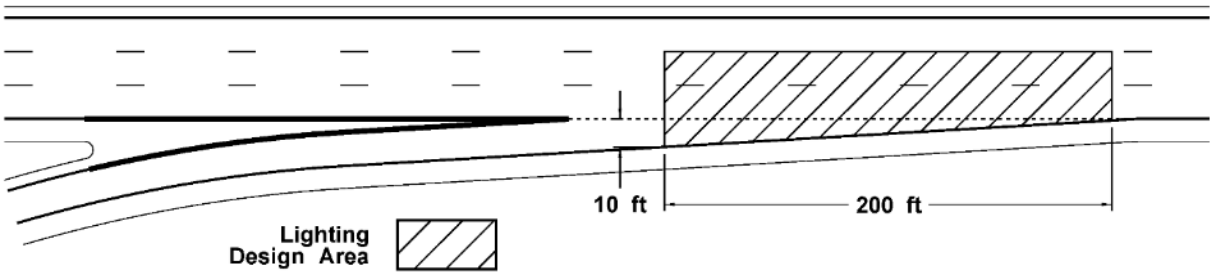
Exhibit 1040-21 Off-Ramp Lighting Design Area Adjustment Limit



1040.04(1)(b) On-Ramps

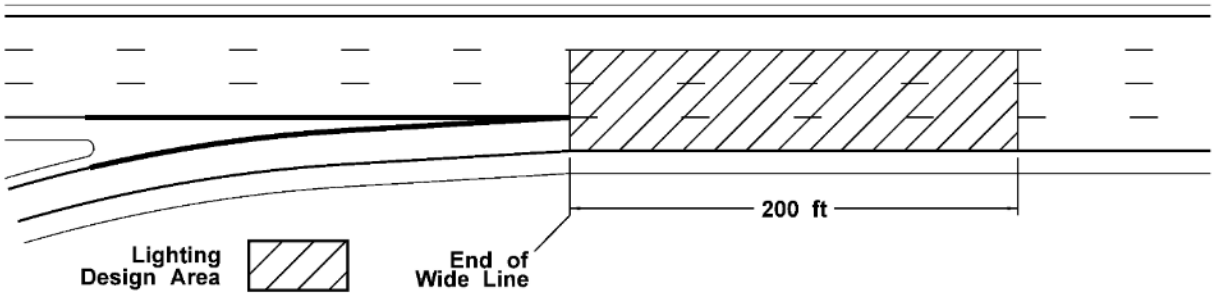
Where a single lane on-ramp connects and merges into the freeway lanes, lighting is required for 200 feet starting from where the merging lane has reduced to a width of 10 feet (see Exhibit 1040-22). This length is measured along the mainline freeway, and the area includes the two adjacent continuing freeway lanes.

Exhibit 1040-22 Single Lane On-Ramp Merge Lighting Design Area



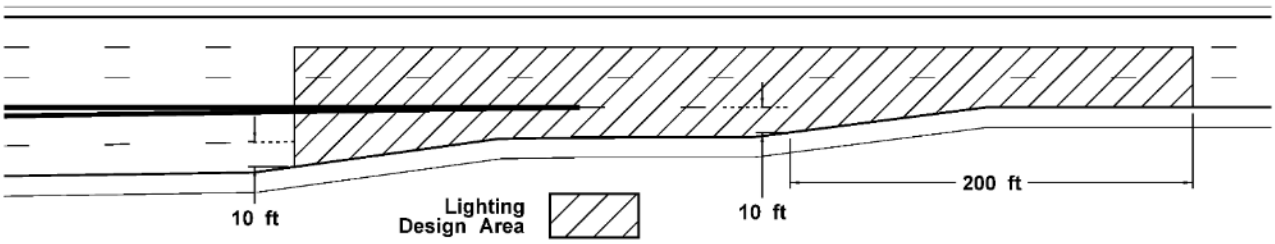
Where an on-ramp (one or more lanes) connects to a freeway as additional lanes (add lanes), lighting is required for 200 feet starting from the start of the new lane (end of ramp wide line) (see Exhibit 1040-23). This length is measured along the mainline freeway, and the area includes the two adjacent continuing freeway lanes.

Exhibit 1040-23 Add Lane On-Ramp Lighting Design Area



Where a multi-lane on-ramp connects to a freeway and the lanes merge into the freeway lanes, lighting is required starting from where the outermost lane reduces to a width of 10 feet and continues to a point 200 feet downstream of where the last merging lane has reduced to a width of 10 feet (see Exhibit 1040-24). There may be only one merge area in some cases. This length is measured along the mainline freeway, and the area includes the two adjacent continuing freeway lanes.

Exhibit 1040-24 Multi-Lane On-Ramp Lighting Design Area

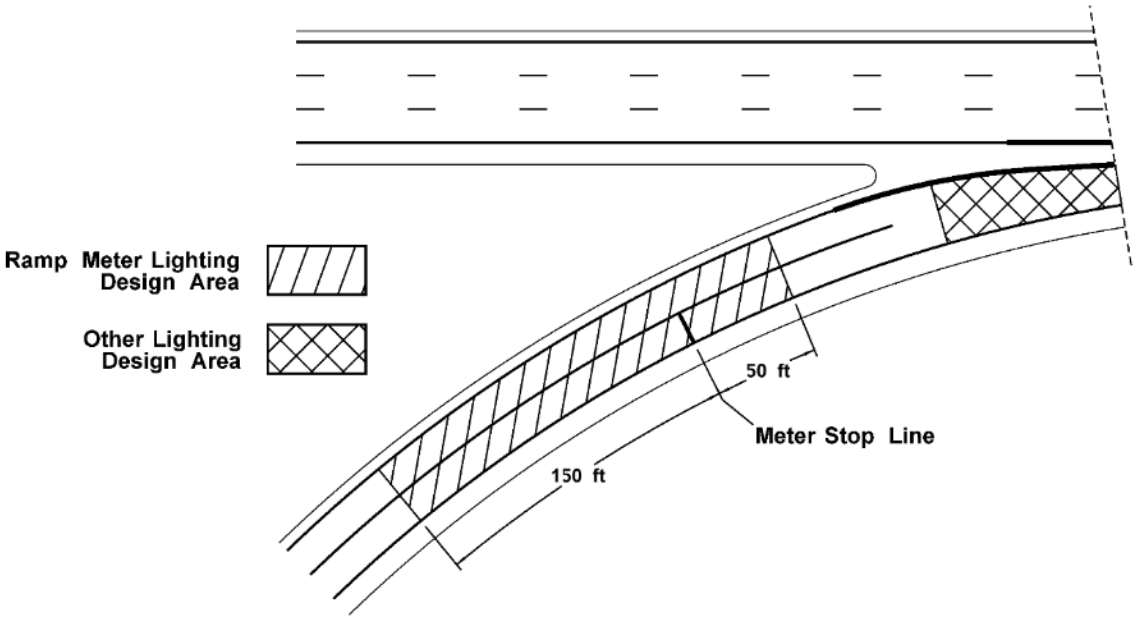


Lighting design areas for on-ramps may be shifted up to 100 feet downstream. The design area may only be shifted to avoid light foundation obstructions or to avoid the need to add new light poles to existing bridges.

1040.04(1)(c) Metered On-Ramps

On-ramps with ramp meters require lighting of all lanes, including any HOV lanes or shoulders used as lanes during metering, from 150 feet before to 50 feet after the stop line for the ramp meter (see Exhibit 1040-25). Lighting is also required for any lane merges for general purpose lanes, HOV lanes, and HOV shoulders (metered or unmetered) as shown in Exhibit 1040-24.

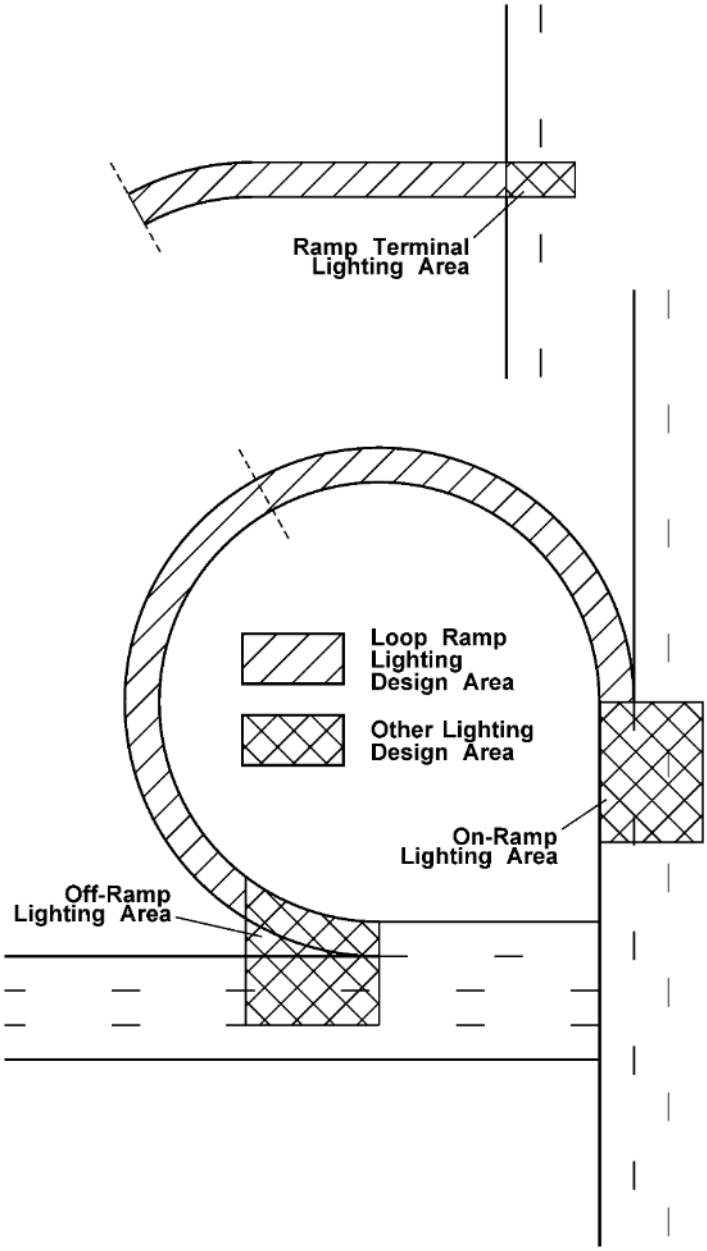
Exhibit 1040-25 Metered On-Ramp Lighting Design Area



1040.04(1)(d) Loop Ramps

Loop ramps typically have a tight radius that does not allow for headlights to effectively illuminate the roadway ahead. Loop ramps shall be illuminated for their entire length, starting from the freeway connection to the other roadway connection point. The second connection point may be another freeway connection or a roadway connection or intersection. The loop ramp lighting design area covers the area between the two end lighting design areas (see Exhibit 1040-26).

Exhibit 1040-26 Loop Ramp Lighting Design Area



1040.04(1)(e) Ramp Terminals

Ramp terminals are where the freeway ramp connects to the secondary roadway. This secondary roadway may be a local roadway, a state highway, or another freeway. The ramp terminal lighting design area will depend on the type of connection.

Ramp terminal intersections shall follow the requirements for intersections defined for Stop or Signal Controlled Intersections (Section 1040.02(1)) or Roundabouts (Section 1040.02(2)). Stop controlled ramp terminal intersections may use a single luminaire if none of the items listed in Section 1040.02(1) are present.

Ramps that connect to the secondary roadway using an on or off-ramp type connection shall follow Section 1040.04(1)(a) or 1040.04(1)(b) as applicable.

Ramp terminals using a specialized intersection such as a Diverging Diamond Interchange (DDI) or Single Point Urban Interchange (SPUI) are required to be illuminated out to the start of the raised channelization or the start of the intersection (see Exhibit 1040-27 and Exhibit 1040-28). The on-ramp merge point where ramps from two different directions of the cross-street meet shall be illuminated for at least 100 feet beyond the merge point.

Exhibit 1040-27 Diverging Diamond Interchange (DDI) Lighting Design Area

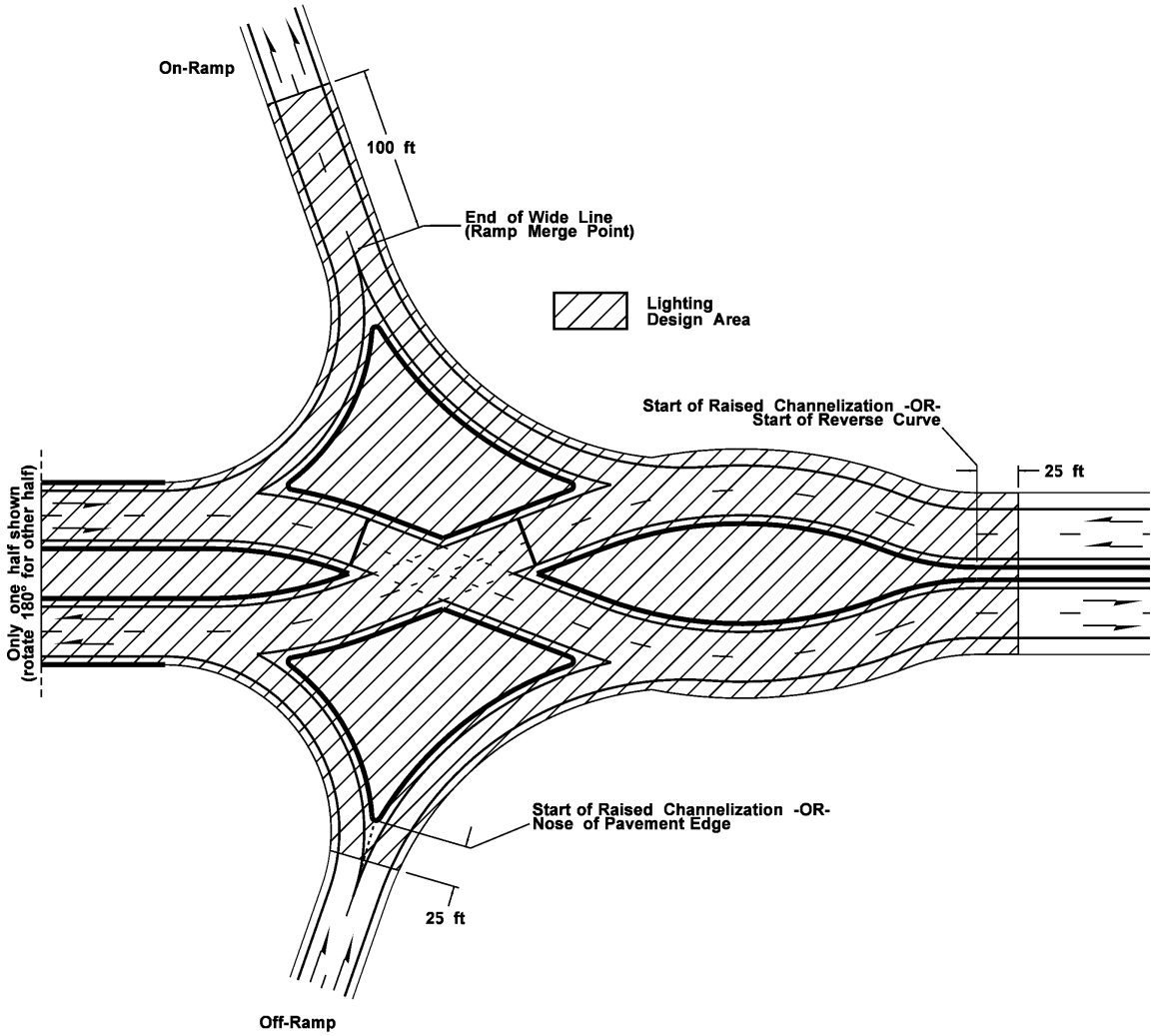
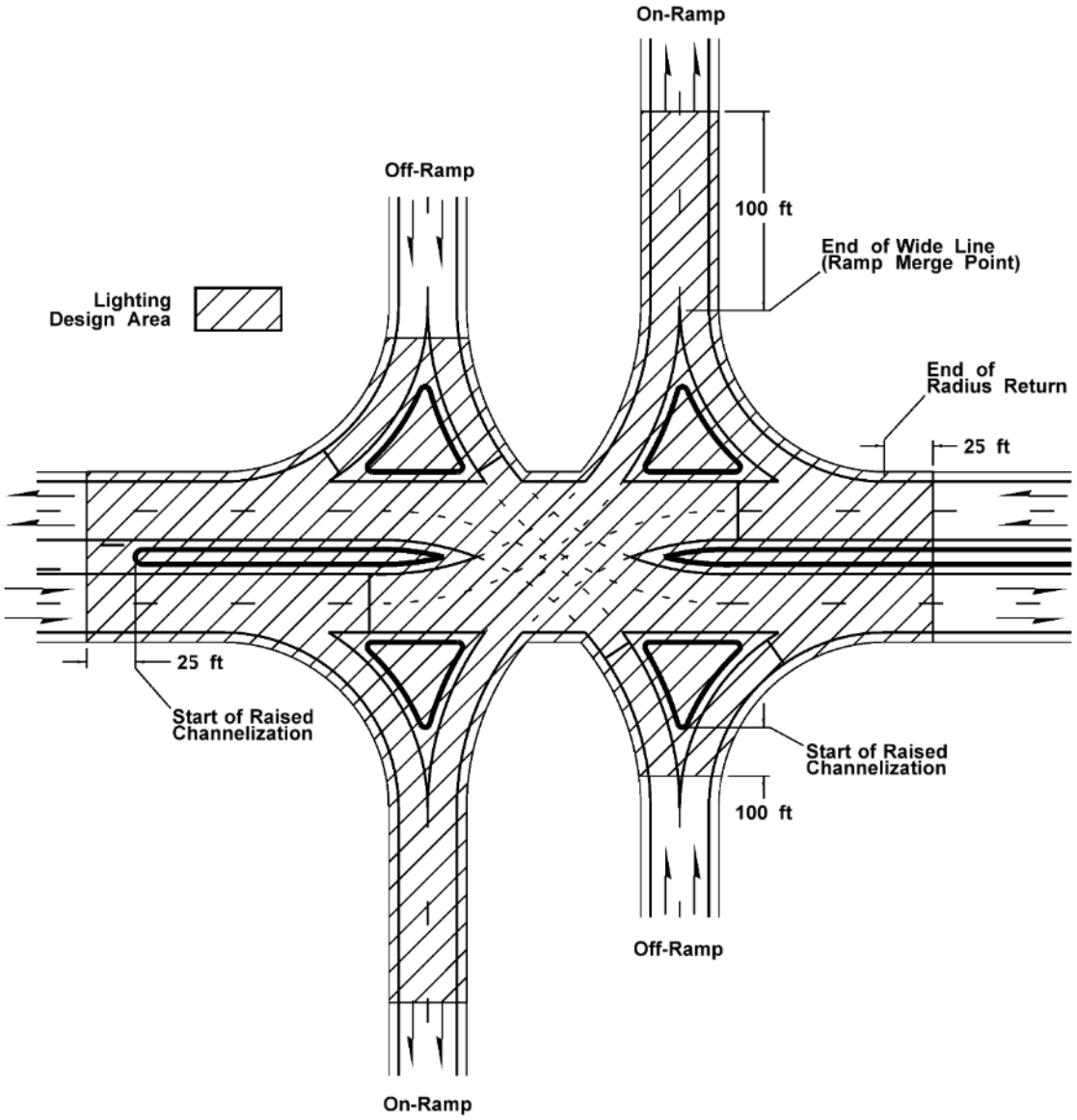


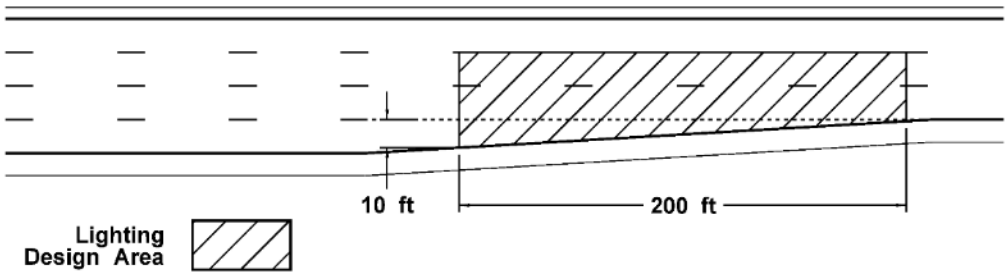
Exhibit 1040-28 Single Point Urban Interchange (SPUI) Lighting Design Area



1040.04(2) Lane Reductions

Where the number of freeway lanes is reduced and lanes merge, lighting is required starting from where the merging lane has reduced to a width of 10 feet (see Exhibit 1040-29). This lighting is not required where utility power is not available within one-half mile.

Exhibit 1040-29 Lane Reduction Lighting Design Area

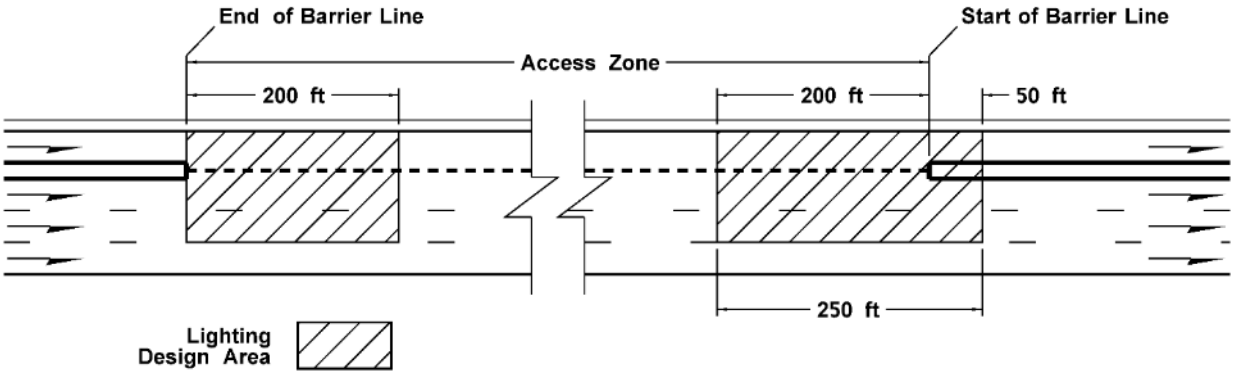


1040.04(3) Special Use Lane Access Zones

Certain freeway lanes may be designated for special use, such as High Occupancy Vehicle (HOV) lanes, or Express Toll Lanes (ETL). As part of these lane use designations, there may be limited zones for exit from and entry to these lanes. A minimum of two lights are required for each lighting design area.

Where a special use lane is separated by a barrier or barrier line (extra wide line our double wide lane line), and the access zone is provided by changing the barrier line to a standard lane line (basic access zone), lighting is required for the first 200 feet after the line changes to a lane line, and for 200 feet before and 50 feet after the barrier or barrier line is restored (see Exhibit 1040-30). The design area includes the special use lane and the two adjacent freeway general purpose lanes.

Exhibit 1040-30 Special Use Lane – Basic Access Zone Lighting Design Area



Where the special use lane is separated by barrier, and an access zone is provided by using a dedicated weaving transition lane, lighting is required at the start and the end of the access zone. The lighting area covers all of the special use lanes and the two adjacent general-purpose lanes.

The area at the start of the access zone starts 200 feet before the start of the weave lane and extends to 200 feet after the start of the weave lane (see Exhibit 1040-31). The area at the end of the access zone starts 200 feet before the end of the weave lane and ends 200 feet after the merging weave lane reduces to 10 feet in width (see Exhibit 1040-32).

Exhibit 1040-31 Special Use Lane – Start Weaving Access Zone Lighting Design Area

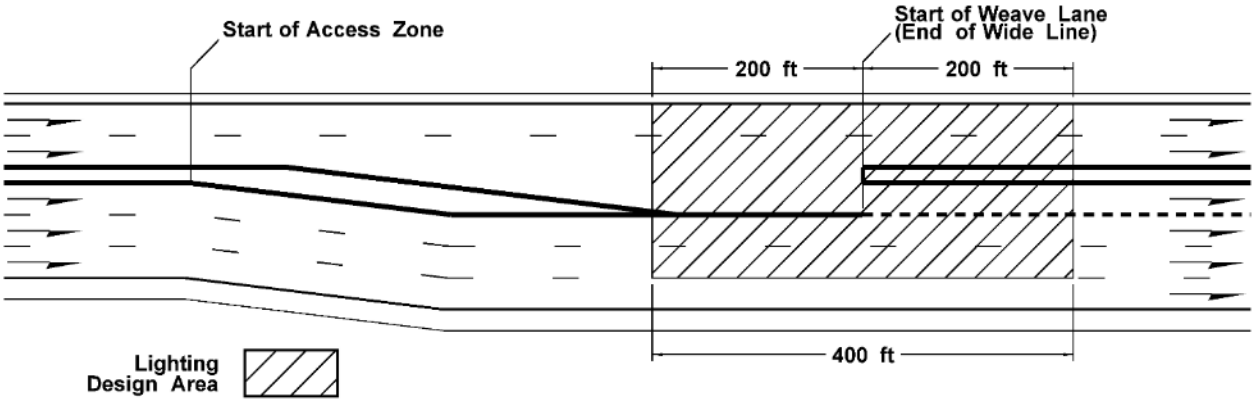
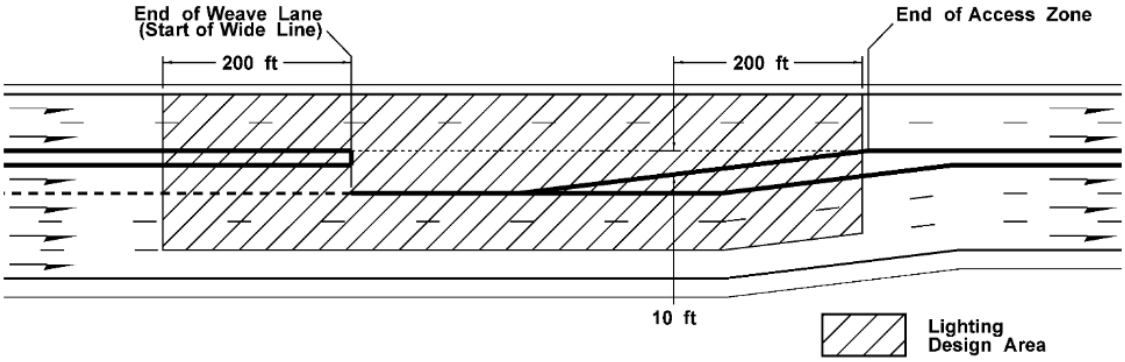


Exhibit 1040-32 Special Use Lane – End Weaving Access Zone Lighting Design Area



1040.04(4) Freeway Transit Stations

Freeway transit stations consist of an off-ramp, a conventional roadway transit stop, and an on-ramp. On and off-ramp lighting shall be in accordance with Section 1040.04(1). Transit stop lighting is required and shall be in accordance with Section 1040.03(1) covering the entire length of the loading area curb and sidewalk using a minimum of two lights.

1040.04(5) Safety Rest Areas

On and off-ramps for safety rest areas require lighting in accordance with Section 1040.04(1). Within the rest area, there are four types of areas that require lighting:

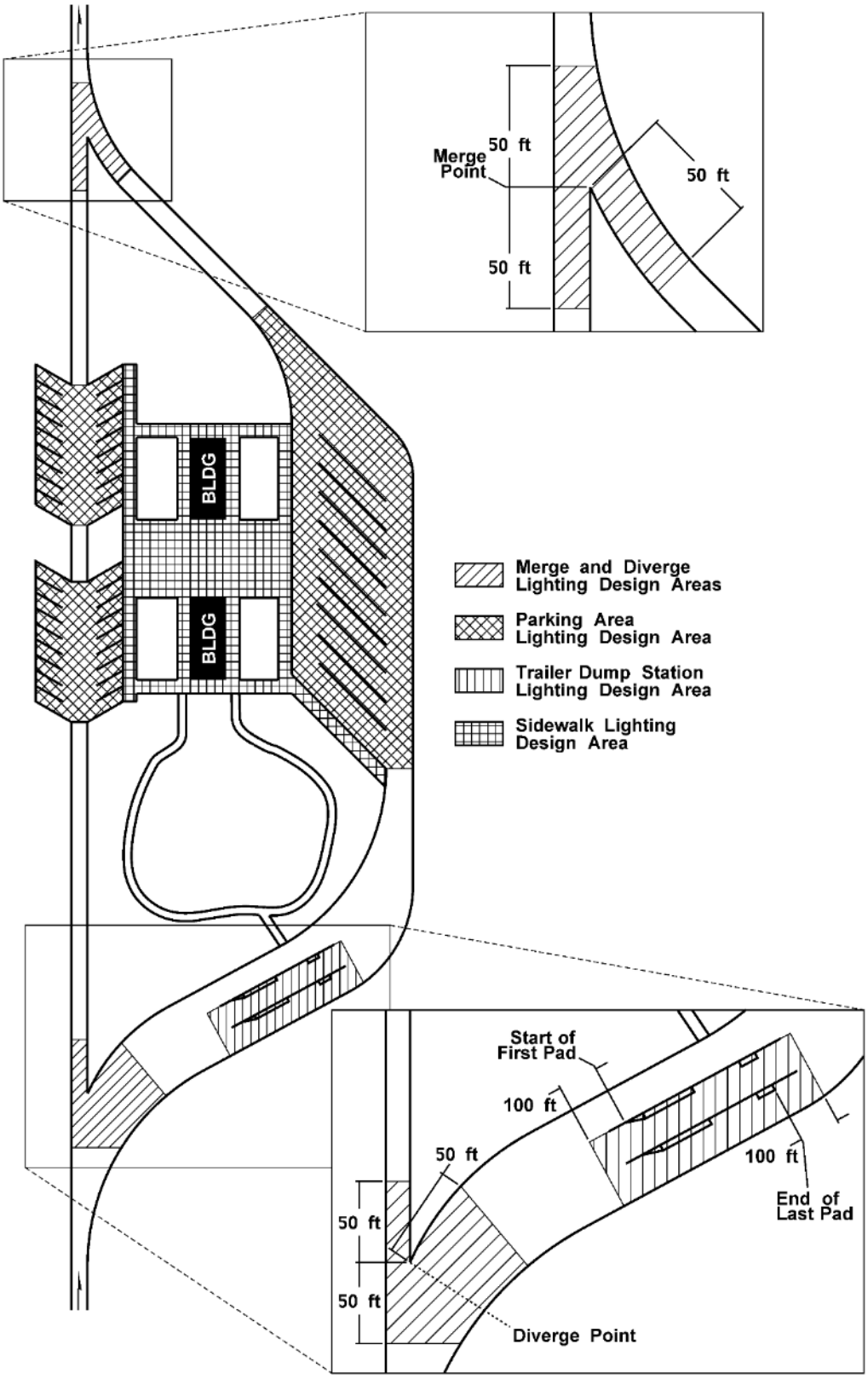
- Lane merge and diverge points, connecting to the different parking areas (usually separated into cars and large trucks)
- Parking areas
- Pedestrian walkways
- Recreational Vehicle (RV) sanitary disposal facilities

Lighting coverage for each of these areas is as follows (see Exhibit 1040-33):

- Merge and diverge areas from 50 feet before to after the merge or diverge point (minimum 100 feet total).
- Parking areas for the full area of each parking area, from the entry lane connection to the exit lane connection, including sidewalks. Where parking areas are divided into separate sections and connected with a single lane, lighting is not required for the connecting single lane.
- Each pedestrian walkway connecting the services buildings to the parking lots.
- Each lane for RV sanitary disposal facilities, from 25 feet before the start of the station pad to 25 feet beyond the end of the station pad. Where there are multiple pads, such as if there is a separate water station, the area starts before the first pad and ends after the last pad.

Parking areas and RV sanitary disposal facilities shall use a minimum of two lights. Interior merge and diverge areas may use a single light if light levels can be met.

Exhibit 1040-33 Safety Rest Area Lighting Design Areas

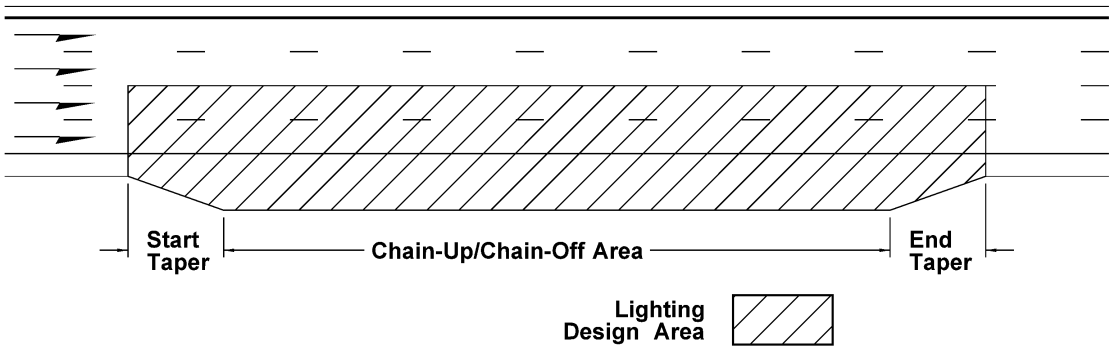


1040.04(6) Chain-Up and Chain-off Areas

Chain-up and chain-off (chaining) areas present a unique situation on a freeway where drivers are expected to be out of their vehicles and walking around while other vehicles are moving. Providing lighting both to highlight users on foot and to provide visibility for Exhibit 1040-34 the installation or removal of chains is particularly important. Lighting may be omitted if power is not available within one-half mile of either end of the chaining area.

Lighting is required from the start of the chaining area shoulder widening taper to the end of the chaining area shoulder narrowing taper and shall include the two adjacent freeway lanes (see Exhibit 1040-34). Lighting is required on both the left and right side of the freeway to help illuminate users on foot, using a minimum of two lights on each side of the freeway (a minimum of four total). Lighting shall only be operational when chains are required for any vehicle type.

Exhibit 1040-34 Chain-Up and Chain-Off Area Lighting Design Area

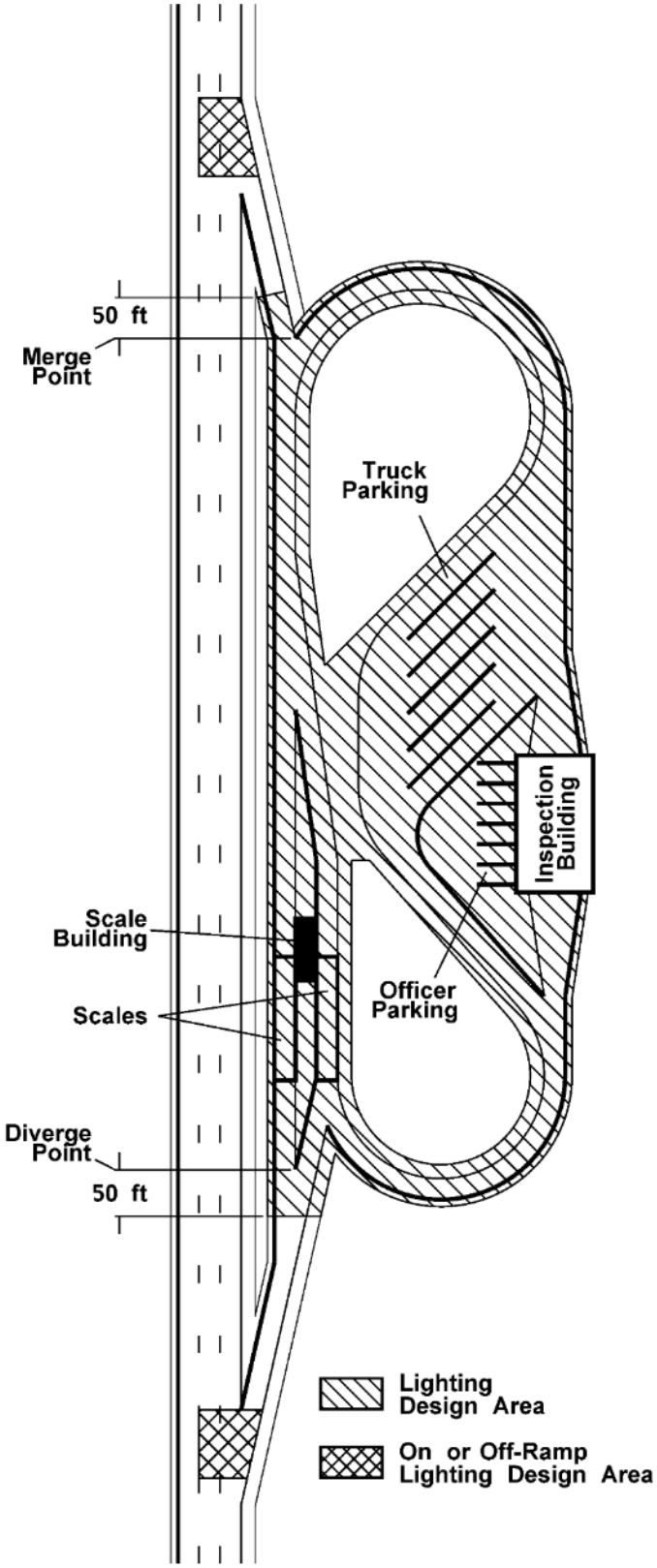


1040.04(7) Freeway Weigh Sites

Truck weighing and inspection sites (weigh stations) involve both slow moving large vehicles trying to maneuver and users on foot either inspecting vehicles or walking to and from the scale facility. To improve the safety of all users of the site, weigh sites are illuminated during hours of darkness when operational or open for nighttime truck parking. There are two basic types of weigh sites – standard and Port of Entry. Standard weigh sites include one or two scales and truck parking. Ports of Entry also include additional inspection buildings and usually a larger scale building.

Lighting is required for the entirety of the weigh station paved areas, starting from 50 feet before the first internal diverge point to 50 feet beyond the last merge point, and all paved areas in between including the scale area, truck parking area, officer parking area, inspection building access, and all connecting roadways and walkways (see Exhibit 1040-35). On and off-ramp connections to the weigh station shall include illumination in accordance with Section 1040.04(1).

Exhibit 1040-35 Freeway Weigh Station Lighting Design Areas

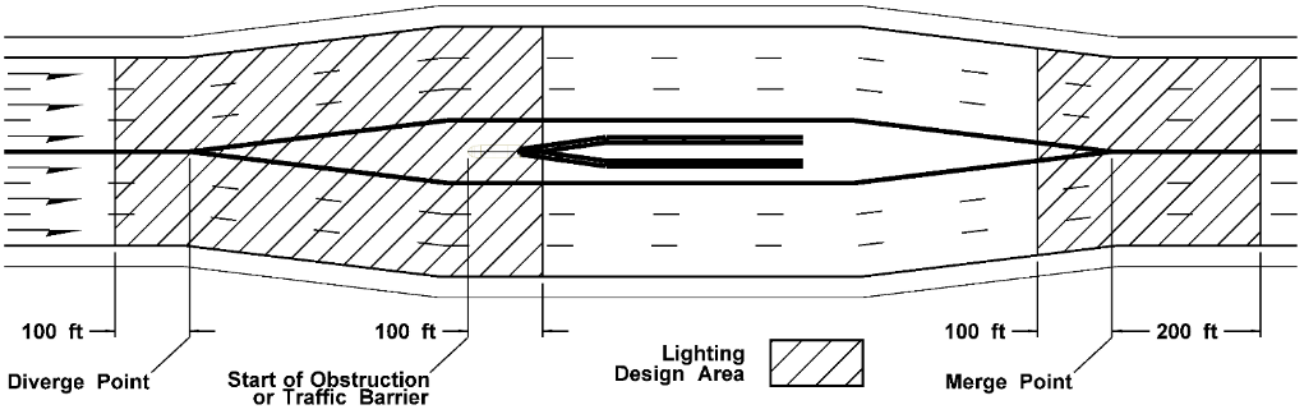


1040.04(8) Lane Splits

Lane splits are locations where same direction lanes split around an obstruction or onto different alignments. These could be general purpose lanes splitting around an obstruction, or a special use lane (such as an HOV lane) splitting from the general-purpose lanes.

Lighting is required where the lanes split and where the lanes come back together (see Exhibit 1040-36), with a minimum of two lights required for each area, covering all lanes of traffic to the right of the split and at least two lanes to the left of the split. Lighting at the split point starts 100 feet before the painted diverge point and extends to 50 feet beyond the start of the obstruction or traffic barrier (such as concrete barrier, guardrail, or similar protective barrier). Lighting at the merge point starts 100 feet before the painted merge point and extends 200 feet beyond the painted merge point.

Exhibit 1040-36 Lane Split Lighting Design Area



1040.04(9) Continuous Lighting

Freeway continuous lighting is limited to areas designated by the WSDOT HQ Transportation Operations Division. Continuous lighting is typically limited to urban core areas with significant interchange density and weaving movements. Continuous lighting of open freeways away from interchanges provides minimal benefits, increases energy use and light pollution, increases maintenance and operations costs, and can encourage riskier driver behavior such as speeding during low volume nighttime hours.

Where continuous lighting is installed, lighting shall be split into separate circuits for minimum required lighting and all additional lighting. This allows for any lighting not required to cover a basic design area to be controlled separately as part of operational and energy use management.

Direction specific continuous lighting may be appropriate in areas where significant weaving between on and off-ramps occurs in one direction of the freeway. The lighting design area for this application extends from the start of the upstream on-ramp lighting design area to the end of the downstream off-ramp lighting design area and includes the entirety of the two right-most freeway lanes, as well as any auxiliary (add-drop) lanes. This limited application of continuous lighting is not considered general continuous illumination, and only requires approval from the Region Traffic Engineer.

1040.05 Bridges and Tunnels

Bridges and tunnels have special lighting considerations due to the complex nature of the structure and impacts of the structure regarding both daytime and nighttime visibility.

1040.05(1) Bridge Lighting

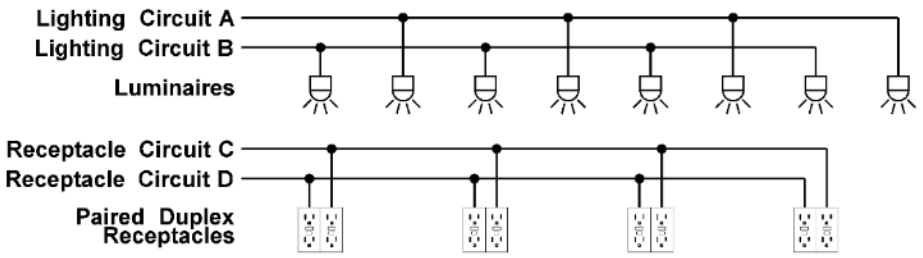
Bridges do not specifically require lighting by themselves. The need for lighting on a bridge is determined by the presence of another lighting design area. If any of the lighting design areas described in this chapter are present on or under a bridge, then lighting for that area may be attached to the bridge.

Decorative illumination such as lighting of architectural features of a bridge structure requires the approval of the State Transportation Operations Engineer. Decorative lighting may not include light sources that are visible to drivers (drivers can see the bulb or LED source itself), lighting that is cast above horizontal (night sky light pollution), or lighting that is cast off the structure (environmental light pollution).

1040.05(2) Bridge Inspection Lighting and Receptacles

Bridges where the interior of the structure is accessible, such as floating bridges or box girders, require inspection lighting and receptacles for use by inspection and maintenance staff. Lighting and receptacles shall be powered from separate circuits. Receptacles shall use two-gang boxes with two 20A duplex GFCI receptacles, where each duplex receptacle is powered from a separate circuit. There shall be no less than three circuits in use for bridge inspection lighting and receptacles. See Exhibit 1040-37 for typical lighting and receptacle circuit arrangements.

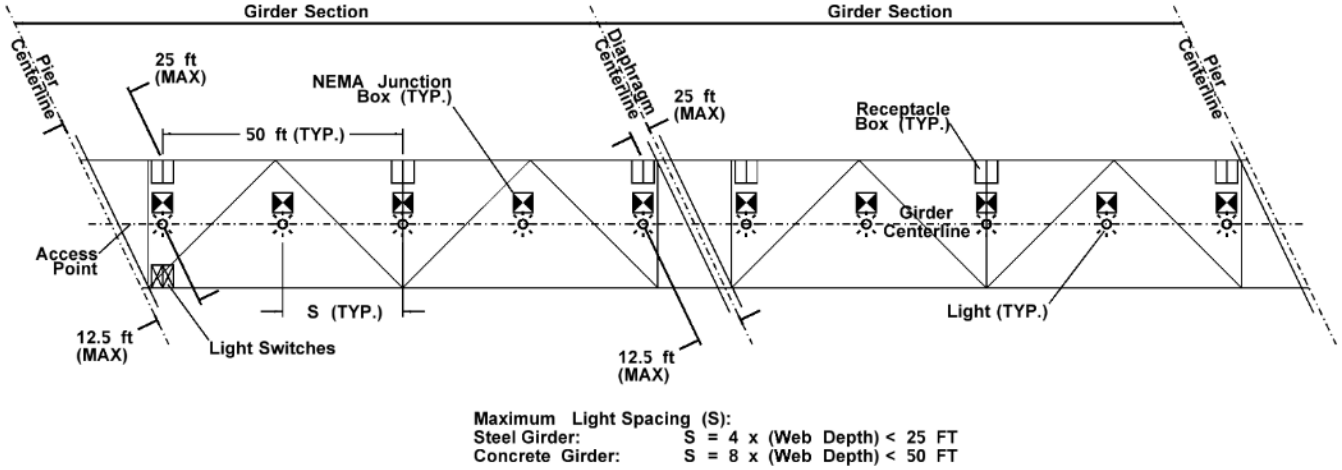
Exhibit 1040-37 Bridge Inspection Lighting and Receptacle Circuit Layout



Bridge inspection lighting shall be ceiling mounted and uses vapor-tight bulb enclosures. Bulbs are LED type A19 bulbs with E26/Medium sockets. Bulbs have an output of 1600-2000 lumens (100W equivalent), and a color temperature of 4000K or higher. Each girder shall be supplied by two lighting circuits such that every other light is on a separate circuit.

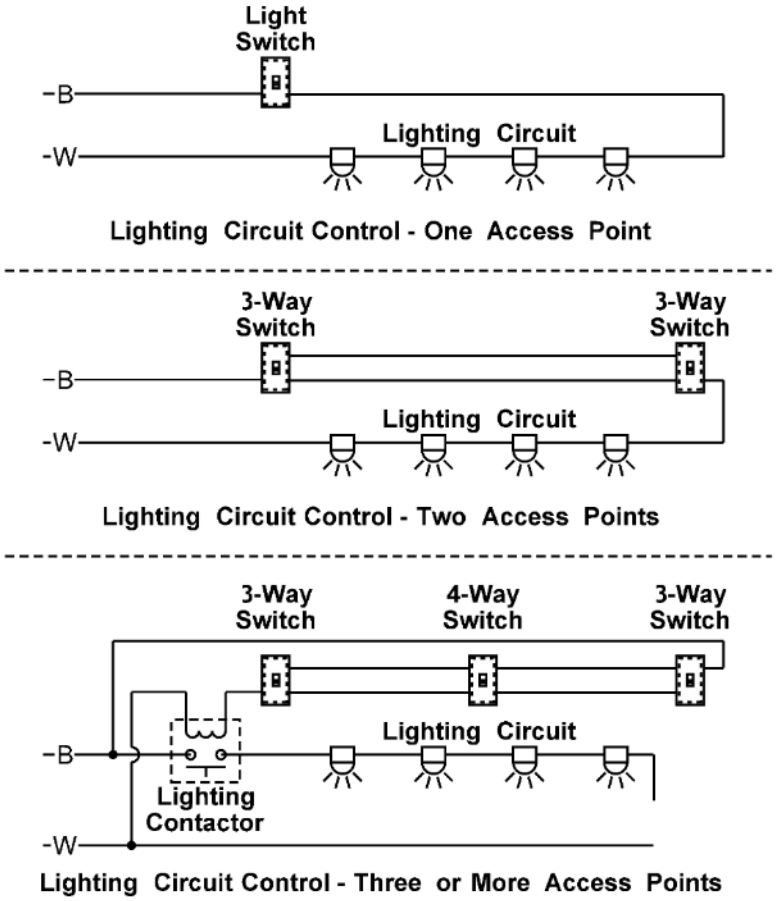
Bridge inspection lighting does not need to be analyzed for a target light level as it uses a set spacing arrangement instead. Lights are evenly spaced within each girder section as separated by diaphragms, with the end lights of each girder section no more than 12.5 feet from the ends of the girder section (pier centerline) as measured perpendicular from the diaphragm face. For steel box girder bridges, lights are spaced at either 25-foot centers or four times the web depth, whichever is shorter. For concrete box girder bridges, lights are spaced at either 50-foot centers or eight times the web depth, whichever is shorter. Receptacles shall be evenly spaced within each girder section, spaced at 50-foot centers for all girder types, and no more than 25 feet from the ends of the girder section (pier centerline). See Exhibit 1040-37 for typical spacing arrangements.

Exhibit 1040-38 Bridge Inspection Lighting and Receptacle Layout



Lighting shall be operable from any external access point to the girders, with switches located adjacent to the access point. If there are only two access points, then a three-way light switch is required at each access point and the switches may be integrated into the lighting circuit. If there are three or more access points, such as with an intermediate access point or multiple girders are accessed from common access points, then two three-way and one or more four-way switches are required, and these switches shall operate a lighting contactor for the lighting circuit. Circuits with four-way switches cannot have the switches installed in-line with the rest of the lighting circuit. See Exhibit 1040-39 for lighting circuit design examples.

Exhibit 1040-39 Bridge Inspection Lighting Circuit Control Layouts



1040.05(3) Tunnels, Lids, and Underpasses

For the purposes of this chapter, a tunnel is defined as any structure that restricts the normal daytime illumination of a roadway such that driver visibility is substantially diminished. This includes tunnels, highway lids, and roadways under bridges where the structure over the roadway is covered for more than 80 feet.

Where tunnel lighting is required, tunnel lighting shall be designed in accordance with ANSI/IES RP-8-18. Short tunnels are tunnels where the exit portal is visible from the entrance portal, and the tunnel length is less than or equal to the design stopping sight distance as defined in Chapter 1260. Some short tunnels may not require daytime lighting, depending on tunnel characteristics and the requirements of ANSI/IES RP-8-18. Where daytime lighting is not required, nighttime lighting is also not required unless it is part of another required design area or within a designated continuous lighting area.

Short tunnels in urban areas where a non-state highway roadway passes through the tunnel may require lighting by the local agency, even if not required by ANSI/IES RP-8-18. Consult with the local agency for tunnel lighting requirements for local roadways.

1040.05(3)(a) Daytime Light Levels for Tunnels

Tunnels long enough to warrant daytime lighting present a difficult situation for users. Without daytime tunnel lighting, users would be required to have their eyes adjust from a high light level (daylight) to a much lower light level (near darkness) within the tunnel very quickly. Where users' eyes cannot adjust fast enough, they may not be able to see a hazard or obstruction in front of them in time to avoid a collision and may slow down significantly because they cannot see far enough ahead. Transitional lighting allows for a more gradual adjustment and can minimize the "black hole" effect of a rapid transition from a bright space to a dark space, reducing the risk of a collision and the likelihood of users to slow down upon entering a tunnel. Depending on the length and direction of the tunnel, the opposite condition may be true for exiting the tunnel resulting in daylight blindness at the exit.

ANSI/IES RP-8-18 provides detailed lighting requirements for tunnels. In support of those requirements:

- All tunnel lighting designs are required to be reviewed and approved by the State Transportation Operations Engineer.
- Long tunnels are divided into zones in accordance with ANSI/IES RP-8-18, using the calculations methods described there.
- Long tunnel lighting designs are required to use the Lseq (Equivalent Veiling Luminance) calculation method. Lseq values obtained from this calculation shall be used to adjust the Suggested Daytime Maintained Average Pavement Luminance Levels where indicated.
- Lighting analysis shall include the required portions of the tunnel walls.
- Additional lighting is required outside the tunnel on the roadway approaching and exiting the tunnel. This area shall be illuminated at night for a distance no less than the stopping sight distance as defined in Chapter 1260. The light levels for these areas shall be no less than one third of the tunnel interior nighttime light level.
- Fire protection and safety equipment, such as fire alarm pull stations, phones, and emergency exits, shall be illuminated (see NFPA 502 for additional information).

1040.06 Work Zone and Construction Lighting

Lighting is required within Work Zones and construction areas, both to illuminate standard lighting design areas and unusual conditions or features within the project limits.

Lighting of existing required design areas is required to be maintained operational at all times. This may require temporary (timber) light poles in place of permanent equipment. If a new or temporary required design area is created as part of the project, such as a temporary ramp relocation or a new temporary intersection, lighting shall be provided for the new or temporary lighting design area as required for a permanent location in accordance with this Chapter. This includes traffic splits around obstructions, even if they are on non-freeway roadways.

1040.06(1) Roadways Constrained by Barrier

Where the roadway will have barrier protection (guardrail or concrete barrier) along the roadway shoulder, temporary lighting is required if any of the following conditions apply:

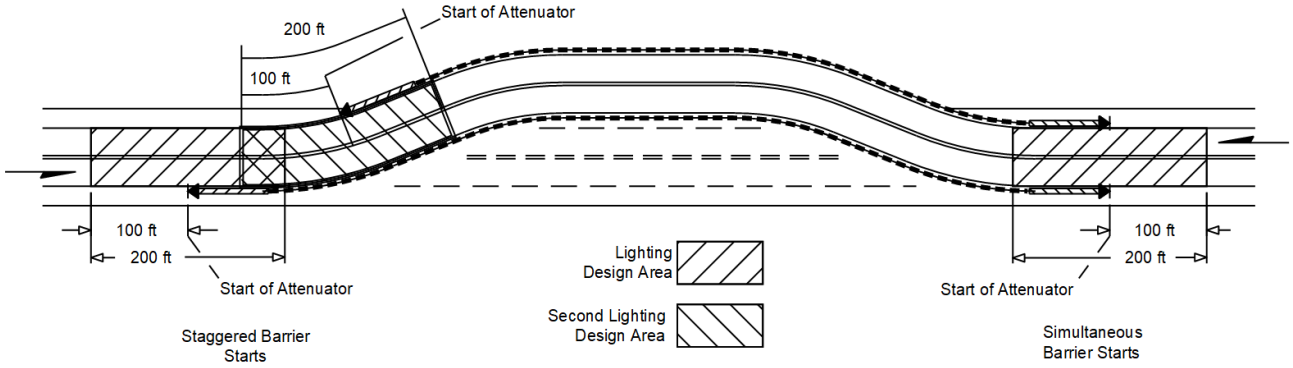
- The distance from the edge of the active lane to the roadside edge of the attenuator is less than 4 feet and the roadway has a posted speed of 45 MPH or higher, is a freeway on-ramp, or is within the first 500 feet from the gore nose (see Exhibit 1360-13) of an off-ramp.

- The distance from the edge of the active lane to the roadside edge of the attenuator is less than 2 feet and the roadway has a posted speed of 30 MPH to 40 MPH (inclusive).

Where none of these conditions apply, lighting for the barrier protected section of roadway is not required if reflective barrier mounted delineators are provided for the entire length of the barrier.

Where temporary lighting for barrier protection is required, the roadway shall be illuminated for a 200-foot distance starting from 100 feet before the start of the barrier to 100 feet after the start of the barrier. Where barrier is present on both sides of the roadway, such that barrier on the left side of the roadway is within clear zone of the leftmost side of any lanes in that direction of travel, lighting of the start of this barrier is also required. See Exhibit 1040-40 for basic barrier constrained roadway lighting requirements. For multilane roadways, at a minimum the two lanes adjacent to the barrier must be illuminated.

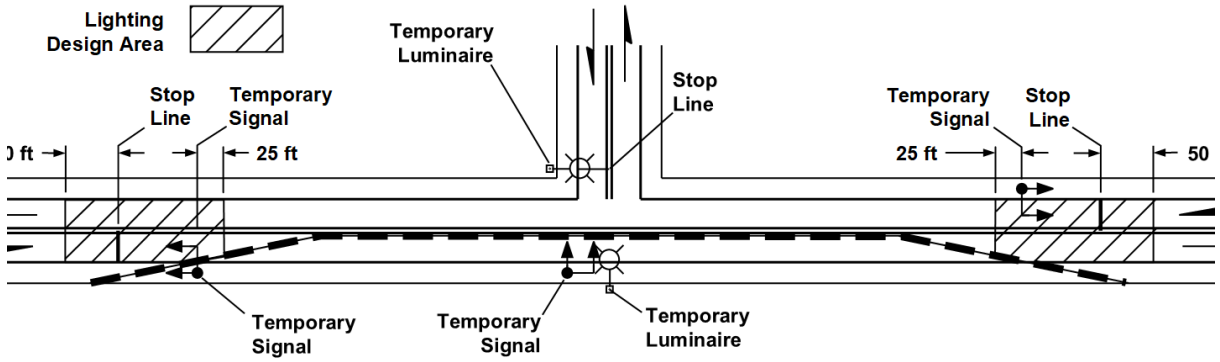
Exhibit 1040-40 Barrier Constrained Roadway Lighting Design Areas



1040.06(2) Two-Way One-Lane Signal Controlled Roadways

For two-way, one lane traffic control using a temporary or portable signal system, lighting is required from 50 feet before the stop line for the temporary traffic signal to a point 25 feet beyond the temporary signal displays. Lighting is required at each end of the signal system. Where there is an intermediate signal-controlled access point to the one lane section, such as a cross-street or commercial driveway, at least one 200W class light is required at the stop line for the cross-street. An additional 200W class light shall be provided at the intersection. The same light can be used for both locations if the stop line for the cross-street is no more than 75 feet from the edge line of the main roadway. See Exhibit 1040-41.

Exhibit 1040-41 Two-Way One Lane Signal Control Lighting Design Areas



1040.06(3) Other Temporary Lighting Conditions

Flagging stations are normally illuminated by temporary light plants. Flagging station lighting can be provided by other required temporary lighting, if the flagging station is within a required lighting design area, or by a single 250W class luminaire installed at a 30-foot mounting height and 20 feet in advance of the flagging station.

Temporary lighting should be considered for other non-standard or unexpected roadway conditions, such as substandard lane widths, corners, lane shifts, or vertical alignment changes. Where high-mast temporary lighting is used, it is generally beneficial to try and illuminate as much of the work area as possible along with any required lighting design areas. For freeway applications with multiple stages of traffic control where required design areas may shift multiple times, it may be preferable to illuminate the entirety of the potential roadway limits to allow for required design areas to move multiple times without having to add, remove, or relocate lighting to ensure that required areas remain covered in all stages.

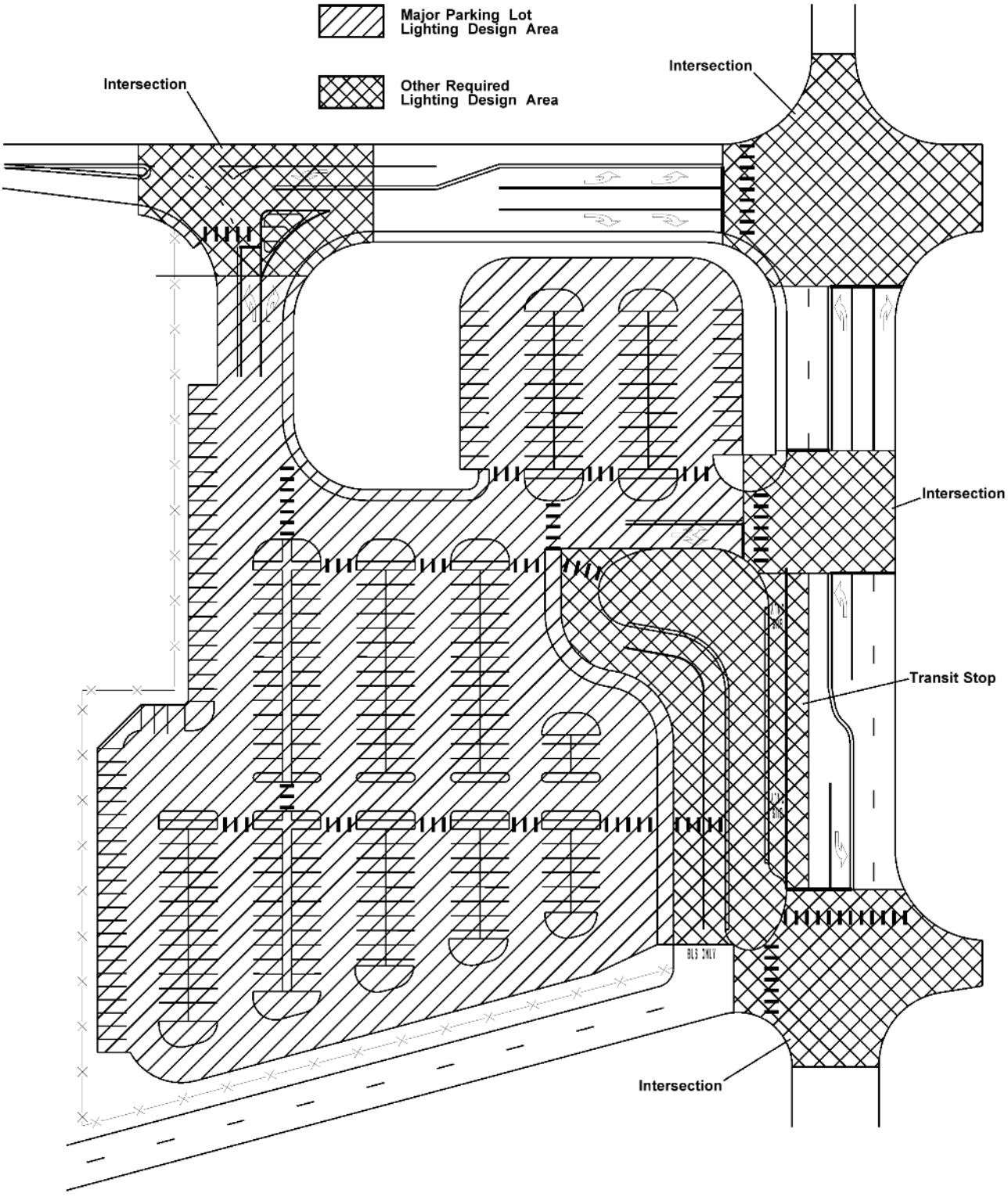
1040.07 Parking Lots

Parking lots are illuminated to support both user safety and security. Parking lots involve significant interaction between multiple modes of travel, such as vehicles and pedestrians, and present unique challenges in relation to potential criminal activity. Parking lots are divided into two classifications: major and minor.

Major parking lots are locations with usage exceeding 50 vehicles during hours of darkness, such as larger park and ride lots. Lighting for major parking lots covers the entirety of the lot, including all parking stalls and interior sidewalks and walkways (see Exhibit 1040-42).

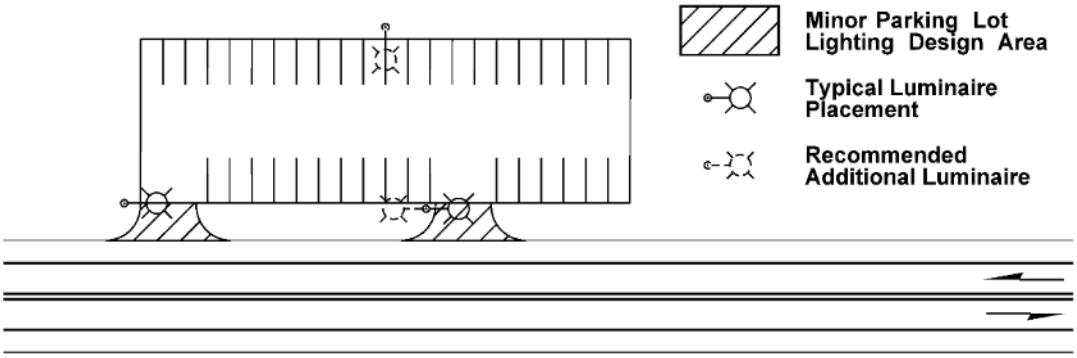
Transit stop areas shall be illuminated in accordance with Section 1040.04(4). Lighting for the parking lot shall be designed to allow for the overall light level to be reduced to approximately 25% of required light levels during hours of darkness outside of normal usage, such as from one-half hour after the last bus of the evening to one-half hour before the first bus of the following morning. This lighting reduction shall be accomplished through the selective shut off of lights around the parking lot, through the use of separated circuits, to simplify circuit design and operation.

Exhibit 1040-42 Major Parking Lot Lighting Design Area



Minor parking lots are the remaining parking lots with significantly less general use. Lighting for minor parking lots is only required to cover the entrance and exit areas of the parking lot but should also cover as much of the lot as possible (see Exhibit 1040-43). Lighting of the entire parking lot may be desirable for safety or security purposes and will often not significantly increase the size of the lighting system.

Exhibit 1040-43 Minor Parking Lot Lighting Design Areas



1040.08 Pedestrian Facility Lighting

Lighting provided specifically for pedestrian type modes of transportation (walking and rolling) is dependent on the type and features of the facility.

Lighting of sidewalks and shoulders is required for any location listed in Section 1040.02, with the exception of weigh sites. The required design area shall be expanded to include the full width of the adjacent sidewalk, or the full width of the roadway shoulder where sidewalk is not present.

Where lighting is provided in accordance with Section 1040.03(2), include the full width of the sidewalk or shoulder in the lighting design area. Separate pedestrian level light poles (standards) may be required or requested by a local agency requesting continuous lighting of a non-freeway state highway.

WSDOT does not provide illumination for separated pedestrian facilities such as isolated sidewalks or shared use paths with the exception of specific tunnels. If illumination of a separated pedestrian facility is desired, a local agency must be engaged to take responsibility for the pedestrian level lighting system. Dedicated pedestrian facilities adjacent to state highways, such as shared use paths along freeways, may be illuminated by roadway lighting. Where a shared use path is on a bridge that does not have roadway lighting, approved embedded concrete barrier lighting may be used. Tunnels specifically for shared use paths shall use flush ceiling mounted luminaires with vandal resistant and other protective features to minimize the risk of damage to the fixtures or any part of the supporting electrical system.

Additional protective measures are necessary for isolated pedestrian facility lighting, as these areas are more susceptible to vandalism and wire theft.

1040.09 Adjacent Lighting Areas

In some cases, multiple required lighting design areas may be close together but not touching or overlapping. If these areas are addressed independently, they create a light-dark-light transition that makes it difficult for users' eyes to adjust back and forth quickly, with the dark section between the two light areas being hardest to see in. This is aggravated by traveling speed and the increased brightness of LED luminaires.

Where two lighting design areas are within 500 feet of each other, the two lighting design areas shall be combined into a single area. If different light levels are required for the merged areas, the higher light levels shall be used. This may result in multiple lighting design areas combined into a single large analysis area.

In general, a gap of up to 500 feet between lighting design areas is usually able to be covered by no more than two additional lights.

1040.10 Light Level Criteria

Light levels vary slightly with the type of highway, the functional classification of the highway, development of the adjacent area, and nighttime levels of vehicle and pedestrian activity. Light level activity classifications fall into three categories:

- **High Activity**. These are areas where more than 100 pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. These are typically urban core retail or event areas such as shopping districts, stadiums, concert venues, major transit centers, and their associated parking areas. This classification corresponds with ANSI/IES RP-8-18 High Pedestrian Conflict Areas.
- **Medium Activity**. These are areas where 11 to 100 pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. Most basic urban and suburban areas with less dense commercial districts fall into this category. This category is the default standard unless justification can be provided for using the High or Low Activity classifications. This classification corresponds with ANSI/IES RP-8-18 Medium Pedestrian Conflict Areas.
- **Low Activity**. These areas are where 10 or fewer pedestrian crossings occur over a one-hour period during hours of darkness at any time of the year. These are typically low density suburban or rural areas with low housing density, little retail activity, or farms. This classification corresponds with ANSI/IES RP-8-18 Low Pedestrian Conflict Areas. Lighting design areas with sidewalks or marked crosswalks cannot be classified as Low Activity Areas.

Four light levels are measured for each design area:

- Minimum light level, in footcandles (fc). For any lighting design area, no point within the calculation area may be less than 0.2 footcandles (fc).
- Minimum average light level, in fc. This is the average light level over the entirety of the design area.
- Uniformity ratio (no units). This is how even the light levels are over the entirety of the design area and is calculated by dividing the average light level by the minimum light level. Uniformity ratio requirements only apply to locations with more than one light.
- Maximum veiling luminance ratio (no units). This is a measurement of disability glare resulting from the lighting system and is calculated by dividing the maximum veiling luminance by the average luminance. Veiling luminance calculations are only required in locations that are tangent for at least 322 feet and have little to no change in grade and can only be calculated for points starting 272 feet after the start of the tangent section. Veiling luminance is not calculated on sidewalks or roadway shoulders.

Requirements for minimum average light levels, uniformity ratios, and maximum veiling luminance ratios are dependent on the roadway type and activity classification and are provided in Exhibit 1040-44 through Exhibit 1040-46.

Crosswalks at roundabouts and midblock crossings (without intersection lighting) shall also have a vertical average light level of 0.9 footcandles (fc) at a height of 5 ft above the roadway, evaluated at 1.5 ft intervals and oriented relative to oncoming traffic for each lane.

Exhibit 1040-44 Light Level Requirements for Conventional Roadways

Location Type	Minimum Average Light Level: High Activity Area (fc)	Minimum Average Light Level: Medium Activity Area (fc)	Minimum Average Light Level: Low Activity Area (fc)	Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
1040.02(1) Stop and Signal Controlled Intersections	1.2	0.9	0.9	4:1	0.3:1
1040.02(2) Roundabouts	1.2	0.9	0.9	4:1	0.3:1
1040.02(3) Midblock Crossings	2.0	2.0	2.0	4:1	0.3:1
1040.02(4) Railroad Crossings	1.2	0.9	0.6	4:1	0.3:1
1040.02(5) Non-Freeway Weigh Sites	0.8	0.8	0.8	4:1	0.3:1
1040.03(1) Transit Stops	2.0	2.0	2.0	4:1	0.3:1
1040.03(2) Continuous Lighting	1.2	0.9	0.6	4:1	0.3:1

Exhibit 1040-45 Light Level Requirements for Freeways and Expressways

Location Type	Minimum Average Maintained Horizontal Light Level (fc)	Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
1040.04(1)(a) Off-Ramps	0.6	4:1	0.3:1
1040.04(1)(b) On-Ramps	0.6	4:1	0.3:1
1040.04(1)(c) Metered On-Ramps	0.6	4:1	0.3:1
1040.04(1)(d) Loop Ramps	0.6	4:1	0.3:1
1040.04(1)(e) Ramp Terminals	See Conventional Intersections	See Conventional Intersections	See Conventional Intersections
1040.04(2) Lane Reductions	0.6	4:1	0.3:1
1040.04(3) Special Use Lane Access Zones	0.6	4:1	0.3:1
1040.04(4) Freeway Transit Stations	See 1040.03(1), 1040.04(1)(a), and 1040.04(1)(b)	See 1040.03(1), 1040.04(1)(a), and 1040.04(1)(b)	See 1040.03(1), 1040.04(1)(a), and 1040.04(1)(b)
1040.04(5) Safety Rest Areas	0.8	4:1	0.3:1

Location Type	Minimum Average Maintained Horizontal Light Level (fc)	Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
1040.04(6) Chain Installation and Removal Areas	0.9 on freeway 1.6 on shoulders	4:1	0.3:1
1040.04(7) Freeway Weigh Sites	1.0	4:1	0.3:1
1040.04(8) Lane Splits	0.6	4:1	0.3:1
1040.04(9) Continuous Lighting	0.6	4:1	0.3:1

Exhibit 1040-46 Light Level Requirements for Special Locations

Location Type	Minimum Average Maintained Horizontal Light Level (fc)	Maximum Uniformity Ratio	Maximum Veiling Luminance Ratio
1040.06 Work Zone areas not covered by another design area	1.0	4:1	0.3:1
1040.07 Parking Lots	0.8	4:1	0.3:1
1040.08 Pedestrian Facilities	0.8	4:1	0.3:1

Light levels for local agencies shall be in accordance with local agency requirements. Some local agencies do not use lighting analysis but instead use a set spacing criterion. Confirm placement and light level requirements with the local agency. Where the local agency does not have light level or spacing requirements, WSDOT light level requirements are used.

Guidance for conducting light level analysis is available from https://wsdot.wa.gov/engineering-standards/design-topics/traffic-illumination-traffic-signals-and-intelligent-transportation-systems-its

1040.11 Basic System Design

When working on an existing illumination system, address items based on the following:

- Existing wiring that is not being affected by the work can remain. Additional circuits may be affected beyond those for the circuit where work is planned in cases where there is a conduit failure or wiring needs to be removed and reinstalled.
- Grounding and bonding must be addressed from the equipment being worked on back to the service cabinet.
- Any junction boxes within the project limits that are part of a system included in the contract work must be replaced if they do not have locking lids as shown in the Standard Plans and defined in the Standard Specifications, and if they have locking lids but are damaged or are no longer able to be secured. ADA projects require replacement of all junction boxes in sidewalks with new boxes with slip-resistant lids and frames.
- Poles and foundations only need to be addressed if the pole is included in the work, or the required grading is not present for a slip-base luminaire.
- Luminaires only need to be addressed where poles are being relocated or if they are contributing to a project lighting design area.

- Service cabinets within the project limits that are part of a system being worked on are required to be replaced if they do not meet current standards as shown in the Standard Plans and defined in the Standard Specifications. Service cabinets that meet these requirements are not required to be replaced unless they require modifications that cannot be supported by the existing service cabinet (such as not enough room for additional circuits).

New system construction is usually simple and straight-forward. New construction still requires coordination with other design disciplines to manage systems in near proximity that are in the ground, as well as tracking any changes to roadway geometrics which may affect design area locations. Additional widening is required to support slip-bases for light standards and must be included in any roadway section plans. Early and regular coordination with drainage, earthwork, roadway design, work zone traffic control, among others, is critical to development of a buildable and maintainable system.

Modifications of existing systems are more complex. Any existing system that is worked on is required to be updated to current system design and NEC requirements. This may require modifications such as adding ground wires to conduits, replacing junction boxes and/or conduits, modifying light standard foundations and grading to support proper slip base function, or replacing wiring and splices.

The following items need to be addressed when working on an existing system:

- Bring existing circuits into compliance with current NEC.
- Bring materials into compliance with current material standards.
- Bring service cabinets up to current standards.
- Replace existing junction that do not meet current standards, including thicker bolt-down lids. Boxes in sidewalks must have slip-resistant surfacing to be compliant.
- Replace conductors that are no longer in serviceable condition.
- Bring grounding and bonding system up to current standards, including adding ground conductors where missing, bonding junction box lids, etc.
- Replace conduits where conduits have failed (existing conductors will not move) or are too small to support necessary system updates (adding new wires).
- Update light standard foundations and grading to current standards for slip-base luminaires, to support proper breakaway function.
- Replace non-standard foundations, anchor bolt sizes, and anchor bolt patterns (ex: 4-bolt ground installations) with foundations and anchor bolt arrangements meeting current standards.
- Replace light standards not meeting current pole standards, such as 4-bolt bases, aluminum poles, or poles with overbrace or underbrace supported arms.
- Replace non-LED luminaires with LED luminaires meeting current standards.

When working on an existing illumination system, address items based on the following:

- Existing wiring that is not being affected by the work can remain. Additional circuits may be affected beyond those for the circuit where work is planned in cases where there is a conduit failure or wiring needs to be removed and reinstalled.
- Grounding and bonding only needs to be addressed from the equipment being worked on back to the service cabinet.
- Only junction boxes where work is being performed within (new conduit and/or wiring) need to be replaced unless the project includes ADA work. ADA projects require replacement of all junction boxes in sidewalks with new boxes with slip-resistant lids and frames.

- Poles and foundations only need to be addressed if the pole is included in the work, or the required grading is not present for a slip-base luminaire.
- Luminaires only need to be addressed where poles are being relocated or if they are contributing to a project lighting design area.
- Service cabinets are only required to be replaced when being modified new equipment is being installed (such as new wiring, new conduit, new circuit/breaker, etc.), as directed by the Region Signal Maintenance Manager. Older service cabinets do not have full coverage dead front panels and do not meet current safety requirements.

Coordinate with HQ and Region illumination design and maintenance staff starting with project scoping to ensure that the project is addressing any deficiencies in affected equipment and the project can support the necessary work.

Lighting design areas are required to be illuminated at all times, even during a project, unless a shutdown has been approved for modification or final removal of an existing system.

1040.11(1) Light Standards

Light standards are the poles that support luminaires above the roadway.

For new construction, WSDOT only uses Type 1 davit arm light standards as shown in Standard Plan J-28.10.

WSDOT does not use any decorative pole types for new construction but may use poles powder-coated in a corridor specific color or when located within National Forests or similar natural areas. Existing non-standard poles may remain in service until their end of useful life.

High-mast lighting using high-mast type poles shall not be used for new construction. High-mast systems place poles in locations that are inaccessible to maintenance, require significantly more resources to operate and maintain, require barrier protection, and in many cases cast half or more of their light off the roadway where it affects locations like natural areas and private residences. Existing high-mast lighting may remain in service until their end of useful life but may not be relocated or replaced. Where the roadway geometry is changing such that the high-mast lighting is not covering a required design area, it shall be replaced with conventional light standards.

Light standards may be incorporated into signal standards for traffic signals and ramp meters (Type III signal standards). Where a Type III signal standard is used for a ramp meter, the light must be powered from the same direct source – service cabinet or transformer cabinet – as the ramp meter signals, such that the entire signal standard can be shut off from the same breaker panel.

Slip bases are always required unless a fixed base is justified as described in Chapter 1610. Light standards that are 50 feet or taller with double mast arms, Type III signal standards, and high-mast type light standards cannot be made breakaway and require barrier protection, with the sole exception of Type III signal standards at intersections (see Chapter 1330).

1040.11(1)(a) Light Standard Sizes

WSDOT light standards are available in standard heights of 20, 30, 40, and 50 feet. 20-foot heights are restricted to special cases and require approval from the HQ Transportation Operations Division. Luminaire arms are available in lengths of 6, 8, 10, 12, 14, and 16 feet, and both single and double (180-degree offset) arm configurations. Slip bases cannot be used on 50-foot poles with double arms longer than 8 feet (each) in length. Starting configurations are 30-, 40-, or 50-foot-tall poles with 12- or 16-foot luminaire arms. Custom heights may only be used where a light standard is attached to the top of a wall, in order to provide the correct height above

roadway for the luminaire. Barrier mounted light standards use standard heights, with adjustments made in the lighting analysis to account for additional luminaire height above the roadway.

1040.11(1)(b) Light Standard Placement

Light standards hall be placed as far away from the traveled way as possible to minimize the risk of a collision or other damage. Light standards shall be placed such that the luminaire is directly over the roadway edge line, plus or minus 4 feet maximum. This offset distance may be exceeded with approval from the HQ Transportation Operations Division, provided that required light levels are met. Type III signal standards may be placed where luminaires will be more than 4 feet from the roadway edge line.

WSDOT light standards shall be placed on the right shoulder of the roadway. Light standards may be placed on traffic barrier separating two roadways, provided that the barrier is on the right shoulder of at least one of the roadways. Light standards may be placed on the left shoulder of a single lane roadway or ramp with approval from the HQ Transportation Operations Division. Light standards shall not be placed in medians, on median traffic barrier, or in traffic islands. Type III signal standard locations shall be in accordance with Chapter 1330 or ramp meter system design requirements as applicable.

Where light standards are placed along roadways with curb and sidewalk, light standards shall be placed at the back of the sidewalk to provide adequate lighting of the sidewalk and improve visibility of pedestrians.

Light standards shall not be placed in planter or similar strips between the sidewalk and the roadway, as they place the lights too close to the roadway and increase the risk of even minor collisions or sideswipes. Where pole bases encroach on the sidewalk, the available sidewalk width passing the pole baseplate shall be in accordance with Chapter 1510.

Where light standards will be placed on a bridge, coordination is required with the WSDOT Bridge office to ensure that the structure can support the light standard and that an adequate anchorage can be provided. Standard bridge mounting uses elbow mounts as shown in the Standard Plans.

Light standards shall not be placed such that a luminaire will be within 50 feet of a bridge if the luminaire will be above the top of the solid concrete bridge barrier, or above the top of the bridge deck where open barrier is used. Placement of new light standards near overhead sign structures is subject to the following requirements:

- New light standards shall not be placed between 5 and 50 feet in front of any overhead sign, due to the higher reflectivity of newer overhead sign faces.
- New light standards may be placed between 5 and 50 feet of the back of an existing overhead sign if lighting analysis includes the sign as an obstruction and shows that required light levels are met.
- New light standards may be placed within 5 feet of an overhead sign structure (in front of or behind) without analyzing the sign structure or addressing reflectivity of the sign face. The light is too directly above the sign to reflect into users' eyes or for the sign to provide a significant lighting obstruction.

Existing light standards within 50 feet of an overhead sign are not required to be relocated unless there is a known problem caused by the proximity of the light and the sign, or the light is being relocated for other reasons.

Light standard placement must be a minimum of 10 feet horizontally from any overhead power line, including neutrals and aerial service connections. Even if a location may be more than 10 feet from the wire, 10 feet of horizontal clearance is required for crane operations to place the pole. Depending on the line voltage of the power line, the horizontal clearance distance may be greater than 10 feet, such as in cases of high voltage transmission lines.

For overhead line voltages in excess of 50,000 volts (50 kV), the minimum required offset distance from the lines shall be increased by 0.4 inches for every additional 1 kV in accordance with WAC 296-24-960. Consideration should also be given to crane clearances as described in WAC 296-155-53408 Table 4.

1040.11(1)(c) Light Standards for Local Agencies

Light standards for local agency owned and maintained systems shall meet local agency requirements, including pole types. Local agency pole types may be of a different material such as aluminum, fiberglass, or concrete, may include decorative features such as fluted poles, decorative mast arms, or banner arms, and may be powder coated a specific color.

Local agency light standards may be placed in accordance with local agency requirements, provided that they meet clear zone requirements for the roadway. Some local agency clear zone requirements differ from WSDOT requirements and shall be verified before placing light standards. Local agencies may place poles within medians or shoulder planter strips at their discretion.

1040.11(1)(d) Temporary Light Standards

Temporary light standards are normally timber pole light standards used to provide lighting during a temporary condition or until permanent lighting can be placed in operation. The most common uses of temporary lighting include:

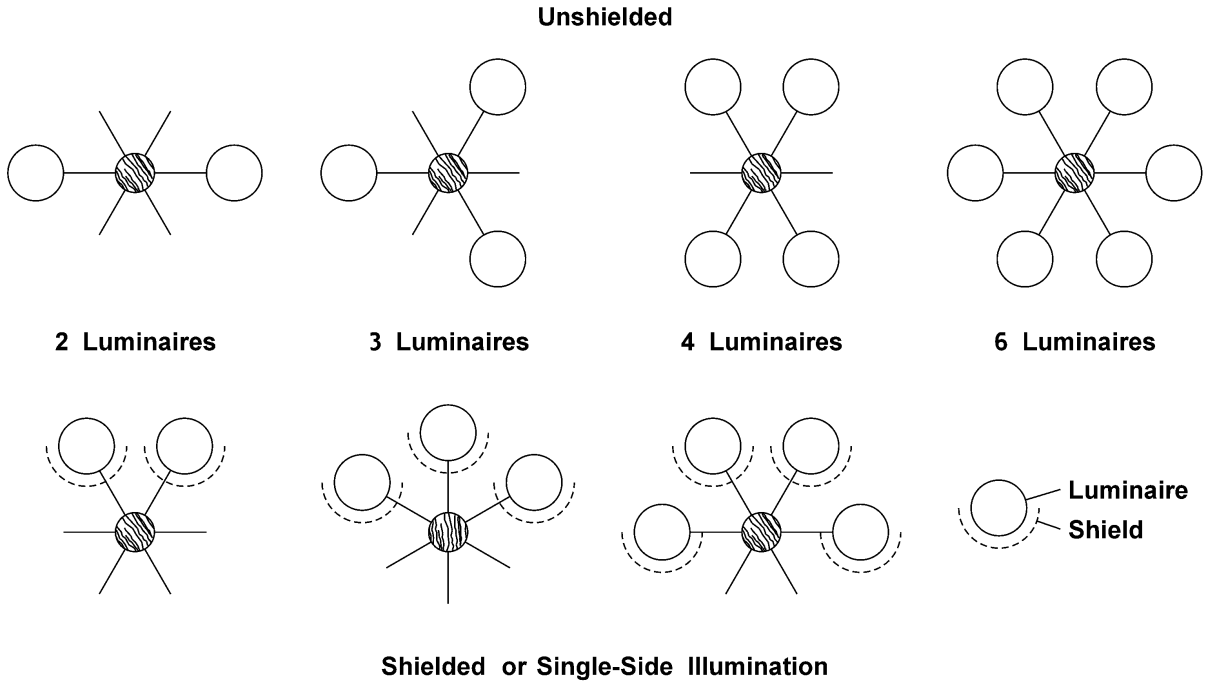
- Conditions where the roadway geometrics are temporarily changed to support construction work but will be restored to the original condition upon project completion.
- Conditions where the roadway geometrics are being permanently modified, but the permanent lighting will not cover temporary locations of required design areas or cannot be made operational early enough to cover required design areas.

Timber light standards are available in any mounting height from 20 to 90 feet in height. The type of luminaire and arm depends on the mounting height used. Both types of arrangements are shown in Standard Plan J-15.10.

Timber light standards with mounting heights up to 60 feet can support up to three luminaire arms, with lengths of 6, 8, 10, 12, 14, or 16 feet. Longer arm lengths of 18 and 20 feet may also be available, but they are less common and should be avoided if possible. Multiple luminaire arms are normally installed at increments of 90-degrees from each other, with a standard 180-degree double-arm configuration being most common.

Timber light standards with mounting heights of 60 feet and higher use high-mast type luminaires and arms. These luminaire arms are a “wagon wheel” type design with six 3-foot arms arranged at 60-degree intervals. Up to six luminaires may be installed in any configuration, but typical arrangements use 2, 3, 4, or 6 luminaires. Where three or four luminaires are used, it is recommended that they all be on the same side of the pole when shielding is necessary or only one side of the pole requires lighting, rather than evenly spread around the pole. See Exhibit 1040-47 for typical high-mast light arrangements.

Exhibit 1040-47 Typical Temporary High Mast Light Arrangements



Timber light standards require a crane for installation, so overhead clearances are critical. Timber light standards are normally installed in the ground using direct burial, at a depth of 10% of total pole height plus 2 feet. For example, a 60-foot timber pole requires a burial depth of 8 feet (10% of 60 feet = 6 feet, plus 2 feet). Specify the mounting height rather than the pole height, to allow for contractors to determine the length of pole needed. Where the ground has a lateral bearing pressure of less than 1000 psf or a friction angle of less than 26 degrees, standard direct burial installation cannot be used. Contact the HQ Transportation Operations Division for design support where poor soil conditions are present.

Timber light standards do not require guy wires by themselves, but they may be necessary when aerial circuits are used depending on how they are attached to the pole.

1040.11(2) Luminaires

WSDOT standard luminaires are Light-Emitting Diode (LED) type cobra-head type fixtures with IESNA Type III distribution patterns. These luminaires are classified by their High-Pressure Sodium (HPS) equivalent wattage, even though they are LED. The standard wattage classifications are 200W, 250W, 310W, and 400W. Lighting analysis is done using a standard benchmark luminaire for each wattage class, which allows for any approved LED luminaire of that class to be used.

WSDOT uses high-mast type luminaires for Type V distribution applications, where more of an area light may be needed instead of a roadway (more rectangular) light pattern. These luminaires may be used where lights may be installed between roadways or are required to light a longer distance across the roadway. Type V distribution lights are only available in 400W and 750W classes for permanent systems, and 1000W class is available for temporary installations.

Wall mount and ceiling mount (tunnel) type fixtures are available as well, but their use has become more complicated as manufacturers have moved from HPS light sources to LED. Contact the HQ Transportation Operations Division for assistance with wall and ceiling mount type luminaires.

Wall mount luminaires may be installed on the faces of walls, on bridge piers, or on bridge pier crossbeams. Ceiling mount luminaires may be attached to ceilings, the underside of bridge decks, or supported on metal hanger systems. No luminaire may be attached directly to a bridge girder, with the exception of box girders with pre-approval from the WSDOT Bridge Office. Any attachment to a structure requires coordination with the WSDOT Bridge Office.

No WSDOT lighting system may include decorative luminaires. Decorative luminaires may be used at the discretion of local agencies on systems that they will own and maintain.

1040.11(3) Electrical Design

Lighting system electrical design is part of the roadside power distribution system and may be concurrent with power supplies to other equipment such as traffic signals or intelligent transportation system (ITS) equipment.

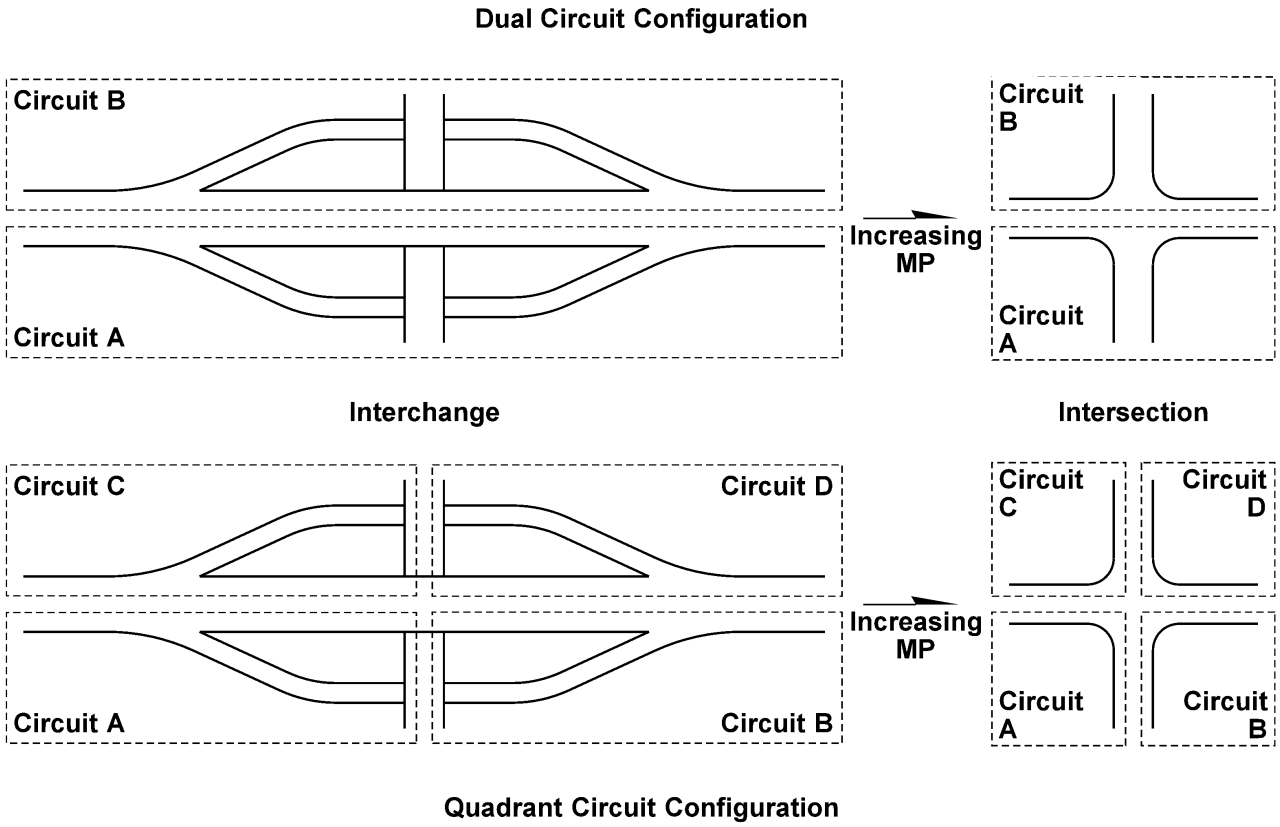
General electrical system design shall follow the requirements of the WSDOT Roadside Power Distribution Manual available from https://wsdot.wa.gov/engineering-standards/design-topics/traffic-illumination-traffic-signals-and-intelligent-transportation-systems-its.

Electrical systems may not be owned and maintained by multiple agencies. For example, one agency cannot own the lights and poles with a second agency owning the boxes, conduit, wiring, and service cabinets. The entirety of each electrical system must be owned and maintained by a single agency and designed to that agency's standards.

1040.11(3)(a) Basic Circuit Layout

Where four or more luminaires are installed, there shall be at least two lighting circuits to provide a minimum level of system redundancy. Where circuits are split, they shall be split so that a separate circuit is on each side of the roadway. For larger systems, they shall be split into a minimum of quadrants based on the interchange or intersection configuration or based on the service cabinet location if there is not an interchange or intersection. See Exhibit 1040-48 for basic circuit arrangements. Circuits are designated starting at the lowest SRMP on the increasing MP side of the highway, continuing in the increasing MP direction on that side of the highway first, then continuing at the lowest SRMP location on the decreasing MP side of the highway and continuing in the increasing MP direction on that side. Where two highways intersect, use the higher classification highway (such as the freeway and not the crossing highway or the US Highway over the State Highway).

Exhibit 1040-48 Basic Lighting Circuit Divisions



WSDOT does not use adaptive lighting systems due to the design of the lighting systems and their typically linear nature, rather than being spread out over more of a grid system, and standard luminaires do not include photocell sockets. To allow for management of continuous lighting systems, lighting that is needed to cover basic required lighting design areas shall be installed on separate circuits from any additional lighting, such that lighting beyond the basic required may be switched off as needed without compromising minimum lighting requirements.

1040.11(3)(b) Conduits, Junction Boxes, and Vaults

The basic power distribution system is composed of conduits and junction boxes or vaults. For the purposes of this section, the term box is used for all junction box types including in-ground standard duty and heavy-duty junction boxes and both surface and concrete embedded NEMA junction boxes, and the term vault is used for all closed-bottom in-ground pull boxes and cable vaults. Small cable vaults cannot be used for electrical distribution, and standard cable vaults are rarely if ever used for power distribution.

Box and vault spacing depends on the nearby equipment and the geometry of the conduit runs connected to them. Basic box and vault spacing is as follows:

- A box or vault is required within 10 feet (5 feet is preferable) of any light standard and within 5 feet of any system connected cabinet (includes service and transformer cabinets).
- Boxes or vaults are required within 10 feet of a transition to or from barrier (bridge rail, cast in place barrier, etc.) on both sides of the transition. The box on the structure side of the transition may be adjusted to fit barrier joint spacing. Coordination with the WSDOT Bridge office is required.
- Basic spacing between boxes and vaults is 200 feet for all box types, including structure mounted and barrier embedded boxes.
- In-ground and surface mounted box spacing may be increased to 300 feet between boxes where the conduit path does not include more than a total of 30 degrees of bends. This does not include the 90-degree conduit sweeps into the boxes themselves. This also applies to any conduit run connecting a box to a vault.
- Vault spacing may be increased to 750 feet between vaults where the conduit path does not include more than a total of 30 degrees of bends.
- Extended vault spacing of 1000 feet may not be used for power circuits. This spacing is restricted to fiber-optic or copper communications lines only.

Conduit sizes are limited to full inch sizes, with certain limited exceptions. Locations where specific conduit sizes are allowed or required include:

- 1-inch conduit is required between the light standard foundation and its supplying box or vault, due to limitations on the size of conduit entering the foundation and to ensure proper operation of the fused disconnect in slip-base light standards.
- ¾-inch rigid or flexible conduit may be used for the connection between a wall or ceiling mounted luminaire and its supplying box.
- All other conduits shall be at least 2-inch diameter or larger, unless otherwise approved by maintenance.

1040.12 Documentation

Lighting design documentation includes the lighting analysis, line loss calculations, conduit fill calculations, and any associated breaker schedule calculations (for either service or transformer cabinets).

Document justification for inclusion of any additional illumination, such as continuous illumination and illumination that is only recommended or to be considered.

Maintenance approval, when required, may be an e-mail or memo from the Region Signal Maintenance Supervisor/Superintendent.

Retain all elements in the Design File and the Design Documentation Package. Provide electronic copies (both AGI and PDF format) of the lighting analysis to the HQ Transportation Operations Division for tracking and record-keeping purposes.

It is recommended that documentation be made available to the Region Signal Maintenance Office, in electronic (PDF) format, as an additional record-keeping resource.

Refer to Chapter 300 for design documentation requirements.

1040.13 References

1040.13(1) Federal/State Laws and Codes

NFPA 70: National Electrical Code (NEC), National Fire Protection Association (NFPA), Quincy, MA, 2020

Revised Code of Washington (RCW) 47.24.020, Jurisdiction, control — Exception

Washington Administrative Code (WAC) 296-24-960, Working on or near exposed energized parts

WAC 296-46B-010, Adopted standards

WAC 296-155-53408, Power line safety

WAC 468-18-040, Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings

WAC 468-18-050, Policy on the construction, improvement and maintenance of intersections of state highways and city streets

WAC 468-95-010, General (MUTCD adoption)

1040.13(2) Design Guidance

American National Standard Practice for Roadway Lighting, IES RP-8-18, Illuminating Engineering Society (IES), New York, NY 2018

Manual on Uniform Traffic Control Devices for Streets and Highways, with Revisions 1 and 2, US Department of Transportation (USDOT), Federal Highway Administration (FHWA), 2012; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)

NFPA 502: Standard for Road Tunnels, Bridges, and Other Limited Access Highways, NFPA, Quincy, MA 2020

Roadway Lighting Design Guide, 7th Edition, AASHTO, October 2018

Lighting Handbook, FHWA, Washington, DC 2012

Standard Plans, M 21-01, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

1040.13(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, Current Edition

City Streets as Part of State Highways Guidelines Reached by the Washington State Department of Transportation and the Association of Washington Cities on Interpretation of Selected Topics of RCW 47.24 and Figures of WAC 468-18-050 for the Construction, Operations, and Maintenance Responsibilities of WSDOT and Cities for such Streets, April 30, 1997, amended April 2, 2013

Roadway Lighting's Effects on Pedestrian Safety at Intersection and Midblock Crosswalks, FHWA Research Report FHWA-ICT-21-023, Illinois Center for Transportation, Rantoul, IL, https://doi.org/10.36501/0197-9191/21-028

Solid-State Roadway Lighting Design Guide: Volume 1 - Guidance, Report 940, National Cooperative Highway Research Program (NCHRP), Washington, DC 2020