

Innerbelt Contract Group 3A

January 17, 2024

Photometric Analysis: ODOT Freeway/Ramp Lighting

The existing lighting on I-90 within the limits of the CCG3A project is high mast lighting. Per previous coordination with ODOT and CPP, the following approach was determined for CCG3A lighting infrastructure improvements:

1. Existing high mast lighting (for infrastructure installed in 2010 or later) will be used in the Central Interchange area to the extent feasible. Asymmetric distributions for new high mast lighting will be considered where advantageous.
2. Any existing lighting infrastructure in the Central Interchange area installed prior to 2010 will be removed or replaced.
3. Lighting between East 22nd Street and Carnegie Avenue Overpasses is proposed to be low mast, supplemented with conventional wall packs.
4. High mast towers north of Carnegie Avenue will generally remain unless impacted.
5. Local street lighting will comply with CPP standards. East 14th Street (where not in conflict with the future CCG3B project), East 18th Street, and East 22nd Street will be shoeboxes on fiberglass poles with underground conduit. All other CPP lighting will be luminaires with 8' arms on wood poles. Segments of luminaires with 8' arms on wood poles shall have overhead wiring except when running overtop of bridges 13 and 14, where conduit shall be used to pass wiring under the bridge decks and/or in the parapets.
6. The shared use path and pedestrian corridor being installed along East 22nd Street and the north side of Midtown Connector will comply with ODOT standards for illuminance criteria and CPP standards for installation. Lighting will be shoeboxes on fiberglass poles with underground conduit.
7. CPP is responsible for any necessary circuit design for luminaires with 8' arms on wood poles with overhead wiring on Carnegie Avenue, Cedar Avenue, Midtown Connector, and Central Avenue Connector (generally all project locations where primary poles are being relocated and the lighting is secondary to the primary poles). The CCG3A project is responsible for furnishing and installing the wood poles and luminaires with 8' arms in these locations.
 - a. CPP will be responsible for making connections between relocated/new poles and transformers.
8. The CCG3A Project is responsible for the light poles on the Carnegie bridge, which will be powered from conduit in the parapet also installed by the project. CPP will be responsible for connecting these lights to the overhead circuitry for the lights on either side of the bridge.
9. The CCG3A project is responsible for bronze shoebox on fiberglass poles with underground conduit along E. 22nd street, E. 14th street north of Ramp B6, and E. 18th street, as well as luminaires with 8' arms on wood poles with overhead wiring on E. 14th street south of Ramp B6. The CCG3A project is also responsible for bronze shoebox on fiberglass poles with underground conduit for pedestrian and shared pathway applications along East 22nd Street and Midtown Connector. The project will take care of circuit design and layout for these poles.
10. CPP will provide new poles with transformers, and CPP staff will perform actual connection(s) to the existing CPP infrastructure.

Michael Baker International (MBI) developed a preliminary lighting layout per the ODOT freeway/ramp lighting criteria listed above and ODOT standards for photometrics using Visual Lighting 2020. For the proposed lighting layout to meet ODOT illuminance criteria, I-90 must have an average illuminance value

INTERNATIONAL

of at least 0.9 footcandles, an absolute minimum illuminance value of 0.3 footcandles, and a preferred uniformity ratio (average/minimum) of 3:1 (per Table 1197-04 in the ODOT TEM for Freeways/Ramps, see **Table 1** below). While the preferred ratio is 3:1, the uniformity ratio for continuous freeway lighting can vary to a maximum of 4:1 and a minimum of 2:1 (see section 1106-2.3 of the ODOT TEM).

Average Maintained Illuminance Design Values

Average Illuminance on the Pavement ¹			
Roadway and Walkway Classification ²		Foot-Candles	Uniformity (avg./min.)
Freeway (including ramps) ³		0.9	3:1
Expressway (including ramps) ³	Commercial	1.4	3:1
	Intermediate	1.3	
	Residential	0.9	
Major ³	Commercial	1.7	3:1
	Intermediate	1.3	
	Residential	0.9	
Collector ³	Commercial	1.2	4:1
	Intermediate	0.9	
	Residential	0.6	
Local ³	Commercial	0.9	6:1
	Intermediate	0.7	
	Residential	0.4	
Sidewalks	Commercial	1.4	3:1
	Intermediate	0.9	4:1
	Residential	0.4	6:1
Pedestrian Ways and Bicycle Paths ⁴		2.0 (mixed ped, veh) 1.0 (ped only)	4:1

Notes:

1. Based upon R3 pavement classification, i.e. asphalt road surface, rough texture, $Q_0 = 0.07$. ODOT generally does not separate Freeway into classes A and B as RP-8 does (Note 3).

2. The terms "commercial," "intermediate" and "residential" are defined in **Section 1103-4**. See **Chapter 1301** for definitions of the other terms.

3. Adapted from **American National Standard Practice for Roadway Lighting ANSI/ES RP-8, 200/2005: Illuminating Engineering Society of North America**. Used by permission.

4. This assumes a separate facility. Facilities adjacent to a vehicular roadway should use the illuminance levels for that roadway.

Table 1: Recommended values for roadway illuminance. Table from ODOT TEM.

INTERNATIONAL

The central interchange as well as I-90 and ramps between E. 14th Street and E. 22nd Street and Carnegie Avenue and Prospect Avenue are all to be illuminated by high-mast tower lighting. The following luminaires and distributions were used for high-mast towers as needed to meet ODOT standards for photometrics:

1. 3 Holophane HMLED4 fixtures evenly spaced on the tower lighting ring
2. 4 Holophane HMLED4 fixtures evenly spaced on the tower lighting ring
3. 2 Holophane HMLED4 fixtures evenly spaced on the tower lighting ring
4. 2 Holophane HMLED4 fixtures with 180-degree shields on the tower lighting ring

Per the ODOT TEM Section 1140-4.3.5, the minimum allowable height for a tower is 70'. The high-mast towers proposed on the project range in height from 80' to 130'. See the callouts included on the exhibits in ***Exhibit D-CCG3A Photometric Analysis-ODOT Infrastructure*** for tower heights.

I-90 between E. 22nd Street and Carnegie Avenue is to be illuminated by low-mast lighting. The following luminaire and distribution were used for low-mast lighting:

1. 1 Holophane HMLED4 fixture on 50' tall low-mast pole mounted on median barrier
2. 1 Holophane HMLED4 fixture with 180-degree shields on 50' tall low-mast pole with aluminum transformer

For additional detail – including system watts, lumens, and light loss factor – regarding the light fixtures used, refer to the spec sheets included in ***Exhibit F-ODOT Light Fixtures-Specs***.

The above fixtures were used in the defined locations of the project to meet the photometric criteria specified in the ODOT TEM. After placement of light towers and poles, the model still included dark spot areas under bridges, or due to shadows created by proposed walls, cantilevered signs, and sign trusses. To address dark spots created by cantilevered signs and sign trusses, proposed high-mast towers and low-mast light poles were adjusted such that no fixture was directly over top of any sign structure and that each sign structure was illuminated by at least two different light fixtures (one throwing light on each side of the sign structure). To illuminate dark spots due to bridges and proposed walls, Holophane W4PLED underpass luminaires (also referred to as wallpack fixtures) were added to the model. Locations and justifications for wallpack fixtures installed on the project are included in ***Exhibit E-Wallpack Structure Matrix***.

All wallpack fixtures are mounted on the face of a bridge pier, bridge abutment, or retaining wall except for CR3-4. In order to fully address the dark spot on I-90 westbound being created by bridge 14 and the sign truss structure proposed just east of the bridge, a wallpack fixture (CR3-4) needs to be mounted on the cross frame bridge 14. Mounting details for this wallpack fixture are included in the structure plans for bridge 14. These mounting details are consistent with the design used in present project CUY-77-14.35. Additionally, the wallpack fixture proposed in this location matches the wallpack fixture used in CUY-77-14.35. The sign truss east of bridge 14 will no longer be needed once CCG3B is completed; as such, wallpack CR3-4 is only needed from the completion of CCG3A through the completion of CCG3B.

One additional dark spot where the techniques discussed above could not be used was along Ramps IH4 and H5 where they separate from Ramps A2 and IJ3. At the end of CCG3A, these two ramps are right next to each other with no median between them to ensure space for Ramp IJ3. However, Ramp IJ3 will be removed as part of CCG3B, which will also permit Ramps IH4 and H5 to separate and have a median between them. When this occurs, a tower can be added between the two ramps, removing the dark

I N T E R N A T I O N A L

spot. In the meantime, a 50' low-mast pole is proposed at the western edge of Ramp IH4 (at around station 14+10) to address the dark spot until CCG3B is constructed.

Photometric Analysis Results

The developed photometric model can be observed in the photometric exhibits included in ***Exhibit D-CCG3A Photometric Analysis-ODOT Infrastructure***. ODOT photometric criteria is met on all ODOT infrastructure. There are two ramps that have uniformity ratios lower than 2:1 (Ramp A1 at 1.7:1 and existing Ramp E-17 at 1.8:1); however, because lower ratios indicate more uniformity (over-designed rather than sub-compliant design) in the lighting, the proposed lighting layout is acceptable.