APPENDIX K:

PBOT Lighting Level Guidelines

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City of Portland
Recommended Light Levels and Guidelines for Roadway Lighting
May 2019

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City of Portland Recommended Light Level Guidelines

Background

The Portland Bureau of Transportation (PBOT) previously adopted roadway lighting standards on February 28, 1980 and revised them on November 1, 1984. Those roadway lighting standards provided illuminance and luminance lighting values for different roadway classifications.

On April 27, 1990, PBOT implemented an infill policy (STL-201) for residential streets which set maximum spacing standards for practical lighting infill of local streets that the 1980 and 1984 policies did not cover. As part of this policy, the City developed a standard detail identifying the different light pole layout configurations (Cases I to VI). The City also adopted a neighborhood traffic management program device lighting enhancement policy (Policy STL-202) which set forth options for enhancing lighting and visibility in the areas of traffic circles and other traffic control devices when considered to be in the public's best interest.

In 2017, PBOT commissioned an evaluation of its roadway lighting standards to compare them to current lighting industry practices, identify new recommended minimum light levels, and define a "recommended procedure" to develop aspirational goals for lighting Portland's roadways. The purpose of the "recommended procedure" is to adjust the minimum recommended average horizontal light levels on roadways based on user needs and specific roadway characteristics. The "recommended procedure" includes a series of weighted values that consider the various roadway parameters that may be present and expands upon the initial functional roadway classifications. The "recommended procedure" is not intended to be used on local service roadways or patterned lighting districts (e.g. River District) except as noted. The implementation of the "recommended procedure" is ultimately applied at the discretion and judgement of the City's District Engineer.

These guidelines are intended for use in conjunction with new lighting projects as they are scoped, designed, and constructed.

Recommended Procedure to Adjust Minimum Roadway Lighting Values

The steps to develop the adjustments to the minimum values for roadway lighting within the City of Portland jurisdiction are as follows:

Step 1: Based on the functional classification of the roadway, determine the minimum average horizontal recommended lighting values from Table 1.
Step 2: Select the appropriate roadway parameters that apply to the roadway segment to be analyzed from Table 2. The roadway parameters should be based on the constructed/future condition of the roadway segment.
Step 3: Sum the values selected in Step 2 to determine the overall weighting value.
Step 4: Based on the overall weighting value calculated in Step 3, determine the adjusted average horizontal lighting values from Table 3.
Step 5: Compare the "adjusted lighting value" determined in Step 4 to the "minimum recommended lighting value" determined in Step 1. The value with the highest average maintained light level and lower uniformity ratio is used for the roadway segment.
Step 6: Determine average horizontal light level values for intersections if applicable. The average maintained lighting value for intersections between collectors and/or arterial level streets is 1.5 times the lighting value of the intersecting roadway with the highest roadway functional classification. Do not apply a weighting factor for intersections with a local service street.

Table 1: Minimum Recommended City of Portland Light Level Guidelines.

Street Functional Classification	Illuminance Method	
	Average Maintained (fc)	Uniformity Ratio E_{ave}/E_{min} [a]
Major Traffic/Major Transit/Traffic Access	1.0	3
District Collector	0.7	4
Neighborhood Collector - Major Transit	0.7	4
Neighborhood Collector - Minor Transit	0.6	4
Local Service	0.2	6[b]
Notes: (a) Uniformity Ratio values should be rounded to the nearest integer. (b) "Recommended Procedure" aspirational goal. If uniformity ratio cannot be achieved, approval from the City of Portland is required.		

Table 2: Roadway Parameter and Weighted Values.

Roadway Parameter	Options	Weighted Value
Posted Speed	≥ 35 mph	2
	30 mph	1
	≤ 25 mph	0
Traffic Volume (veh/day)	> 15,000	2
	5,000 - 15,000	1
	< 5,000	0
Bicycle Traffic	Major City Bikeways	2
	City Bikeways	1
	Local Service Bikeways	0
Pedestrian Traffic	Pedestrian-Transit Streets/ Major City Walkways	2
	City Walkways	1
	Neighborhood Walkways	0

Table 3: Overall Corridor Weighting and Adjusted Lighting Values.

Overall Weighting Value [(a)]	Adjusted Corridor Illuminance	
	Average Maintained (fc)	Uniformity E_{ave}/E_{min} [a]
≥ 6	1.2	3
5	1.0	3
4	0.8	4
3	0.6	4
2	0.4	4
≤ 1	0.2	6
Notes: (a) Uniformity Ratio values should be rounded to the nearest integer.		

Table 4: Overall Intersection Weighting and Adjusted Lighting Values. Intersections with local service streets should be illuminated to the corridor level at the intersecting street.

Overall Weighting Value [(a)]	Adjusted Intersection Illuminance	
	Average Maintained (fc)	Uniformity E_{ave}/E_{min} [a]
≥ 6	1.8	3
5	1.5	3
4	1.2	4
3	0.9	4
2	0.6	4
≤ 1	0.3	6
Notes: (a) Uniformity Ratio values should be rounded to the nearest integer.		

Pedestrian Zones

Pedestrian Zones include marked crosswalks, multi-use paths, and woonerf streets. The additional guidelines for these zones are summarized in Table 5.

Sidewalks

Sidewalks are intended to provide a safe place for pedestrians to navigate the transportation network without conflicts from vehicles and, in the downtown area, conflicts with bicyclists. Illumination levels for sidewalks are intended to aid pedestrians in identifying obstacles and are not intended to provide sufficient illumination for facial recognition. Illuminating sidewalks may affect nearby properties in the form of light trespass. Average horizontal illumination for sidewalks should be between 0.2 and 0.9 fc average with no uniformity metric. Sidewalks should be illuminated to include no areas devoid of measurable light.

Marked Crosswalks

Marked crosswalks are intended to provide a safe place for pedestrians to cross where pedestrians are visible by other road users. Marked crosswalks at locations other than those at fully-signalized intersections, which includes crosswalks controlled by beacons (RRFBs and PHBs), should maintain an average vertical illumination of 0.2 to 0.5 foot-candles over the crosswalk area. Vertical illumination should be calculated at a 5-foot height in the direction opposite the traffic direction.

Multi-Use Paths

Multi-Use paths are areas shared by bicyclists and pedestrians and are often located in residential or natural areas. Multi-use paths should be illuminated such that hazards on the path surface can be identified. Acceptable average horizontal lighting levels should be between 0.4 and 2.0 foot-candles with a uniformity ratio of 4. Where multi-use paths intersect roadways, multi-use paths should be treated as marked crosswalks, where vertical illuminance will aid drivers in identifying bicyclists or pedestrians. See RP-8-14 Table 6 for additional lighting guidance for multi-use paths or low pedestrian conflict areas.

Woonerf

A woonerf (plural Woonerven) is also known as a “living street.” A woonerf is a space shared primarily by bicyclists and pedestrians, but also includes low-speed motor vehicles. While a woonerf is not intended for through traffic by motor vehicles and is intended for local access only, the conflict area between motor vehicles and pedestrians spans the entirety of the woonerf accessible by motor vehicles. The vertical illumination calculation should be oriented opposite each motor vehicle direction of travel. The area outside of the conflict area may be treated as a multi-use path or a sidewalk depending on projected non-motorized usage.

Table 5: Special Treatment Zone Illuminance Guidelines.

Special Treatment Zone	Illuminance Method		
	Average Maintained (fc) E_{ave}	Average Vertical Maintained (fc) EV_{min}	Uniformity Ratio* E_{ave}/E_{min}
Marked Crosswalk (unsignalized or at RRFB/PHB)	Use corridor calculation	0.2 - 0.5	–
Multi-Use Path	0.4 – 2.0	-	4
Woonerf	0.4 – 2.0	0.2 - 1.0	4

* = Uniformity Ratio does not apply to vertical illumination.

Definitions:

Speed: Current speed limit of the roadway segment.

Traffic Volume: Average Daily Traffic (ADT) of the roadway segment. ADT includes traffic volumes for both directions of travel.

Bicycle Traffic: Weighted values were developed based on the street classifications for bicycle travel described in the City of Portland Transportation System Plan. The following street classifications for bikeway travel are included in the parameters:

1. **Major City Bikeways:** They are intended to serve high volumes of bicycle traffic and provide direct, seamless, efficient travel across and between transportation districts. Where conditions are warranted and where practical, Major City Bikeways should have separate facilities for bicycles and pedestrians.
2. **City Bikeways:** They are intended to establish a direct and convenient bicycle access to significant destinations, to provide access to Major City Bikeways and provide coverage within three city blocks of any given point
3. **Local Service Bikeways:** They are intended to serve local circulation needs for bicycles and provide access to adjacent properties. Includes streets not classified as City Bikeways, Major City Bikeways or Regional Trafficways.

Pedestrian Traffic: Weighted values were developed based on the street classifications for pedestrians described in the City of Portland Transportation System Plan. The following street classifications for pedestrian travel are included in the parameters:

1. **Major City Walkways:** They are intended to create a strong connection between pedestrians and transit facilities within the City. They should include wide sidewalks to accommodate high levels of pedestrian traffic, and design features that attract pedestrian traffic.
2. **City Walkways:** They are intended to provide safe, convenient, and attractive pedestrian access to activities along major streets and to recreation and institutions; provide connections between neighborhoods; and provide access to transit.
3. **Neighborhood Walkways:** They are intended to serve the circulation needs for pedestrians and provide safe and convenient access to local destinations, including safe routes to school.

Horizontal Illuminance Method:

1. The horizontal illuminance method of roadway lighting design determines the amount of light incident on the horizontal roadway surface from the roadway lighting system.
2. Average maintained illuminance is measured in foot-candles (fc) and calculated as the average over the area of the traffic lanes including the center median, bike lanes, and parking lanes.
3. Uniformity (E_{ave}/E_{min}) is the ratio of the average maintained illuminance (E_{ave}) to the minimum illuminance value (E_{min}). Uniformity values should be rounded to the nearest integer.
4. For design calculations, the end-of-life lamp lumens should be used together with an appropriate luminaire maintenance factor.

Vertical Illuminance Method:

1. The vertical illuminance method of roadway lighting design determines the amount of light incident on imaginary vertical surfaces facing the oncoming traffic direction. The vertical surfaces are located 5 feet above the roadway surface.
2. Average maintained vertical illuminance is measured in foot-candles (fc) and calculated as the average over the area of the crosswalk including the center median, bike lanes, and parking lanes.
3. There is no uniformity metric for the vertical illuminance method.
4. For design calculations, the end-of-life lamp lumens should be used together with an appropriate luminaire maintenance factor.