I. VIRGINIA LAW

A. Code of Virginia, § 2.2.111

Code of Virginia, § 2.2.111, covers purchases to be made in accordance with the Virginia Public Procurement Act, specifically discussing procurements by the Department of Transportation related to lighting systems. The portions of this law relating to lighting systems were passed into VA Legislation through SB379-2002 and SB1351-2003. This section of law:

1. Requires state public bodies to procure only shielded light fixtures (defined as no light above horizontal plane or no more than two percent of total luminaire lumens in the zone of 90 to 180 degrees vertical) when the total lumen output of the luminaire is greater than 3200 lumens.
2. Allows for waivers when the Division of Purchases and Supply (State Department of General Services) determines that a bona fide operations, temporary, safety or aesthetic need is indicated or when fixtures are not cost-effective over the life cycle of the fixture.
3. Requires the Virginia Department of Transportation (VDOT) to design all lighting systems in accordance with current Illuminating Engineering Society of North America (IESNA) standards and recommended practices.
4. Requires VDOT to use fixtures that minimize glare, light trespass, and skyglow, all as defined by the IESNA, while still providing a comfortable, visually effective, safe and secure outdoor environment in a cost-effective manner over the lifecycle of the lighting system.

This law appears to apply to State public bodies who make purchases through The State Department of General Services, Division of Purchases and Supply. If the City of Charlottesville makes lighting fixture purchases through this Division, then the first two bullets above, requiring light fixtures to be cutoff, are applicable.

The second part of the law (bullets 3 and 4 above) is directed solely at lighting systems designed by VDOT. While the City of Charlottesville would not be subject to this portion of the law, the recommendations to design lighting systems in accordance with IESNA standards and recommended practices, as well as to use fixtures that minimize glare, light trespass and skyglow, are good recommendations that should be considered by the City of Charlottesville in establishing lighting system criteria.

II. VDOT LIGHTING STANDARDS AND GUIDELINES

VDOT lighting standards and guidelines can be found in the VDOT Traffic Engineering Design Standards and Guidelines, Chapter 2, Roadway Lighting, which was published in September 2014. VDOT’s standards acknowledge that roadway lighting designed, installed, or funded by VDOT must be in accordance with VA Legislation in SB379-2002 and SB 1351-2003, which are described in Section I of this document.

VDOT roadway lighting designs must meet the requirements in RP-8-00 (reaffirmed in 2005), including illuminance, luminance and veiling luminance ratio recommendations. VDOT does not provide specific design criteria for sidewalks or pedestrian lighting.

III. IES RECOMMENDED PRACTICES AND GUIDELINES

The Illuminating Engineering Society of North America (IESNA) is a nationally recognized technical authority on illumination. They issue technical publications to communicate information on aspects of good lighting practice, including lighting for exterior environments, such as roadways, sidewalks and pathways. This section summarizes recommendations of several recommended practices (RP), guidelines (G), and Lighting Measurement Testing and Calculation Guides (LM) applicable to sidewalk and pedestrian lighting. To keep the summaries somewhat succinct, not all sections of each document are summarized. For additional information and guidance, please refer to the original publication of each document.

A. RP-8-14 Roadway Lighting

The IES RP-8-14 Roadway Lighting was published in 2014 as is the successor to the RP-8-00 (reaffirmed in 2005). Many jurisdictions, including VDOT, are still using the RP-8-00 as the basis for lighting design criteria. The summary in this section focuses on the recommendations of the RP-8-14, as it provides the most current guidance from the IESNA on this topic.

The primary purpose of the RP-8-14, as noted in the Introduction (Section 1.1) of the document, is “to serve as the basis for design of fixed lighting for roadways, streets, adjacent bikeways, and pedestrian ways”. As such, the recommendations provided in this document should serve as the basis for establishing pedestrian and sidewalk lighting criteria.

Cost-Benefit Considerations. Section 1.2 of the Introduction recommends that the benefits of lighting should be considered against the drawbacks: engineering, capital and maintenance costs, energy use, appearance, added fixed object hazards, light trespass, and skyglow. Lighting is considered “‘good’ when it is economical in equipment, energy and maintenance costs, and meets a proven or reasonably predictable need, with a minimum of adverse effect.”

Ambient Lighting. Section 3.6 of the Design Considerations discusses glare and sky-glow issues. It notes that impact of lighting is different in relative terms depending on the surrounding area (e.g., a lighting system using the higher end of recommended horizontal and vertical lighting levels will have a different impact in urban environments, which typically have high ambient lighting from surrounding areas, than in rural environments, which typically have little to no ambient lighting from surrounding areas). The IES has developed Lighting Zones describing different ambient lighting conditions. The appropriate application of the established Lighting Zones relative to the light level recommendations in the RP-8 was under review by the IES Roadway Lighting Committee, who authors the RP-8, at the time the RP-8-14 was issued. Therefore, no factors for adjacent Lighting Zones were incorporated into the RP-8-14. This is important to note, as the IES has not yet weighed in on the appropriate way to apply adjustment factors for ambient lighting to pedestrian lighting. More information on Lighting Zones can be found in the Joint IDA/IES Model Lighting Ordinance (MLO), IES RP-33 Outdoor Environmental Lighting, or the IES Lighting Handbook.
Mesopic Adjustment Factors. The RP-8-14 includes a new discussion on spectral considerations in Section 3.9. It notes that the average light levels for street and roadway lighting are usually in the mesopic range, between the photopic and scotopic ranges. There have been studies that have shown improved visual performance in the periphery with light sources that have enhanced scotopic content (such as LED light sources) when light levels are in the mesopic range. Mesopic adjustment factors have been introduced by the *IES Lighting Handbook*. Until better information is available, the IES Roadway Lighting Committee recommends that mesopic multipliers only be used to assess the luminances of off-road locations in applications for street lighting where the posted speed limit is 25 mph or less. The committee is not recommending the factors for other application in the right-of-way at this time.

Based on this recommendation, one could conclude that a driver, when traveling at 25mph or less, may see a pedestrian on the sidewalk in their peripheral vision clearer using an LED light source with lower light levels. This is a key discovery. Unfortunately, the IES Roadway Lighting Committee has not provided insight as to whether those lower light levels on the sidewalk would impact the visual capacity of pedestrians seeing other pedestrians on the sidewalk. Until more research is conducted, application of Mesopic adjustment factors to recommended pedestrian way light levels is not appropriate.

Lighting Recommendations. Section 4.0 contains lighting recommendations for pedestrian areas. Horizontal and vertical illuminance is the selected design method for pedestrian areas. It’s noted that field validation of lighting system performance can be done by luminance or illuminance.

Recommendations for pedestrian lighting are divided into high, medium and low pedestrian conflict areas.

- High pedestrian conflict areas are defined as commercial areas in urban environments that have high nighttime pedestrian activity. The visual environment is typically much more cluttered in these areas with detection of other pedestrians being of importance.
- Medium pedestrian conflict areas are defined as intermediate areas that have moderate high pedestrian activities. These are might typically be those near community facilities, such as libraries and recreations centers. Safety for the pedestrian as well as providing guidance to primary travel ways are key elements of lighting design in these areas.
- Low pedestrian conflict areas are defined a residential areas. Lighting design in these areas should focus on allowing the pedestrian to visually orient in the environment, detect obstacles, identify other pedestrians, read street signs and recognize landmarks.

The table below contains the recommended light level values for Pedestrian Areas.

<table>
<thead>
<tr>
<th></th>
<th>$E_{\text{avg}}$(fc)</th>
<th>$E_{\text{min}}$(fc)</th>
<th>$E_{\text{avg}}/E_{\text{min}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Pedestrian Conflict Areas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Vehicle and Pedestrian</td>
<td>2.0</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Pedestrian Only</td>
<td>1.0</td>
<td>0.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

IES RP-8-14 Recommended Values for Pedestrian Areas
### Medium Pedestrian Conflict Areas

<table>
<thead>
<tr>
<th>Pedestrian Areas</th>
<th>0.5</th>
<th>0.2</th>
<th>4.0</th>
</tr>
</thead>
</table>

### Low Pedestrian Conflict Areas

<table>
<thead>
<tr>
<th>Rural/Semi-Rural Areas</th>
<th>0.2</th>
<th>0.06</th>
<th>10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Residential (2 or fewer dwelling units per acre)</td>
<td>0.3</td>
<td>0.08</td>
<td>6.0</td>
</tr>
<tr>
<td>Medium Density Residential (2.1 to 6.0 dwelling units per acre)</td>
<td>0.4</td>
<td>0.1</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Adaptive Lighting.** Adaptive lighting, as discussed in Section 5.4 of the RP-8-14, describes a lighting system that can be adjusted based on time of day use changes. Typically dimming systems are used to control the output of luminaires. It may be appropriate to adjust light level from High, for example, to Medium, as pedestrian volumes drop during overnight hours.

**Calculations and Measurements.** Annex A, included in the RP-8-14 for informational purposes only, defines the formulae and assumptions used to perform calculations to evaluate the criteria contained in the RP-8-14. For sidewalks adjacent to roadways, the following method is recommended:

- Match grid spacing in the roadway for vertical and horizontal illuminance calculations. (Note: Roadway lighting grids allow for a maximum of 5 meters on center longitudinally between points.)
- Grid should be positioned in the center of the sidewalk / pedestrian area.
- For vertical calculations, locate the light meter at 1.5 meters in height and calculate with the meter aimed along the sidewalk in both walking directions.

**B. RP-33-14 Lighting for Exterior Environments**

The IES RP-33-14 *Lighting for Exterior Environments* was published in 2014. The intent of the RP-33 is to address design issues related to outdoor lighting, including sky glow and light trespass; lighting zones; community based design; and specific recommendations for outdoor lighting areas.

**Visual Adaptation and Spectral Distribution.** Sections 2.3.4 and 2.3.5 provide a nice overview of visual adaptation and spectral distribution considerations. Clear definitions for Photopic Vision, Scotopic Vision and Mesopic Vision are provided:

- **Photopic Vision** is the human eye’s response at high light levels (luminance greater or equal to 5 cd/m²). At these levels, cones are responsible for foveal vision (the central area where the eye focuses on objects) and for color perception.
- **Scotopic Vision** is the human eye’s response at very low light levels such as starlight (luminance less than or equal to 0.001 cd/m²). At these levels, rods account for the majority of vision. Stimuli from rods are responsible for peripheral vision, with most objects appearing in black, white and gray.
- **Mesopic Vision** is an adaptive combination of Scoptotic and Photopic vision that occurs under most exterior lighting applications (luminance between 0.001 and 5 cd/m²). Both rods and cones are involved in viewing objects. Rods are more sensitive to short wavelength light (blue
light), which is why some people perceive they can see better at night with LED light sources that tend to be bluer.

**Target Light Levels.** The RP-33-14 includes a discussion on Target Light Levels, which is also present in Chapter 4 of the *IES Lighting Handbook*. A range of target light levels are provided for a particular task, area or age group. Target light level recommendations for pedestrian ways and bikeways are contained in Table 4 of the RP-33-14. This table does not provide specific light level criteria for pedestrian ways. It does, however, refer to IES RP-8-14, Section 4.2.1, Pedestrian Areas and Bikeways, for additional information. RP-8-14 provides specific light level criteria for pedestrian areas, as previously summarized in this literature review.

**Model Lighting Ordinance and Community Responsive Design.** Sections 3 and 4 of the RP-33-12 provide a good framework for developing a model lighting ordinance that considers community responsive design. The model lighting ordinance focuses on establishing Lighting Zones, which, as previously noted, do not apply to pedestrian ways per the RP-8-14. The community responsive design section focuses on determining community lighting goals, developing a “family” of luminaires, determining how selected lights impact the visual environment, assessing safety and security lighting, and establishing design guidelines.

**Key Considerations.** Two considerations of note discussed in the RP-33-14 are:

- “Since cost is always a factor, it is worth establishing a policy of establishing lighting goal priorities to take advantage of ‘easy fixes’ and encourage compliance. Periodic review of goals and accomplishments should be a part of any light plan. For example, rather than require immediately replacing all non-conforming lighting, it could be phased out. Alternative methods of reducing lights could be allowed, such as shields on existing lights and controls.” (Section 4.7)
- “Many walkways and bikeways are adjacent to lighting roadway and no separate lighting system is required. If the roadway lighting does not adequately serve the walkway because of distance, landscape obstructions, or elevation changes, additional lighting may be required.” (Section 7.0)

*C. LM-50-13 Photometric Measurements of Roadway and Street Lighting Installations*

The IES LM-50-13 *Photometric Measurements of Roadway and Street Lighting Installations*, published in 2013, provides specific luminance and illuminance measurement methods. Section 6.0 of the LM-50-13 discusses measurement procedures, including how to perform illuminance measurement. It specifically references the IES RP-8, Annex A, for definition of the standard measurement and calculations points to be used for a roadway. A summary of the recommended procedure for measuring horizontal and vertical illuminance along sidewalks is included in the RP-8-14 section of this literature review. The LM-50-13 recommends that the light meter should not be more than 6 inches about the road surface (or sidewalk surface in the case of pedestrian area measurements).

*D. G-1-03 Guidelines for Security Lighting for People, Property and Public Spaces*

The IES G-1-03 *Guidelines for Security Lighting for People, Property and Public Spaces*, published in 2003, provides guidelines for the design and implementation of security lighting. The document is intended to provide specific guidelines where it has been determined that security is an issue. To better understand the difference between safety lighting and security lighting, the following definitions are presented:
• **Security lighting** is intended to protect people and property from criminal activities.
• **Safety lighting** is intended to provide safe working conditions, safe passage, and identification of hazards or obstructions.

**When Security is an Issue.** Section 4.0 of G-1-03 indicates that security should be considered an issue when one or more of the following conditions exist:

1. The persons and/or property in the area to be secured present a desirable target to would-be criminals.
2. The property has a history of relevant crime or increases in crime.
3. Crime in the surrounding area is high compared to other political subdivisions, parts of the city or county.
4. The results of a physical security survey or threat analysis indicate a problem.
5. There are changing conditions, which expose persons to new security hazards or increased risk.
6. Obvious physical signs of anti-social behavior near or on the property such as graffiti, vagrants, broken windows, trash buildup, trespass, or poorly maintained properties.
7. There are recurring, reasonable resident or customer complaints or concerns about security or fear of crime.
8. High provide of troublesome areas exist, such as bars, nightclubs, gambling halls, gang or teen gathering spots.
9. There are industrial or commercial applications where persons or property are prone to attack, such as ATM and night depositories, convenience stores, and railway yards.
10. Restricted access industrial or government installations are in the area.

This section goes on to note that good lighting alone cannot guarantee security. It must be integrated into a balanced security plan.

**Visibility Concerns.** Horizontal and vertical illuminance are key criteria for security lighting. Vertical illuminance is important for identification of people. There should be sufficient light to positively identify a face and ready body language at a distance of at least 30 feet in areas where security is a concern. A vertical illuminance of 5-8 lux, with an average to minimum uniformity ratio of 4 to 1 is recommended for facial recognition.

Sections 5.8, 5.9, and 5.10 discuss site lighting, with typical pole mounting heights between 30 and 60 feet (somewhat similar to roadway lighting). Mounting heights for pedestrian zone lighting will typically be in the range of 10 to 20 feet. It is noted that while cutoff luminaires are fine for site lighting, the use of full cutoff luminaires at low mounting heights will not provide high vertical illuminance levels required for security lighting.

**Specific Applications.** Applications of security lighting for specific areas are discussed, including office buildings, ATMs, parking facilities, supermarkets, convenience stores, schools, etc. Specific applications of security lighting for sidewalks adjacent to streets are not discussed.

E. **Joint IDS/IES Model Lighting Ordinance (MLO)**

The Joint IDS/IES Model Lighting Ordinance (MLO) was established as a tool for jurisdictions to use when developing their own lighting ordinances. The International Dark Sky Association (IDA) and Illuminating Engineering Society of North America (IES) recognized that there was no consistency in lighting.
ordinances across the nation and therefore worked jointly to develop a MLO to provide a common basis for the development of lighting ordinances. One of the features of the MLO is the use of Lighting Zones (LZ) that allow each jurisdiction to vary the stringency of lighting restrictions according to the sensitivity of the area. The established lighting zones are as follows:

- **LZ0 – No Ambient Lighting:** Areas where the natural environment will be seriously and adversely affected by lighting. Examples include wilderness areas, parks and preserves, and undeveloped rural areas.
- **LZ1 – Low Ambient Lighting:** Areas where lighting might adversely affect flora and fauna or disturb the characters of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience, but it is not necessarily uniform or continuous. Examples include rural and low density residential areas.
- **LZ2 – Moderate Ambient Lighting:** Areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may be used for safety and convenience, but it is not necessarily uniform or continuous. Examples include commercial business districts, high density or mixed use residential districts, schools, churches, and neighborhood recreation facilities.
- **LZ3 – Moderately High Ambient Lighting:** Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. Examples include large city business districts, high intensity suburban commercial areas, town centers, mixed use areas, and regional shopping malls and other nighttime active exterior retail areas.
- **LZ4 – High Ambient Lighting:** Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and it is mostly uniform and/or continuous. Examples include high density entertainment or business districts. This zone should only be use for special cases and is not appropriate for most cities.

Use of lighting controls and curfews to reduce light levels after a given time are also discussed. Additionally, recommended maximum BUG (Backlight, Uplight and Glare) ratings are provided by zone. The MLO also provides recommendations on the maximum total initial luminaire lumens as well as total initial site lumens. The examples provided in the MLO (e.g., outdoor dining, vehicle service stations, outdoor sales lots) lead the reader to believe that these ordinance were established for site lighting and not for the sidewalk or pedestrian way lighting under consideration by the City of Charlottesville.

IV. **IES LIGHTING HANDBOOK, 10TH EDITION**

The Illuminating Engineering Society of North America (IESNA) also produces a *Lighting Handbook* in addition to the recommended practices and guidelines discussed in the previous section. The *Lighting Handbook* reflects the current state of lighting knowledge and practice in both interior and exterior environments. The 10th Edition, published in 2011, included new discussion on factors such as age-based illuminance ranges, mesopic adaptation, light trespass, sustainability and light pollution. This section summarizes discussion on factors associated with sidewalk and pedestrian lighting from several chapters in the *Lighting Handbook*. To keep the summaries somewhat succinct, not all chapters or
sections of each chapter are summarized. For additional information and guidance, please refer to the original publication of the *Lighting Handbook*.

A. Chapter 4 – Perceptions and Performance

Chapter 4, Perceptions and Performance, discusses brightness, contrast, glare and visual acuity. The key recommendation of this chapter is the establishment of a system to determine target illuminance values. This is the same system referenced in RP-33-14 *Lighting for Exterior Environments*. The factors that are used in the determination of recommended illuminances are task characteristics, task importance, and observer characteristics.

Table 4.1 provides illuminance ranges involved with discussion of corresponding tasks. Pedestrian lighting, while not specifically mentioned in this table, would seem to fall into categories A through H. Based on the description of the tasks (slow-to-moderate paced situations; low-to-moderate-to-high density situations), Categories A-E, with illuminance recommendations between 1 and 8 lux, align with RP-8-14 recommendations for sidewalk lighting for low and medium pedestrian conflict areas. Based on the descriptions of the tasks (moderate-to-fast paced situations; high density situations), categories F-H, with illuminance recommendations between 10 and 20 lux, align with RP-8 recommendations for sidewalks for high pedestrian conflict areas. Note that the aforementioned illuminance recommendations correspond to target levels where at least half of the observers are between 25 and 65 years of age.

Chapter 4 also contains discussion on spectral effects and use of the scotopic-photopic (S/P) ratio to select a multiplier that can be used to adjust recommended illuminance for mesopic adaptation. As research is still ongoing in this field and the IES Roadway Lighting Committee does not yet feel comfortable making recommendations on using these multipliers for roadway and pedestrian way lighting, it does not seem appropriate to apply these multipliers to lighting recommendations for the City of Charlottesville.

B. Chapter 12 – Components of Lighting Design

Chapter 12 of the *Lighting Handbook* presents the key components of lighting design. One element of interest in this chapter is Table 12.7, which provides an example worksheet of how to establish recommended mesopic illuminance criteria based on the following factors: outdoor lighting zone, outdoor activity level, observers’ visual ages, surface reflectances, and mesopic multipliers based on lamp type.

Age-related illuminance factors, while discussed elsewhere in the *Lighting Handbook*, are also discussed in Section 12.5.5.2. It is noted that by the time a person reaches 65 years old, he or she may require four times the amount of light he or she required at 20 years old. In the *Lighting Handbook*, the IES addresses this disparity by assigning three target values to each task or application based on the average age of observers:

- At least half of observers or users are less than 25 years old (less light needed)
- At least half of observers or users are between 25 and 65 years old (normal light)
- At least half of observers or users are greater than 65 years old (more light needed)
Demographics for the City of Charlottesville would be required to determine whether age should factor into recommended light levels.

C. Chapter 25 – Lighting for Emergency, Safety and Security

Table 25.2, Safety and Security Illuminance Recommendations, provides baseline illuminance criteria to address indoor safety situations. The baseline criteria in this table address most indoor situations, but are not appropriate for application to pedestrian lighting. The table references IES G-1 Guidelines for security lighting for People, Property, and Public Spaces for criteria when security lighting is deemed necessary for addressing both interior and exterior situations.

It is noted in this section that security lighting should be applied in a limited and strategic manner and only where normal application illuminances are considered inadequate. Light trespass and light pollution concerns must be addressed for outdoor scenarios with higher light levels associated with security lighting.

Section 25.2.3 outlines a procedure to establish recommended security lighting illuminance criteria based on activity level, nighttime outdoor lighting zone, observer’s age, and mesopic multipliers.

D. Chapter 26 – Lighting for Exteriors

Chapter 26, Lighting for Exteriors, covers exterior illuminance recommendations based on the current IES illuminance determination procedure using illuminance targets. The introduction to this chapter notes that exterior illuminance criteria related to parking lots, parking structures, pedestrian sidewalks and paths, and streets and roadways are not yet aligned with this procedure. Consequently, while the discussion about target illuminance throughout the Lighting Handbook and other IES guides provides valuable background information, it is not yet ready for application to pedestrian ways.

Section 26.2 notes that “outdoor lighting...will not necessarily reduce or eliminate crime. However, lighting that addresses the normal criteria appropriate for public nighttime activity may be a potential deterrent to criminal activity and provide pedestrians with a sense of security (and a sense of safety). Lamps with CRIs >= 80 help people better identify and distinguish colors. It is also important that the lighting is tuned to the nighttime outdoor lighting zone to avoid adaptation issues.”

Table 26.2, Exterior Illuminance Recommendations, provides comprehensive qualitative and quantitative criteria for outdoor lighting. Only qualitative criteria are provided in the section of this table related to Pedestrian Ways and Bikeway; quantitative illuminance targets are not provided. The table refers the reader to Section 26.2.9 for discussion on pedestrian and bike circulation paths.

Section 26.2.9 notes that the lighting for pedestrian or bikeways depends on the proximity to vehicular traffic, activity level, and nighttime outdoor lighting zone. Being adjacent to vehicular traffic general warrants higher horizontal and vertical illuminances. Similarly, higher activity levels and LZ3 and LZ4 lighting zones generally warrant higher horizontal and vertical illuminances. Where pedestrian activity is anticipated and encouraged and a more sociable setting is desired, attention to factors such as optical control, efficiency, luminaire scale, light intensity and distribution, color of light, style of luminaire should be considered.
V. SIDEWALK LIGHTING CRITERIA USED BY OTHER JURISDICTIONS

The purpose of this section is to review other jurisdictions to determine what criteria they are using for sidewalk lighting. Many jurisdictions reviewed as a part of the literature review have light level criteria for roadways, but do not provide light level criteria for sidewalks. One jurisdiction’s lighting design guide even noted that no separate calculations are required for sidewalks, as they are typically illuminated by the street lighting system and lights on adjoining properties. Several examples of pedestrian lighting criteria for various jurisdictions nationwide are presented in the following discussion.

A. District of Columbia Department of Transportation (DDOT)

The District of Columbia Department of Transportation (DDOT) issued updated Streetlight Policy and Design Guidelines in February 2013. DDOT follows AASTHO criteria and uses the illuminance method for sidewalks.

<table>
<thead>
<tr>
<th>Walkway Classification</th>
<th>Off-Roadway Light Sources / General Land Use</th>
<th>Minimum Average Maintained Illuminance (fc)</th>
<th>Illuminance Uniformity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pavement Class.:</td>
<td>R1</td>
<td>R2/R3</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>Commercial</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>0.3</td>
<td>0.4</td>
</tr>
</tbody>
</table>

B. New York City Department of Transportation

The New York City Department of Transportation’s Street Design Manual, Chapter 4, covers street lighting. Their light levels and uniformity guidelines are based on those established by the IES. Recommended light levels for Plazas, Walkways and Bikeways are as follows:

- Average Horizontal Illuminance: 5-10 lux (0.46 – 0.93 fc)
- Illuminance Uniformity: 4:1

C. San Francisco, California

The City of San Francisco established a Better Streets Plan, effective January 2011, to provide guidelines for pedestrian and streetscape features in the public right-of-way in San Francisco. Chapter 6 of this plan covers streetscape elements, including lighting. Figure 6.9, shown below, illustrates sidewalk illuminance requirements.
D. Baltimore City Department of Transportation, Maryland

The City of Baltimore Department of Transportation (BCDOT) published their *Street Lighting and Photometric Design Guide* in 2012. BCDOT uses the illuminance method for sidewalk lighting. The following table summarizes their light level recommendations:

<table>
<thead>
<tr>
<th>Walkway And Bikeway Classification</th>
<th>Minimum Average Horizontal Levels ($E_{avg}$)</th>
<th>Average Vertical Levels For Special Pedestrian Security ($E_{avg}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside Sidewalks and Bikeways</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Areas</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Intermediate Areas</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Residential Areas</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Walkways and Bikeways Distant from Roadways</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Pedestrian Tunnels</td>
<td>5.4</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Note 1. Shall be calculated for areas where facial recognition is critical.
Note 2. Calculation to be performed 4.9 ft. above sidewalk/bikeway in a bidirectional manner parallel to the main pedestrian flow.

E. City of San Diego, California

The City of San Diego published their *Street Design Manual* in 2002 to provide information and guidance for the design of the public right-of-way. This manual provides recommendations for sidewalk and walkway lighting when pedestrian scale lighting is installed. The following table summarizes the recommendations:

<table>
<thead>
<tr>
<th>San Diego Sidewalk Light Level Requirements</th>
<th>Average Maintained Horizontal Levels ($E_{avg}$)</th>
<th>Illuminance Uniformity Ratio ($E_{avg}$ / $E_{min}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Areas</td>
<td>0.9 fc</td>
<td>4:1</td>
</tr>
<tr>
<td>Mixed-Use Areas</td>
<td>0.6 fc</td>
<td>4:1</td>
</tr>
<tr>
<td>Residential Areas</td>
<td>0.4 fc</td>
<td>6:1</td>
</tr>
</tbody>
</table>
F. City of Redmond, Washington

The City of Redmond issued an *Illumination Design Manual* in 2015 to establish uniform procedures for the preparation of design plans to install illumination systems within the city. This manual contains light level criteria for pedestrian facilities. The light level requirements are as follows:

<table>
<thead>
<tr>
<th>Pedestrian Facility</th>
<th>Min. Maintained Avg. (fc)</th>
<th>Uniformity Ratio (Avg/Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked Crossing and Mid-block Crossing</td>
<td>1.0</td>
<td>3:1</td>
</tr>
<tr>
<td>Unmarked Crosswalk at Intersection</td>
<td>Same as adjacent Intersection</td>
<td></td>
</tr>
<tr>
<td>Curb Ramps (marked crossings)</td>
<td>1.0</td>
<td>n/a</td>
</tr>
<tr>
<td>Sidewalk:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial/CBD/Old Town</td>
<td>1.0</td>
<td>4:1</td>
</tr>
<tr>
<td>Overlake Village</td>
<td>0.8</td>
<td>4:1</td>
</tr>
<tr>
<td>Residential</td>
<td>0.4</td>
<td>4:1</td>
</tr>
</tbody>
</table>