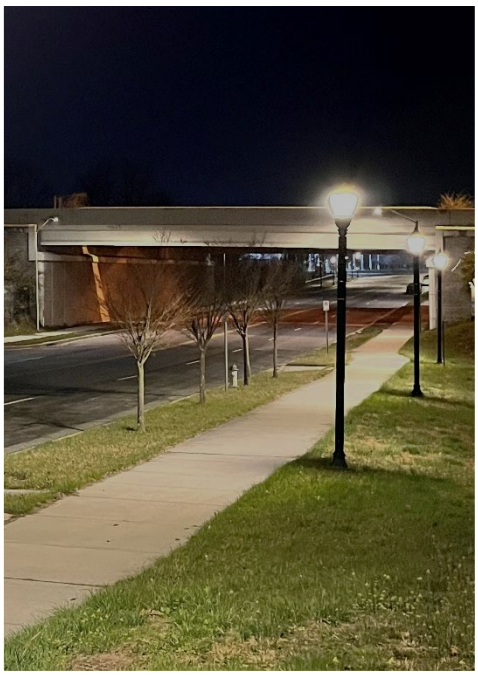
Streetlighting Design Requirements, Installation Procedures, and Specifications



Montgomery County

Streetlighting Design Requirements, Installation Procedures, and Specifications

REVISED

December 2024

Contents

Glossary

Active Zone – The portion of a public right of way that contains all active transportation such as pedestrians and bicyclists. Zone includes sidewalks or sidepaths, separated bike lanes, frontage zones, and a variety of buffers as defined in the Complete Streets Design Guide.

ADA – Americans with Disabilities Act.

Backlight – The backward component of the BUG rating system. The percent lamp lumens or the luminaire lumens distributed behind a luminaire between zero degrees vertical and 90 degrees vertical.

BUG Rating – A luminaire classification system developed to assess light trespass, glare, and skyglow. This system replaced the "cutoff" classification system, which focused on uplight. It provides the maximum lumens within defined angles for the primary areas known as backlight (B), uplight (U), and glare (G). FHWA recommends that veiling luminance be used rather than the glare component of the luminaire classification system when determining glare.

Correlated Color Temperate (CCT) – A measure of the visual warmth or coolness of light expressed in kelvins (K). The lower the value, the more "warm" or yellow in color light appears. The higher the value, the more "cool" or blue in color the light appears.

DarkSky – Previously known as the International Dark-Sky Association, it is a non-profit organization focusing on combating light pollution worldwide. They provide a third-party, objective certification process for light fixtures that minimize glare, light trespass, and pollution. The certification is known as "DarkSky Friendly."

FHWA – Federal Highway Administration.

Glare – The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted, causing annoyance, discomfort, or loss in visual performance and visibility.

Horizontal Illuminance – The amount of light falling on a horizontal plane. Increased values at night improve the accuracy and speed at which information can be ascertained by the suer from the roadway environment.

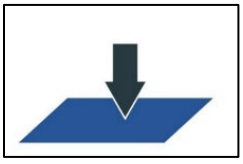


Figure 1. Horizontal Plane. (Source: FHWA)

IES – Illuminating Engineering Society.

Intensity – The measure of the concentration of light in a particular direction, which is expressed in candelas (cd).

Illuminance – The measure of the density of light on a surface divided by the area of the surface, which provides an average illuminance over that area. Illuminance is expressed in lux (lx) where 1 lx = 1 lumen per square meter, or footcandles (fc) where 1 fc = 1 lumen per square foot. See definitions of vertical, horizontal, and semi-cylindrical illuminance.

Lumens – The unit measure of luminous flux, which is the amount of light emitted by a source in all directions.

Luminance – the measure of the concentration of light reflected toward the observe per unit area of surface. Luminance is expressed in candelas per square meter (cd/m^2).

Light Trespass – The effect of light that strays from the intended purpose, or the encroaching of light causing annoyance, loss of privacy, or another nuisance.

MCC – Montgomery County Code.

MDOT SHA – Maryland Department of Transportation State Highway Administration.

Mounting Height – The vertical distance between the street zone or active zone surface and the center of the apparent light source of the luminaire.

Pedestrian-Scale Lighting – Streetlighting providing luminaires with a mounting height less than 25 feet.

Photometrics – The measurement of quantities associated with light both visual and physical; also known as photometry.

Roadway-Scale Lighting – Streetlighting providing luminaires with a mounting height greater than or equal to 25 feet.

Semi-Cylindrical Illuminance – The amount of light falling on a vertical, semi-cylindrical plane. This metric provides a wider angle of measure that may more accurately represent the ability of a driver to see a pedestrian in some scenarios because it helps account for the three-dimensional nature of a pedestrian. It may also be an effective measure when considering pedestrian-to-pedestrian interactions, such as facial recognition.

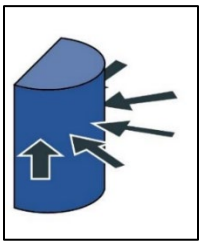


Figure 2. Semi-Cylindrical Plane. (Source: FHWA)

Uniformity Ratio – As used in this document, uniformity refers to the ratio of average horizontal illuminance to minimum horizontal illuminance within a given calculation area. Uniformity reduces the need for the eye to adapt to varying light conditions.

Uplight – The upward component of the BUG rating system. It is the percent lamp lumens or the luminaire lumens distributed above a luminaire between 90 and 180 degrees vertical.

Veiling Luminance – The metric used to evaluate disability glare as experienced by a driver. The term originates from the "veil" of luminance that is superimposed on the retina by stray light within the eye.

Vertical Illuminance – The amount of light falling on a vertical plane. Typically recorded at the eye level of observers oriented to their path of travel. This metric helps road users see objects and influences the amount of glare experienced by those users.

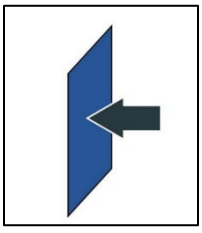


Figure 3. Vertical Plane. (Source: FHWA)

Streetlighting Overview

Streetlights are primarily used for illuminating sidewalks, bikeways, and roadways to provide an enhanced visual environment for road users during times of darkness. The street network is a significant public asset, serving a multitude of important roles in the community. At the same time, streets are not always used to their full potential as public places of shared use. This document aligns the Streetlighting Design Requirements, Procedures, and Specifications for Materials and Construction with the County's Complete Streets Design Guide (CSDG), Vision Zero framework, and industry best practices for streetlighting. Similar to the County's CSDG, this document offers design considerations and recommendations to make our streets safer, more sustainable, and more vibrant. Streetlighting enhances transportation infrastructure by improving safety and providing inviting spaces, which also promotes economic exchange, recreation, and social engagement.

How To Use This Document

Montgomery County Department of Transportation (MCDOT) and Montgomery Planning, with funding from the Metropolitan Washington Council of Governments (MWCOG) Transportation Land Use Connections (TLC) program, developed this document to provide policy and design guidance to government agencies, consultants, private developers, and community groups on the planning, evaluation, design, and construction of streetlighting. This document should be used in the following situations:

- When designing future streets or reconstructed streets in an area experiencing land development.
- When implementing a capital improvement project, such as construction or reconstruction of a street, intersection, bridge, bikeway, walkway, or transit station and large-scale street lighting projects.
- When implementing traffic safety countermeasures that have identified the need for streetlighting at a given location, based on engineering judgment.

In each of these circumstances, existing and proposed streetlighting conditions should be evaluated to determine if the desirable photometric criteria are or will be met. Photometric criteria are provided in Tables 1, 2, and 3 of this document. Recognizing that streetlighting design is complex and must respond to varied local conditions and site constraints, this document should be used in conjunction with engineering judgement to make site-specific decisions. The photometric criteria in this document are required but may be adjusted on a case-by-case basis by MCDOT based on unique circumstances. Lighting may not be appropriate in certain contexts where the costs and/or impacts outweigh the benefits. In these cases, it may be appropriate for the photometrics to have lower target values to minimize or mitigate potential impacts.

Montgomery County has an extensive street and trail network and as such, many of the recommendations in this document are meant to be implemented incrementally over time. The intent is that anyone involved in a project within public rights-of-way will actively seek out opportunities to design and retrofit streets and trails to meet target light levels with the

appropriate equipment and materials. Safety shall be held paramount while also considering environmental impacts, equity, maintenance, and sustainability.

This document establishes policy for the design of County-owned public rights-of-way, public spaces, or privately-owned streets located in the County. For State-owned roads, this document is intended to present the County's vision for the roadway, to serve as a starting point for collaboration between the County and Maryland Department of Transportation State Highway Administration (MDOT SHA). State-owned rights-of-way are subject to the lighting criteria defined in MDOT SHA's Lighting Design Guide and the Standard Specifications for Construction and Materials, except County requirements will be used where the county funds, owns and maintains streetlights.

The policy is intended to be a living document, to be supplemented and updated over time to adapt to the needs of the County, as well as to utilize emerging technologies and best practices.

Streetlighting Fundamentals

Streetlighting is primarily used for lighting sidewalks, bikeways, and roadways to provide an enhanced visual environment for road users during times of darkness. Streetlighting, when used properly, reduces motor vehicle collisions, and provides a safer environment for all road users. Streetlighting can also be used to provide comfort for road users by providing a clearer knowledge of what lies ahead and a sense of personal security. Other non-road user considerations may include aesthetic and economic benefit of streetlighting that can be used to draw attention and visibility to commercial areas or other features.

Streetlighting substantially decreases nighttime collision rates, most importantly the occurrence of fatalities. While streetlighting has many benefits, the primary necessity for streetlighting along Montgomery County roadways is to enhance public safety and reduce traffic fatalities and serious injuries resulting from motor vehicle crashes.

To understand streetlighting, we must understand the human factors that are associated with lighting. These include both physical and psychological factors such as the condition of the driver's eyes, constantly changing eye adaptation, road user fatigue, and sensitivity to light. Visual cues comprise approximately 90% of a driver's information, which is used to control the vehicle, estimate gaps, detect hazards, and estimate speed.

Streetlighting is a critical component of traffic safety, but its installation and placement must also minimize adverse impacts to the natural environment. Lighting has been found to influence wildlife behavior and habits, as well as plant life responses. Electric lighting increases sky glow above the background levels through a combination of direct and reflected light. Any light emitted above the horizontal contributes directly to sky glow. To minimize sky glow, Montgomery County uses streetlight luminaires that are DarkSky Friendly. Light trespass must also be evaluated to ensure that obtrusive light from streetlighting does not negatively affect adjacent private properties.

Light and Visibility Principles

For an overview of visible light and the principles of human vision, please refer to the Illuminating Engineering Society's (IES) Recommended Practice: Lighting Roadway and Parking Facilities (RP-8-21) or the FHWA Lighting Handbook 2023.

Visibility and the factors influencing visual perception at night are complex and involve eyes undergoing constant adaptation to differing luminance levels. Within the public right-of-way, a road users' visual scene does not consist solely of a roadway surface and a potential hazard but may include opposing vehicle headlights and off-street light sources in addition to streetlighting. Contrast, visual acuity, and glare are important factors affecting visibility for road users.

Contrast for streetlighting refers to the difference between the luminance of an object and the luminance of the background. Human's contrast sensitivity is the ability of the eye to discern objects and backgrounds. Visual acuity is a measure of one's ability to identify details under a given set of lighting conditions. Glare is the presence of non-uniformities in the visual field, mostly resulting from bright sources that affect the adaptation of the eye. There are two categories of glare – disability and discomfort. Disability glare can drastically decrease visibility. Discomfort glare does not impact visibility but can result in physical pain and annoyance. Both are quantifiable, though disability glare is the only one with maximum recommended levels, which are defined in this document.

Light Distribution

IES defines a classification system for describing the lateral and longitudinal pattern of light that is produced by a luminaire. Distribution types range from Type I (very linear) to Type V (circular). These distribution types are illustrated below.

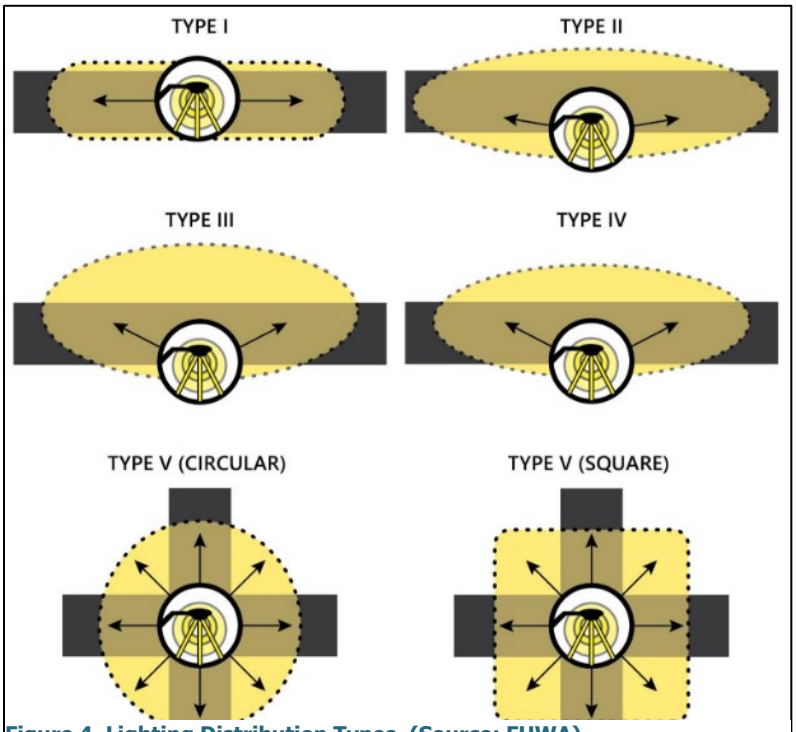


Figure 4. Lighting Distribution Types. (Source: FHWA)

Streetlighting Considerations

The addition of streetlighting within public rights of way must be justified using various criteria to determine if a facility is eligible for streetlighting installations. Streetlights will not be approved if existing lighting conditions meet desirable light levels. If desirable light levels are not met, streetlighting will be considered under one or more of the following conditions:

- If streetlighting is required or recommended based on street typology as defined in the Complete Streets Design Guide (CSDG).
- If a residential area (Neighborhood Collector, Neighborhood Street, Neighborhood Yield Street, Country Road, Rustic Road, or Residential Shared Street) has a petition for streetlighting along a road segment that is supported by at least two-thirds (2/3) majority of affected residents (those residing in properties directly abutting the area to be lit). A petition is not required for business or industrial areas.
- Undeveloped segments of roadway may include streetlighting to address safety considerations.
- Intersection lighting and streetlighting along non-residential street types (Downtown Boulevard, Downtown Street, Town Center Boulevard, Town Center Street, Boulevard, Industrial Street, Country Connectors, Major Highways, or Commercial Shared Streets) may be installed without concurrence from abutting property owners.
- Streetlighting shall conform with the specifications of this document. MCDOT will not maintain streetlighting that uses non-standard poles, luminaires, or operating equipment without prior authorization.
- If streetlighting is recommended as a traffic safety countermeasure in a safety assessment prepared by MCDOT or Montgomery Planning.

To minimize additional light pollution, energy usage, and environmental impacts, lighting enhancement efforts should prioritize conversion to high-efficiency (LED) lights with appropriate fixtures that meet target illuminance levels and limit light trespass over installation of new lights, except where safety deficiencies may exist.

Streetlighting Warrant Criteria

Street type should be the primary factor for determining if streetlighting is to be pursued for a given project or facility, as identified in Table 1 on the next page. Building on the CSDG considerations, a literature review of industry best practices and research informs the criteria established in Table 1 for Streetlighting Warrant Criteria for both active zones and streets zones, with street zones broken into intersections and segments (continuous roadway lighting). Table 1 provides Warrant Criteria based on the CSDG Street Types.

Table 1. Streetlighting Warrant Criteria

CDSG Street Type	Active Zone	Street Zone	
		Intersection	Segment
Downtown Boulevard	Required	Required	Required
Downtown Street	Required	Required	Required
Boulevards	Required	Required	Recommended
Town Center Boulevard	Required	Required	Required
Town Center Streets	Required	Required	Required
Area Connector	Required	Required	Recommended
Neighborhood Connector	Required	Required	Recommended
Neighborhood Streets	Recommended	Required	Optional
Neighborhood Yield Streets	Recommended	Required	Optional
Industrial Street	Optional	Required	Recommended
Country Connector	Optional	Required	Recommended
Country Roads	Optional	Optional	Optional
Major Highway	Optional	Required	Required
Alley	Optional	Optional	Optional
Rustic Road	Optional	Optional	Optional
Shared Street	Required	Required	Required
Bikeways	**Active Zone**	**Street Zone**	
		Intersection	**Segment**
Off-Street / Trail	Required	Required	N/A
Sidepath / Shared Use Path / Separated or Protected Bike Lanes	Required	Required	N/A
On-Street Bikeway*	N/A	Required	See Street Type
Transit Corridors	**Active Zone**	**Street Zone**	
		Intersection	**Segment**
Dedicated or Shared Transitway	Required	Required	Required

*On-street bikeways include buffered bike lanes, advisory bike lanes, conventional bike lanes, bikeable shoulders, shared streets, neighborhood greenways, and priority shared lane markings

Where streetlighting is optional, a context-sensitive approach should be used in evaluating the appropriateness of an installation. This may include a lower correlated color temperature (CCT), house side shielding, or reduced light level targets. A Historic District or adjacent property may require use of non-standard structures or fixtures to keep in character with the historic setting. Context-sensitive considerations may result in the decision to not provide streetlighting where it's determined that the benefits do not outweigh the impacts and costs. Higher CCT or light level targets may be desirable in locations with perceived personal safety concerns or increased rates of crime.

Active and Street Zones along with their basic components are illustrated in Figure 5 below.

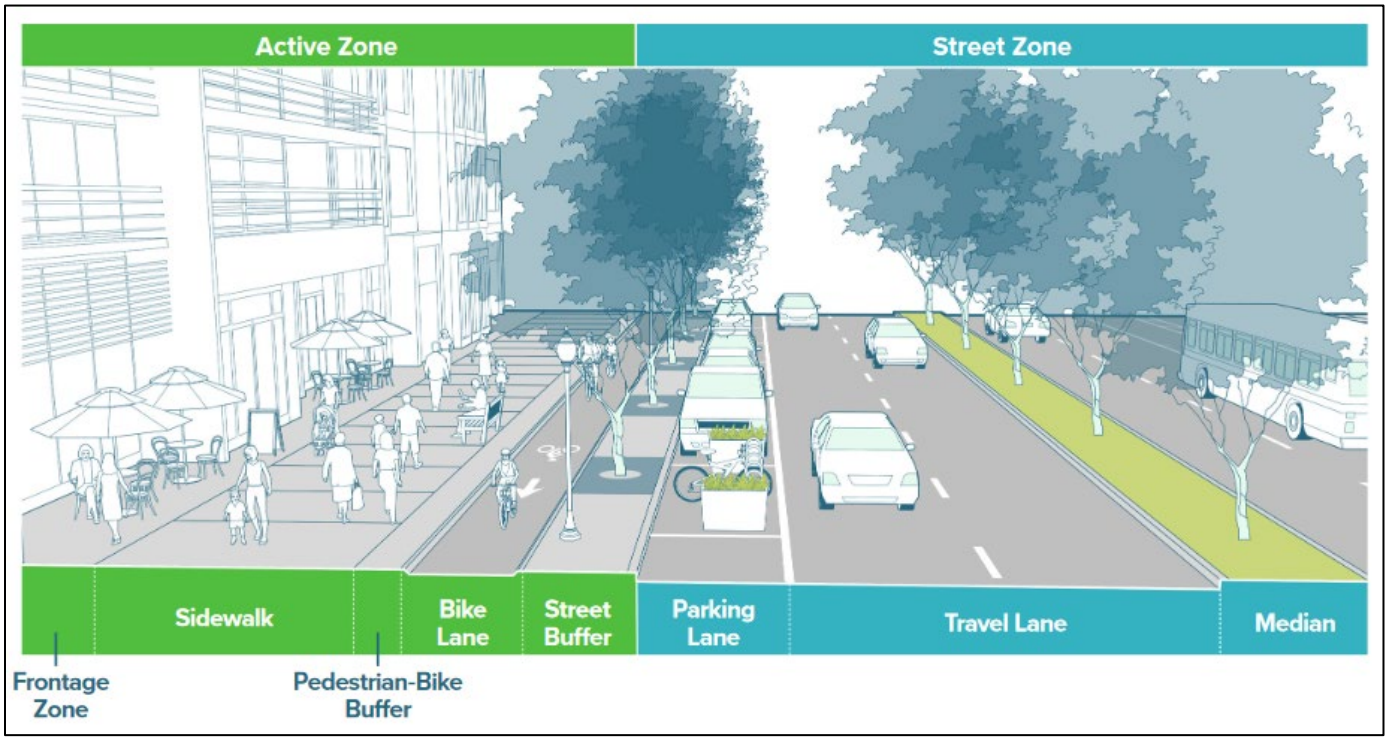


Figure 5. Street and Active Zones Defined. (Source: Montgomery County CSDG)

Environmentally and Culturally Sensitive Areas

As noted in Thrive Montgomery 2050, the update to the County's General Plan, transportation systems that make alternatives to driving practical and attractive are an essential component of a comprehensive strategy to fight climate change. A stronger focus on walking, biking, and transit infrastructure is crucial. Active Zones must be appropriately lit to provide safety and comfort while balancing ecological impacts to surrounding wildlife, natural resources, and areas of cultural and historical significance.

Streetlighting proposals should be cross referenced with Environmentally and Culturally Sensitive Areas (ECSA) as defined by Montgomery Parks and Planning. Light level criteria should first be defined by the Street Type. Where proposal would introduce artificial light into ECSAs, Street Type light level criteria may have an adverse impact that outweighs the benefit of the streetlighting. Flexibility in light level target criteria and streetlighting equipment may be appropriate to ensure ecological impacts are balanced with the goals and objectives of the

project. Design flexibilities may include mitigating light trespass with shielding, reducing light output or warmer color temperatures in combination with reduced light level targets, or "no-build" scenarios where streetlighting is omitted in critical areas or for an entire project. Lighting controls will improve flexibility as new technologies become more reliable and cost efficient. Refer to the Emerging Technologies section for further discussion of lighting controls.

ECSAs as defined by Montgomery Parks and Planning are listed below in Table 2.

Table 2. Environmentally and Culturally Sensitive Areas

Areas	Definition
Agricultural Areas	Agricultural Reserve
Conservation Oriented Parks	Best Natural Areas, Biodiversity Areas, Conservation Parks, Stream Valley Parks, Regional Parks
DNR Focal Areas	Targeted Ecological Areas, Rural Legacy Areas
Forests	Biological community dominated by trees and other woody plants covering a land area of 10,000 square feet or greater. Areas that have at least 100 trees per acre with at least 50% of those trees having 2-inch or greater diameter at a height 4.5 feet above ground, including areas that have been cut but not cleared.
Historic Properties / Historic Districts	Individual properties and historic districts that are: Listed in the County's Master Plan for Historic Preservation; Identified in the County's Locational Atlas and Index of Historic Sites; Or Listed in or determined eligible for listing in the National Register of Historic Places.
Meadows / Grasslands	Areas dominated by herbaceous vegetation (>80% cover).
State Designated Protected Lands	DNR Owned Lands and Conservation Easements, Rural Legacy Properties, MD Environmental Trust Easements, Forest Conservation Act Easements, MD Agricultural Land Preservation Foundation Easements, Local Protected Lands, Coast and Estuarine Land Conservation Program, Private Conservation Lands, Protected Federal Lands, and Transfer Development Rights and Purchase Development Rights
Streams	Body of water within a channel that flows at last some of the time.
Wetlands	Area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

Streetlighting proposals within any of the ECSAs listed above, the design team and MCDOT should meet with Montgomery Parks and Planning staff to determine the appropriate light level criteria and approaches to mitigate ecological impacts from artificial light sources.

Equity Considerations

Streetlighting proposals should be implemented following the principles of the County's Vision Zero Equity Framework. While safety projects recommended or requested by communities should be given priority, funding, County resources, and types of projects should be prioritized using data-driven approaches. Prioritization of streetlighting improvements and allocation of resources should focus on the transportation modes and communities experiencing the highest rates of fatal and serious injury crashes while also considering equity emphasis areas, school walksheds, and areas with high rates of senior populations that may be at higher risk for traffic-related death or injury.

Traffic safety outcomes are a core component of transportation equity, but designers must also consider the impacts of artificial lighting on the surrounding community when performing equity evaluations. The built environment must provide equitable safety outcomes and accessibility for communities, as well as address inequities resulting from the negative impacts of streetlighting.

Light Level Target Criteria

The Active Zone is comprised of the elements of the public right of way located off-street – the Street Buffer Zone, Clear Zone, and Frontage Zone. The Street Buffer Zone is adjacent to the curb line or edge of pavement and is the preferred location for the placement of streetlighting, but must compete for space with trees, vegetation, street furniture, signs, utilities, and green infrastructure. The Clear Zone is the area behind the Street Buffer Zone that is specifically reserved for walking and rolling. The Clear Zone is labeled as the sidewalk/sidepath in Figure 6 below. It should provide accessible pedestrian space meeting the appropriate vertical and horizontal clearance requirements. The Frontage Zone is the space between the Clear Zone at the right-of-way boundary or building frontage. It is desirable for light levels to meet target values for the entire Active Zone, but various constraints may limit the calculation area to the Clear Zone. Table 3 provides the target light level criteria for Active Zones.

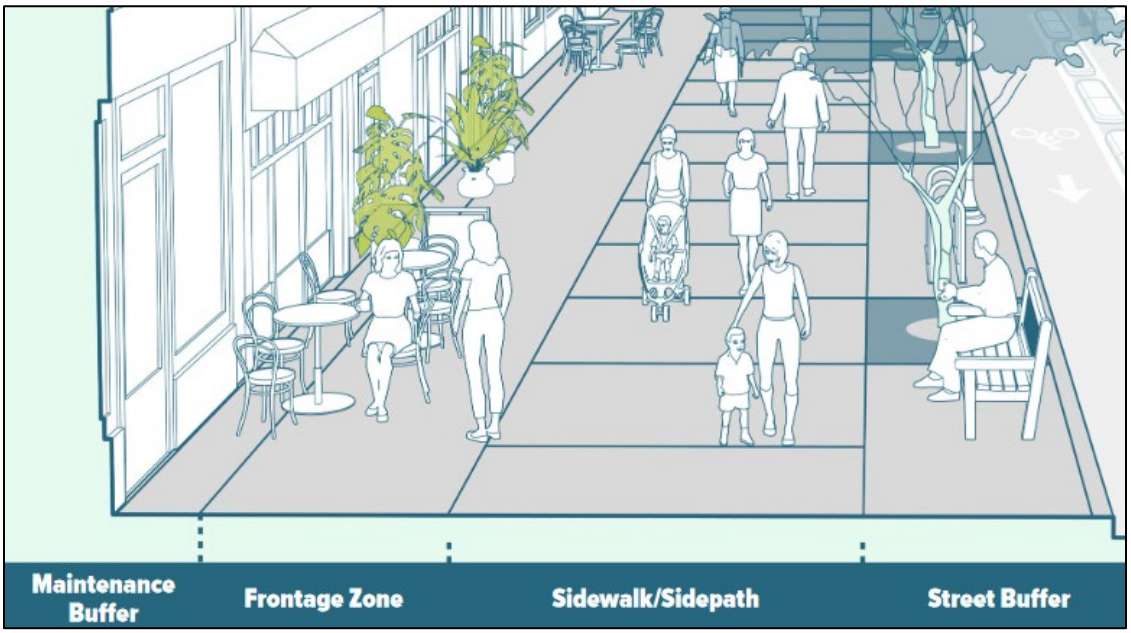


Figure 6. Active Zone. (Source: Montgomery County CSDG)

Table 3. Target Lighting Values for Active Zones

CSDG Street Type	Active Zones Adjacent to Roadways				
	Minimum Horizontal Illuminance (fc), $E_{H,min}$	**Maintained Average Horizontal Illuminance (fc), $E_{H,avg}$**	**Maintained Average Vertical Illuminance (fc), $E_{V,min}$**	**Uniformity Ratio ($E_{H,avg}$ / $E_{H,min}$)**	**Maintained Average Surface Luminance (cd/m^2), L_{avg}**
Downtown Boulevard	0.2	0.9	1.0 – 1.2	3.0	2.0 – 2.5
Downtown Street					
Boulevards	0.2	0.5	0.2 – 0.4	4.0	1.0 – 1.5
Town Center Boulevard	0.2	0.9	1.0 – 1.2	3.0	2.0 – 2.5
Town Center Streets					
Area Connector	0.2	0.5	0.2 – 0.4	4.0	1.0 – 1.5
Neighborhood Connector					
Neighborhood Streets					
Neighborhood Yield Streets					
Industrial Street	0.2	0.3	0.2 – 0.4	6.0	1.0 – 1.5
Country Connector	0.1	0.2	0.2 – 0.4	10.0	0.4 – 1.0
Country Roads					0.3 – 0.8
Major Highway	0.2	0.3	0.2 – 0.4	6.0	0.8 – 1.3
Alley	0.2	0.5	0.2 – 0.4	4.0	1.0 – 1.5
Rustic Road	0.1	0.2	0.2 – 0.4	10.0	0.3 – 0.8
Shared Street	0.2	0.9	1.0 – 1.2	3.0	2.0 – 2.5
Specialty	**Active Zones in Area with Increased Security Needs**				
Security	0.5	1.2	2.2 – 2.4	3.0	2.0 – 2.5
Facility	**Active Zones Not Adjacent to Roadways**				
Trail / Shared Use Path	0.1	0.4 – 2.0	0.5	4.0	1.0
Tunnel	-	5.4	5.4	3.0	2.0

1. The low end of the range is for Roadway-Scale light sources, while the high end of the range is for Pedestrian-Scale light sources.

The Street Zone is the area bound by the curbs or pavement that provides access and mobility for motor vehicles, transit, freight, and emergency vehicles. It can be further divided into the Curbside Zone, Travelway Zone and Median Zone. The Curbside Zone is the area adjacent to the Active Zone that may be used for on-street parking, active transportation corrals, loading zones for people or freight, on-street bikeways, or parklets. These uses may vary by segment and by time of day. The Travelway Zone is used for the movement of motor vehicles, transit, freight, and emergency vehicles, and in many locations, bicycles or micromobility vehicles. The Median Zone runs along the center of the Street Zone and can be used to bifurcate opposing directions of travel in addition to providing space for stormwater management, landscaping, transit access, auxiliary turn lanes, and other roadway elements. The Median Zone may also be used for placement of streetlighting. Figure 7 illustrates the Street Zones below.

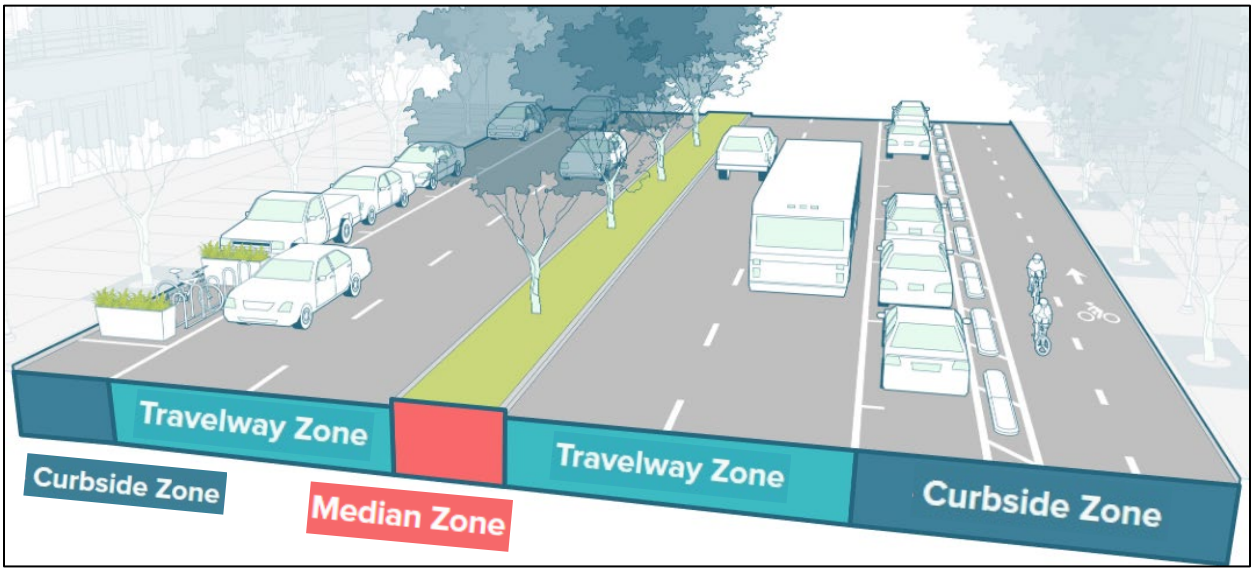


Figure 7. Street Zones. (Source: Montgomery County CSDG)

Table 4 provides the target minimum light level criteria for Street Zones where two streets intersect. Table 5 provides the target minimum light level criteria for Street Zones along segments (in between intersections). The intersection area should be bound by the outer limits of crosswalks for uncontrolled approaches or stop lines for controlled approaches. Median Zones are desirable to include in photometric calculation areas, but where pedestrian refuge is not provided, illumination of the Median Zone is optional. On-street bike facilities located within the curbside zone shall be included in Street Zone calculations.

The light level criteria provided in this document are derived from literature review of industry best practices and research related to streetlighting, as well as recommended lighting criteria provided by IES and FHWA. Lighting criteria is based on a variety of street parameters including speed, traffic volumes, median presence, intersection or interchange density, ambient lighting conditions, pavement marking quality, VRU activity levels, on-street parking, and security needs. The approach outlined in the FHWA Lighting Handbook 2023 has been adapted for use with the Montgomery County CSDG Street Types using design parameters defined in the Lighting Handbook that most closely align with the target design parameters for each CSDG Street Type.

Table 4. Target Lighting Values for Street Zones – Intersections

Highest CSDG Street Type for Intersections	Minimum Horizontal Illuminance (fc), $E_{H,min}$	Maintained Average Horizontal Illuminance (fc), $E_{H,avg}$	Uniformity Ratio ($E_{H,avg}$ / $E_{H,min}$)
Downtown Boulevard	0.1 – 0.5	1.3 – 2.0	3.0
Downtown Street			
Boulevards			
Town Center Boulevard			
Town Center Streets			
Area Connector			
Neighborhood Connector	0.2 – 0.5	1.3 – 1.5	4.0
Neighborhood Streets			
Neighborhood Yield Streets			
Industrial Street			
Country Connector			
Country Roads			
Major Highway	0.1 – 0.5	1.3 – 2.0	3.0
Alley	0.2 – 0.5	1.3 – 1.5	4.0
Rustic Road			
Shared Street	0.1 – 0.5	1.3 – 2.0	3.0

Table 5. Target Lighting Values for Street Zones – Segments

CSDG Street Type	Maintained Average Horizontal Illuminance (fc), $E_{H,avg}$	Uniformity Ratio ($E_{H,avg}$ / $E_{H,min}$)	Maintained Average Surface Luminance (cd/m^2), L_{avg}	Veiling Luminance (L_{max}/L_{avg})
Downtown Boulevard	0.7 – 1.0	3.0	0.6 – 1.5	0.3
Downtown Street				
Boulevards				
Town Center Boulevard				
Town Center Streets				
Area Connector	0.6 – 0.7	3.0	0.4 – 1.0	0.4
Neighborhood Connector				
Neighborhood Streets	0.2	6.0	0.3 – 0.8	0.4
Neighborhood Yield Streets				
Industrial Street	0.6 – 0.7	3.0	0.4 – 1.0	0.4
Country Connector				
Country Roads	0.2	6.0	0.3 – 0.8	0.4
Major Highway	0.6 – 0.8	3.0	0.8 – 1.3	0.3
Alley	0.2	6.0	0.3 – 0.8	0.4
Rustic Road				
Shared Street	0.7 – 1.0	3.0	0.6 – 1.5	0.3

Photometric Evaluation

Light Source Selection

Once streetlighting design and photometric considerations are defined and agreed upon, site-specific structures and fixtures must be selected from MCDOT's standard specifications. Alternate poles, fixtures, luminaires, or controls may be proposed, but will require an executed memorandum of understanding (MOU) detailing responsibilities for ongoing maintenance and operation of non-standard streetlighting equipment. MCDOT does not operate or maintain non-standard streetlighting equipment. Emerging technologies may be tested and reviewed for adoption into standard specifications as opportunities are presented. Formal adoption of emerging technologies and new equipment are subject to available funding and resources.

Standard equipment for both pedestrian-scale and roadway-scale streetlighting is detailed in this section. Pedestrian-scale streetlighting refers to any luminaire and pole with a mounting height less than 25 feet above grade. A mounting height greater than or equal to 25 feet is referred to as roadway-scale streetlighting. Pedestrian-scale lighting may be used to illuminate the Street Zones or Active Zones. Lower mounted fixtures may increase glare along a street segment. When pedestrian-scale lighting is used, it may require greater offset from the Street Zone or increased luminance levels to ensure that glare will be within the acceptable range. Roadway-scale lighting is typically used for illuminating Street Zones but may also be used to light Active Zones. Higher mounted fixtures provide greater lighting coverage, allowing for less structures to be placed within a given area. However, higher mounting heights increase light spillover and due care should be taken to ensure that light trespass is properly accounted for and mitigated to limit adverse impacts to adjacent properties and the environment.

Extraneous and Decorative Light Sources

While extraneous light sources contribute to the ambient light conditions within a public right of way, they are not acceptable substitutes for light sources maintained and operated by MCDOT. Parking lot area lights, building sconces and lanterns, illuminated bollards, flood lights, string lights, and other artificial light sources installed by others in public spaces or on private property adjacent to the public right of way shall not be factored into photometric analysis. These light sources are not controlled by MCDOT, nor can their specifications be easily verified.

No artificial light sources are permitted within County public rights of way without approval from MCDOT.

Photometric Layout

Photometric evaluations should be performed using computer software that follows the calculation methodologies detailed in IES RP-8-21, *Recommended Practice: Lighting Roadways and Parking Facilities*. While photometric evaluations are necessary for proposed permanent streetlighting conditions, they may also be used for determining existing lighting conditions.

Light sources used in photometric analyses shall be those identified in the Streetlight Specifications. Mounting heights to use for photometric evaluation are detailed in the MCDOT's standard specifications. While the preferred placement is within the Street Buffer Zone,

streetlighting placement may vary based on site constraints and photometric needs. General placement of streetlight structures should follow the criteria below:

- Minimum 2’ offset from curb face for closed sections.
- Minimum 6’ offset from edge of roadway for open section.
- Minimum 2’ offset from edge of bikeway.
- Desirable minimum 5’ offset from driveways and utilities.
- Desirable minimum 15’ offset from center of trees.

Streetlighting should be placed in a manner that is consistent, regular, and compatible with other street design elements. Uniform spacing and a consistent pattern for streetlighting and street trees is highly desirable to limit road user distraction and provide a cohesive sense of place along a corridor.

Light Loss Factor

The light loss factor (LLF) applied to a fixture is a product of multiple factors related to equipment and maintenance. Lamp lumen depreciation (LLD) describes the gradual reduction in light output over the lifetime of a fixture. This information is typically provided by manufacturers. Luminaire dirt depreciation (LDD) describes the reduction in luminaire light output resulting from the accumulation of dirt on both the inside and outside of a luminaire reflector. MDOT SHA specifications define a LLF of 0.81 for LED roadway luminaires. Typical luminaires used by MCDOT are expected to have a LLF between 0.80 and 0.90. Where street trees are expected to interfere with light output along a Street Zone or Active Zone, FHWA recommends applying an additional 10% to 20% light loss to account for shading.

LLF should be discussed and agreed upon by the designer and MCDOT prior to performing photometric analysis. When streetlighting installations are located within MDOT SHA rights of way, a LLF of 0.81 shall be used.

Streetlighting Design Plans

All streetlighting plans shall be reviewed and approved by MCDOT prior to construction. Streetlighting design must be verified by photometric analysis and approved by MCDOT. All materials shall be per MCDOT specifications. All streetlights shall be energized by the utility company and placed into operation prior to the County acceptance of the project.

Streetlighting Infrastructure

Splice Boxes

Splice boxes shall be provided adjacent to all streetlight structures to serve as access, as well as providing a boundary for establishing MCDOT and utility company maintenance responsibilities. Splice boxes may be required to meet the specifications of the utility company. Cover shall be installed flush with the final grade, sidewalk, or pathway. The structures shall be designed for light truck loading per ASTM C857. If a splice box location requires installation within a vehicular travel way, MDOT SHA Standards MD 811.04 and MD 811.04-01 shall be used.

Conduits

All electrical cables for streetlighting shall be run in Schedule 40 or 80 rigid polyvinyl chloride (PVC) conduits installed with a minimum 24 inches of ground cover. Streetlighting conduit sizes should follow the requirements of the utility company. Streetlighting conduits installed beneath the roadway shall be 4-inch diameter. Conduits installed via directional boring may be constructed of high-density polyethylene (HDPE) in lieu of PVC.

Ground Rods

Ground rods are to be installed in all splice boxes adjacent to streetlighting poles. If a splice box is not provided, the ground rod should be installed adjacent to the streetlight pole. Connections between ground wire and ground rods should be made by exothermic weld.

Cable

Streetlight installations shall include wiring from the luminaire to the base of the support or to the adjacent handbox as applicable. Three (3) #10 AWG electrical cables are to be provided between the luminaire and the location where the utility will splice into branch circuits.

Design Revisions

In circumstances where site conditions have evolved or previously unknown constraints or considerations require shifting of a streetlight greater than 10 feet from its location in the approved photometric analysis, the designer shall update the photometric plan and resubmit to MCDOT for approval. Design changes may not result in a lighting condition that is substandard to the agreed upon target criteria or create additional light trespass exceeding allowable thresholds. MCDOT may require justification where targets can no longer be met.

While this document provides specifications for streetlighting luminaires and poles, environmental and land use contextual considerations may justify deviation from targets. Alternate correlated color temperatures (CCTs) may be considered for neighborhoods or environmentally sensitive areas where a reduction to 2700K may better align with the character of a community. This may be applicable for streetlighting installations within Historic Districts,

adjacent to historic properties, adjacent to or within Parks properties, or other context-sensitive areas.

Deviation from criteria may also be necessary due to site-specific constraints. Shielding of luminaires can be used to minimize adverse impacts to wildlife and light trespass along adjacent residential properties. Light level targets may be less than desirable where it is impractical to install streetlighting due to overhead and underground utility constraints. Leased lights may be installed on utility poles to provide streetlighting, but placement would be subject to the existing locations of utility poles along a segment.

Maintenance Considerations

It is recommended that splice boxes be provided adjacent to all streetlight poles, and that access holes be provided at the base of all streetlight poles to accommodate maintenance efforts for replacing and troubleshooting issues in the field. Roadway-scale lighting that places luminaires over the roadway should minimize encroachment into the travelway for achieving light level targets. This will limit the need for temporary lane closures and allow for maintenance workers to be buffered from active travelways. All streetlighting structures shall be placed in compliance with the Maryland High Voltage Line Act, providing adequate aerial clearance from utilities to accommodate safe installation and maintenance of streetlighting.

Splice boxes placed within Active Zones, specifically the Clear Zone, present hazards to those walking and rolling should the splice box cover be damaged or when maintenance work is taking place. Splice boxes should be placed outside of the Clear Zone when practical.

Stakeholders often inquire about the implementation of non-standard equipment and controls as part of a streetlighting design. Timers, adaptive lighting sensors, and similar products cannot presently be maintained by MCDOT will continue to be evaluated and considered for formal adoption as funding and resources become available. See Emerging Technologies section for additional information.

Luminaires and photocells may require routine cleaning to ensure photocontrol operates as intended, and light remains close to the initial lumen output of the fixture. MCDOT maintains the physical infrastructure needed for streetlighting including splice boxes, conduits, foundations, and poles. Luminaires and wiring are maintained by the utility company.

Other Design Considerations

Physical site constraints may dictate streetlighting placement, mounting heights, and circuity layout. The following should be considered during streetlighting plan development:

Power Source: The availability of electrical power may impact a decision to provide streetlighting. As photovoltaics and energy storage systems improve and become more efficient, cheaper, and readily available, alternatives to hardwire electrical power should be considered. Presently, streetlighting requires a hardwire connection to a public utility. These connections may be metered or unmetered. Streetlighting circuits to be owned and maintained by MCDOT are typically unmetered. Streetlighting plans must identify proposed power sources – utility pole, transformer, junction box, or electrical manhole. The ultimate power service location and design will be provided by the utility company.

Proximity to Aircraft Facilities: Typically, an airport authority will have specific pole height limitations within a defined glide path surrounding an airfield. Aircraft facilities in close proximity to streetlighting installations should be identified early in the design process to determine the relevant criteria for that specific facility.

Overhead Utilities: Streetlighting designs and installations shall adhere to the Maryland High Voltage Line Act and National Electric Code (NEC). Transmission lines in close proximity to streetlighting installations should be identified early in the design process and radial clearances verified with utility companies.

Roadside Safety: Streetlighting pole placement should adhere to the AAHSTO *Roadside Design Guide.* Structures may require the use of transformer bases that meet MASH criteria depending on the operating speed of a roadway and offset from the traveled way.

Development Procedures

All submissions should be made electronically via email. Photometric analysis and streetlighting plans should be sent to streetlights@montgomerycountymd.gov. For site development projects, procedures are outlined below by utility region. A map illustrating the general limits of PEPCO, BGE, and First Energy is provided in Appendix C. Developers should contact MCDOT to verify utility region prior to final design. Site development plans are also subject to review and approval from Montgomery Planning.

PEPCO Region

Site development projects may approach streetlighting implementation through the four (4) approaches described below:

1) **Streetlighting is furnished and installed by PEPCO at the request of the developer.**
   a) The developer shall contact MCDOT to establish the appropriate light level targets, pole, and fixture types.
   b) The developer shall prepare and submit a photometric plan with a proposed lighting layout that meets the target light levels. If light levels cannot be achieved, justification should be provided. MCDOT will accept the photometric plan for the developer to proceed with lighting design or provide review comments to update photometric analysis.
   c) The developer shall prepare a streetlighting plan illustrating the pole locations, handboxes, and underground conduits, and all relevant existing and proposed geometry, utilities, right-of-way lines, trees, and other pertinent design features that may influence streetlighting design and location. Plans must be submitted in PDF format with the corresponding CAD files in .dgn format. Plans that are incorrect or incomplete will be returned to the developer for revision and resubmission.
   d) The streetlight plans are reviewed and minor revisions, if necessary, are made by MCDOT. All three (3) copies of the plans are approved (as revised). An MCDOT stamp indicating the type, wattage and number of lights will be affixed to each plan and signed as approved by the designated County official.
   e) MCDOT signs and approves streetlighting plans and provides them to the developer with an official letter of approval. A copy of the approval letter is also sent to PEPCO (without plans).
   f) The developer shall submit one (1) copy of the approved streetlight plans to PEPCO with a request for streetlight installation and energization.
   g) PEPCO prepares the streetlight installation/electrical drawings in accordance with the County approved streetlight layout plan and submits a cost estimate to the developer for the installation and energization of the streetlights.
   h) After PEPCO receives payment, the streetlights are scheduled for installation in conjunction with the construction of the subdivision streets. PEPCO advises MCDOT, in writing, when payment is received.

i) Remittance of payment alone shall not release the developer from lighting responsibility. The developer shall repair any damage to the streetlights following their installation, and prior to County acceptance of the street(s).

j) Upon notification by the Department of Permitting Services (DPS), which shall be applied for by the developer for release of the paving permit, MCDOT inspects the project to assure that all streetlights have been installed per the approved plans.

k) Once it is determined that the streetlights have been installed satisfactorily and PEPCO confirms in writing that they have received payment for installation, MCDOT signs the DPS check-off sheet accepting the streetlights for County maintenance.

2) Streetlighting is furnished and installed by the developer without streetscaping.

Follows the same procedures as Part 1, with the following exceptions:

a) The developer shall furnish and install luminaires, poles, wiring in poles, handboxes, and conduits for streetlighting per the streetlighting plans approved by MCDOT. Wiring shall be installed by the developer from the adjacent handboxes to the luminaires.

b) The developer shall coordinate with PEPCO for the installation of underground cabling connections and power service.

3) Streetlighting is furnished and installed by the developer with streetscaping.

a) The developer shall contact MCDOT to establish the appropriate light level targets, pole, and fixture types.

b) MCDOT provides the developer/consultant with the design requirements and standards, equipment specifications, and construction details for the street lighting equipment.

c) The developer shall prepare and submit a photometric plan with a proposed lighting layout that meets the target light levels. If light levels cannot be achieved, justification should be provided. MCDOT accepts the photometric plan for the developer to proceed with lighting design or provides review comments to update photometric analysis.

d) The developer shall prepare a streetlighting plan illustrating the pole locations, handboxes, and underground conduits, and all relevant existing and proposed geometry, utilities, right-of-way lines, trees, and other pertinent streetscaping design features that may influence streetlighting design and location. The plans are submitted to MCDOT for review and approval.

e) The plans are reviewed and minor revisions, if necessary, are made by MCDOT. All three (3) copies of the plans are approved (as revised). An MCDOT stamp indicating the type, wattage and number of lights will be affixed to each plan and signed as approved by the designated County official.

f) The developer shall provide MCDOT with the approved streetlight plans and the approved streetscape plans with a letter committing the developer to pay PEPCO for the initial costs to energize the streetlights.

g) The developer shall furnish and install luminaires, poles, wiring in poles, handboxes, and conduits for streetlighting per the streetlighting plans approved by MCDOT. Wiring shall be installed by the developer from the adjacent handboxes to the luminaires.

h) The developer shall coordinate with PEPCO for the installation of underground cabling connections and power service.

i) MCDOT submits to PEPCO a written request to energize the new lights with five copies of the approved streetlight plan, and one copy of the developers' commitment to pay letter. The developer should not install conduit prior to receiving the approved electrical plan from PEPCO.

j) PEPCO determines the source and location of the power connection and provides MCDOT and the developer with the approved electrical plan showing the conduit connection to the power source. PEPCO shall submit an energization cost request to the developer for payment.

k) The developer/contractor shall install all streetlight fixtures per County requirements and standards and install conduits in accordance with the PEPCO's electrical plan and construction standards. The developer/contractor shall coordinate inspection of all underground conduit work with PEPCO prior to backfilling.

l) Once all streetlight equipment is installed and wired to the bases and after PEPCO has been paid, the developer/contractor shall request PEPCO to energize the streetlights.

m) Once the streetlights are energized and inspected by MCDOT, the permit will be released and MCDOT will accept the streetlights for County maintenance.

4) Streetlighting is furnished and installed by PEPCO at the County's request.

a) MCDOT prepares a streetlighting plan illustrating the pole locations, handboxes, and underground conduits, and all relevant existing and proposed geometry, utilities, right-of-way lines, trees, and other pertinent design elements, then submits the approved plan to PEPCO with a request for streetlight installation and energization.

b) PEPCO submits a cost agreement to MCDOT for approval. MCDOT returns the signed cost agreement and encumbers the necessary funds for future payment.

c) PEPCO schedules the installation of the streetlights and notifies MCDOT when the work has been completed. MCDOT schedules an inspection of the streetlights, authorizes payment, and accepts the streetlight for County maintenance.

BGE Region

Site development projects may approach streetlighting implementation through the two (2) approaches described below:

1) Streetlighting is furnished and installed by BGE at the request of the developer.

Streetlighting procedures are the same as PEPCO Region Part 1, except that the streetlighting maintenance is the responsibility of BGE.

2) **Streetlighting is furnished and installed by BGE at the County's request.**

   Streetlighting procedures are the same as PEPCO Region Part 4, except that the streetlighting maintenance is the responsibility of BGE.

Allegheny Power (FirstEnergy) Region

Site development projects may approach streetlighting implementation through the two (2) approaches described below:

1) **Streetlighting is furnished and installed by Allegheny Power at the request of the developer.**

   Streetlighting procedures are the same as PEPCO Region Part 1, except that the streetlighting maintenance is the responsibility of Allegheny Power.

2) **Streetlighting is furnished and installed by Allegheny Power at the County's request.**

   Streetlighting procedures are the same as PEPCO Region Part 4, except that the streetlighting maintenance is the responsibility of Allegheny Power.

Emerging Technologies

Streetlighting is intended to provide increased traffic safety with a focus on reducing fatal and serious injury crashes throughout the County's transportation network. The County also has a Climate Action Plan aimed at building healthy, equitable, and resilient communities. Appropriate streetlighting helps promote shifts towards active and sustainable modes of transportation by providing safe, comfortable, and inviting public spaces.

The transition to LED light sources from high-intensity discharge (HID) fixtures has significantly reduced the County's energy consumption rates for streetlighting. A strategy for the County to reduce greenhouse gas emissions includes increasing the use of solar energy in the electrical supply. The County will continue to explore and pilot solar streetlighting applications as the technology advances. Streetlighting criteria needs consistent, constant light sources during times of darkness in order to best promote safe travel for all. As energy storage technology advances and photovoltaics improve, the County will consider solar streetlighting applications. Supplement specifications and standard drawings may be incorporated into this document at the discretion of MCDOT.

It is recommended that equipment be compatible with technologies that may be adopted by the County in the future as much as practical. These include wireless connectivity for remote streetlighting control and monitoring and adaptive lighting control. The County continues to pursue investment opportunities to improve road user safety and experience, enhance community spaces, and effectively manage and operate its infrastructure assets.

Appendix A – Typical Applications

The following illustrates typical applications of streetlighting along Montgomery County roadways.

Pedestrian-Scale Lighting Along a Pathway

Appendix B – Utility Company Service Areas