

**STAFF REPORT TO THE PLANNING COMMISSION  
FOR THE  
WORK SESSION ON OCTOBER 7, 2013  
  
PROPOSED DARK SKIES REGULATIONS**

**CASE FILE: PC-2013-3056**

**PART I. INTRODUCTION**

This topic was first introduced on the Planning Commission work program in 2004. This staff report introduces the concept of creating a rural outdoor lighting ordinance for the purpose of conserving the night skies. Outdoor lighting ordinances are commonly referred to as ‘dark sky’ ordinances in the communities where they have been adopted in reference to a primary goal of such ordinances – to protect dark skies at night. Dark skies are one of the many qualities that set rural areas apart from urban and suburban communities. Existing County land-use codes only require lighting standards in certain scenarios. The documentation in this report is based on the information contained in the included attachments.

**PART II. CREATION OF AN OUTDOOR LIGHTING ORDINANCE - WHY DO IT?**

**Preservation of the Night Skies**

Growth and light pollution from excessive outdoor lighting is diminishing the view of the stars in and around urban areas, as well as within smaller towns and rural areas. While excessive light may cause a nuisance to others, it also wastes money and electricity, results in unnecessary emissions of greenhouse gases, and can have negative effects on humans and wildlife (see Attachment E).

The “Dark Skies” concept promotes the precautionary approach to outdoor lighting design. Light Pollution Research has shown links between light pollution and negative impacts on human health, adverse behavioral changes in insect and animal populations, and a decrease of both quality of ambient lighting and safety in the nighttime environment (see Attachment G).

**Better Lighting Means Better Neighbors**

Outdoor lighting, when appropriately illuminated and positioned can improve visibility, safety, and a sense of security, while minimizing energy use, operating costs, and glare. Improperly aimed lights and lights directed above the horizontal can shine onto neighboring properties and

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can create conflict with neighbors, drivers, and pedestrians. A general rule of thumb is if the bulb is visible from a distance, it's contributing to glare and sky glow. With dark sky friendly lighting, only the intended area is illuminated (Attachment A-3).

### **Economic Case for a Lighting Ordinance**

According to the International Dark Sky Association, the wasted energy from inappropriate outdoor lighting results in wasted energy amounting to over one billion dollars a year. When lighting is used only where needed and at the right illumination for the job, money that would otherwise be spent on the electric bill can instead be spent on other things, which is good for property owners and good for the economy (Attachment A-5).

### **Impacts on Human Health**

Excessive light at night negatively impacts many areas of human health. Bright points of light from poorly designed lighting produces a condition known as “disability glare”. Disability glare is so intense it causes us to avert our eyes from the veil of light being scattered across our retinas. The 24 –hour day/night cycle, known as the circadian clock, affects physiologic processes in almost all organisms. Studies show disruption of these rhythms can result in insomnia, depression and cardiovascular disease. In June 2009 the American Medical Association adopted resolutions that support reducing light pollution and glare and advocate for use of energy efficient, fully shielded outdoor lighting (Attachment D).

### **Impacts on Wildlife**

Data suggest that artificial night lighting has negative effects on a wide range of wildlife, including amphibians, birds, mammals, insects and even plants. Light pollution disorients migratory birds, disrupts mating behavior of frogs and interferes with predatory/prey relationships. Since the eyes of nocturnal animals have evolved for foraging in low-light conditions, small changes in illumination can alter their relationship with prey species. Light fixation is a constant bird hazard that kills thousands of birds in urban areas every year (see attachments A-2 & A-7).

### **Safety**

Brighter light does not necessarily mean safety. Bright, glaring lights that illuminate nighttime events or locations can actually decrease the security of the sites. Excessively bright lighting can create a sharp contrast between light and darkness, making the area outside the light nearly impossible to see. Studies have shown there is no definite correlation between night lighting and crime. Most property crime is still committed during the day, or inside lit buildings. A safe environment involves shielding lighting for roadways, parking lots, homes, businesses and landscapes, increasing visibility and decreasing distractions, such as glare (Attachment A-8).

## Model Lighting Ordinance

Many communities have adopted anti-light pollution laws and ordinances. However, there is no consistency with language, technical quality or stringency. Therefore, the International Dark Sky Association and the Illuminating Engineering Society of North America have produced a Model Lighting Ordinance (Attachment B). The Ordinance includes general and specific use lighting recommendations to aid communities in developing a lighting ordinance.

### **PART III. EXISTING COUNTY REGULATIONS AND COMPREHENSIVE PLAN POLICIES**

Staff has analyzed the Multnomah County Code (MCC) and the County Comprehensive Plan for existing codes and policies relating to outdoor lighting. The standards noted below are generally zone specific with the exception of the Columbia River Gorge National Scenic area where the standards are applicable for all development. Generally, the existing code standards apply when new development is proposed and there is currently no requirement to retrofit existing lighting. A dark sky ordinance could, where appropriate, make the existing standards noted below more consistent.

**Off Street Parking Standards:** *Any artificial lighting which may be provided shall be shielded or deflected so as to not shine into adjoining dwellings or other types of living units, and so as not to create a hazard to the traveling public on any street.*

**Significant Environmental Concern for Scenic Views:** *No exterior lighting, or lighting that is directed downward and sited, hooded and shielded so that it is not highly visible from identified viewing areas. Shielding and hooding materials should be composed of nonreflective, opaque materials.*

**Significant Environmental Concern for Streams:** *Any exterior lighting associated with a proposed development shall be placed, shaded or screened to avoid shining directly into a Stream Conservation Area.*

**Pleasant Home Rural Center, Orient Rural Center Residential, and Orient Commercial-Industrial:** *New and replacement exterior lighting fixtures shall be of the "cut off" or fully shielded type so that no light is emitted above the horizontal.*

**Significant Environmental Concern for Water Resources and Significant Environmental Concern for Wildlife Habitat in the West of Sandy River Plan Area:** *Outdoor lighting shall be of a fixture type and shall be placed in a location so that it does not shine directly into undeveloped water resource or habitat areas. Where illumination of a water resource or habitat area is unavoidable, it shall be minimized through use of a hooded fixture type and location. The location and illumination area of lighting needed for security of utility facilities shall not be limited by this provision.*

**Columbia River Gorge National Scenic Area Review and Conditional Uses topographically visible from Key Viewing Areas and Expedited Review Criteria:** *Exterior lighting shall be*

*directed downward and sited, hooded and shielded such that it is not highly visible from Key Viewing Areas. Shielding and hooding materials shall be composed of non-reflective, opaque materials.*

**Special Management Area of the Columbia River Gorge National Scenic Area:** *Any exterior lighting shall be sited, limited in intensity, shielded or hooded in a manner that prevents lights from being highly visible from Key Viewing Areas and from noticeably contrasting with the surrounding landscape setting except for road lighting necessary for safety purposes.*

**Facility Design Standards for All Recreation Projects in the Columbia River Gorge National Scenic Area:** *Exterior lighting shall be shielded, designed and sited in a manner which prevents such lighting from projecting off-site or being highly visible from Key Viewing Areas.*

### **Multnomah County Comprehensive Plan:**

#### **Introduction**

*“The quality of the community environment and its desirability as a place to live as well as its long range stability are factors of design. How a use functions refers to how it performs its functions on the site and relates to neighboring uses. For example, the location of a use on its site in a manner which assures privacy for the surrounding uses is a functional concern. Consideration must also be given to automobile access, parking, pedestrian circulation, signing, **lights** and landscaping. Other elements include making adequate provisions for the handicapped and designing and lighting the use in a manner that reduces the potential for crime”*

#### **Policy 19**

*“The County's policy is to maintain a community design process which:*

*A. Evaluates and locates development proposals in terms of scale and related community impacts with the overall purpose being a complementary land use pattern.*

*B. Evaluates individual public and private developments from a functional design perspective, considering such factors as privacy, noise, **lights**, signing, access, circulation, parking, provisions for the handicapped and crime prevention techniques.”*

## **PART IV. POLICY CHOICES TO CONSIDER IN THE DEVELOPMENT OF AN OUTDOOR LIGHTING ORDINANCE**

Outdoor lighting ordinances can vary from fairly general “good neighbor” lighting codes that have basic requirements regarding the aiming and shielding of light fixtures on one end of the scale to very detailed comprehensive lighting ordinances that regulate illumination, placement and spacing, and spectrum on the other end of the scale. Jurisdictions with comprehensive lighting ordinances often require detailed lighting plans prepared by a lighting engineer to be submitted with development proposals. Existing Multnomah County requirements tend toward the ‘good neighbor’ general standards. As noted in Part III of this report the existing county lighting requirements are not across the board and are generally applicable in certain Significant

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Environmental Concern zones, community plan areas in the West of Sandy River, and in the entire National Scenic Area. The primary policy question relates to the question of scope and geographical extent of any new lighting ordinance.

**Scope:** While staff believes the more comprehensive standards have plenty of merit, we have concerns about the availability of staff resources to take on a highly detailed, comprehensive major code update that would surely involve a high level of time, research, and community outreach to achieve. Staff finds that lighting ordinances have at their core standards that focus on the design of the fixture itself; that is requiring the fixture to be cut off at the horizontal and for the light source itself to be properly tucked into the fixture. A second core feature of lighting ordinances requires the fixtures themselves to be cast downwards and only towards the area intended for illumination. Staff believes that any new lighting ordinance should focus primarily on these two fundamental requirements. In a future work program we may want to take on more specific lighting standards such as the degree of illumination (lumens) that is appropriate for a given fixture in a given location for a given purpose.

**Geographical Extent:** Because the Multnomah County Land Use Program is responsible for planning in the county's rural areas, any proposed lighting ordinance would necessarily exclude the cities and those unincorporated urban areas under the city planning authority. The next question then is what scenarios should trigger lighting regulations beyond what is currently on the books? Staff believes that a logical choice to initially consider is to apply lighting regulations to all residential development proposals including additions and residential accessory buildings such as garages and shops. Residential development comprises the majority of development proposals reviewed by the Land Use program. Staff believes that developing an outdoor lighting standard for residential development essentially covers much of the gap of those developments that do not currently have lighting standards imposed.

### **General Applicability:**

Staff is seeking guidance from the Commission regarding two general approaches for application of new outdoor lighting standards:

1. Require that all proposed and existing residential outdoor lighting on the property come into compliance when a residential development is proposed regardless of whether a particular area of the property is included as part of the proposed development.

**Pros:** Brings the rural areas into the dark sky standard one property at a time.

**Cons:** Added burden and cost to property owners who need to bring all existing outdoor lighting up to standard as part of their development project.

2. Require the regulations only for new lighting that is included as part of a proposed residential development project.

**Pros:** Less of a burden and cost to property owners than option 1 – property owner only needs to consider new lighting associated with proposed development.

**Cons:** This scenario essentially keeps the situation from getting worse but doesn't do much in terms of decreasing light pollution and associated effects over time. If a property is already producing significant sky glow and glare the addition of a few dark sky compliant fixtures to the mix doesn't alleviate the existing problem.

### **What triggers the standards?**

There are a few approaches to consider in terms of what development actions would trigger compliance with proposed new lighting standards beyond the existing triggers. Staff would like to discuss these options with the Commission at the Work Session as well.

1. Lighting requirements apply when any new residential building or addition is proposed.
2. Lighting requirements apply when new buildings or additions in excess of a certain size are proposed. 400 square feet is the current threshold for certain SEC permits and 500 square feet is the current threshold for requiring storm water review – so a similar area threshold would seem appropriate in this scenario. Staff believes this may be the best option if property owners are required to bring all existing lighting into compliance when they develop.
3. Other triggers could include any development activity on the property inclusive of things such as new landscape grading, new parking configurations, sport courts and any residential development regardless of whether a building or addition is contemplated.

## **PART V. CONCLUSION**

After the Planning Commission considers the above concepts and policy considerations staff is ready to contemplate feedback from the Commission and begin preparing draft code for consideration at a Commission meeting as soon as resources allow. The attachments in part VI below are intended to provide background information in order to provide a foundation for furthering the discussion.

## **PART VI. ATTACHMENTS**

### **Attachment A: International Dark Sky Association Materials:**

- A-1:** Introduction to Light Pollution
- A-2:** Effects of Artificial Light at Night on Wildlife
- A-3:** Residential Lighting (Good Neighbor Guide)
- A-4:** Light Pollution and Human Health

**A-5:** Light Pollution and Energy

**A-6:** Glossary of Lighting Terms

**A-7:** IDA Information Sheet #187: Lighting and Wildlife

**A-8:** IDA Information Sheet #24: Security Lighting

**Attachment B:** IDA-IES Model Lighting Ordinance

**Attachment C:** Los Angeles Rural Outdoor Lighting Ordinance

**Attachment D:** U.S. Physicians Join Light-Pollution Fight - *Sky & Telescope*

**Attachment E:** Our Vanishing Night - *National Geographic*

**Attachment F:** Los Angeles County Lighting Information Sheet

**Attachment G:** Lighting Design: Considering the Impacts of Light Pollution – *Landscape Online*

# **EXHIBIT A1**

# IDA Practical Guide



Sky glow over the Netherlands

Photograph by Wim Schmidt

**F**OR MOST OF EARTH'S HISTORY, our spectacular Universe of stars and galaxies has been visible in the darkness of the night sky. From our earliest beginnings, this cosmic array has inspired questions about our Universe and our relation to it. The history of scientific discovery, art, literature, astronomy, navigation, exploration, philosophy, and even human curiosity itself would be diminished without our view of the stars. But today, the increasing number of people living in cities and the corresponding increase in inappropriate and unshielded outdoor lighting has resulted in light pollution—a brightening night sky that has obliterated the stars for much of the world's population. Most people must travel far from home, away from the glow of artificial lighting, to experience the awe-inspiring expanse of the Milky Way as our ancestors once knew it.

The negative effects of the loss of this inspirational natural resource might seem intangible. But a growing body of evidence links the brightening night sky directly to measurable negative impacts on human health and immune function, on adverse behavioral changes in insect and animal populations, and on a decrease of both ambient quality and safety in our nighttime environment. Astronomers were among the first to record the negative impacts of wasted lighting on scientific research, but for all of us, the adverse economic and environmental impacts of wasted energy are apparent in everything from the monthly electric bill to climate change.

In refreshing contrast to some of today's complex and lingering environmental problems, many existing solutions to light pollution are simple, cost-effective, and instantaneous. Recognizing when outdoor lighting no longer serves its function and becomes a pollutant is the first step toward choosing appropriate solutions.

## *Topic :* *Introduction to Light* *Pollution—* *What's the Problem?*

**Light pollution** is excessive and inappropriate artificial light. The four components of light pollution are often combined and overlapping:

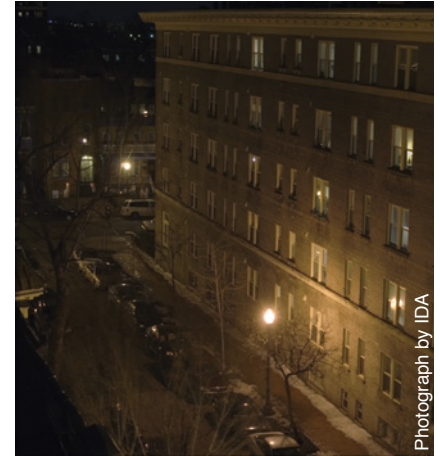
**Urban sky glow**—the brightening of the night sky over inhabited areas.

**Light trespass**—light falling where it is not intended, wanted, or needed.

**Glare**—excessive brightness which causes visual discomfort. High levels of glare can decrease visibility.

**Clutter**—bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas. The proliferation of clutter contributes to urban sky glow, trespass, and glare.

Increased **urban sky glow** is responsible for the disappearance of the Milky Way from our night skies. For professional astronomers, the increasing distance to prime observing sites, well away from sources of air pollution and urban sky glow, becomes more problematic as economic and environmental energy costs continue to rise. Amateur astronomers, meanwhile, find prime observing spots eradicated by commercial and residential development and must travel farther from home for a clear view of the skies. Increasingly, the most important equipment needed to enjoy the wonders of the night sky is an automobile with a full tank of gas and a map.



Light trespass, Washington, DC. This “street lighting” directs very little light onto the street. Instead, it sends wasted light into the sky and the sides of residential buildings where it may not be needed or wanted.



Glaring lights can actually reduce visibility. Here the brightest most visible objects in the area are the lighting fixtures, not the roadways, walkways or parking areas which a driver or pedestrian would expect to be lit. Atlanta, Georgia.

The adverse effects of light pollution extend well beyond astronomy. New research suggests that light at night may disrupt circadian rhythms, the 24-hour cycle of day and night that regulates biological function in all life on Earth. **Light trespass**, occurring when streetlights or a neighbor’s security light directs unwanted lighting onto our property or into our homes, contributes to a loss of natural darkness.

Wildlife, too, is harmed by the unnecessary brightening of the night. From newly hatched sea turtles to migrating birds, fish, frogs, salamanders, and lighting bugs, artificial night lighting disrupts the cycles of nocturnal creatures in potentially devastating ways. Research is ongoing but it is becoming apparent that both bright days and dark nights are necessary to maintain healthy hormone production, cell function, and brain activity, as well as normal feeding, mating, and migratory behavior for many species, including humans.

Paradoxically, in addition to wasting resources, a nighttime environment that is over-lit results in *lowered* visibility: direct **glare** from improperly shielded fixtures is often blinding. Light spilling into the sky does



Sky glow over Istanbul, Turkey.



Effects of two different types sports lighting: Partially shielded lighting directed downward in Tucson, Arizona, USA (left); stadium lighting contributes to sky glow Portsmouth, Hampshire UK (right).

not light the ground where we need it. The redundant lighting found in many urban centers results in a **clutter** of lights that contribute to sky glow, trespass, and glare while destroying the ambiance of our nighttime environment. Our eyes, when dark-adapted, have good natural capacity in low-light situations. But when nightscapes are over-lit, eyes never have a chance to become dark-adapted, and areas adjacent to brightly lit areas become impenetrable, reducing safety. Some communities have experienced a decrease in crime by reducing or eliminating nighttime lighting in appropriate areas.

Light pollution wastes money and energy. Billions of dollars are spent on unnecessary lighting every year in the United States alone, with over \$2.2 billion going directly into the nighttime sky via unshielded outdoor lights. Unshielded outdoor lights are directly responsible for 14.7 million tons of carbon dioxide waste. Simply reducing and removing unnecessary lighting saves money and energy, often at minimal expense. Over-lighting the night neither improves visibility nor increases nighttime safety, utility, security, or ambiance.

Many homeowners, city planners, and lighting contractors rely on the theory that “more is better” when it comes to lighting our nightscapes. We have learned, however, that the glare of excessive light can actually reduce visibility and that well-planned lighting can save money, decrease crime and improve nighttime ambiance. Learning what does and does not constitute quality lighting is the next step toward implementing simple, common sense strategies for effective, efficient outdoor lighting. Set a good example in your own environment, and when selecting or recommending an outdoor fixture, refer to the guidelines suggested in the *Practical Actions* listed on the right.

Solutions exist now for the problem of light pollution, and control programs are underway in many communities. Education and personal action can begin in your own neighborhood. IDA’s Web site provides sample letters and information to help you implement constructive solutions to lighting problems in

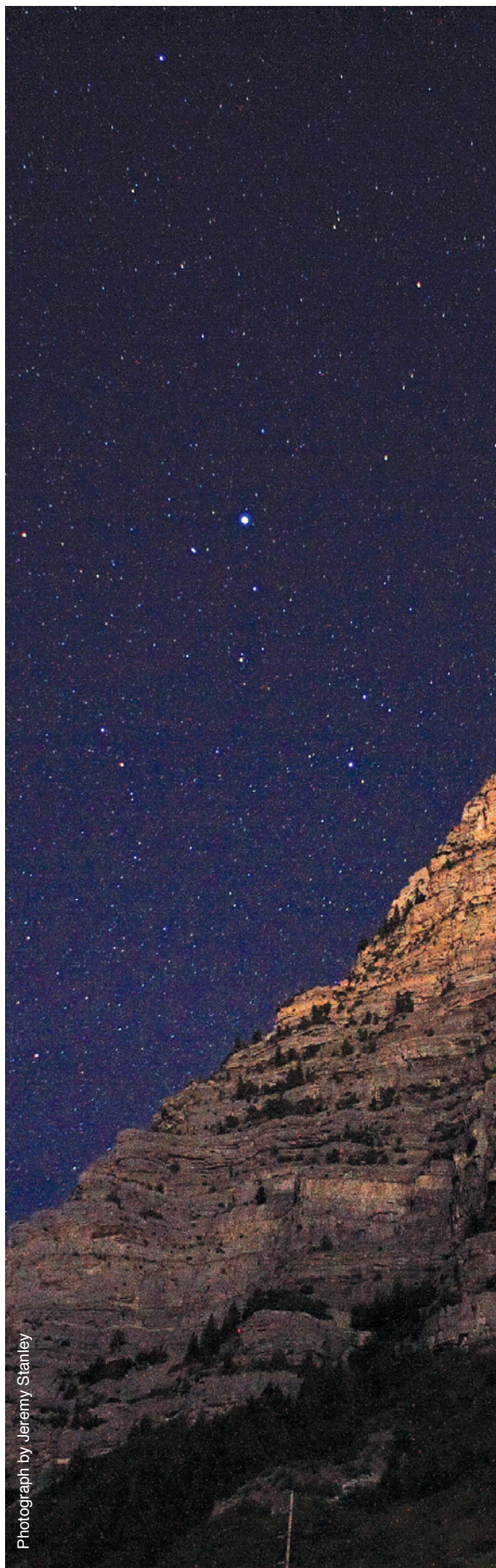
## Practical Actions

**Use light only when and where it’s needed.** Turn off lights when they are not needed and create a curfew for lights-out. Minimize interim light use with timers and motion detectors.

**Use only as much light as needed.** Over lighting reduces the eye’s ability to see outside of the lit area. In addition, excess light can produce glare, which also reduces visibility. Selecting the correct lamp wattage for your needs increases safety and reduces costs.

**Shine lights down, not up.** A well-designed fixture will direct the light where it’s needed most—at the ground. Select new fixtures that are fully shielded; retrofit or replace poor quality fixtures. For more information on selecting dark-sky friendly fixtures, refer to IDA’s Web site and the fixtures featured in the IDA Fixture Seal of Approval program.

**Use efficient light sources for outdoor lighting around homes and businesses.** Consider a compact fluorescent for good, energy efficient, economical lighting—a low-wattage lamp gives plenty of light for most properties and applications, and in a fully shielded fixture, it makes an excellent choice. When higher wattage lamps are necessary, be sure that they are fully shielded and energy efficient.



Photograph by Jeremy Stanley

your community. Community involvement can pave the way for the adoption of outdoor lighting codes and ordinances essential to the long-term preservation and protection of our dark skies. Thousands of communities around the world have established lighting ordinances to regulate efficient, effective nighttime lighting. In response to this, IDA's "Simple Guidelines for Lighting Regulation" is a useful tool for developing lighting ordinances that reflect community standards and conform to recommended practices of the international lighting associations.

Light pollution affects every citizen. It is a serious environmental concern that wastes money and resources while jeopardizing wildlife, our environment, health, and human heritage. Fortunately, concern about light pollution is rising dramatically. A growing number of scientists, homeowners, environmental groups and civic leaders are taking action to restore the natural night. Each of us can implement practical solutions to combat light pollution locally, nationally, and internationally. IDA can guide you through the process.

**Learn the facts about light pollution.** Learn how to recognize fixtures that are well-designed, dark sky friendly and efficient. IDA is the leading authority on the problems and solutions related to light pollution, and IDA's Web site is a great educational resource.

**Educate others.** Educating the public, government officials, and lighting professionals is an important part of combating light pollution. Share what you know about the value and effectiveness of quality outdoor lighting with your friends, neighbors, and community leaders. Find a local IDA Chapter in your community.

**Get Involved.** Encourage your community to implement lighting regulations. The "Outdoor Lighting" section of the IDA Web site offers many resources to help you get started. "Simple Guidelines for Lighting Regulations" and the "Homeowner's Guide to Outdoor Lighting" are especially informative.

**Donate now.** Established in 1988, the International Dark-Sky Association is an educational, environmental 501(c)(3) nonprofit dedicated to protecting and preserving the nighttime environment and our heritage of dark skies through quality outdoor lighting. With over thousands of members in more than 70 countries, IDA relies on contributions from concerned citizens like you who become members, donate, or make us a part of their planned giving portfolios.

*We could all see the sky as our ancestors once saw it just by turning off the lights.*

**Referenced Material:**

*U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate*—Received by Building Technologies Program; Office of Energy Efficiency and Renewable Energy; U.S. Department of Energy; Prepared by Navigant Consulting Inc. 1801 K Street, NW Suite 500 Washington DC, 20006 with XENERGY, Inc. Burlington, MA; September 2002.

**Related Practical Guides and Web Links:**

“PG2: Effects of Artificial Light at Night on Wildlife”—[www.darksky.org](http://www.darksky.org)

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***For information on IDA membership and donations, visit our Web site at [www.darksky.org](http://www.darksky.org).***

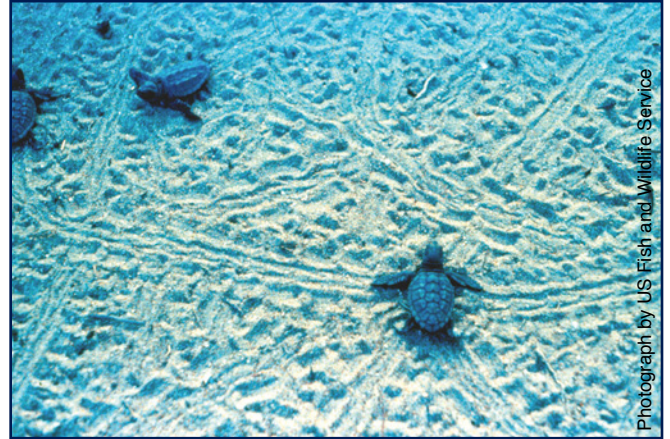
# **EXHIBIT A2**

# IDA Practical Guide



Photograph by Blair Witherington

Turtle trails that go straight to the ocean, as they should.



Photograph by US Fish and Wildlife Service

Turtles that are confused by light pollution (shown above with their erratic trails), are unable to find their way to the ocean.

## *Topic :* *Effects of Artificial Light at Night on Wildlife*

**F**ROM THE BEGINNING OF EXISTENCE, humans have controlled their immediate environment, building shelters to keep out the elements and fires to banish the darkness. As civilizations continue to develop, humans are able to affect dizzying change on habitats in all corners of the globe. Though agreeable to us, many of the comforts of advanced society are devastating to the creatures that share the earth. A growing body of data suggests that artificial night lighting has negative and deadly effects on a wide range of creatures, including amphibians, birds, mammals, insects, and even plants.

Humans have evolved as diurnal animals, biased toward the daytime and dependant on visual cues, so illumination of our nightscapes seems comfortable and necessary. All animals, including humans, depend on a regular interval of daylight and darkness for proper functioning of behavioral, reproductive and immune systems. Many of these animals need the natural night to survive. For thousands of species, the natural dark night of the evolutionary past is an integral component of their continued existence.

Artificial night lighting harms species directly by triggering unnatural periods of attraction or repulsion that lead to disruptions in reproductive cycles, by fixation, by

disorientation, or by interfering with feeding and sustenance. Light pollution has been shown to disorient migratory birds and hatchling turtles, disrupt mating and reproductive behavior in fireflies and frogs, and interfere with communication in species from glowworms to coyotes. Disruptions such as degradation of habitat, creation of artificial and dangerous habitat, and energy waste that may lead to climate change can all be linked to excessive artificial night lighting. Research biologists are warning that the negative synergy of such combinations can result in a cascade effect, with disastrous results for entire ecosystems around the world.

Climate characteristics vary from one year to the next; it is not uncommon to experience cool summers, dry springs, and slow falls. A season's photoperiod is the only consistent factor in the natural environment. Therefore, many species of plants and animals rely on the length of the day to indicate the proper season for mating, molting, and other life cycle activities. This photoperiodic sensitivity is often so acute that many species can detect discrepancies in natural light as short as one minute. Reproduction cycles are most often disrupted when artificial light at night interferes with species' natural detection systems. Trees have been known to bud prematurely; some flowers cease blooming. Artificial light also can cause animals such as squirrels and robins to mate out of season. Changes in plant and animal reproductive activity can create difficulty in finding food and increase chances of starvation.

**There is evidence that the use of high and low pressure sodium light in ecologically sensitive areas such as wetlands, woods, and coastal areas has less impact on habitat and life cycle behavior than use of other kinds of light.** The relatively monochromatic wavelength emitted by the yellow tinted sodium vapor lights attracts fewer insects and can be more easily filtered to minimize negative effects.

**Diurnal**—active during daylight

**Photoperiod**—duration of sunlight as determined by season (photoperiodic—internal clock governed by how long the day is)

**Phototaxis**—movement in response to light

**Predation**—predatory behavior in animal relationships



Pine Barrens tree frog

Photograph by U.S. Fish and Wildlife Service

Insects, frogs, toads, and salamanders have demonstrated both physical and behavioral disruptions as a result of artificial night lighting. A majority of frog and toad species are nocturnal and, because they must remain close to a water source, are less able to compensate for changes in the environment by relocating.

Like other amphibians, salamanders are currently suffering population declines around the world. Many species of pond-breeding salamanders show strong site fidelity to their home ponds, and studies to date have shown that artificial illumination can disrupt salamanders' ability to return to home ponds to breed.



Insects are attracted to the white light of floodlights.

Photograph by Alexei Pace

Artificial light at night contributes to lack of food (starvation) by interfering with predator/prey relationships. For instance, moths and other night-flying insects are attracted to lights. This involuntary phototaxis leads to their easy capture. Their incessant gravitation toward artificial points of light not only makes them vulnerable as prey and subjects them to increased predation, but disrupts the normal nocturnal patterns of predator species by creating an artificial feed concentration around points of light. For some species of predators, such as bats or birds that are not repelled by light, this disruption means a change in the concentration and location of their feed, which can lead to imbalances in predator/prey ratio. For species repelled by light, such as horseshoe bats, long eared bats, and mouse eared bats, feed becomes scarcer and difficult to procure, as many insects swarm around lights, leaving fewer to be caught as they fly free. The decreasing amount of available food due to



Photograph by Cameron Hansen

Visible for miles, squid boat lights unnaturally attract species of fish and migratory birds.



Photograph by www.offshorepictures.com

Relentless lights are common on offshore oil platforms.

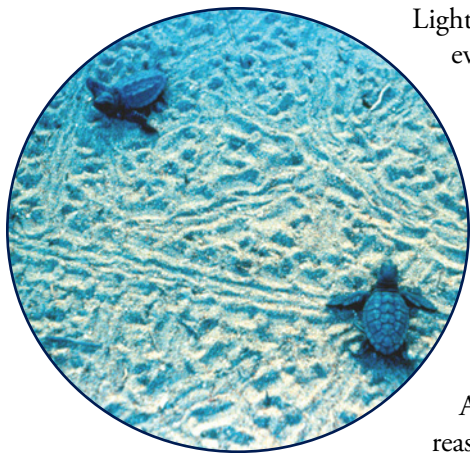
**Upon discovering the magnitude of fatal bird collisions,** some cities are initiating mitigation procedures. The Lights Out Toronto campaign, established in 2006 in Toronto, Canada calls for residents to turn out any unnecessary lights for the protection of migratory birds. In addition, the city has issued bird friendly development guidelines for all new buildings, which include the control of unnecessary artificial light. In September 2008, Boston, MA, USA began a two-month initiative to conserve electricity by shutting off lights at 34 city skyscrapers. A stated purpose of this project was the protection of migrating birds. Chicago, IL and New York, NY USA also participate in a “Lights Out” during migration season.

**As awareness of the danger of artificial light to sea turtles grows,** an increasing number of communities are restricting coastal illumination. Countries all over the world have passed ordinances that control the amount and type of light used in coastal environments. As the list grows, hatchling sea turtles are starting to be able to find the sea without the help of human volunteers to guide them. Learn more about local and regional action by visiting [www.seaturtle.org](http://www.seaturtle.org).

a combination of habitat loss and life cycle disruption is causing many bat populations, such as Europe’s horseshoe bat, to become threatened or endangered.

Since the eyes of nocturnal animals are specially evolved for foraging in low-light conditions, small changes in illumination can compromise strategies and profoundly alter their relationship with prey species. Even fish are affected by artificial light. Some species of fish, normally exposed only to natural light sources such as phosphorescence, can be temporarily blinded and left vulnerable by artificial light. Artificial light also inhibits normal anti-predation behavior such as schooling, and can affect migratory patterns in species such as salmon and sockeye fry.

Offshore, brightly lit oil and gas platforms and squid vessels that attract prey and affect numerous species of fish with lights pose both primary and secondary hazards to marine birds. The illumination and heat of offshore hydrocarbon platforms and squid fishing vessels also encourage algae growth, attracting fish and invertebrates. Marine birds are then killed around squid vessels by swallowing hooked prey or by feather contamination in oil-fouled water at hydrocarbon platforms. Marine birds that feed on bioluminescent prey may be particularly sensitive to light source attraction, many threatened and endangered species at great risk from artificial ocean lighting. Many species are susceptible to fixation—also known as “capture”—on artificial lights at sea; exhausted birds will circle for hours or days until they fall into the sea. Off eastern Canada in 1998, tens of thousands of seabirds were observed circling the newly operational Hibernia platform, fixated by an unrelenting point of illumination.



Light fixation is a constant bird hazard that continues to kill thousands of birds in urban areas every year. Hundreds of terrestrial bird species fly and migrate under cover of night. While the mechanisms for birds' attraction to artificial night lighting are not well understood, its hazards to birds have been well documented. During the 1960s, it is estimated that over a million birds a year were killed in collisions with lighted television towers in the United States. Since that time, the number and height of communication towers has increased exponentially. Skyscrapers and other urban buildings also threaten birds, posing collision, fixation, and disorientation hazards.

## Light and Sea Turtles

Artificial light at night is devastating sea turtle populations around the world for several reasons. Studies in Florida have shown that loggerhead, leatherback, and green turtle females choose the darkest beaches for their nest sites and will not nest at beaches lit by mercury vapor lights. On beaches subject to indirect light trespass, turtles will avoid the more brightly lit areas in preference to the dark. Nests are, therefore, more concentrated in the dwindling dark spaces, causing more hatchlings to succumb to predators and other site-specific hazards.

However, the most deadly problem facing these internationally protected sea turtles is disorientation from excessive and carelessly placed light. Many types of coastal illumination, including street, residential, and business lighting, confuses newly emerged hatchlings, which instinctively orient to the brightest light source. For thousands of years, this source was the reflection of moon and starlight on the sea. The turtles' natural programming allowed them to reach the water safely. Today, development along coastlines can cause hatchlings to head inland instead toward artificial lights, where they die of exhaustion, dehydration, predation, and road traffic. Each year, Florida alone loses hundreds of thousands of hatchlings.

Inappropriate artificial night lighting disrupts physiological as well as environmental functions. Hormone production in vertebrates, for example, is regulated by the circadian rhythm. Studies in humans and rats show a correlation between exposure to even low levels of illumination during normally dark hours and depressed levels of melatonin (a hormone produced in the retina), resulting in an increased risk of accelerated growth in breast cancer tumors. The effect of artificial night lighting on melatonin and other hormonal systems has yet to be studied in the wild, a study made more difficult by the scarcity of natural dark night conditions in most Western ecosystems.

While the wide range of potential damage caused by artificial light at night is still being discovered, steps to reset the natural balance between light and darkness are already being taken. To help preserve wildlife and minimize damage to ecosystems, start by following the steps listed in the Practical Actions to the right. A list of resources to increase knowledge of these topics and links to information on local and regional action groups can be found at the end of this practical guide.

## Practical Actions:

**Turn off unnecessary lights around your house and yard.** Use timers and sensors to help put light only where and when it is needed.

**Use fully shielded fixtures to direct the light ONLY WHERE NECESSARY FOR COMFORT AND SAFETY.**

**See red:** Use red filters on house and street lights. Red lights emitting a low wavelength generally have less of an impact on wildlife. Sea turtles and other coastal creatures, as well as amphibians and many species of insects, react especially well to red light—by hardly reacting at all.

**...or yellow:** Yellow lights such as high pressure sodium (HPS) or low pressure sodium (LPS) lamps attract fewer insects and moths (think of your typical yellow front porch bug light). If light is required, advocate for their use in environmentally sensitive areas such as coastal regions or forest preserves.

**Get educated:** field guides and nature walks will help identify vulnerable species in your area.

**Raise awareness:** Most people are blind to the impact artificial light has on wildlife. A presentation to a social club or activist group could increase interest and win supporters.

**Ask that any further development in your community include a report on ecological issues of light pollution in their environmental impact statement.**

## Referenced Material:

Cinzano, P., F. Falchi, and C.D. Elvidge. "The First World Atlas of the Artificial Night Sky Brightness." *Monthly Notices of the Royal Astronomical Society*. 328 (2001): 689-707.

Rich, Catherine, and Travis Longcore, eds. *Ecological Consequences of Artificial Night Lighting*. Washington: Island Press, 2006.

## Related Practical Guides and Web Links:

Blair E. Witherington and R. Erik Martin. "Artificial Lighting and Sea Turtle Hatchling Behavior." *Florida Marine Research Institute Technical Reports*. TR-2 (1996)—[http://research.myfwc.com/features/view\\_article.asp?id=2156](http://research.myfwc.com/features/view_article.asp?id=2156)

Cinzano, P., F. Falchi, and C.D. Elvidge. "The First World Atlas of the Artificial Night Sky Brightness." *Monthly Notices of the Royal Astronomical Society*. 328 (2001): 689-707. *Light Pollution in Italy*. 2006—<http://www.lightpollution.it/cinzano/download/0108052.pdf>.

FLAP—Fatal Light Awareness Program—<http://www.flap.org>

FWC—Florida Fish and Wildlife Conservation Commission—[http://www.myfwc.com/WILDLIFEHABITATS/Seaturtle\\_Lighting.htm](http://www.myfwc.com/WILDLIFEHABITATS/Seaturtle_Lighting.htm)

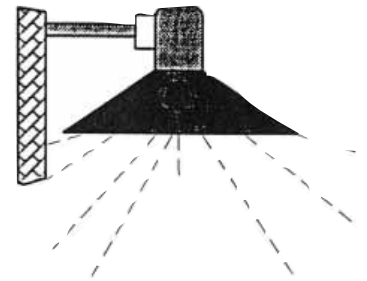
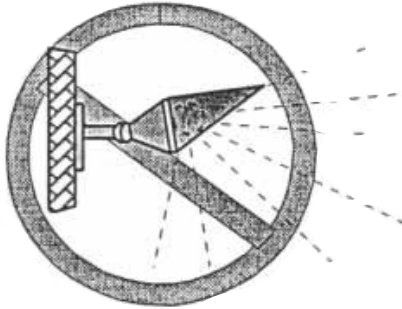
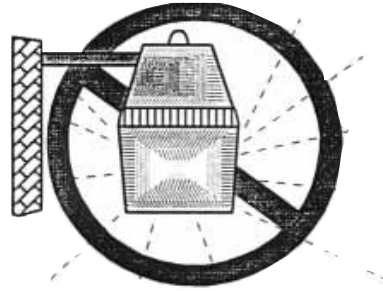
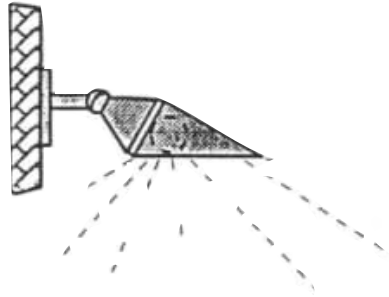
seaturtle.org—<http://www.seaturtle.org>

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***For information on IDA membership and donations, visit our Web site at [www.darksky.org](http://www.darksky.org).***

# **EXHIBIT A3**

# IDA Practical Guide



Fixture illustrations by Peter Talmage

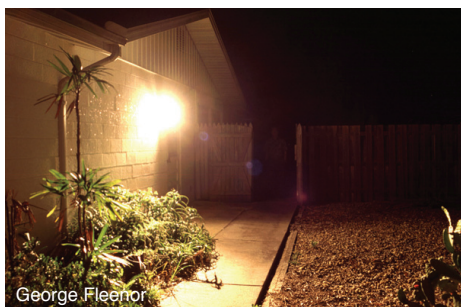
## Topic:

### *Residential Lighting (Good Neighbor Guide)*

**M**ANY OF US HAVE EXPERIENCED THIS SCENARIO: Your neighbors have installed a new light on their property. It is an unshielded fixture that casts a bright light with no control and lots of glare. The light trespass from this fixture produces light pollution and energy waste. Their new fixture is lighting up your yard or shining into your home, maybe even illuminating your bedroom and disrupting your sleep. Your neighbors cite safety as the reason for installing this light. The illumination gives them a newfound “feeling of security.”

What your neighbor may not know is that unshielded fixtures that create glare and splatter light everywhere may make a property less safe by not focusing the light where it is needed. Likewise, your neighbor also may not be aware of how you are affected by the light trespass coming off the property.

How do you talk to your neighbor about this situation? The International Dark-Sky Association suggests the following steps to educate your neighbor, and by extension your community, about the value of dark sky friendly lighting.



George Fleenor

The glare from an unshielded light creates deep shadows.



George Fleenor

The glare from the light hid a possible attacker.

**Don't hesitate to ask your neighbors for their advice or opinion in solving the problem. Goodwill goes a long way.**



IDA

Fixture shields can be made from household objects. This shield is made from a rain gutter.



IDA

Fully shielded lighting casts light on your porch, not your neighbor's yard.

## Practical Actions:

1. **Make friends, not enemies.** Your neighbors probably don't realize the light is bothersome.
  - Always approach people in a friendly, non-threatening way.
  - Don't argue. Be tactful and understanding about their right to light their property.
  - Don't dismiss their need to feel safe.
  - Suggest alternatives to their current fixture. Ask them to move the light, shield it or add a motion sensor.
2. **Be informative.** Talking to your neighbor is an exciting chance to be an advocate for good lighting and share knowledge on an important issue.
  - There are many reasons to use dark sky friendly lighting. IDA sound bites can help to convey the benefits:
    - » Dark sky friendly lighting does not mean dark ground.
    - » Safety is important, but brighter does not mean safer.
    - » A starry sky is a natural resource.
  - The topics of safety, energy savings, cost, wildlife are addressed briefly in this document. Additional articles and brochures from the IDA Web site are downloadable and free for use.
    - » Print off free materials from the IDA Education tab and present this information to your neighbor.
3. **Do your homework and be prepared to address the real issues.**
  - It is useful to know the local costs of electricity (cents per KWH), and the local lighting control ordinances. This information is available on most city Web sites, from your regional utility company, and on your utility bill.
  - You may also want to compile a list of local businesses with good quality lighting as an example of effective security measures that are dark sky friendly.
  - A list of shielded light fixtures to provide as alternatives to your neighbor's current light is also recommended. A comprehensive list of dark sky friendly fixtures and devices is available on the IDA Web site in the Fixture Seal of Approval section.
  - If there are any further questions, call us +1 520 293 3198, or e-mail us at [ida@darksky.org](mailto:ida@darksky.org). IDA will answer!
4. **Stay positive.** Don't let bad lighting create a feud in your residential area.
  - Remember that home is a place where everyone wants to feel relaxed and safe.
  - Accept your neighbors' need to feel secure and politely ask them to accept your need to enjoy the nighttime environment in your own yard.
  - Explain that light trespass is a form of light pollution, but never threaten to sue. The idea of a lawsuit can create bad feelings among the whole neighborhood.
  - Remember that everyone wants the same thing: a chance to relax in their own environment. Work together to create an atmosphere that benefits the community.

# What you and your neighbors should know about dark sky friendly lighting

## Safety

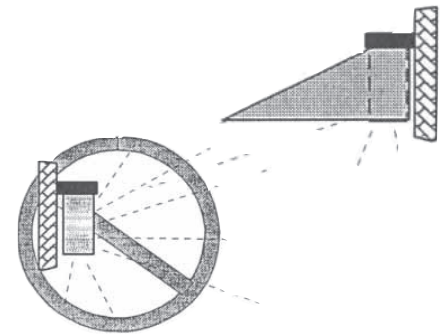
**Studies have indicated that there is no conclusive correlation between night lighting and crime\*.** Most property crime is still committed during the day, or inside lit buildings. Outside illumination can draw attention to the building or facility and help a criminal see what they are doing. Lights triggered by motion sensors are much more effective in indicating the presence of an intruder.

IDA believes that outdoor lighting should provide real security, not just the feeling of safety. Effective security lighting starts with determining and illuminating target areas such as entry points. Using shielded fixtures is beneficial in two ways. First, glare is decreased or eliminated. Uncomfortable or temporarily blinding, a glaring light can distract the eye and cast harsh shadows that create easy concealment opportunities for a trespasser. Second, shielded fixtures help you control both the placement and the amount of light. Entrances, windows, and gates can be the focal points of a lighting scheme that does not over illuminate, but allows adequate and uniform visibility that dissipates shadows.



Malcolm Smith

This fully shielded lighting with motion sensors safely lights the walkway with a pleasant ambiance.



**“Crime is not reduced by sending light upward into the sky or by sending glare into your eyes.”**

—Maggie Tracey,  
IDA Nevada Section Leader

People can see more in soft lighting than they can in spotlights because they can see beyond the point of illumination. Our eyes can take up to 20 minutes to adjust to the dark—longer for aging eyes. Fully shielded lighting provides enough illumination to see your surroundings while reducing excess light harmful to your night vision.

Safety lighting for your home includes being able to see where you are walking. However, you do not need a floodlight or a single harsh lamp to create enough light. Shielded foot lamps along paths provide an alternative to harsh illumination. A smart lighting plan directs the light where you need it, so you don't have to choose between security and the preservation of the night sky.

**Lights do not need to be bright to be effective.** Effective lighting produces uniform coverage of the area, while glaring points of light can attract criminals by creating shadows in which to hide.



GlareBuster

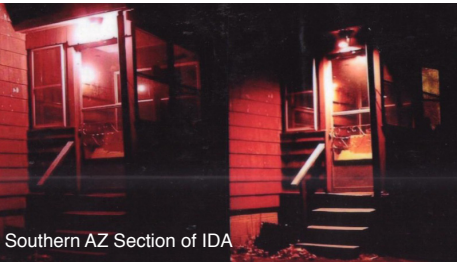
Shielding reduces glare and points the light where it will do the most good.

\* Sherman, Lawrence W., et al. “Preventing Crime: What Works, What Doesn’t, What’s Promising” A Report to the United States Congress Chapter 7. 1997—<http://www.ncjrs.gov/works/chapter7.htm>

## Energy and cost savings



A floodlight run amok!



Southern AZ Section of IDA  
By shielding the light (right side), the bulb was reduced from 60 watts to 40 watts, a 33% savings.

Dark sky friendly lighting fixtures can be less expensive to operate than traditional outdoor lights. Shielding the fixture so no light escapes above a 90 degree angle concentrates the light exactly where it is needed. In their Consumers Guide to Home Energy Savings, the American Council for an Energy-Efficient Economy (ACEEE)<sup>†</sup> endorses IDA approved outdoor fixtures that can “save energy as well as light pollution that can keep your property safe without disturbing dark hours.”

The downward concentration of light created by fully shielded fixtures typically requires a lesser wattage lamp than traditional lighting because every bit of illumination is directed where it can make a difference. A lesser wattage lamp can now be used effectively because you aren't lighting the sky or your porch roof as well as your steps. Cost savings on your utility bill will pay for the fixture within the year. Switching from a 75-watt incandescent bulb (cost: \$0.75) to a 20-watt compact fluorescent (CFL) bulb (cost: \$4.00) can save money the first year if it is used only two hours every day. Switching to a CFL that is on for up to 12 hours a day can save over \$200.00 over five years<sup>‡</sup>. Why pay for light that is not being used? Approximately 30% of the energy produced by every unshielded bulb is used to illuminate the sky. This wasted energy costs \$2.2 billion annually in the United States alone.

Additional energy savers include putting timers, dimmers, and motion sensors on outdoor lighting. These features allow you to use the light when you need it without constant use “just in case” you need it.

## Use of compact fluorescent lighting in homes

- CFL bulbs contain mercury, but did you know that they contain only 4 milligrams? Compare that amount to the 500 milligrams in a traditional thermometer<sup>†</sup>.
- The largest source of mercury in the air comes from coal burned to produce electricity. Because CFLs use less electricity than traditional bulbs, their use contributes to a reduction in net mercury emissions.
- Recycling your CFLs is easy. Many cities accept these in their recycling program, otherwise you can find a mail-in recycling program through the EPA at: <http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm>
- Many CFLs do not work well in cold weather, taking time to “warm up.” Make sure to purchase a CFL with a cold-weather ballast if you are in an area that is consistently cold.
- Use a CFL with a built in reflector for outdoor fixtures. CFLs distribute their light differently than incandescents, so using a bulb with a built in reflector allows you to maximize lamp output.
- Try to purchase lamps with a color temperature of 2700 to 3000K<sup>§</sup>. The ENERGY STAR program is proposing that all new qualified lamps include this number on the packaging. If the correlated color temperature (CCT) is not listed, look for one advertised as being Warm White or Soft White. This range of CCT is also the most nighttime friendly for wildlife and stars.

### A bright idea for dimmer lights

The Lighting Research Center is currently experimenting with the cost savings of dimmer switches and daylight sensors on LED streetlights. Automatic dimmers are becoming increasingly popular in residences too, because they are affordable, reliable, and relatively easy to program. Motion sensors offer another way to ensure lights go on when they are needed and turn off when they are not.

<sup>†</sup> Values according to the American Council for an Energy-Efficient Economy (ACEEE):

<http://www.aceee.org/consumerguide/lighting.htm>

<sup>‡</sup> [http://www.energystar.gov/ia/partners/promotions/change\\_light/downloads/Fact\\_Sheet\\_Mercury.pdf](http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf)

<sup>§</sup> [http://www.energystar.gov/index.cfm?c=cfls.pr\\_cfls\\_color](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls_color)

## Fixture Seal of Approval

IDA's certification program, called the Fixture Seal of Approval, was created in 2005 to promote environmentally responsible outdoor lighting. The Fixture Seal of Approval provides objective, third-party certification for luminaires that minimize glare, reduce light trespass, and don't pollute the night sky. IDA evaluates the photometric data of any luminaire submitted by its manufacturer. Fixtures that do not emit any light above a 90 degree angle earn the FSA certification.

Previously open exclusively to industrial lighting fixtures, certification has recently been extended to residential lighting fixtures for outdoor use. The criteria of not emitting light above a 90 degree angle remains stringent, ensuring dark sky compliance. The FSA page on the IDA Web site (under the Policy/Programs tab) provides a list of approved fixtures and manufacturers, as well as vendors who distribute dark sky friendly fixtures.



## Wildlife

From bird feeders to firefly chases, many people like to experience wildlife in their backyard. But bright light throughout the night can have calamitous effects on animals, insects, and plants. As humans expand into more rural areas, our light pollution produces a continual state of “twilight” in the habitats around us. This twilight affects the mating habits, feeding patterns, and navigational skills of mammals, birds, amphibians, reptiles, and insects. Even certain trees are induced to shed their leaves out of cycle, disrupting the basis of the food chain. Scientists and researchers are only now beginning to understand the long term impacts of artificial light at night on ecosystems. Smart lighting choices can help restore the environmental balance in your neighborhood.



Insects are attracted to the white light of floodlights.

**Upon discovering the magnitude of fatal bird collisions, some cities are initiating mitigation procedures.** The Lights Out Toronto campaign, established in 2006 in Toronto, Canada calls for residents to turn out any unnecessary lights for the protection of migratory birds. In addition, the city has issued bird friendly development guidelines for all new buildings, which include the control of unnecessary artificial light. In September 2008, Boston, MA, USA began a two-month initiative to conserve electricity by shutting off lights at 34 city skyscrapers. A stated purpose of this project was the protection of migrating birds. Chicago, IL and New York, NY USA also participate in a “Lights Out” during migration season.

**As awareness of the danger of artificial light to sea turtles grows, an increasing number of communities are restricting coastal illumination.** Countries all over the world have passed ordinances that control the amount and type of light used in coastal environments. As the list grows, hatchling sea turtles are starting to be able to find the sea without the help of human volunteers to guide them. Learn more about local and regional action by visiting [www.seaturtle.org](http://www.seaturtle.org).



### Sample letter to neighbor:

Putting your thoughts in writing is good way to avoid a miscommunication. IDA has prepared a sample letter of issues you may want to convey to a neighbor if a lighting nuisance ever arises.

Dear **(insert name)**,

Allow me to introduce myself, I am your neighbor **(insert name)** and I would love to talk to you about good outdoor lighting. I have noticed that you have installed outdoor lights on your property, and I applaud your desire to help improve our neighborhood.

At this time your lights are a bit too bright and they are shining in **(pick areas as they apply: our bedroom window, the backyard, into our house etc.)**, and interfering with our **(sleep, hobbies, view of the sky, etc)**. I'm sure you weren't aware of this and I wanted to bring it to your attention as soon as possible to avoid any misunderstanding. Let me be clear, I am not asking you to remove the lights, but perhaps they can be re-directed onto the ground where they will do the most good.

In addition, we could work together to shield the lights so that they are even more effective. Shielding a lamp usually requires a lesser wattage bulb, which is a big money saver within just a year's time. Shielding reduces glare which can be blinding and produces fewer harsh shadows where the "bad guys" can hide. Dark sky friendly lighting provides real security, not just an illusion.

There are other ways to save money and still be safe. When lights have motion sensors, they provide an alert if someone is in your yard after dark and they save you money by keeping the lights off when they aren't needed. Timers are another money saver because they can turn off your lights when you will not be using the yard; for instance, when you retire for the night.

Thank you so much for your time and understanding. I would love to talk with you about the advantages to using dark sky friendly lighting and how it benefits your safety, your budget, and the night sky.

Sincerely,  
Your Neighbor

A Word document of this letter is available by contacting IDA.

## Referenced Material:

*American Council for an Energy-Efficient Economy*—[www.aceee.org](http://www.aceee.org)

*Consumers Guide to Home Energy Savings*—<http://www.aceee.org/consumerguide/lighting.htm>

*ENERGY STAR*®—[http://www.energystar.gov/ia/partners/promotions/change\\_light/downloads/Fact\\_Sheet\\_Mercury.pdf](http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf)

The Facts About Mercury in CFLs, Press Release, October 1, 2007, Released by Focus on Energy and Energy Star—[http://www.focusonenergy.com/data/common/dmsFiles/K\\_MK\\_MKPR\\_PR\\_2048118480.pdf](http://www.focusonenergy.com/data/common/dmsFiles/K_MK_MKPR_PR_2048118480.pdf)

Sherman, Lawrence W., Denise Gottfredson, Doris MacKenzie, John Eck, Peter Reuter, and Shawn Bushway. “Preventing Crime: What Works, What Doesn’t, What’s Promising” A Report to the United States Congress. Prepared for the National Institute of Justice. 1997. <http://www.ncjrs.gov/works/>

*U.S. Environmental Protection Agency*—<http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm>

## Related Practical Guides and Web Links:

*Crime Prevention Through Environmental Design*—[www.cpted.net](http://www.cpted.net)

*FLAP—Fatal Light Awareness Program*—[www.flap.org](http://www.flap.org)

*ENERGY STAR*®—[http://www.energystar.gov/index.cfm?c=cfls.pr\\_cfls\\_color](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls_color)

“PG1: What is Light Pollution”—[www.darksky.org](http://www.darksky.org)

“PG2: Effects of Artificial Light at Night on Wildlife”—[www.darksky.org](http://www.darksky.org)

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**For information on IDA membership and donations, visit our Web site at [www.darksky.org](http://www.darksky.org).**

# EXHIBIT A4

## Vision and blue light

Daylight is composed of the entire spectrum of color. Different types of visible light, seen as colors, have different wavelengths varying from violet to red light. Blue light has the shortest wavelength, and is therefore more easily “scattered” in the atmosphere. Our sky and oceans appear blue because blue light is most easily refracted. Blue light, especially at night, can cause more eyestrain and fatigue than other types of light and may cause halos around objects, because the short wavelength makes it harder for the eye to focus. Just as blue light scatters in the atmosphere, it scatters in our eyes as well, impairing our night vision.

The aging eye is especially vulnerable to eyestrain and loss of night vision. With age, we undergo a natural process that reduces our visual abilities. Issues of contrast, glare, the uniformity of illumination, and the type of light used are all factors that help determine how well we see.

Smart lighting decisions help preserve vision and promote the overall health of the eye.

### References:

Chepesiuk, Ron. “Missing the Dark: Health Effects of Light Pollution,” *Environmental Health Perspectives* Volume 117, Number 1, January 2009

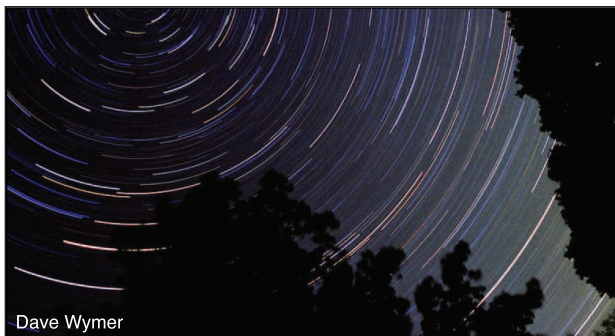
Straif, Kurt, Robert Baan, Yann Grosse, Béatrice Secretan, Fatiha El Ghissassi, Véronique Bouvard, Andrea Altieri, Lamia Benbrahim-Tallaa, Vincent Coglianò. “Carcinogenicity of shift-work, painting, and fire-fighting” *Lancet Oncology*. Volume 8, Issue 12, pp. 1065–1066, 2007



Look for the IDA Fixture Seal of Approval to make sure you are buying a true dark sky friendly fixture.

International Dark-Sky Association images may only be used for non-commercial, educational purposes and must compliment IDA's mission to preserve and protect our night skies through quality outdoor lighting.

- Images attributed to IDA must be credited as such.
- **Images credited to anyone other than IDA may not be used without the consent of the photographer.**



The International Dark-Sky Association (IDA), is an educational organization that seeks to preserve the natural night skies worldwide. Light pollution is an increasing problem threatening astronomical facilities, ecologically sensitive habitats, all wildlife, our energy use as well as our human heritage. Light pollution is excessive and inappropriate artificial light. The four components of light pollution are often combined and overlapping:

- **Urban sky glow**—the brightening of the night sky over inhabited areas.
- **Light trespass**—light falling where it is not intended, wanted, or needed.
- **Glare**—excessive brightness which causes visual discomfort. High levels of glare can decrease visibility.
- **Clutter**—bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas. The proliferation of clutter contributes to urban sky glow, trespass, and glare.

Lights left on in unoccupied buildings, outdoor lights pointing up to the sky or unshielded lights create sky glow. Visit the IDA Web site at [www.darksky.org](http://www.darksky.org) to learn more about the causes of light pollution and what you can do to keep the skies dark.

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Rev 2009/June

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## International Dark-Sky Association

*To preserve and protect the nighttime environment and our heritage of dark skies...*

## Light Pollution and Human Health



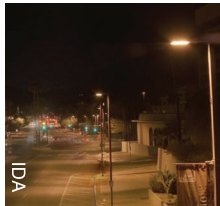
Most people don't know how excessive light at night negatively impacts many areas of human health. This brochure offers an introduction to this treatable problem.

## Glare on the eyes

Bright points of light from poorly designed roadway lighting produce a condition known as “disability glare.” Disability glare is so intense it causes us to avert our eyes from the veil of light being scattered across our retinas.

This veil reduces:

- Contrast sensitivity
- Color perception
- Our ability to see contrasts



Glaring lights can distress the eyes. The brightest, most visible objects in the area are the lighting fixtures, not the roadways, walkways or parking areas Atlanta, Georgia.

This condition can temporarily cast everything except the light source into virtual invisibility. Older drivers are especially vulnerable to disability glare, because as we age the eye loses its ability to quickly adjust to changing levels of illumination. Fully shielded roadway lighting reduces this hazard and creates a safe and more pleasant driving experience by distributing the light evenly.

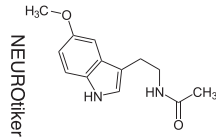
## Circadian rhythms



The 24-hour day/night cycle, known as the circadian clock, affects physiologic processes in almost all organisms. These processes include brain wave patterns, hormone production (melatonin), cell regulation and other biologic activities. Disruption of these rhythms can result in insomnia, depression, cancer and cardiovascular disease\*.

\* Chepesiuk, Ron. “Missing the Dark: Health Effects of Light Pollution,” *Environmental Health Perspectives*. Vol. 117, Num. 1, January 2009

## What is melatonin?



Melatonin is a naturally occurring hormone which is released by darkness and inhibited by light. It serves many functions in the human body, primarily regulating the daily cycles of our systemic activities. Reduction or elimination of light at night can help maintain a robust melatonin rhythm. While any kind of light can interfere with melatonin production, the short wavelength, blue portion of the spectrum is the most potent for melatonin suppression in humans.

## Sleep disorders



Exposure to the artificially extended daytime of our lighted modern world can lead to desynchronization of our internal rhythms. According to the National Institution of Health (NIH), a shift in our clocks impairs our ability to sleep and wake at the appropriate times and leads to a decrease in cognitive and motor skills.

A good night's sleep helps reduce:

- Weight gain
- Stress
- Depression
- Onset of diabetes

The NIH believes humans function best when they sleep at night and act in the daytime. If outdoor light is shining into your window and disrupting your sleep, we recommend you block out the light or request that the light be shielded for everyone's benefit.

## Emerging research

The scientific community is studying the range and complexity of circadian disruption and the role of melatonin suppression from too much artificial light at night.

Scientists are finding an undisputed connection between sufficient sleep and good health. Moreover, they are recognizing the importance of exposure to daylight during the day and darkness at night to maintain a routine circadian rhythm. The World Health Organization now lists “shiftwork that involves circadian disruption” as a probable carcinogen†.

On 15 June 2009, the American Medical Association adopted resolutions that support the reduction of light pollution and glare and advocate for use of energy efficient, fully shielded outdoor lighting. Ongoing research continues to probe the connection between natural darkness and human health.

## Solutions

IDA believes that there are solutions to these issues:

- Shield and lower the wattage of all outdoor lighting: homeowners, businesses, and cities.
- Use only the light you need to get the job done.
- Use timers, dimmers, and sensors to darken unoccupied areas. Shut off the lights when you can.
- Keep your bedroom as dark as possible by using blackout curtains when sleeping.



The shielding keeps light on the ground where it is needed.

A shielded light uses less wattage and saves everyone money, reduces our energy use and shrinks our carbon footprint. Work with your neighbors and local government to keep the light on the ground and the skies natural. This is a win-win situation for everyone. You save money while preserving a valuable natural resource.

† Straif, K, et al. *Lancet Oncol*. Vol. 8, Is. 12 pp. 1065–1066, 2007.

# **EXHIBIT A5**

## Some Quick Outdoor Lighting Tips

When switching to Outdoor Compact Fluorescent Light (OCFL) Bulbs, as shown below, you will not need the same wattage as an incandescent bulb. Help preserve dark skies by not over lighting an area because of a simple miscalculation.

The Department of Energy and Environmental Protection Agency's EnergyStar program have contributed the following table to assist in OCFL conversions.

More information is available at the EnergyStar Web site, [www.energystar.gov](http://www.energystar.gov).

Incandescent Light Bulbs	Minimum Light Output	Energy Star Qualified Bulbs
Watts	Lumens	Watts
40	450	9-13
60	800	13-15
75	1,100	18-25
100	1,600	23-30
150	2,600	30-52

Data from Energy Star Web site, [http://www.energystar.gov/index.cfm?c=cfls.pr\\_cfls](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls).



Look for the IDA Fixture Seal of Approval to make sure you are buying a true dark-sky friendly fixture.

International Dark-Sky Association images may only be used for noncommercial, educational purposes and must compliment IDA's mission to preserve and protect our night skies through quality outdoor lighting

- Images attributed to IDA must be credited as such.
- Images credited to anyone other than IDA may not be used without the consent of the photographer.

Source: United States Department of Energy and the IDA Technical Staff. [http://www.netl.doe.gov/ssl/PDFs/lmc\\_vol1.final.pdf](http://www.netl.doe.gov/ssl/PDFs/lmc_vol1.final.pdf).



The International Dark-Sky Association (IDA), is an educational organization that seeks to preserve the natural night skies worldwide. Light pollution is an increasing problem threatening astronomical facilities, ecologically sensitive habitats, all wildlife, our energy use as well as our human heritage. Light pollution is excessive and inappropriate artificial light. The four components of light pollution are often combined and overlapping:

- **Urban sky glow**—the brightening of the night sky over inhabited areas.
- **Light trespass**—light falling where it is not intended, wanted, or needed.
- **Glare**—excessive brightness which causes visual discomfort. High levels of glare can decrease visibility.
- **Clutter**—bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas. The proliferation of clutter contributes to urban sky glow, trespass, and glare.

Keeping lights on in unoccupied buildings, outdoor lights pointing up to the sky or unshielded lights create sky glow. Visit the IDA Web site at [www.darksky.org](http://www.darksky.org) to learn more about the causes of light pollution and what you can do to keep the skies dark.

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## International Dark-Sky Association

*To preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting.*

## Light Pollution and Energy



Save energy and enjoy the nighttime sky

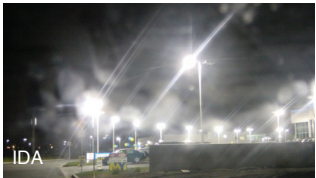
## What is Waste?



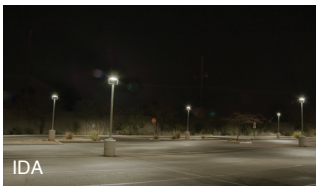
This office building shows wasted energy. The office is empty, but all the lights are on. This type of illumination contributes to the general sky glow of the city as well as wasting energy. Is the most efficient use of your tax dollars to keep buildings lit when they are empty?

Being dark sky friendly does not mean no light. It means using the light that you need for a particular task in the most efficient manner possible.

## Good Lighting vs. Bad Lighting



The photo on the top shows light shining into the sky and creating glare. There are also many more lights being used. The parking lot on the bottom shows shielded lighting. Notice how fewer lights illuminate an area of similar size and without glare.



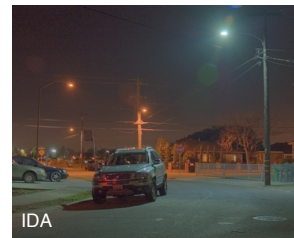
## What is being done?

Municipalities are exploring new ways to save money and keep the skies as natural as possible. Dark sky friendly fixtures are similarly priced as traditional fixtures or the costs are off set through energy efficiency. Shielded lighting usually requires a lower wattage lamp because all the light from the fixture is pointed downward where it is needed.



R. Dechesne/Royal Astronomical Society of Canada  
Notice the glare of the old drop lens fixtures in the background compared to the new flat-lens fixtures in foreground, Calgary, Alberta, Canada.

Calgary, Alberta, Canada switched to shielded lighting in order to save money on their streetlight electricity consumption. By retrofitting their roadway lighting with flat lens fixtures, Calgary will see cost savings from reduced energy consumption of approximately \$1.7 million a year.



Low Pressure Sodium lighting in the background and LED in the foreground

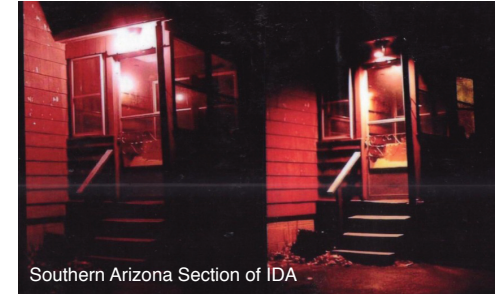
Many cities are using new solid state lighting or light emitting diodes (LED) technology and solar power. These are terrific alternatives in terms of energy and costs savings. To be truly effective and not create sky glow, glare or light trespass, an LED or solar lamp must to be pointed downward, fully shielded to emit no light above the 90 degree angle. A globe light “glare bomb” can still be a “glare bomb” even if it is an LED or solar powered lamp.

## Carbon Footprint

Wasted outdoor lighting, that shines directly upward, is estimated at 17,400 gigawatt-hours a year. At an average of \$.10 per kilo watt-hour the cost of that wasted energy is \$1.74 billion a year. In terms of how that affects our carbon footprint, here's the math:

- 10,768 BTU to generate one kilo watt-hour
- 1 ton of coal = 20.7 million BTU
- 1 barrel of oil = 5.8 million BTU

- 9.1 million tons of coal, or 32.3 million barrels of oil are wasted every year to generate the energy for this lost light. That's almost 600 million gallons of gasoline wasted.



Southern Arizona Section of IDA  
By shielding the light (right side), the bulb was reduced from 60 watts to 40 watts, a 33% savings.

## Solutions

IDA believes that there are solutions to these issues:

- Shield and lower the wattage of all outdoor lighting: Homeowners, businesses, and cities.
- Use only the light you need to get the job done.
- Use timers, dimmers, and sensors to darken unoccupied areas. Shut off the lights when you can.

A shielded light uses less wattage and saves everyone money, reduces our energy use and shrinks our carbon footprint. Work with your neighbors and local government to keep the light on the ground and the skies natural. This is a win-win situation for everyone. You save money while preserving a valuable natural resource.



Malcolm Smith  
This fully shielded lighting with motion sensors safely light the walkway and saves energy.

# **EXHIBIT A6**

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## GLOSSARY OF BASIC TERMS, LIGHTING

We include in this glossary of definitions for a number of the basic terms and words used in the lighting community. For further information and formal definitions, see discussions in standard dictionaries, encyclopedias, the IES Lighting Handbook, and other lighting industry books.

*Note that some of these definitions are quite subjective, and are offered here as a guidance, not as a formal definition.*

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**Accent lighting:** Lighting used to emphasize or draw attention to a special object or building.

**Ambient light:** The general overall level of lighting in an area.

**Angstrom:** A unit of wavelength often used in astronomy, equal to  $10^{-10}$  meter or 0.1 nanometer.

**Baffle:** An opaque or translucent element to shield a light source from direct view.

**Ballast:** A device used with a discharge lamp to obtain the necessary voltage, current, and/or wave form for starting and operating the lamp.

**Beam spread:** The angle between the two directions in the plane in which the intensity is equal to a given percentage (usually 10 percent) of the maximum beam intensity.

**Brightness:** Strength of the sensation that results from viewing surfaces from which the light comes to the eye.

**Bulb or lamp:** The source of electric light. To be distinguished from the whole assembly (see luminaire). Lamp often is used to denote the bulb and its housing.

**Candela (cd):** Unit of luminous intensity. One candela is one lumen per steradian. Formerly called the candle.

**Candlepower distribution curve:** A plot of the variation in luminous intensity of a lamp or luminaire.

**Candlepower:** Luminous intensity expressed in candelas.

**CIE:** Commission Internationale de l'Eclairage. The international light commission. Sets most lighting standards.

**Coefficient of Utilization (CU):** Ratio of luminous flux (lumens) from a luminaire received on the "work plane" [the area where the light is needed] to the lumens emitted by the luminaire.

**Color rendering:** Effect of a light source on the color appearance of objects in comparison with their color appearance under normal daylighting.

**Cones and rods:** Retinal receptors. Cones dominate the response when the luminance level is high, and provide color perception. Rods dominate at low luminance levels. No rods are found in the central part of the fovea. Rods have no color perception ability.

**Conspicuity:** The capacity of a signal to stand out in relation to its background so as to be readily discovered by the eye (as in lettering on a sign, for example).

**Cosine law:** Illuminance on a surface varies as the cosine of the angle of incidence of the light. The inverse square law and the cosine law can be combined.

**Cut off angle, of a luminaire:** The angle, measured up from the nadir (i.e. straight down), between the vertical axis and the first line of sight at which the bare source (the bulb or lamp) is not visible.

**Cutoff fixture:** An IES definition "Intensity at or above 90° (horizontal) no more than 2.5% of lamp lumens, and no more than 10% of lamp lumens at or above 80°".

**Dark adaptation:** The process by which the eye becomes adapted to a luminance less than about 0.03 candela per square meter (0.01 footlambert).

**Disability glare:** Glare resulting in reduced visual performance and visibility. It is often accompanied by discomfort.

**Discomfort glare:** Glare that produces discomfort, but does not necessarily diminish visual performance.

**Efficacy:** The ability of a lighting system to produce the desired result.

**Efficiency:** A measure of the effective or useful output of a system compared to the input of the system.

**Electromagnetic (EM) spectrum:** The distribution of energy emitted by a radiant source, arranged in order of wavelength or frequency. Includes gamma-ray, X-ray, ultraviolet, visual, infrared, and radio regions.

**Energy (radiant energy):** Unit is erg, or joule, or kWh.

**Façade lighting:** The illumination of the exterior of a building

**Fixture:** The assembly that holds the lamp in a lighting system. It includes the elements designed to give light output control, such as a reflector (mirror) or refractor (lens), the ballast, housing, and the attachment parts.

**Floodlight:** A fixture designed to "flood" a well defined area with light.

**Flux (radiant flux):** Unit is erg/sec or watts.

**Footcandle:** Illuminance produced on a surface one foot from a uniform point source of one candela.

**Footlambert:** The average luminance of a surface emitting or reflecting light at a rate of one lumen per square foot.

**Full-cutoff fixture:** An IES definition; "Zero intensity at or above horizontal (90° above nadir) and limited to a value not

exceeding 10% of lamp lumens at or above 80°".

**Fully Shielded fixture:** A fixture that allows no emission above a horizontal plane through the fixture.

**Glare:** Intense and blinding light that reduces visibility. A light within the field of vision that is brighter than the brightness to which the eyes are adapted.

**HID lamp:** In a discharge lamp, the emitted energy (light) is produced by the passage of an electric current through a gas. High-intensity discharge (HID) include mercury, metal halide, and high pressure sodium lamps. Other discharge lamps are LPS and fluorescent. Some such lamps have internal coatings to convert some of the ultraviolet energy emitted by the gas discharge into visual output.

**High-Pressure Sodium (HPS) lamp:** HID lamp where radiation is produced from sodium vapor at relatively high partial pressures (100 torr). HPS is essentially a "point source".

**House-side Shield:** Opaque material applied to a fixture to block the light from illuminating a residence or other structure being protected from light trespass.

**Illuminance:** Density of luminous flux incident on a surface. Unit is footcandle or lux.

**Illuminating Engineering Society of North America (IES or IESNA):** The professional society of lighting engineers, including those from manufacturing companies, and others professionally involved in lighting.

**Incandescent lamp:** Light is produced by a filament heated to a high temperature by electric current.

**Infrared radiation:** EM radiation just to the long wavelength side of the visual.

**Intensity:** The degree or amount of energy or light.

**International Dark-Sky Association (IDA, Inc.):** A non-profit organization whose goals are to build awareness of the value of dark skies, and of the need for quality outdoor lighting.

**Inverse-square law:** Illuminance at a point varies directly with the intensity,  $I$ , of a point source and inversely as the square of the distance,  $d$ , to the source.  $E = I / d^2$

**kWh: Kilowatt-hour:** A unit of energy equal to the work done by one kilowatt (1000 watts) of power acting for one hour.

**Light pollution:** Any adverse effect of artificial light.

**Light trespass:** Light falling where it is not wanted or needed. Spill light. Obtrusive light.

**Low-Pressure Sodium (LPS) lamp:** A discharge lamp where the light is produced by radiation from sodium vapor at a relatively low partial pressure (about 0.001 torr). LPS is a "tube source". It is monochromatic light.

**Lumen:** Unit of luminous flux; the flux emitted within a unit solid angle by a point source with a uniform luminous intensity of

one candela. One footcandle is one lumen per square foot. One lux is one lumen per square meter.

**Lumen depreciation factor:** Light loss of a luminaire with time due to the lamp decreasing in efficiency, dirt accumulation, and any other factors that lower the effective output with time.

**Luminaire:** The complete lighting unit, including the lamp, the fixture, and other parts.

**Luminance:** At a point and in a given direction, the luminous intensity in the given direction produced by an element of the surface surrounding the point divided by the area of the projection of the element on a plane perpendicular to the given direction. Units: candelas per unit area.

**Lux:** One lumen per square meter. Unit of illuminance.

**Mercury lamp:** An HID lamp where the light is produced by radiation from mercury vapor.

**Metal-halide lamp:** An HID lamp where the light is produced by radiation from metal-halide vapors.

**Mounting height:** The height of the fixture or lamp above the ground.

**[Nadir](#):** A point on the celestial sphere directly below the observer, diametrically opposite the zenith.

**Nanometer (nm):** 10<sup>-9</sup> meter. Often used as the unit for wavelength in the EM spectrum.

**Photometry:** The quantitative measurement of light level and distribution.

**Quality of light:** A subjective ratio of the pluses to the minuses of any lighting installation.

**Reflector:** Controlling light output by means of reflection (mirror).

**Refractor:** Controlling light output by means of refraction (lens).

**[Semi-cutoff fixture](#):** An IES definition; "Intensity at or above 90° (horizontal) no more than 5% of lamp lumens and no more than 20% at or above 80°".

**Shielding:** An opaque material that blocks the transmission of light.

**Spotlight:** A fixture designed to light only a small, well-defined area.

**Stray light:** Emitted light that falls away from the area where it is needed or wanted. Light trespass.

**Task lighting:** Lighting designed for a specific purpose or task.

**Ultraviolet "light":** The energy output by a source which is of shorter wavelengths than the eye can see. Some photographic films are sensitive to ultraviolet energy, as are many electronic detectors. "Black Light."

**Urban sky glow:** The brightening of the night sky due to manmade lighting.

**Veiling luminance:** A luminance produced by bright sources in the field-of-view superimposed on the image in the eye reducing contrast and hence visibility.

**Visibility:** Being perceived by the eye. Seeing effectively. The goal of night lighting.

**Zenith:** An imaginary point directly "above" a particular location, on the imaginary **celestial sphere**.

# EXHIBIT A7

## Lighting and Wildlife: 101 Introduction

When we think of artificial light\* at night, we hardly think about how – or even if – it affects wildlife. What little research has been done in this interesting and important area has been carried out in response to specific problems. Much more needs to be done to protect our ecosystem – and us – from the effects of artificial light at night.

What has been shown is that wildlife – including insects, amphibians, birds, and mammals – need both daylight and darkness for normal functioning. Organisms, from a single cell to humans, have a daily or annual rhythm that corresponds to the cycles of light, temperature, availability of food, and other factors affecting behavioral and physiological functions.

The biological clock, a genetically determined internal mechanism for regulating the time, is responsible for these rhythms. This clock needs regular adjustment through the light-dark cycle. Disruption of this clock can lead to a lack of rest or sleep, which in turn leaves the animal less alert and in poorer physical condition.

The length of the day is also rhythmic throughout the year and regulates animal activities, such as procreation, migration, and hibernation. The biological calendar, an internal mechanism, is responsible for the hormonal, physiological, and anatomical preparation that these activities require.

Neuroendocrine processes are responsible for the day-night and seasonal rhythms in behavioral and physiological functions of organisms. These processes are controlled by an organ in the brain particularly sensitive to light, the pineal (pronounced PINE-eel) gland. The pineal gland produces the hormone melatonin, the key to the transfer of external light stimuli to an animal's hormonal system.

If their darkness is disturbed by light, all organisms may experience: attraction, fixation, and repulsion; improvement in orientation, or disorientation; disruption of biological rhythms; and change in habitat quality.

Effects of nighttime light on wildlife include:

- Loggerhead, green, leatherback, and other **sea turtles** nest on the coast of Florida. Lights along the beach may keep females from coming to shore and nesting. Lights can be deadly to hatchling turtles, which come out of the nest when it is cooler, generally at night, and orient themselves toward the brightest area. On natural beaches this light comes from the night sky reflecting off the ocean. However, where beach areas are highly populated and overlit, the hatchlings become disoriented and crawl away from the ocean and toward the lights, often dying from exhaustion, dehydration, being eaten by predators, or being run over by cars.
- Fledglings of the Newell's shearwater, a threatened Hawaiian **seabird**, make their first flights using light to guide them. Under normal conditions, the light is reflected from the water, and they fly toward the horizon, out to sea. But when the moon is not full or visible, the birds tend to fly toward the lights of resorts and towns, where they crash into structures or drop from the sky. Two other species, the dark-rumped petrel (endangered) and the band-rumped petrel (rare), have similar problems on Kauai, especially in autumn.
- Thousands of **birds** collide with communication towers and buildings each year. Albert M. Manville II, in an article in the *Proceedings of the Avian Interactions Workshop* held in December 1999 in South Carolina, and others reported on bird collisions with communication towers. Some 350 species of songbirds breed in North America in spring and summer and migrate – generally at

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night and at low altitudes – to the southern U.S.A., the Caribbean or Mexico. Some of these song-birds, especially thrushes, vireos, and warblers, are very susceptible to collisions with light towers and buildings during storms and other low-visibility conditions during their spring and fall migrations.

The U.S.A. has some 75,000 towers; one estimate is that an average of 2,500 birds die at each tower a year. Another estimated 98 to 100 million birds die each year when they fly into windows, usually of tall buildings. Collisions with light-houses are a problem, though less severe, and airports attract birds, as well. (For details, see [www.jmu.edu/wmra/engineering/bibliography.html](http://www.jmu.edu/wmra/engineering/bibliography.html) and [www.flap.org](http://www.flap.org)).

Researchers have noted that, during or near a full moon, birds seldom or never fly into towers, suggesting that moonlight offsets this disorienting effect of artificial light on their migration.

Night light may disrupt the biological calendar, resulting in early brooding and the bearing of offspring when weather and food supply are not optimal. British scientists have observed robins singing at night when streetlights are in their territories. Scientists have also noticed nesting by other birds in the fall instead of the spring. One explanation is that too much light in the area has “reset” the birds’ biological clocks.

- Certain **bats** in Europe and North America are attracted to moths and other insects at lights, which offer a steady supply of larger insects. In a 1996 article in the journal *Bats*, researchers Jens Rydell and Hans J. Baagøe worry that the species that take over lighted areas displace other species of bats. Entomologists are concerned about the bats’ decimating insect populations.
- Species of slow-flying bats are sometimes seen around lights, Rydell and Baagøe noted. Rather than flying around in the light, however, their hunting strategy is to turn up very briefly in the light cone, grab a moth, and then disappear again into the vegetation. These slower bats, which may be more vulnerable to the owls that frequent open, lighted areas, are found among the most threatened species in Europe.

- **Moths** are attracted to light at night, as nearly everyone has observed. Kenneth D. Frank, a physician and amateur moth enthusiast in Philadelphia, Pennsylvania, pointed out that scientists have found that outdoor lighting disrupts moth navigation and suppresses flight, thus interfering with mating, dispersal, and migration. The energy a female expends in flying around a light may cost her the chance to attract a mate. Researchers have found that light can interfere with the females’ finding prime spots to lay their eggs, thus giving larvae inadequate conditions to develop. Artificial light also disturbs feeding, nocturnal vision, and, possibly, circadian rhythms of the moths. It exposes the moths to predation by bats, birds, and others.

- German scientists G. Eisenbeis and F. Hassel found that various lights attract **insects** differently. Sodium vapor lamps reduced the attraction of insects by more than 50 percent and of *Lepidoptera* (i.e., moths) by about 75 percent, compared to the older high-pressure mercury lamps. This means that proper light selection can minimize risk to moths and other insects while still providing visibility for human needs.

- Artificial light may have an impact on **fireflies**. James E. Lloyd of the University of Florida at Gainesville has suggested that the chemiluminescence fireflies use for sexual communication in dimly lit or dark environments has similar spectra to incandescent light. This is an area still to be researched and documented.

- Researchers Barbara Nightingale and Charles Simenstad of the University of Washington in Seattle write that studies in the Pacific Northwest show potential changes in **fish** migration behavior and the distribution of fish in areas lit at night. These changes could increase the mortality risks for salmon, herring, and sand lance. Juvenile

\* *The term “artificial light” is used to connte any human-caused lights, such as outdoor lighting, billboards, strobe lights, or lights in buildings.*

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chum and their predators appear to congregate below night security lights, perhaps delaying migration

The hatching of halibut eggs can be controlled by exposure to light, which delays the process. Light also influences the amount and the depth at which halibut swim. Norwegian studies ([http://miljolare.no/virtue/newsletter/00\\_09/curr-holm/more-info/halibut.php](http://miljolare.no/virtue/newsletter/00_09/curr-holm/more-info/halibut.php)) showed that halibut tend to swim most actively in the dark; artificial light keeps the fish at the bottom and slows them down, thus causing them to grow more. And another study shows that, in salmonids (including salmon and trout), spawning can be manipulated through light. All this may be desirable in aquaculture, but not necessarily in nature.

Artificial light is often used to keep fish and some freshwater crustaceans away from the intake valves of hydroelectric plants or to guide them through migration barriers, fish ladders, spillways, and bridges. However, using light in this manner can have an effect on the entire lake ecosystem, since it affects the behavior of the fish. Young chinook and coho salmon smolts (about two years old) are normally passive at night. However, exposure to mercury lights at night increases activity by 90 percent (see Nemeth and Anderson, article cited in abstracts at [www.urbanwildlands.org/nightlightbiblio.html](http://www.urbanwildlands.org/nightlightbiblio.html)). Young fish may be attracted to the lights – along with their predators.

- Most **frogs** are thought to be at least largely nocturnal. Experiments and anecdotal evidence show that frog reproduction, foraging, predator avoidance, and social interactions are affected when a dark area is illuminated artificially. The frogs may be temporarily blinded by the light, leaving them vulnerable to predation and unable to see prey.

- Nocturnal **salamanders** may face similar problems. Increased lighting is useful for locating prey, but is also useful for their predators. Increased light may alter the outcome of territorial

contests. Light near ponds may attract or repel adults that migrate to the ponds to breed and lay their eggs.

Although the moon and stars provide illumination, this changes each night. Artificial lighting gives off a different type of light – constantly.

Research continues to address specific light-related problems, such as the decline of sea turtles along the Florida coast, and problems related to human activities, such as building and operating power plants. Much more needs to be done, including making current research results more widely known and available.

*All of the above information can be found in the “Links” area of the IDA home page. The following, which were valid in spring 2003, are of special interest and are good sources for specific information:*

[www.urbanwildlands.org/nightlightbiblio.html](http://www.urbanwildlands.org/nightlightbiblio.html)

Proceedings of the Conference on the Ecological Consequences of Artificial Night Lighting (ECANL)

[www.sciencenews.org/20020420/bob9.asp](http://www.sciencenews.org/20020420/bob9.asp) Article covering ECANL above

[www.jmu.edu/wmra/engineering/bibliography.html](http://www.jmu.edu/wmra/engineering/bibliography.html)

Bird Kills at Towers and Other Man-Made Structures, bibliography and abstracts

[www.flap.org](http://www.flap.org) Fatal Light Awareness Program, leading info site on bird kills

<http://fwie.fw.vt.edu/jlw/light.htm> Light Effects on Wildlife References

[www.batcon.org/batsmag/v14n4-4.html](http://www.batcon.org/batsmag/v14n4-4.html) Bats and streetlights

*continued*

# **EXHIBIT A8**

## Security Lighting: Let's Have Real Security, Not Just Bad Lighting

One of the main goals for nighttime lighting is to have good safety and security at night, both at home and away from home, for ourselves, our families, our homes and property. However, the task is to **be** safe, not just to **feel** safe. This means that we need effective and efficient lighting. Good visibility is the goal. We want to be able to see well, rather than just lighting the criminal's way. This goal exists for us at home, on the streets, in parking lots, at work, wherever. Good lighting can be a help; poor lighting always compromises safety.

While most crime occurs during the day or inside buildings, we nonetheless want the feeling and the reality of being safe outside at night. That does not mean putting in the brightest light we can find, blinding everyone in the area, creating light trespass, and lighting up the night sky. What we need is effective lighting, lighting that puts light where we need it (and nowhere else) and where it will help visibility. That means: no glare, no light trespass, no direct upright, no harsh shadows, no steep transitions from light to dark, etc. Lighting by itself does not ensure safety. Is there more crime in the "well lit" centers of large cities or in smaller towns with much less lighting? A cynic might derive a positive correlation between crime and light: the more light, the more crime. Current and past studies by competent crime authorities can be summarized as follows: "The paucity of data precludes any definitive statement regarding the relationship of lighting and crime, but there is a strong indication that lighting decreases the fear of crime." Quality lighting rather than a large quantity of poor lighting is essential for any real security.

Here are some examples of bad security lighting--lighting that too often compromises safety. Poor quality fixtures can give the illusion of safety or the feeling of security, but in reality they don't add to safety at all; they often make things worse. They are beacons to the criminal: "Come and get me, my lighting will help you, not me." In essence, they provide criminal-friendly lighting and a false sense of security.

**1. The 175-watt dusk-to-dawn "security light".** This fixture was designed in the old days when energy was cheap, there were no good lighting fixture designs, and the adverse effects of bad lighting were not well appre-

ciated. It sells for \$29.95 or less, but uses more than 200 watts of power. That means it costs about \$70 per year to operate in most locations much more in high electricity cost areas. A good deal of the light output is wasted, going up or sideways where it does no good at all. This fixture has a great deal of glare, often blinding the homeowner and others. It splatters light everywhere, alienating neighbors. It casts harsh shadows behind trees and buildings, allowing criminals plenty of dark areas to hide in. It is a prime example of bad lighting. But it is in use by the millions throughout the country. Why? It's cheap, and bright. We see lots of glare so we think there is lots of light. But it is a most ineffective and inefficient light. (See IDA Information Sheets No. 3, 26, and 103 for more information.)

**2. Globes.** Again, light is splattered everywhere. Because they waste so much light, they require a high-wattage lamp to get any light on the ground. The lamp means a great deal of glare is produced, so much that it often is not easy to see the ground! Why are so many of these inefficient fixtures used? Mainly because they look good in the daytime! Only a very low wattage lamp (as in the days of gas lighting) should be used, thus preserving the daytime appearance and providing a nice nighttime "ambience". A separate, quality lighting system can be installed to light the ground. There is no glare or light trespass from this system, so it doesn't detract from the looks of the globes. This provides the desired attractiveness as well as good lighting and safety. It costs more initially, but there is now good lighting.

**3. Poorly shielded "wall packs" or similar fixtures.** These also splatter light everywhere, with some of the light getting where it's needed but most being wasted. They also create lots of glare. Well-shielded wall packs can be excellent light sources, if they have good light control; many have nearly none.

**4. Poorly designed or installed flood lights.** Flood lights can be good, if they have good light control. But they must be well-designed and well installed to take advantage of their pluses. Often they are poorly

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installed, aimed at what seems a random direction or, worse, right at the street (causing terrible glare for motorists) or at a neighbor's yard or bedroom window. We have all seen many examples of such bad lighting at night.

Enough of the bad, here now are some examples of good quality security lights:

**1. A well-shielded low pressure sodium (LPS) fixture:**

This offers well-controlled light, energy efficiency, no glare. A lack of color rendering is not a disadvantage for most security lighting. Visibility is excellent with LPS lighting.

**2. A similar full-cutoff high pressure sodium (HPS) or metal halide (MH) fixture, or the new low-wattage compact fluorescent (PL) lamps used in good fixtures:** These have no uplight and no glare.

**3. Well-controlled and installed flood lights or spot lights.** These need great care in design and installation to be in the "good" camp, for almost all present installations are clearly not that way.

4. The **infrared sensor spot lights** that come on when someone walks into the field of view of the infrared (IR) detector. (They can activate an alarm too, if wanted.) These lights are very effective in terms of cost and security. They scare intruders away, they offer good visibility to the homeowner when needed (e.g. when taking out the garbage, or when there is an intruder). They must be installed so as to put the light only where it is needed, not shooting up into the sky or onto the neighbor's property. Under the house's eave is often a good location.

To see well, we need adequate light, but not too much. Too much can ruin our adaptation to darker areas at night, blinding us just when we need to see. When we go from too bright to too dark or vice versa, we have poor visibility for a while. This effect is called "transient adaptation", and good designs should minimize its adverse effect on visibility.

To see well, we need to minimize glare and dark areas near well-lit areas. This means good lighting design is required.

To see well, we must not allow the eye to be flooded with too much light when driving or walking at night. "Luminance overload" can easily compromise vision and dark adaptation.

Think, too, about energy savings. We should not waste light nor use inefficient light sources. More than a billion dollars is wasted annually in the U.S.A., with much more throughout the world, due to poor lighting.

What else can we do to maximize safety at night? Here are some ideas. Consult libraries, the local police, companies specializing in security equipment, and others for details and other ideas, but here are a few:

- Use good locks; use a peep hole in the door to see who is there before answering the door
- Have an effective alarm system; include motion sensors (such as are used in the IR spotlight mentioned above)
- Have good phone sense (what you say when answering the phone or on your answering machine)
- Play the radio when gone; put indoor lights on a time switch; put labels on your property (and put security labels on your windows)
- Have a dog; join or promote a neighborhood watch program (one of the best ideas: promote quality outdoor lighting through a neighborhood watch or other group).

Write IDA for a list of additional information sheets about outdoor lighting; we also have excellent slides that illustrate the differences between poor lighting and quality lighting.

# EXHIBIT B



**Illuminating**  
ENGINEERING SOCIETY



**JOINT IDA - IES**

**MODEL  
LIGHTING  
ORDINANCE  
(MLO)**

**with USER'S GUIDE**

**June 15, 2011**

## The User Notes

The User Notes are intended to clarify the sections of the MLO for the various audiences who will use it: lighting designers, city officials, engineers, citizen groups, and others. Every effort has been made to keep the language technically accurate and clear, but since different disciplines may use the same term in different ways, or have different interpretations, some guidance may be helpful. While these Notes can not be a full tutorial on modern lighting design, it is hoped that the Notes will help facilitate the dialogue necessary to adopt the MLO.

## Background

The problems of light pollution first became an issue in the 1970s when astronomers identified the degradation of the night sky due to the increase in lighting associated with development and growth. As more impacts to the environment by lighting have been identified, an international “dark sky” movement is advocating for the precautionary approach to outdoor lighting design.

Many communities have passed anti-light-pollution laws and ordinances. However, there is little or no agreement among these laws, and they vary considerably in language, technical quality, and stringency. This is confusing for designers, engineers, and code officials. The lack of a common basis prevents the development of standards, educational programs, and other means of achieving the goal of effective lighting control.

This MLO will allow communities to drastically reduce light pollution and glare and lower excessive light levels. The recommended practices of the IES can be met using readily available, reasonably priced lighting equipment. However, many conventional lighting practices will no longer be permitted, or will require special permits.

This Model Lighting Ordinance (MLO) is the result of extensive efforts by the International Dark Sky Association (IDA) and the Illuminating

Engineering Society of North America (IES). Among its features is the use of lighting zones (LZ0-4) which allow each governing body to vary the stringency of lighting restrictions according to the sensitivity of the area as well as accommodating community intent. In this way, communities can fine-tune the impact of the MLO without having to customize the MLO. The MLO also incorporates the Backlight-Uplight-Glare (BUG) rating system for luminaires, which provides more effective control of unwanted light.

## Joint IDA-IESNA Model Outdoor Lighting Ordinance (MLO)

June 15, 2011

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## General Notes in Adopting this Model Ordinance

Adoption of this ordinance should follow the established development, review, and approval processes of the adopting authority. If no such processes are in place, this ordinance may be adopted as a new independent section of the Municipal Code.

The MLO is probably best adopted as an “overlay zoning” ordinance. This means that it overlays, but is different from, land-use zoning. It can be added to or integrated into existing ordinances or codes and cross-referenced to other applicable codes and ordinances such as the electrical code, the sign code, planning ordinances, etc.

The MLO may best be managed by assigning it to planning officials and using existing administrative structures.

Because of the diverse community and lighting needs across large areas, this MLO is not intended for adoption as a state, provincial or national ordinance. Regional coordination is encouraged. Light pollution knows no boundaries, and the effects of polluting light persist as far as 200 kilometers (about 120 miles) from the source. One large city could adopt the MLO and dramatically affect a region, but adoption in suburbs and small towns must be part of a regional effort to achieve significant improvements in the overall quality of the night sky.

Adopting agencies should also consider that the MLO, like all other modern codes, is designed to evolve over time. Lighting technology will change, and MLO changes will be needed every few years. On-going renewal cycles are strongly recommended as any part of an adopting ordinance.

## MLO Development and Task Force Members

This Model Lighting Ordinance has been developed as a joint undertaking by the Illuminating Engineering Society and the International Dark-Sky Association.

The Joint Task Force responsible for developing the MLO include

IDA  
Co-Chair: Jim Benya  
Co-Chair: Nancy Clanton  
Leslie Lipstein  
Leo Smith  
Michael Mutmanský

IES  
Naomi Miller  
Cheryl English  
Denis Lavoie  
Eric Gibson

John Walter representing the electric utility industry also contributed as a member of the Joint Task Force.

## I. PREAMBLE - User's Guide

In general, the preamble is part of the ordinance but is typically not part of the code. It establishes the reasons why the municipality is undertaking these regulations.

Local governments may add other purposes to the Preamble including established local government environmental or energy goals that support the model lighting ordinance. The environmental impacts of outdoor lighting fall into two categories: carbon footprint (energy used in the life of a lighting product) and obtrusive light.

CARBON FOOTPRINT	OBTRUSIVE LIGHT
Cost & Impact of Mining the Materials Used	Impact on Humans
Energy Used in Production	Impact on the Environment
Energy Used during Product Life	
Disposal/Recycling Costs	

## II. LIGHTING ZONES - User's Guide

Lighting zones reflect the base (or ambient) light levels desired by a community. The use of lighting zones (LZ) was originally developed by the International Commission on Illumination (CIE) and appeared first in the US in IES Recommended Practice for Exterior Environmental Lighting, RP-33-99.

It is recommended that lower lighting zone(s) be given preference when establishing zoning criteria. Selection of lighting zone or zones should be based not on existing conditions but rather on the type of lighting environments the jurisdiction seeks to achieve. For instance, new development on previously rural or undeveloped land may be zoned as LZ-1. Using lighting zones allows a great deal of flexibility and customization without the burden of excessive regulation. For example, a jurisdiction may choose to establish vertical lighting zones with the lighting zone at street level at a higher zone than the residential housing on upper levels.

## I. PREAMBLE - Ordinance Text

The purpose of this Ordinance is to provide regulations for outdoor lighting that will:

- Permit the use of outdoor lighting that does not exceed the minimum levels specified in IES recommended practices for night-time safety, utility, security, productivity, enjoyment, and commerce.
- Minimize adverse offsite impacts of lighting such as light trespass, and obtrusive light.
- Curtail light pollution, reduce skyglow and improve the nighttime environment for astronomy.
- Help protect the natural environment from the adverse effects of night lighting from gas or electric sources.
- Conserve energy and resources to the greatest extent possible.

## II. LIGHTING ZONES - Ordinance Text

The Lighting Zone shall determine the limitations for lighting as specified in this ordinance. The Lighting Zones shall be as follows:

### LZ0: No ambient lighting

Areas where the natural environment will be seriously and adversely affected by lighting. Impacts include disturbing the biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of the natural environment. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished.

## II. LIGHTING ZONES (cont.) - User's Guide

However, if an adjacent use could be adversely impacted by allowable lighting, the adopting authority may require that a particular site meet the requirements for a lower lighting zone. For example, the authority could specify Lighting Zone 1 or 2 requirements if a commercial development were adjacent to a residence, hospital or open space, or to any land assigned to a lower zone.

Lighting zones are best implemented as an overlay to the established zoning especially in communities where a variety of zone districts exists within a defined area or along an arterial street. Where zone districts are cohesive, it may be possible to assign lighting zones to established land use zoning. It is recommended that the lighting zone includes churches, schools, parks, and other uses embedded within residential communities.

Zone	Recommended Uses or Areas	Zoning Considerations
<b>LZ-0</b>	Lighting Zone 0 should be applied to areas in which permanent lighting is not expected and when used, is limited in the amount of lighting and the period of operation. LZ-0 typically includes undeveloped areas of open space, wilderness parks and preserves, areas near astronomical observatories, or any other area where the protection of a dark environment is critical. Special review should be required for any permanent lighting in this zone. Some rural communities may choose to adopt LZ-0 for residential areas.	Recommended default zone for wilderness areas, parks and preserves, and undeveloped rural areas.  Includes protected wildlife areas and corridors.
<b>LZ-1</b>	Lighting Zone 1 pertains to areas that desire low ambient lighting levels. These typically include single and two family residential communities, rural town centers, business parks, and other commercial or industrial/storage areas typically with limited nighttime activity. May also include the developed areas in parks and other natural settings.	Recommended default zone for rural and low density residential areas. Includes residential single or two family; agricultural zone districts; rural residential zone districts; business parks; open space include preserves in developed areas.

## II. LIGHTING ZONES (cont.) - Ordinance Text

### LZ1: Low ambient lighting

Areas where lighting might adversely affect flora and fauna or disturb the character 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. After curfew, most lighting should be extinguished or reduced as activity levels decline.

### LZ2: Moderate ambient lighting

Areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may typically be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

### 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. After curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

### 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. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

## II. LIGHTING ZONES (cont.) - User's Guide

Zone	Recommended Uses or Areas	Zoning Considerations
<b>LZ-2</b>	Lighting Zone 2 pertains to areas with moderate ambient lighting levels. These typically include multifamily residential uses, institutional residential uses, schools, churches, hospitals, hotels/motels, commercial and/or businesses areas with evening activities embedded in predominately residential areas, neighborhood serving recreational and playing fields and/or mixed use development with a predominance of residential uses. Can be used to accommodate a district of outdoor sales or industry in an area otherwise zoned LZ-1.	<p><b>Recommended default zone for light commercial business districts and high density or mixed use residential districts.</b></p> <p>Includes neighborhood business districts; churches, schools and neighborhood recreation facilities; and light industrial zoning with modest nighttime uses or lighting requirements.</p>
<b>LZ-3</b>	Lighting Zone 3 pertains to areas with moderately high lighting levels. These typically include commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses and shipping and rail yards with high night time activity, high use recreational and playing fields, regional shopping malls, car dealerships, gas stations, and other nighttime active exterior retail areas.	<p><b>Recommended default zone for large cities' business district.</b></p> <p>Includes business zone districts; commercial mixed use; and heavy industrial and/or manufacturing zone districts.</p>
<b>LZ-4</b>	Lighting zone 4 pertains to areas of very high ambient lighting levels. LZ-4 should only be used for special cases and is not appropriate for most cities. LZ-4 may be used for extremely unusual installations such as high density entertainment districts, and heavy industrial uses.	<p><b>Not a default zone.</b></p> <p>Includes high intensity business or industrial zone districts.</p>

### III. GENERAL REQUIREMENTS - User's Guide

This Section sets out the requirements that apply to all lighting, both residential and non-residential.

Each adopting jurisdiction should incorporate their existing standards as to when compliance with new regulations is required, when repair or remodeling triggers compliance and if the new ordinance will be retroactive to existing development. The Applicability section of this model ordinance should serve as a guide if the adopting jurisdiction does not have standards or policies in place. Likewise, the adopting jurisdiction should use their existing policies and definitions of what constitutes public monuments, and temporary and/or emergency lighting. Community attitudes and precedents should be taken into account in deciding to regulate seasonal holiday lighting.

#### EXEMPTIONS - User's Guide

This is standard language intended to prevent conflict of laws and to give the community the ability to set specific lighting requirements in special plans and under use permits. It can be amended to conform to similar language in other ordinances. For example, while public monuments, statuary, and flags should be lighted, the lighting also should be limited to avoid excess.

Lighting for streets, roads, and highways is usually regulated by a street lighting ordinance, and is not covered by this model ordinance. However, since street lighting can affect nearby areas, some recognition of its effect is appropriate. (See Section XI)

#### SIGN LIGHTING - User's Guide

A sign lighting ordinance is strongly recommended if not already in place. It should carefully limit lighting to prevent over-lighted signs from being used to circumvent lighting ordinances.

### III. GENERAL REQUIREMENTS - Ordinance Text

#### A. *Conformance with All Applicable Codes*

All outdoor lighting shall be installed in conformance with the provisions of this Ordinance, applicable Electrical and Energy Codes, and applicable sections of the Building Code.

#### B. *Applicability*

Except as described below, all outdoor lighting installed after the date of effect of this Ordinance shall comply with these requirements. This includes, but is not limited to, new lighting, replacement lighting, or any other lighting whether attached to structures, poles, the earth, or any other location, including lighting installed by any third party.

**Exemptions from III.(B.)** The following are not regulated by this Ordinance

- a. Lighting within public right-of-way or easement for the principal purpose of illuminating streets or roads. No exemption shall apply to any lighting within the public right of way or easement when the purpose of the luminaire is to illuminate areas outside the public right of way or easement, unless regulated with a streetlighting ordinance.

**Note to adopting agency: if using the street lighting ordinance (Section XI), this exemption should read as follows:**

Lighting within the public right-of-way or easement for the principal purpose of illuminating roads and highways. No exemption shall apply to any street lighting and to any lighting within the public right of way or easement when the purpose of the luminaire is to illuminate areas outside of the public right of way or easement.

- b. Lighting for public monuments and statuary.
- c. Lighting solely for signs (lighting for signs is regulated by the Sign Ordinance).
- d. Repairs to existing luminaires not exceeding 25% of total installed luminaires.

### III. GENERAL REQUIREMENTS (cont.) - Ordinance Text

- e. Temporary lighting for theatrical, television, performance areas and construction sites;
- f. Underwater lighting in swimming pools and other water features
- g. Temporary lighting and seasonal lighting provided that individual lamps are less than 10 watts and 70 lumens.
- h. Lighting that is only used under emergency conditions.
- i. In lighting zones 2, 3 and 4, low voltage landscape lighting controlled by an automatic device that is set to turn the lights off at one hour after the site is closed to the public or at a time established by the authority.

**Exceptions to III. (B.)** All lighting shall follow provisions in this ordinance; however, any special requirements for lighting listed in a) and b) below shall take precedence.

- a. Lighting specified or identified in a specific use permit.
- b. Lighting required by federal, state, territorial, commonwealth or provincial laws or regulations.

### C. *Lighting Control Requirements*

#### 1. Automatic Switching Requirements

Controls shall be provided that automatically extinguish all outdoor lighting when sufficient daylight is available using a control device or system such as a photoelectric switch, astronomic time switch or equivalent functions from a programmable lighting controller, building automation system or lighting energy management system, all with battery or similar backup power or device.

### LIGHTING CONTROLS - User's Guide

This section requires all outdoor lighting to have lighting controls that prohibit operation when sufficient daylight is available, and to include the capability, either through circuiting, dimming or alternating sources, to be able to reduce lighting without necessarily turning all lighting off.

### CURFEW REQUIREMENTS - User's Guide

The intent is to reduce or eliminate lighting after a given time. Benefits include reduced environmental impact, longer hours of improved astronomy, energy savings, and improved sleeping conditions for residents. Additionally, some police departments have indicated that post-curfew light reductions make drive-by patrolling easier because it allows them to see further into and through a site.

The authority should determine the time of curfew and the amount of lighting reduction based on the character, norms and values of the community.

Typically, curfews go into effect one hour after the close of business. Restaurants, bars and major entertainment facilities such as sports stadiums, may require the curfew go into effect two hours after the close of business. The authority may elect to have no curfew for facilities with shift workers and 24 hour operations, or to extend the curfew time to meet specific needs. The MLO can be modified to address those concerns.

Areas without street lights or with very low ambient light levels should consider turning off all non-emergency lighting at curfew while commercial areas or urban areas may prefer a reduction in lighting levels. A reduction of at least 30% is recommended for most uses.

### III. GENERAL REQUIREMENTS (cont.) - Ordinance Text

**Exceptions to III.(C.) 1.** Automatic lighting controls are not required for the following:

- a. Lighting under canopies.
- b. Lighting for tunnels, parking garages, garage entrances, and similar conditions.

#### 2. Automatic Lighting Reduction Requirements

The Authority shall establish curfew time(s) after which total outdoor lighting lumens shall be reduced by at least 30% or extinguished.

**Exceptions to III.(C.) 2.** Lighting reductions are not required for any of the following:

- a. With the exception of landscape lighting, lighting for residential properties including multiple residential properties not having common areas.
- b. When the outdoor lighting consists of only one luminaire.
- c. Code required lighting for steps, stairs, walkways, and building entrances.
- d. When in the opinion of the Authority, lighting levels must be maintained.
- e. Motion activated lighting.
- f. Lighting governed by special use permit in which times of operation are specifically identified.
- g. Businesses that operate on a 24 hour basis.

#### IV. NON-RESIDENTIAL LIGHTING - User's Guide

This section addresses non-residential lighting and multiple-family residences having common spaces, such as lobbies, interior corridors or parking. Its intent is to:

- Limit the amount of light that can be used
- Minimize glare by controlling the amount of light that tends to create glare
- Minimize sky glow by controlling the amount of uplight
- Minimize the amount of off-site impacts or light trespass

This MLO provides two methods for determining compliance. The *prescriptive method* contains precise and easily verifiable requirements for luminaire light output and fixture design that limit glare, uplight, light trespass and the amount of light that can be used. The *performance method* allows greater flexibility and creativity in meeting the intent of the ordinance. Note that both the prescriptive and the performance method limit the *amount* of light that can be used, but do not control *how* the lighting is to be used.

Most outdoor lighting projects that do not involve a lighting professional will use the prescriptive method, because it is simple and does not require engineering expertise.

For the prescriptive method, the initial luminaire lumen allowances defined in Table A (Parking Space Method) or B (Hardscape Area Method) will provide basic lighting (parking lot and lighting at doors and/or sensitive security areas) that is consistent with the selected lighting zone. The prescriptive method is intended to provide a safe lighting environment while reducing sky glow and other adverse offsite impacts. The Per Parking Space Method is applicable in small rural towns and is a simple method for small retail “mom and pop” operations without drive lane access and where the parking lot is immediately adjacent to the road. A jurisdiction may

#### IV. NON-RESIDENTIAL LIGHTING - Ordinance Text

For all non-residential properties, and for multiple residential properties of seven domiciles or more and having common outdoor areas, all outdoor lighting shall comply either with Part A or Part B of this section.

**PRESCRIPTIVE METHOD - User's Guide**

also allow a prescriptive method for classes of sites, such as car dealerships, gas stations, or other common use areas.

Note that the values are for initial luminaire lumens, not footcandles on the target (parking lot, sidewalk, etc). Variables such as the efficiency of the luminaire, dispersion, and lamp wear can affect the actual amount of light so the lumens per square foot allowance is not equal to footcandles on the site. By specifying initial luminaire lumen values, it is easier for officials to verify that the requirement is being met. Initial luminaire lumens are available from photometric data. Each initial luminaire lumens calculation should be supplied on the submittal form.

Solid state luminaires, such as LEDs, do not have initial lamp lumens, only initial luminaire lumens (absolute photometry). Other luminaires tested with relative photometry will have initial luminaire lumens which can be calculated by multiplying initial lamp lumens by the luminaire efficiency. In this example, three types of luminaires are used to light a parking area and building entry in a light commercial area. Two of these three luminaires use metal halide lamps: 70 watt wall mounted area lights and 150 watt pole mounted area lights. For these, the Initial Luminaire Lumens is equal to the initial lamp lumens multiplied by the luminaire efficiency. These values are entered into the compliance chart. The lumen value for the building mounted LED luminaires is equal to the lumens exiting the luminaire. Therefore, the value already represents the Initial Luminaire Lumens and no luminaire efficiency is needed. The total Luminaire Lumens for the site is equal to 247,840.

The allowable lumens are based on the lighting zone and the total hardscape area. Referencing Table B, the allowed lumens are 2.5/SF for LZ2. Multiplying this by the total hardscape square footage gives a value of 250,000 lumens allowed. Because this value is greater than the value calculated for the site, the project complies. Listed below is an example on a typical compliance worksheet for the Prescriptive Method.

**IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text*****A. Prescriptive Method***

An outdoor lighting installation complies with this section if it meets the requirements of subsections 1 and 2, below.

**1. Total Site Lumen Limit**

The total installed initial luminaire lumens of all outdoor lighting shall not exceed the total site lumen limit. The total site lumen limit shall be determined using either the Parking Space Method (Table A) or the Hardscape Area Method (Table B). Only one method shall be used per permit application, and for sites with existing lighting, existing lighting shall be included in the calculation of total installed lumens.

The total installed initial luminaire lumens is calculated as the sum of the initial luminaire lumens for all luminaires.

**IV. NON-RESIDENTIAL LIGHTING (cont.) - User's Guide**

In this example, three types of luminaires are used to light a parking area and building entry in a light commercial area. Two of these three luminaires use metal halide lamps: 70 watt wall mounted area lights and 150 watt pole mounted area lights. For these, the Initial Luminaire Lumens is equal to the initial lamp lumens multiplied by the luminaire efficiency. These values are entered into the compliance chart. The lumen value for the building mounted LED luminaires is equal to the lumens exiting the luminaire. Therefore, the value already represents the Initial Luminaire Lumens and no luminaire efficiency is needed. The total Luminaire Lumens for the site is equal to 247,840. The allowable lumens are based on the lighting zone and the total hardscape area. Referencing Table B, the allowed lumens are 2.5/SF for LZ2. Multiplying this by the total hardscape square footage gives a value of 250,000 lumens allowed. Because this value is greater than the value calculated for the site, the project complies.

PRESCRIPTIVE METHOD EXAMPLE - COMPLIANCE CHART			
<i>Lamp Descriptions</i>	<i>QTY</i>	<i>Initial Luminaire Lumens</i>	<i>Total</i>
70 W Metal Halide	8	3,920	31,360
150 W Metal Halide	20	9,600	192,000
18 W LED	24	1,020	24,480
TOTAL INITIAL LUMINAIRE LUMENS			247,840
SITE ALLOWED TOTAL INITIAL LUMENS*			250,000
PROJECT IS COMPLIANT?			YES

\* Listed below is the method of determining the allowed total initial lumen for non-residential outdoor lighting using the hardscape areamethod. (Table B).

SITE ALLOWED TOTAL INITIAL LUMENS	
<i>Site Description</i>	Light Commercial
<i>Lighting Zone</i>	LZ-2
<i>Hardscape Area (SF)</i>	100,000
<i>Allowed Lumens per SF of Hardscape (Table B)</i>	2.5
<i>Site Allowed Total Initial Lumens (lumens per SF X hardscape area)</i>	250,000

**IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text**

**PRESCRIPTIVE METHOD (cont.) - User's Guide****LIMITS TO OFFSITE IMPACTS**

The prescriptive method of the MLO restricts uplighting, including upward light emitted by decorative luminaires. A jurisdiction may choose to preserve some types of lighting, including lighting of monuments or historic structures. In this case, the adopting jurisdiction should exempt or otherwise regulate these types of lighting carefully so that it does not inadvertently allow glaring or offensive lighting systems.

Offsite effects of light pollution include glare, light trespass, sky glow, and impacts on the nocturnal environment. All of these are functions of the fixture or luminaire design and installation. This document replaces the previous luminaire classification terminology of full cut-off, semi cut-off, and cut-off because those classifications were not as effective in controlling offsite impacts as with the new IESNA luminaire classification system as described in TM-15-07.

A traditional method of defining light trespass is to identify a maximum light level at or near the property line. However, this method does not address offensive light that is not directed toward the ground, or the intensity of glaring light shining into adjacent windows. The requirements defined in Table C limit the amount of light in all quadrants that is directed toward or above the property line. The Backlight/Uplight/Glare (BUG) rating will help limit both light trespass and glare. (A detailed explanation of the BUG system is provided in the section on Table C.)

The limits for light distribution established in Table C (for the BUG rating system) prevent or severely limit all direct upward light. A small amount of uplight reflected by snow, light-colored pavement or a luminaire's supporting arms is inevitable and is not limited by the prescriptive method of this ordinance.

**IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text****PRESCRIPTIVE METHOD****2. Limits to Off Site Impacts**

All luminaires shall be rated and installed according to Table C.

**3. Light Shielding for Parking Lot Illumination**

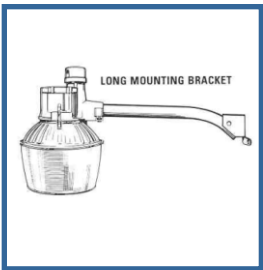
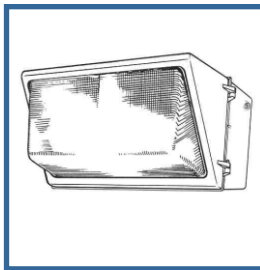
All parking lot lighting shall have no light emitted above 90 degrees.

Exception:

a) Ornamental parking lighting shall be permitted by special permit only, and shall meet the requirements of Table C-1 for Backlight, Table C-2 for Uplight, and Table C-3 for Glare, without the need for external field-added modifications.

**PRESCRIPTIVE METHOD (cont.) - User's Guide****LIMITS TO OFFSITE IMPACTS**

A seemingly non-compliant fixture, such as a post-top translucent acorn luminaire, may in certain cases meet the BUG ratings, as long as it has proper interior baffling within the acorn globe. However, the BUG ratings in Table C will limit the use of the following types of luminaires in all lighting zones:

**Barn Lights****Non-Shielded  
Wall Packs****Floodlights or  
lights not aimed  
downward****IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text**

## PERFORMANCE METHOD - User's Guide

The performance method is best for projects with complex lighting requirements or when the applicant wants or needs more flexibility in lighting design. The performance method is also used when any lighting designer plans to aim or direct any light fixture upward (above 90 degrees). An engineer or lighting professional generally will be required to design within the performance method. An adopting jurisdiction may also wish to hire an engineer or lighting professional to review and approve projects using this method and/or incorporate review of the performance method into special review procedures.

The Performance Method is also best for projects where higher lighting levels are required compared to typical area lighting. An example might be a car sales lot where more light might be required on the new cars than would be needed for a standard parking lot. Another example is a gas station canopy requiring more light than a building entrance canopy.

The first step in the Performance Method regulates overlighting by establishing the Total Initial Site Lumens (Table D) that are allowed.

Allowances include the summation of the following (Table D):

- 1) Initial lumen allowance per site
- 2) Per area (SF) of hardscape

Table E allows additional lumens for unique site conditions.

Examples of allowances include:

- 1) Per building entrance/exit
- 2) Per length (linear feet) of Outdoor Sales Frontage Perimeter
- 3) Per area (SF) of Vehicle Service Station Canopy
- 4) Plus more ...

The Site Total Initial Site Lumens allowed are a combination of allowances from Table D and Table E.

## IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

### *B. Performance Method*

#### 1. Total Site Lumen Limit

The total installed initial luminaire lumens of all lighting systems on the site shall not exceed the allowed total initial site lumens. The allowed total initial site lumens shall be determined using Tables D and E. For sites with existing lighting, existing lighting shall be included in the calculation of total installed lumens.

The total installed initial luminaire lumens of all is calculated as the sum of the initial luminaire lumens for all luminaires.

**IV. NON-RESIDENTIAL LIGHTING (cont.) - User's Guide****LIMITS TO OFFSITE IMPACTS (cont.)**

The second step in the Performance Method is to determine if the proposed luminaires are producing off site impacts such as glare, sky glow and light trespass. One may either use Option A which are the Maximum Allowable BUG Ratings in Table C, or Option B through computer lighting calculations show compliance with Maximum Vertical Illuminance at any point in the plane of the property line in Table F. Option B will be required for all non-residential luminaires that

- A) do not have BUG ratings, or
- B) exceed the BUG ratings,
- C) are not fully shielded, or
- D) have adjustable mountings.

For the performance method, Option B (2) requires photometric calculations for the site perimeter, to a height of no less than 33 feet (10 meters) above the tallest luminaire. Vertical illuminances at eye height (5 feet above grade) will give values that can be used to verify compliance by comparing actual site conditions to the photometric plan submitted during review.

Note that the MLO specifies 'total initial luminaire lumens' as a measurement in addition to footcandles/lux. The footcandle (lux) is equal to one lumen per square meter. Lux is the metric unit and is equal to one lumen per square meter.

**IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text****PERFORMANCE METHOD****2. Limits to Off Site Impacts**

All luminaires shall be rated and installed using either Option A or Option B. Only one option may be used per permit application.

Option A: All luminaires shall be rated and installed according to Table C.

Option B: The entire outdoor lighting design shall be analyzed using industry standard lighting software including inter-reflections in the following manner:

- 1) Input data shall describe the lighting system including luminaire locations, mounting heights, aiming directions, and employing photometric data tested in accordance with IES guidelines. Buildings or other physical objects on the site within three object heights of the property line must be included in the calculations.
- 2) Analysis shall utilize an enclosure comprised of calculation planes with zero reflectance values around the perimeter of the site. The top of the enclosure shall be no less than 33 feet (10 meters) above the tallest luminaire. Calculations shall include total lumens upon the inside surfaces of the box top and vertical sides and maximum vertical illuminance (footcandles and/or lux) on the sides of the enclosure.

The design complies if:

- a) The total lumens on the inside surfaces of the virtual enclosure are less than 15% of the total site lumen limit; and
- b) The maximum vertical illuminance on any vertical surface is less than the allowed maximum illuminance per Table F.

## DESIGN COMPLIANCE - User's Guide

The application form will require information about the number of luminaires, the number of lamps in each luminaire, the initial luminaire lumens for each luminaire and the initial lumen output for each lamp (based on the wattage and type of lamp selected) as well as plans showing the site area measurements. This will allow the reviewer to verify that the lumen output of all the luminaires does not exceed the allowance.

Field verification can be achieved by asking the applicant and/or owner to verify that the luminaire type, lamp type and wattages specified have been used. Also ask the applicant for photometric data for each luminaire, since the initial luminaire lumens and B-U-G ratings are stated on the photometric report.

However, if a jurisdiction requires additional on-site verification, it may also request a point-by-point photometric plan. While this will not be a true measure of compliance with the criteria of this Ordinance, comparing the actual measured levels on site to the photometric plan can be an indication whether or not the installed lighting varies from the approved design.

## V. RESIDENTIAL LIGHTING - User's Guide

This section applies to single family home, duplexes, row houses, and low rise multi-family buildings of 6 dwelling units or less.

### RESIDENTIAL LIGHTING EXCEPTIONS

The exceptions allow for typical lighting that might exceed the specified limits.

Landscape Lighting - While not common in residential areas, it can cause light pollution and light trespass if it is not controlled.

Lighting controlled by Vacancy (Motion) Sensor - Reduces light pollution and light trespass and should be encouraged.

#### RESIDENTIAL LIGHTING EXAMPLE

In this example on the following page, five different luminaires are used on a residential property. Each luminaire must comply to meet the requirements. The site plan following shows luminaire types followed by a tabulation of each luminaire, whether or not it is fully shielded, lamp type, and initial luminaire lumens. If the luminaire lumens are not known, multiply the initial lamp lumens by the luminaire efficiency. If the efficiency is not known, multiply the initial lamp lumens by 0.7 as a reasonable assumption. The maximum allowable lumen values come from Table G, based on the shielding classification and location on the site. In this case, each luminaire complies with the requirements of Table G.

Comparison of efficacy by power  
(120 Volt Incandescent lamps)

Output (Lumens)	Power (Watt)		
	Incan	CFL	LED
500	40	8 - 10	9
850	60	13 - 18	12 - 15
1,200	75	18 - 22	15
1,700	100	23 - 28	18

## V. RESIDENTIAL LIGHTING - Ordinance Text

### A. General Requirements

For residential properties including multiple residential properties not having common areas, all outdoor luminaires shall be fully shielded and shall not exceed the allowed lumen output in Table G, row 2.

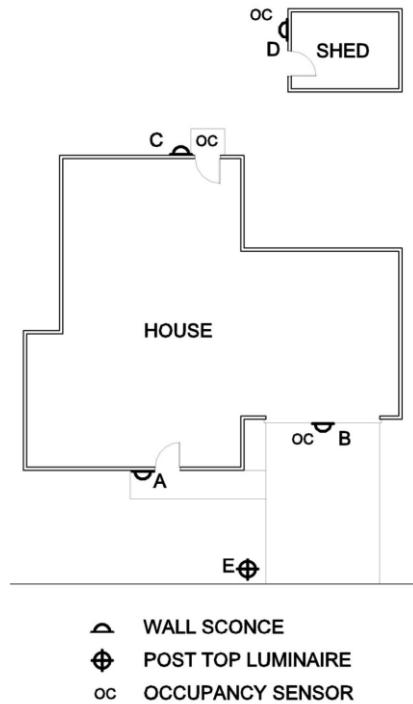
#### Exceptions

1. One partly shielded or unshielded luminaire at the main entry, not exceeding the allowed lumen output in Table G row 1.
2. Any other partly shielded or unshielded luminaires not exceeding the allowed lumen output in Table G row 3.
3. Low voltage landscape lighting aimed away from adjacent properties and not exceeding the allowed lumen output in Table G row 4.
4. Shielded directional flood lighting aimed so that direct glare is not visible from adjacent properties and not exceeding the allowed lumen output in Table G row 5.
5. Open flame gas lamps.
6. Lighting installed with a vacancy sensor, where the sensor extinguishes the lights no more than 15 minutes after the area is vacated.
7. Lighting exempt per Section III (B.).

### B. Requirements for Residential Landscape Lighting

1. Shall comply with Table G.
2. Shall not be aimed onto adjacent properties.

## V. RESIDENTIAL LIGHTING - User's Guide



Property Type: Residential Lighting Zone 1								
Luminaire Type	Location	Luminaire Description	Fully Shielded	Lamp Type	Initial Luminaire Lumens*	Maximum Allowed Initial Luminaire Lumens (Table G)	Controls	Compliant
A	Front Entry	Decorative wall sconce	No	9W CFL	420	420	None	Yes
B	Garage Door	Fully shielded wall pack	Yes	23W CFL	1050	1260	Occupancy Sensor	Yes
C	Back Entry	Decorative wall sconce	No	7W CFL	280	315	Occupancy Sensor	Yes
D	Shed Entry	Fully shielded wall pack	Yes	40W INC	343	1260	Occupancy Sensor	Yes
E	Driveway	Fully shielded post top	Yes	13W CFL	1260	1260	None	Yes

\*Initial Luminaire Lumens are calculated by multiplying the total initial lamp lumens by the luminaire efficiency.  
If the luminaire efficiency is not known, assume an efficiency of 70% and multiply the lamp lumen value by 0.7.

## VI. LIGHTING BY SPECIAL PERMIT ONLY - User's Guide

This section addresses types of lighting that are intrusive or complex in their impacts and need a higher level of scrutiny and/or site sensitivity.

It should be noted that safety could be compromised if lighting conforming to this ordinance is located adjacent to excessively bright and/or glaring lighting.

It is important that the authority set clear and reasonable guidelines for applying for a special lighting use permit, and establish rules and procedures for granting or refusing them. They may differ from existing special use policies, in which case one or the other may be changed to achieve the overall goal of effective lighting without glare, sky glow, or light trespass.

### SPORTS FIELD LIGHTING

For athletic and sports fields, the appropriate level of lighting will depend on the Class of Play and Facilities. Class of Play is divided into 4 categories, depending on the number of fixed spectator seats. (Competition play intended for nighttime TV broadcast may require higher lighting levels).

**CLASS I:** Competition play at facilities with 5,000 or more fixed spectator seats. (Professional, Colleges & Universities, some Semi-Professional & Large Sports Clubs)

**CLASS II:** Games at facilities with over 1,500 fixed spectator seats. (Smaller Universities and Colleges, some Semi-pro, large amateur leagues and high schools with large spectator facilities)

**CLASS III:** Games at facilities with over 500 fixed spectator seats. (Sports Clubs and amateur leagues, some high schools and large training professional training facilities with spectator sections)

**CLASS IV:** Competition or recreational play at facilities with 500 fixed spectator seats or less. Class IV Class of Play applies to games at which family and close friends of the players and staff are usually the majority of spectators. (Smaller amateur leagues, park and recreation department facilities, most Little Leagues smaller high schools, elementary and middle schools, and social events)

## VI. LIGHTING BY SPECIAL PERMIT ONLY - Ordinance Text

### A. High Intensity and Special Purpose Lighting

The following lighting systems are prohibited from being installed or used except by special use permit:

1. Temporary lighting in which any single luminaire exceeds 20,000 initial luminaire lumens or the total lighting load exceeds 160,000 lumens.
2. Aerial Lasers.
3. Searchlights.
4. Other very intense lighting defined as having a light source exceeding 200,000 initial luminaire lumens or an intensity in any direction of more than 2,000,000 candelas.

### B. Complex and Non-Conforming Uses

Upon special permit issued by the Authority, lighting not complying with the technical requirements of this ordinance but consistent with its intent may be installed for complex sites or uses or special uses including, but not limited to, the following applications:

1. Sports facilities, including but not limited to unconditioned rinks, open courts, fields, and stadiums.
2. Construction lighting.
3. Lighting for industrial sites having special requirements, such as petrochemical manufacturing or storage, shipping piers, etc.
4. Parking structures.
5. Urban parks
6. Ornamental and architectural lighting of bridges, public monuments, statuary and public buildings.
7. Theme and amusement parks.
8. Correctional facilities.

To obtain such a permit, applicants shall demonstrate that the proposed lighting installation:

- a. Has sustained every reasonable effort to mitigate the effects of light on the environment and surrounding properties, supported by a signed statement describing the mitigation measures. Such statement shall be accompanied by the calculations required for the Performance Method.

**SPORTS FIELD LIGHTING**

When Class of Play is above Class IV, a dual control should be installed to limit illumination to Class IV levels during practices where spectators are fewer than 500.

(See IES Recommended Practice for Sports and Recreational Area Lighting RP-6)

**VII. EXISTING LIGHTING - User's Guide**

Adoption of this section on existing lighting is strongly encouraged.

If the adopting jurisdiction has criteria in place that require a property to come into compliance with the current zoning ordinance, it is recommended that the criteria also be applied to bringing existing lighting into compliance. If there are no established criteria, this section of the MLO is recommended.

Amortization allows existing lighting to gradually and gracefully come into compliance. Substantial changes or additions to existing properties are considered the same as new construction, and must comply.

Most outdoor lighting can be fully depreciated once it is fully amortized, usually no longer than 10 years, if not sooner, from the date of initial installation. Some jurisdictions may prefer to require phase-out in a substantially shorter period. The Authority may also wish to require compliance much sooner for "easy fixes" such as re-aiming or lowering lumen output of lamps. Where lighting is judged to be a safety hazard, immediate compliance can be required.

**VI. LIGHTING BY SPECIAL PERMIT ONLY (cont.) - Ordinance Text**

- b. Employs lighting controls to reduce lighting at a Project Specific Curfew ("Curfew") time to be established in the Permit.
- c. Complies with the Performance Method after Curfew.

The Authority shall review each such application. A permit may be granted if, upon review, the Authority believes that the proposed lighting will not create unwarranted glare, sky glow, or light trespass.

**VII. EXISTING LIGHTING - Ordinance Text**

Lighting installed prior to the effective date of this ordinance shall comply with the following.

***A. Amortization***

On or before [amortization date], all outdoor lighting shall comply with this Code.

***B. New Uses or Structures, or Change of Use***

Whenever there is a new use of a property (zoning or variance change) or the use on the property is changed, all outdoor lighting on the property shall be brought into compliance with this Ordinance before the new or changed use commences.

***C. Additions or Alterations******1. Major Additions.***

If a major addition occurs on a property, lighting for the entire property shall comply with the requirements of this Code. For purposes of this section, the following are considered to be major additions:

**VII. EXISTING LIGHTING (cont.) - Ordinance Text**

Additions of 25 percent or more in terms of additional dwelling units, gross floor area, seating capacity, or parking spaces, either with a single addition or with cumulative additions after the effective date of this Ordinance.

Single or cumulative additions, modification or replacement of 25 percent or more of installed outdoor lighting luminaires existing as of the effective date of this Ordinance.

2. Minor Modifications, Additions, or New Lighting Fixtures for Non-residential and Multiple Dwellings

For non-residential and multiple dwellings, all additions, modifications, or replacement of more than 25 percent of outdoor lighting fixtures existing as of the effective date of this Ordinance shall require the submission of a complete inventory and site plan detailing all existing and any proposed new outdoor lighting.

Any new lighting shall meet the requirements of this Ordinance.

3. Resumption of Use after Abandonment

If a property with non-conforming lighting is abandoned for a period of six months or more, then all outdoor lighting shall be brought into compliance with this Ordinance before any further use of the property occurs.

**VIII. ENFORCEMENT & PENALTIES - Ordinance Text**

**(Reserved)**

**VIII. ENFORCEMENT AND PENALTIES - User's Guide**

Enforcement and penalties will vary by jurisdiction. There are, however, certain practices that will promote compliance with lighting regulations. Education is a key tool in promoting compliance. Proactive enforcement procedures can include providing a copy of the lighting regulations to every contractor at the time they visit to obtain a building permit. Another effective tool is a requirement that the builder or developer acknowledge in writing that the he or she is familiar with the lighting requirements and will submit a lighting plan for approval.

**VIII. ENFORCEMENT AND PENALTIES (cont.) - User's Guide**

Submission of the Lighting Plan should be required as a precondition to any approvals. The Lighting Plan should include the location and BUG rating for each luminaire, specify whether compliance is by the performance or prescriptive method, and a worksheet to show that the luminaires and their BUG ratings are compliant.

**IX. TABLES - User's Guide**

The tables are to be reviewed periodically by a joint committee of the IES and IDA, and adjusted as standards and technology permit. If more research on the impacts of outdoor lighting shows the effects of light pollution to be a significant concern, then the values in the tables may be modified. Such changes will have no significant impact to the balance of the language of the Ordinance or Code.

**VIII. ENFORCEMENT & PENALTIES - Ordinance Text****IX. TABLES - Ordinance Text****Table A - Allowed Total Initial Luminaire Lumens per Site for Non-residential Outdoor Lighting, Per Parking Space Method**

May only be applied to properties up to 10 parking spaces (including handicapped accessible spaces).

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
350 lms/space	490 lms/space	630 lms/space	840 lms/space	1,050 lms/space

**Table B - Allowed Total Initial Lumens per Site for Non-residential Outdoor Lighting, Hardscape Area Method**

*May be used for any project. When lighting intersections of site drives and public streets or road, a total of 600 square feet for each intersection may be added to the actual site hardscape area to provide for intersection lighting.*

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
<b>Base Allowance</b>				
0.5 lumens per SF of Hardscape	1.25 lumens per SF of Hardscape	2.5 lumens per SF of Hardscape	5.0 lumens per SF of Hardscape	7.5 lumens per SF of Hardscape

## IX. TABLES - Ordinance Text

**Table B** - *Lumen Allowances, in Addition to Base Allowance*

	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
<b>Additional allowances for sales and service facilities.</b> <b>No more than two additional allowances per site, Use it or Lose it.</b>					
<b>Outdoor Sales Lots.</b> This allowance is lumens per square foot of uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale, and may not include driveways, parking or other non sales areas. To use this allowance, luminaires must be within 2 mounting heights of sales lot area.	0	4 lumens per square foot	8 lumens per square foot	16 lumens per square foot	16 lumens per square foot
<b>Outdoor Sales Frontage.</b> This allowance is for lineal feet of sales frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. In order to use this allowance, luminaires must be located between the principal viewing location and the frontage outdoor sales area	0	0	1,000 per LF	1,500 per LF	2,000 per LF
<b>Drive Up Windows.</b> In order to use this allowance, luminaires must be within 20 feet horizontal distance of the center of the window.	0	2,000 lumens per drive-up window	4,000 lumens per drive-up window	8,000 lumens per drive-up window	8,000 lumens per drive-up window
<b>Vehicle Service Station.</b> This allowance is lumens per installed fuel pump.	0	4,000 lumens per pump (based on 5 fc horiz)	8,000 lumens per pump (based on 10 fc horiz)	16,000 lumens per pump (based on 20 fc horiz)	24,000 lumens per pump (based on 20 fc horiz)

**IX. TABLES - TABLE C BUG RATING - User's Guide**

Work on the BUG system started in 2005 when the IES upgraded the roadway cutoff classification system. The original system, which included the ratings full cutoff, cutoff, semi-cutoff and non cutoff, had been designed as a rating system focused on brightness and glare control. However, with increasing demand for control of uplight and light trespass in addition to glare, IES realized that a more comprehensive system was needed. IES developed TM-15 *Luminaire Classification System for Outdoor Luminaires*.

As this is a relatively new rating system, and many people may not be familiar with it, more explanation of how the rating system works is provided here. For example, some people are familiar with terms such as "full cutoff" and they may expect the MLO to include those terms. It will be very important that all groups recognize that older terms and concepts are inadequate for the complex tasks of controlling light pollution. It is recommended that the new rating system adopted in TM-15, as followed herein by the MLO, be used intact and exclusively.

BUG requires downlight only with low glare (better than full cut off) in lighting zones 0, 1 and 2, but allows a minor amount of uplight in lighting zones 3 and 4. In lighting zones 3 and 4, the amount of allowed uplight is enough to permit the use of very well shielded luminaires that have a decorative drop lens or chimney so that dark sky friendly lighting can be installed in places that traditional-appearing luminaires are required. BUG typically cannot be used for residential luminaires unless they have been photometrically tested. For non-photometrically tested residential luminaires, shielding description is used instead.

The lumen limits established for each lighting zone apply to all types of lighting within that zone. This includes, but is not limited to, specialty lighting, façade lighting, security lighting and the front row lighting for auto dealerships. BUG rating limits are defined for each luminaire and

**IX. TABLES (cont.) - Ordinance Text****Table C - Maximum Allowable Backlight, Uplight and Glare (BUG) Ratings**

May be used for any project. A luminaire may be used if it is rated for the lighting zone of the site or lower in number for all ratings B, U and G. Luminaires equipped with adjustable mounting devices permitting alteration of luminaire aiming in the field shall not be permitted.

<b>TABLE C-1</b>	<b>Lighting Zone 0</b>	<b>Lighting Zone 1</b>	<b>Lighting Zone 2</b>	<b>Lighting Zone 3</b>	<b>Lighting Zone 4</b>
<b>Allowed Backlight Rating*</b>					
<b>Greater than 2 mounting heights from property line</b>	<b>B1</b>	<b>B3</b>	<b>B4</b>	<b>B5</b>	<b>B5</b>
<b>1 to less than 2 mounting heights from property line and ideally oriented**</b>	<b>B1</b>	<b>B2</b>	<b>B3</b>	<b>B4</b>	<b>B4</b>
<b>0.5 to 1 mounting heights from property line and ideally oriented**</b>	<b>B0</b>	<b>B1</b>	<b>B2</b>	<b>B3</b>	<b>B3</b>
<b>Less than 0.5 mounting height to property line and properly oriented**</b>	<b>B0</b>	<b>B0</b>	<b>B0</b>	<b>B1</b>	<b>B2</b>

\*For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 feet beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the center-line of the public roadway or public transit corridor for the purpose of determining compliance with this section. NOTE: This adjustment is relative to Table C-1 and C-3 only and shall not be used to increase the lighting area of the site.

\*\* To be considered 'ideally oriented', the luminaire must be mounted with the backlight portion of the light output oriented perpendicular and towards the property line of concern.

## IX. TABLES - TABLE C BUG RATING (cont.) - User's Guide

are based on the internal and external design of the luminaire, its aiming, and the initial luminaire lumens of the specified luminaires. The BUG rating limits also take into consideration the distance the luminaire is installed from the property line in multiples of the mounting height (See Table C).

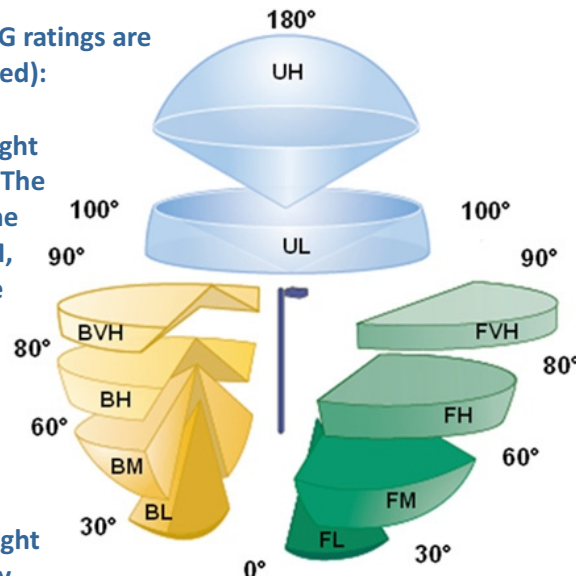
The three components of BUG ratings are based on IES TM-15-07 (revised):

**Backlight**, which creates light trespass onto adjacent sites. The B rating takes into account the amount of light in the BL, BM, BH and BVH zones, which are in the direction of the luminaire OPPOSITE from the area intended to be lighted.

**Uplight**, which causes artificial sky glow. Lower uplight (zone UL) causes the most sky glow and negatively affects professional and academic astronomy. Upper uplight (UH) not reflected off a surface is mostly energy waste. The U rating defines the amount of light into the upper hemisphere with greater concern for the light at or near the horizontal angles (UL).

**Glare**, which can be annoying or visually disabling. The G rating takes into account the amount of frontlight in the FH and FVH zones as well as BH and BVH zones.

BUG ratings apply to the Lighting Zone of the property under consideration.



## IX. TABLES (cont.) - Ordinance Text

**IX. TABLES - TABLE C BUG RATING (cont.) - User's Guide**

(Key: UH=Uplight High, UL=Uplight Low, BVH=Backlight Very High, BH=Backlight High, BM=Backlight Medium, BL=Backlight Low, FVH=Forward Light Very High, FH=Forward Light High, FM=Forward Light Medium, FL=Forward Light Low.)

In general, a higher BUG rating means more light is allowed in solid angles, and the rating increases with the lighting zone. However, a higher B (backlight) rating simply indicates that the luminaire directs a significant portion of light behind the pole, so B ratings are designated based on the location of the luminaire with respect to the property line. A high B rating luminaire maximizes the spread of light, and is effective and efficient when used far from the property line. When luminaires are located near the property line, a lower B rating will prevent unwanted light from interfering with neighboring properties.

At the 90-180 degree ranges:

- Zone 0 allows no light above 90 degrees.
- Zone 1 allows only 10 lumens in the UH and UL zones, 20 lumens total in the complete upper hemisphere. (This is roughly equivalent to a 5 W incandescent lamp).
- Zone 2 allows only 50 lumens in the UH and UL zones, 100 lumens total (less than a 25W incandescent lamp).
- Zone 3 allows only 500 lumens in the UH and UL zones, 1000 lumens total (about the output of a 75W incandescent bulb).
- Zone 4 allows only 1,000 lumens in the UH and UL zones, 2000 lumens total (about the output of a 100W incandescent bulb).

**IX. TABLES (cont.) - Ordinance Text**

**Table C - 2 Maximum Allowable Uplight (BUG) Ratings - Continued**

<b>TABLE C-2</b>	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
<b>Allowed Uplight Rating</b>	<b>U0</b>	<b>U1</b>	<b>U2</b>	<b>U3</b>	<b>U4</b>
<b>Allowed % light emission above 90° for street or Area lighting</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>	<b>0%</b>

**Table C - 3 Maximum Allowable Glare (BUG) Ratings - Continued**

<b>TABLE C-3</b>	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
<b>Allowed Glare Rating</b>	<b>G0</b>	<b>G1</b>	<b>G2</b>	<b>G3</b>	<b>G4</b>
Any luminaire not ideally oriented*** with 1 to less than 2 mounting heights to any property line of concern	<b>G0</b>	<b>G0</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>
Any luminaire not ideally oriented*** with 0.5 to 1 mounting heights to any property line of concern	<b>G0</b>	<b>G0</b>	<b>G0</b>	<b>G1</b>	<b>G1</b>
Any luminaire not ideally oriented*** with less than 0.5 mounting heights to any property line of concern	<b>G0</b>	<b>G0</b>	<b>G0</b>	<b>G0</b>	<b>G1</b>

\*\*\* Any luminaire that cannot be mounted with its backlight perpendicular to any property line within 2X the mounting heights of the luminaire location shall meet the reduced Allowed Glare Rating in Table C-3.

**TABLE D EXAMPLE - PERFORMANCE METHOD - User's Guide**

The first step in the Performance Method is to establish the Site Total Initial Site Lumens which regulates overlighting. The performance method allows layers of light depending on the complexity of the site.

Table D establishes the basic total initial site lumens allowed. These lumen allowances are added together for a total initial site lumen allowance. Allowances include:

- 1) Initial lumen allowance per site
- 2) Per area (SF) of hardscape

**IX. TABLES (cont.) - Ordinance Text****Table D Performance Method Allowed Total Initial Site Lumens**

*May be used on any project.*

Lighting Zone	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Allowed Lumens Per SF	0.5	1.25	2.5	5.0	7.5
Allowed Base Lumens Per Site	0	3,500	7,000	14,000	21,000

**Table E Performance Method Additional Initial Luminaire Lumen Allowances. All of the following are “use it or lose it” allowances.**

All area and distance measurements in plan view unless otherwise noted.

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
<b>Additional Lumens Allowances for All Buildings except service stations and outdoor sales facilities. A MAXIMUM OF THREE (3) ALLOWANCES ARE PERMITTED. THESE ALLOWANCES ARE “USE IT OR LOSE IT”.</b>					
<b>Building Entrances or Exits.</b> This allowance is per door. In order to use this allowance, luminaires must be within 20 feet of the door.	400	1,000	2,000	4,000	6,000
<b>Building Facades.</b> This allowance is lumens per unit area of building façade that are illuminated. To use this allowance, luminaires must be aimed at the façade and capable of illuminating it without obstruction.	0	0	8/SF	16/SF	24/SF

**TABLE E PERFORMANCE METHOD - User's Guide**

The allowable light levels for these uses defined in Table E may be used to set a prescriptive lighting allowance for these uses in each lighting zone. It should be noted that the lighting allowance defined in Table E is only applicable for the area defined for that use and cannot be transferred to another area of the site. For some uses, such as outdoor sales, the jurisdiction is encouraged to define a percentage of the total hardscape area that is eligible for the additional lighting allowance. For example, a set percentage of a car dealership's lot may be considered a display area and receive the additional lighting allowance where the remainder of the lot would be considered storage, visitor parking, etc. and cannot exceed the base light levels defined in Table A.

**TABLE E EXAMPLE - PERFORMANCE METHOD - User's Guide****IX. TABLES (cont.) - Ordinance Text****Table E - Performance Method Additional Initial Lumen Allowances (cont.)**

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
<b>Sales or Non-sales Canopies.</b> This allowance is lumens per unit area for the total area within the drip line of the canopy. In order to qualify for this allowance, luminaires must be located under the canopy.	0	3/SF	6/SF	12/SF	18/SF
<b>Guard Stations.</b> This allowance is lumens per unit area of guardhouse plus 2000 sf per vehicle lane. In order to use this allowance, luminaires must be within 2 mounting heights of a vehicle lane or the guardhouse.	0	6/SF	12/SF	24/SF	36/SF
<b>Outdoor Dining.</b> This allowance is lumens per unit area for the total illuminated hardscape of outdoor dining. In order to use this allowance, luminaires must be within 2 mounting heights of the hardscape area of outdoor dining.	0	1/SF	5/SF	10/SF	15/SF
<b>Drive Up Windows.</b> This allowance is lumens per window. In order to use this allowance, luminaires must be within 20 feet of the center of the window.	0	2,000 lumens per drive-up window	4,000 lumens per drive-up window	8,000 lumens per drive-up window	8,000 lumens per drive-up window
<b>Additional Lumens Allowances for Service Stations only. Service stations may not use any other additional allowances.</b>					
<b>Vehicle Service Station Hardscape.</b> This allowance is lumens per unit area for the total illuminated hardscape area less area of buildings, area under canopies, area off property, or areas obstructed by signs or structures. In order to use this allowance, luminaires must be illuminating the hardscape area and must not be within a building below a canopy, beyond property lines, or obstructed by a sign or other structure.	0	4/SF	8/SF	16/SF	24/SF

## IX. TABLES (cont.) - Ordinance Text

**Table E - Performance Method Additional Initial Lumen Allowances (cont.)**

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
<b>Vehicle Service Station Canopies.</b> This allowance is lumens per unit area for the total area within the drip line of the canopy. In order to use this allowance, luminaires must be located under the canopy.	0	8/SF	16/SF	32/SF	32/SF
<b>Additional Lumens Allowances for Outdoor Sales facilities only.</b> Outdoor Sales facilities may not use any other additional allowances. <b>NOTICE:</b> lighting permitted by these allowances shall employ controls extinguishing this lighting after a curfew time to be determined by the Authority.					
<b>Outdoor Sales Lots.</b> This allowance is lumens per square foot of uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale, and may not include driveways, parking or other non sales areas and shall not exceed 25% of the total hardscape area. To use this allowance, Luminaires must be within 2 mounting heights of the sales lot area.	0	4/SF	8/SF	12/SF	18/SF
<b>Outdoor Sales Frontage.</b> This allowance is for lineal feet of sales frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. In order to use this allowance, luminaires must be located between the principal viewing location and the frontage outdoor sales area.	0	0	1,000/LF	1,500/LF	2,000/LF

IX. TABLES (cont.) - Ordinance Text

Table F Maximum Vertical Illuminance at any point in the plane of the property line

Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
0.05 FC or 0.5 LUX	0.1 FC or 1.0 LUX	0.3 FC or 3.0 LUX	0.8 FC or 8.0 LUX	1.5 FC or 15.0 LUX

## IX. TABLES (cont.) - Ordinance Text

Table G - Residential Lighting Limits

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
<b>Row 1</b> Maximum Allowed Luminaire Lumens* for Unshielded Luminaires at one entry only	Not allowed	420 lumens	630 lumens	630 lumens	630 lumens
<b>Row 2</b> Maximum Allowed Luminaire Lumens* for each Fully Shielded Luminaire	630 lumens	1,260 lumens	1,260 lumens	1,260 lumens	1,260 lumens
<b>Row 3</b> Maximum Allowed Luminaire Lumens* for each Unshielded Luminaire excluding main entry	Not allowed	315 lumens	315 lumens	315 lumens	315 lumens
<b>Row 4</b> Maximum Allowed Luminaire Lumens* for each Landscape Lighting	Not allowed	Not allowed	1,050 lumens	2,100 lumens	2,100 lumens
<b>Row 5</b> Maximum Allowed Luminaire Lumens* for each Shielded Directional Flood Lighting	Not allowed	Not allowed	1,260 lumens	2,100 lumens	2,100 lumens
<b>Row 6</b> Maximum Allowed Luminaire Lumens* for each Low Voltage Landscape Lighting	Not allowed	Not allowed	525 lumens	525 lumens	525 lumens

\* Luminaire lumens equals Initial Lamp Lumens for a lamp, multiplied by the number of lamps in the luminaire

## TABLE G RESIDENTIAL LIGHTING - User's Guide

## Residential Light Levels

Most residential lighting has traditionally used incandescent lamps which are identified by their wattage. However, since new technologies provide more light for fewer watts, it is no longer possible to regulate residential lighting solely by providing a maximum wattage. Table G, therefore, lists maximum initial luminaire lumens only.

**X. DEFINITIONS - User's Guide**

Definitions are typically generally added to any code when new code sections are added. The definitions are legally required and play a significant role in the interpretation of the ordinance and code.

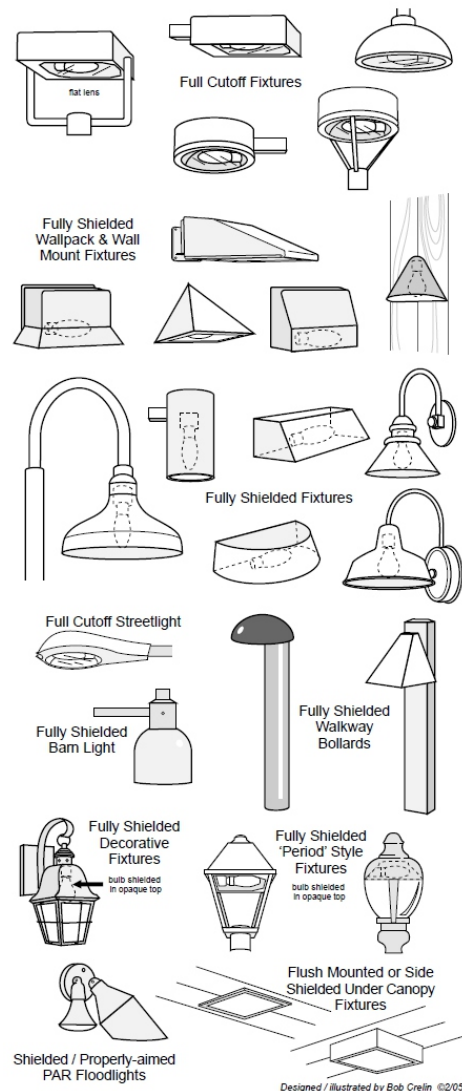
Most city attorneys will not accept references to outside sources regardless of credibility, such as the IES Handbook. Thus as a general rule, a definition for an unfamiliar term (e.g. lumens) must be added by the adopting ordinance.

When adopting or integrating the MLO definitions, be sure to retire conflicting technical terminology. In particular, the latest IES Luminaire Classification System as defined in IES TM-15-07 is likely to need attention.

**X. DEFINITIONS - Ordinance Text**

<i><b>Absolute Photometry</b></i>	Photometric measurements (usually of a solid-state luminaire) that directly measures the footprint of the luminaire. Reference Standard IES LM-79
<i><b>Architectural Lighting</b></i>	Lighting designed to reveal architectural beauty, shape and/or form and for which lighting for any other purpose is incidental.
<i><b>Authority</b></i>	The adopting municipality, agency or other governing body.
<i><b>Astronomic Time Switch</b></i>	An automatic lighting control device that switches outdoor lighting relative to time of solar day with time of year correction.
<i><b>Backlight</b></i>	For an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the opposite direction of the intended orientation of the luminaire. For luminaires with symmetric distribution, backlight will be the same as front light.
<i><b>BUG</b></i>	A luminaire classification system that classifies backlight (B), uplight (U) and glare (G).
<i><b>Canopy</b></i>	A covered, unconditioned structure with at least one side open for pedestrian and/or vehicular access. (An unconditioned structure is one that may be open to the elements and has no heat or air conditioning.)
<i><b>Common Outdoor Areas</b></i>	One or more of the following: a parking lot; a parking structure or covered vehicular entrance; a common entrance or public space shared by all occupants of the domiciles.
<i><b>Curfew</b></i>	A time defined by the authority when outdoor lighting is reduced or extinguished.

## Examples of Fully Shielded Luminaires



## X. DEFINITIONS - Ordinance Text

<b><i>Emergency conditions</i></b>	Generally, lighting that is only energized during an emergency; lighting fed from a backup power source; or lighting for illuminating the path of egress solely during a fire or other emergency situation; or, lighting for security purposes used solely during an alarm.
<b><i>Footcandle</i></b>	The unit of measure expressing the quantity of light received on a surface. One footcandle is the illuminance produced by a candle on a surface one foot square from a distance of one foot.
<b><i>Forward Light</i></b>	For an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the direction of the intended orientation of the luminaire.
<b><i>Fully Shielded Luminaire</i></b>	A luminaire constructed and installed in such a manner that all light emitted by the luminaire, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any part of the luminaire, is projected below the horizontal plane through the luminaire's lowest light-emitting part.
<b><i>Glare</i></b>	Lighting entering the eye directly from luminaires or indirectly from reflective surfaces that causes visual discomfort or reduced visibility.
<b><i>Hardscape</i></b>	Permanent hardscape improvements to the site including parking lots, drives, entrances, curbs, ramps, stairs, steps, medians, walkways and non-vegetated landscaping that is 10 feet or less in width. Materials may include concrete, asphalt, stone, gravel, etc.
<b><i>Hardscape Area</i></b>	The area measured in square feet of all hardscape. It is used to calculate the Total Site Lumen Limit in both the Prescriptive Method and Performance Methods. Refer to Hardscape definition.

**X. DEFINITIONS - Ordinance Text**

<b><i>Hardscape Perimeter</i></b>	The perimeter measured in linear feet is used to calculate the Total Site Lumen Limit in the Performance Method. Refer to Hardscape definition.
<b><i>IDA</i></b>	International Dark-Sky Association.
<b><i>IESNA</i></b>	Illuminating Engineering Society of North America.
<b><i>Impervious Material</i></b>	Sealed to severely restrict water entry and movement
<b><i>Industry Standard Lighting Software</i></b>	Lighting software that calculates point-by-point illuminance that includes reflected light using either ray-tracing or radiosity methods.
<b><i>Lamp</i></b>	A generic term for a source of optical radiation (i.e. "light"), often called a "bulb" or "tube". Examples include incandescent, fluorescent, high-intensity discharge (HID) lamps, and low pressure sodium (LPS) lamps, as well as light-emitting diode (LED) modules and arrays.
<b><i>Landscape Lighting</i></b>	Lighting of trees, shrubs, or other plant material as well as ponds and other landscape features.
<b><i>LED</i></b>	Light Emitting Diode.
<b><i>Light Pollution</i></b>	Any adverse effect of artificial light including, but not limited to, glare, light trespass, sky-glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.

**X. DEFINITIONS - Ordinance Text**

<b><i>Light Trespass</i></b>	Light that falls beyond the property it is intended to illuminate.
<b><i>Lighting</i></b>	“Electric” or “man-made” or “artificial” lighting. See “lighting equipment”.
<b><i>Lighting Equipment</i></b>	Equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.
<b><i>Lighting Zone</i></b>	An overlay zoning system establishing legal limits for lighting for particular parcels, areas, or districts in a community.
<b><i>Lighting Equipment</i></b>	Equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.
<b><i>Low Voltage Landscape Lighting</i></b>	Landscape lighting powered at less than 15 volts and limited to luminaires having a rated initial luminaire lumen output of 525 lumens or less.
<b><i>Lumen</i></b>	The unit of measure used to quantify the amount of light produced by a lamp or emitted from a luminaire (as distinct from “watt,” a measure of power consumption).
<b><i>Luminaire</i></b>	The complete lighting unit (fixture), consisting of a lamp, or lamps and ballast(s) (when applicable), together with the parts designed to distribute the light (reflector, lens, diffuser), to position and protect the lamps, and to connect the lamps to the power supply.

**Mounting Height:** The horizontal spacing of poles is often measured in units of “mounting height”. Example: “The luminaires can be spaced up to 4 mounting heights apart.”

**X. DEFINITIONS - Ordinance Text**

<b><i>Luminaire Lumens</i></b>	For luminaires with relative photometry per IES, it is calculated as the sum of the initial lamp lumens for all lamps within an individual luminaire, multiplied by the luminaire efficiency. If the efficiency is not known for a residential luminaire, assume 70%. For luminaires with absolute photometry per IES LM-79, it is the total luminaire lumens. The lumen rating of a luminaire assumes the lamp or luminaire is new and has not depreciated in light output.
<b><i>Lux</i></b>	The SI unit of illuminance. One lux is one lumen per square meter. 1 Lux is a unit of incident illuminance approximately equal to 1/10 footcandle.
<b><i>Mounting height</i></b>	The height of the photometric center of a luminaire above grade level.
<b><i>New lighting</i></b>	Lighting for areas not previously illuminated; newly installed lighting of any type except for replacement lighting or lighting repairs.
<b><i>Object</i></b>	A permanent structure located on a site. Objects may include statues or artwork, garages or canopies, outbuildings, etc.
<b><i>Object Height</i></b>	The highest point of an entity, but shall not include antennas or similar structures.
<b><i>Ornamental lighting</i></b>	Lighting that does not impact the function and safety of an area but is purely decorative, or used to illuminate architecture and/or landscaping, and installed for aesthetic effect.

**X. DEFINITIONS - Ordinance Text**

<b><i>Ornamental Street Lighting</i></b>	A luminaire intended for illuminating streets that serves a decorative function in addition to providing optics that effectively deliver street lighting. It has a historical period appearance or decorative appearance, and has the following design characteristics: <ul style="list-style-type: none"> <li>· designed to mount on a pole using an arm, pendant, or vertical tenon;</li> <li>· opaque or translucent top and/or sides;</li> <li>· an optical aperture that is either open or enclosed with a flat, sag or drop lens;</li> <li>· mounted in a fixed position; and</li> <li>· with its photometric output measured using Type C photometry per IESNA LM-75-01.</li> </ul>
<b><i>Outdoor Lighting</i></b>	Lighting equipment installed within the property line and outside the building envelopes, whether attached to poles, building structures, the earth, or any other location; and any associated lighting control equipment.
<b><i>Partly shielded luminaire</i></b>	A luminaire with opaque top and translucent or perforated sides, designed to emit most light downward.
<b><i>Pedestrian Hardscape</i></b>	Stone, brick, concrete, asphalt or other similar finished surfaces intended primarily for walking, such as sidewalks and pathways.
<b><i>Photoelectric Switch</i></b>	A control device employing a photocell or photodiode to detect daylight and automatically switch lights off when sufficient daylight is available.
<b><i>Property line</i></b>	The edges of the legally-defined extent of privately owned property.

**X. DEFINITIONS - Ordinance Text**

<b><i>Relative photometry</i></b>	Photometric measurements made of the lamp plus luminaire, and adjusted to allow for light loss due to reflection or absorption within the luminaire. Reference standard: IES LM-63.
<b><i>Repair(s)</i></b>	The reconstruction or renewal of any part of an existing luminaire for the purpose of its on-going operation, other than relamping or replacement of components including capacitor, ballast or photocell. Note that retrofitting a luminaire with new lamp and/or ballast technology is not considered a repair and for the purposes of this ordinance the luminaire shall be treated as if new. "Repair" does <b>not</b> include normal relamping or replacement of components including capacitor, ballast or photocell.
<b><i>Replacement Lighting</i></b>	Lighting installed specifically to replace existing lighting that is sufficiently broken to be beyond repair.
<b><i>Sales area</i></b>	Uncovered area used for sales of retail goods and materials, including but not limited to automobiles, boats, tractors and other farm equipment, building supplies, and gardening and nursery products.
<b><i>Seasonal lighting</i></b>	Temporary lighting installed and operated in connection with holidays or traditions.
<b><i>Shielded Directional Luminaire</i></b>	A luminaire that includes an adjustable mounting device allowing aiming in any direction and contains a shield, louver, or baffle to reduce direct view of the lamp.
<b><i>Sign</i></b>	Advertising, directional or other outdoor promotional display of art, words and/or pictures.

**X. DEFINITIONS - Ordinance Text**

<b><i>Sky Glow</i></b>	The brightening of the nighttime sky that results from scattering and reflection of artificial light by moisture and dust particles in the atmosphere. Skyglow is caused by light directed or reflected upwards or sideways and reduces one's ability to view the night sky.
<b><i>Temporary lighting</i></b>	Lighting installed and operated for periods not to exceed 60 days, completely removed and not operated again for at least 30 days.
<b><i>Third Party</i></b>	A party contracted to provide lighting, such as a utility company.
<b><i>Time Switch</i></b>	An automatic lighting control device that switches lights according to time of day.
<b><i>Translucent</i></b>	Allowing light to pass through, diffusing it so that objects beyond cannot be seen clearly (not transparent or clear).
<b><i>Unshielded Luminaire</i></b>	A luminaire capable of emitting light in any direction including downwards.
<b><i>Uplight</i></b>	For an exterior luminaire, flux radiated in the hemisphere at or above the horizontal plane.
<b><i>Vertical Illuminance</i></b>	Illuminance measured or calculated in a plane perpendicular to the site boundary or property line.

## XI. OPTIONAL STREETLIGHT ORDINANCE - User's Guide

This section was added since the first public review. It is designed to work closely with the proposed revision to ANSI/IES RP-8 Standard Practice for Roadway and Street Lighting.

Street and roadway lighting is one of the world's largest causes of artificial skyglow. Many adopting agencies will recognize that the MLO will make privately owned lighting more efficient and environmentally responsible than their street lighting systems. But because the process of designing street lighting often requires more precise lighting calculations, applying the MLO directly to street lighting is not advised. Using existing standards of street lighting is recommended, particularly IES RP-8 and AASHTO standards.

Until a new recommended practice for street lighting can be developed, this section can serve to prevent most of the uplight of street lighting systems without setting specific requirements for the amount of light, uniformity of light, or other performance factors. Adopting agencies should include these basic improvements to street lighting along with regulations to private lighting.

Lighting streets with "period" ornamental luminaires that evoke the look of a time when the light source was a gas flame can cause glare if high-lumen lamps are used. Such ornamental street lights should not exceed a BUG rating of G1. If additional illuminance and/or uniformity is desired, the ornamental fixtures should be supplemented by higher mounted fully shielded luminaires, as illustrated in RP-33-99.

Few street lighting warranting processes exist. The adopting agency needs to gauge whether a complex warranting systems is required, or if a simple one using posted speeds, presence of pedestrians, or other practical considerations is sufficient.

Examples of a current street lighting warranting system are included in the Transportation Association of Canada's Guide for the Design of Roadway Lighting 2006.

## XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text

***Note to the adopting authority: the intent of this section is that it only applies to streets and not to roadways or highways.***

### A. Preamble

The purpose of this Ordinance is to control the light pollution of street lighting, including all collectors, local streets, alleys, sidewalks and bike-ways, as defined by ANSI/IES RP-8 Standard Practice for Roadway and Street Lighting and in a manner consistent with the Model Lighting Ordinance.

### B. Definitions

Roadway or Highway lighting is defined as lighting provided for freeways, expressways, limited access roadways, and roads on which pedestrians, cyclists, and parked vehicles are generally not present. The primary purpose of roadway or highway lighting is to help the motorist remain on the roadway and help with the detection of obstacles within and beyond the range of the vehicle's headlights.

Street lighting is defined as lighting provided for major, collector, and local roads where pedestrians and cyclists are generally present. The primary purpose of street lighting is to help the motorist identify obstacles, provide adequate visibility of pedestrians and cyclists, and assist in visual search tasks, both on and adjacent to the roadway.

Ornamental Street Lighting is defined as a luminaire intended for illuminating streets that serves a decorative function in addition to providing optics that effectively deliver street lighting. It has a historical period appearance or decorative appearance, and has the following design characteristics:

- designed to mount on a pole using an arm, pendant, or vertical tenon;
- opaque or translucent top and/or sides;
- an optical aperture that is either open or enclosed with a flat, sag or drop lens;
- mounted in a fixed position; and
- with its photometric output measured using Type C photometry per IESNA LM-75-01.

**XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text*****C. Scope***

All street lighting not governed by regulations of federal, state or other superceding jurisdiction.

***EXCEPTION:*** lighting systems mounted less than 10.5 feet above street level and having less than 1000 initial lumens each.

***D. Master Lighting Plan***

The Authority shall develop a Master Lighting Plan based on the American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide GL-6, October 2005, Chapter 2. Such plan shall include, but not be limited to, the Adoption of Lighting Zones and:

1. Goals of street lighting in the jurisdiction by Lighting Zone
2. Assessment of the safety and security issues in the jurisdiction by Lighting Zone
3. Environmentally judicious use of resources by Lighting Zone
4. Energy use and efficiency by Lighting Zone
5. Curfews to reduce or extinguish lighting when no longer needed by Lighting Zone

***E. Warranting***

The Authority shall establish a warranting process to determine whether lighting is required. Such warranting process shall not assume the need for any lighting nor for continuous lighting unless conditions warrant the need. Lighting shall only be installed where warranted.

**XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text*****F. Light Shielding and Distribution***

All street lighting shall have no light emitted above 90 degrees.

Exception: Ornamental street lighting for specific districts or projects shall be permitted by special permit only, and shall meet the requirements of Table H below without the need for external field-added modifications.

**Table H - Uplight Control Requirements  
for Ornamental Street Lights -  
by Special Permit Only**

Lighting Zone	Maximum Uplight Rating
LZ-0	U-0
LZ-1	U-1
LZ-2	U-2
LZ-3	U-3
LZ-4	U-4

# EXHIBIT C

ORDINANCE NO. Draft

An Ordinance amending Title 22 - Planning and Zoning of the Los Angeles County Code, relating to establishment of a rural outdoor lighting district to regulate outdoor lighting in the rural areas of Los Angeles County. In addition, the community standards districts within the rural outdoor lighting district are modified to be consistent with the Ordinance.

The Board of Supervisors of the County of Los Angeles ordains as follows:

...

**SECTION 1.** Part 9 of Chapter 22.44 is hereby added to add regulations for a Rural Outdoor Lighting District as follows:

**PART 9 RURAL OUTDOOR LIGHTING DISTRICT**

**22.44.500 Purpose.**

A. The purpose of this Part 9 is to establish and provide regulations for a rural outdoor lighting district that will:

- Permit reasonable uses of outdoor lighting for nighttime safety, utility, security, productivity and enjoyment;
- Minimize adverse offsite impacts including light trespass and obtrusive light;
- Curtail light pollution and preserve the nighttime environment;
- Protect the natural environment from the adverse effects of excessive outdoor lighting from artificial sources;
- Conserve energy and resources; and
- Promote dark skies for the enjoyment and health of humans and wildlife.

B. All outdoor lighting fixtures shall be installed in conformance with the provisions of this Part, the Building Code and the Electrical Code of the County of Los

1 Angeles and the 2008 Building Energy Efficient Standards, Title 24, Part 6 of the  
2 California Code of Regulations. The installation of an outdoor lighting fixture which is  
3 exempt under the Building Code or Electrical Code is also exempt from this Part.

4 **22.44.510 Description of district.** The Rural Outdoor Lighting District is  
5 depicted on Map No. 22.44.510-A found at the end of this Part.

6 **22.44.520 Definitions.**

7 A. Abandoned Use. A property where operations are discontinued and  
8 deserted by the property owner without any regard of resuming the use or occupying  
9 the structure.

10 B. Accurate color rendition. The ability of artificial lights to accurately  
11 represent colors.

12 C. Drop-down lens. A lens or diffuser that extends below a horizontal plane  
13 passing through the lowest point of the opaque portion of a light fixture.

14 D. Foot-candle. A unit of measure expressing the quantity of light received  
15 on a surface. Foot-candles shall be measured by a photometer.

16 E. Fully shielded fixture. A light fixture that emits no light in the area above a  
17 horizontal plane passing through the lowest point of the fixture and not more than 10  
18 percent of its light in the area between zero and 10 degrees below such horizontal  
19 plane. A full cutoff fixture is a fully shielded fixture of a specific design, usually a box or  
20 oval shape with a flat bottom.

21 F. Lamp. Any source created to produce optical radiation (light), often called  
22 a bulb or tube.

1           G.     Light pollution. Any adverse effect of artificial lighting, including glare, light  
2 trespass, sky glow, energy waste, compromised safety and security and impacts on the  
3 nocturnal environment.

4           H.     Lighting fixture. Light fixtures include, but are not limited to, the lamp,  
5 pole, post, ballast, reflector, lens, diffuser, shielding, electrical wiring, and other  
6 necessary or auxiliary components.

7           I.     Light trespass. Light falling across a property line onto an adjoining lot or  
8 onto an adjoining public right-of-way. Light trespass shall be determined by a  
9 measurement, taken at ground level at the property line. Light trespass shall be  
10 measured by a photometer.

11          J.     Lumen (lm). A unit of light energy or the visual amount of light produced  
12 by a fixture, calculated as a rating by the manufacturer (distinct from a watt, which is  
13 measure of power consumption). For example, a 40-watt incandescent lamp produces  
14 approximately 400 lumens, and a 35-watt high-pressure sodium lamp produces 2,300  
15 lumens.

16          K.     Major additions. For purposes of this Part, the following is considered a  
17 major addition: additions of 25 percent or more, or 10 percent in the coastal zone, in  
18 terms of additions to dwelling units, gross floor area, seating capacity, parking spaces,  
19 or increase to dwelling units, either with a single addition or with cumulative additions  
20 subsequent to the effective date of this ordinance.

21          L.     Obtrusive light. Light that causes light pollution and produces sky glow,  
22 light trespass, glare or other undesirable environmental impacts.

23          M.     Outdoor lighting. Any equipment or fixture located or used to provide  
24 illumination of outdoor areas, objects or activities. Outdoor lighting includes, but is not  
25

1 limited to, all lighting fixtures attached to buildings, structures, poles, or self-supporting  
2 structures and may be found on parking lots, walkways, building entrances, outdoor  
3 sales areas, landscaping, recreational fields, and building facades. Outdoor lighting  
4 excludes street lighting.

5 N. Outdoor recreation facility. An area designed for active recreation,  
6 whether publicly or privately owned, including, but not limited to, sports fields, race  
7 tracks, stadiums and riding arenas. A recreation field within the outdoor recreation  
8 facility refers to the area where the primary activity takes place and includes fields,  
9 riding areas and tracks.

10 O. Rural. A low density environment that does not contain high-intensity land  
11 uses, such as regional commercial centers and suburban density housing tracts, and  
12 has an absence of the infrastructure generally found in urban and suburban areas,  
13 including but not limited to curbs, gutters, sidewalks, street lighting and traffic signals.  
14 This environment typically contains agricultural and equestrian uses, wildlife and  
15 undistributed natural vegetation.

16 P. Sky glow. The brightening of the nighttime sky that results from  
17 scattering and reflection of artificial light by moisture and dust particles in the  
18 atmosphere. Sky glow is caused by light directed upwards or sideways and reduces  
19 one's ability to view the night sky.

#### 20 **22.44.530 Applicability**

21 A. New lighting. Unless otherwise expressly stated, this Part shall apply to  
22 outdoor lighting on all new and major additions to land uses, developments and  
23 buildings.  
24  
25

1 B. Major additions. If a major addition occurs on a property, the entire  
2 property shall comply with the requirements of this Part.

3 C. Replacement lighting.

4 a. Unless otherwise expressly stated, the standards of this Part apply  
5 whenever additions or replacements to existing outdoor lighting fixtures are installed,  
6 including upgrades and replacements to damaged or destroyed fixtures; and

7 b. Section 22.44.550.C shall not apply if only one fixture is being  
8 replaced or less than 50 percent of all outdoor lighting fixtures on the property are being  
9 replaced.

10 D. Resumption of use after abandonment. If a property or use with non-  
11 conforming lighting is abandoned, then all outdoor lighting shall be reviewed and  
12 brought into compliance with this Part before the use is resumed.

13 E. Existing Nonconforming Lighting. Existing nonconforming lighting  
14 includes:

15 1. All outdoor lighting on all residential or agriculture zoned properties; or  
16 2. Any nonresidential zone property where outdoor lighting causes light  
17 trespass onto a residential or agriculture zone property;

18 3. All outdoor lighting per subsections 1 and 2 above in use after (insert  
19 actual effective date of the Ordinance) that does not meet the requirements of this Part  
20 shall be removed or made to comply with the following:

21 a. Light Trespass. Within six months after (actual effective date) if  
22 such light causes light trespass; or

23 b. Without Light Trespass. Within three years after (actual  
24 effective date) if such lighting does not cause light trespass; and  
25

1 c. If the Director determines that a nonconforming lighting fixture  
2 results in light trespass, the Director may require the light be shielded, filtered,  
3 redirected or replaced with a less-intense light source or otherwise modified (including  
4 removal) to eliminate the light trespass.

#### 5 **22.44.540 Development Regulations**

6 A. Lighting allowance. Outdoor lighting shall not exceed the lighting  
7 allowance within the 2008 Building Energy Efficient Standards for Lighting Zone 2 of  
8 0.045 watts per square foot and comply with the lighting trespass regulations in  
9 subsection B below;

10 B. Light trespass. Outdoor lighting shall not cause light trespass. The  
11 following is considered light trespass:

12 1. Over 0.5 foot-candles where the zoning on the adjacent parcel is a  
13 residential, open space, or agricultural zone, or public right-of-way; or

14 2. Over 1.0 foot-candles where the zoning on the adjacent parcel is  
15 any other zone besides residential, open space or agricultural.

16 C. Shielding. All outdoor lighting shall be fully shielded.

17 D. Maximum height. The maximum height for outdoor lighting shall be as  
18 follows, measured from finished grade to the top of the fixture, unless noted otherwise in  
19 Section 22.44.560:

20 1. Residential, agricultural, open space and watershed zones – 20  
21 feet. Each outdoor light installed above 15 feet in height shall have a manufacturer's  
22 maximum output rating of less than 400 lumens;

23 2. Zoning on the property is any other zone besides residential,  
24 agricultural, open space, watershed or industrial – 30 feet; and  
25

1                   3.     Industrial zones – 35 feet.

2                   D.     Maintenance. Outdoor lighting shall be maintained in good repair, intact  
3 and free of severe cracks, with shielding securely attached and functional as designed.

4                   **22.44.550     Additional Requirements for Mixed Use Buildings and**  
5 **Commercial Uses**

6                   A.     Building entrance lighting. All building entrances shall install light fixtures  
7 that provide accurate color rendition so that persons entering or exiting the  
8 establishment can be easily recognized. Building entrance lighting shall be used  
9 between sundown and 10 p.m. or within one hour past the close of the business,  
10 whichever is later.

11                  B.     Hours of operation.

12                   1.     Outdoor lighting shall be turned off between the hours of 10 p.m.  
13 and sunrise, except where uses operate past 10 p.m., in which case lighting shall either  
14 be turned off within one hour after the close of business or regulate lighting in  
15 compliance with Section 22.44.560.C.

16                  C.     Automatic controls. All outdoor lighting systems shall install automatic  
17 time switch control devices or system used to turn lighting off after 10:00 p.m., and  
18 controls shall:

19                   1.     Be capable of programming different schedules for weekdays and  
20 weekends; and

21                   2.     Have program backup capabilities that prevent the loss of the  
22 device's schedules for at least 7 days, and the device's time and date setting for at least  
23 72 hours if power is interrupted.

1           3.     Either subsection 3.a or 3.b below may be used to regulate lighting  
2 between 10:00 p.m. and sunrise;

3           a.     Motion sensors used to turn on lighting after 10 p.m. when  
4 activity is detected. The motion sensor shall be capable of automatically turning off all  
5 the lights in an area no more than 10 minutes after the area has been vacated. The  
6 motion sensor fixture shall be fully shielded; or

7           b.     In lieu of turning all lighting off, commercial and industrial  
8 uses may reduce light levels or eliminate (turn off) by a minimum of 50 percent between  
9 10 p.m. and sunrise.

10          4.     Exemptions to hours of operation.

11          a.     Building code-required lighting for steps, stairs, walkways,  
12 and points of ingress and egress to buildings.

13          b.     Lighting governed by a discretionary use permit in which  
14 types of lighting and times of operation are specifically identified.

15          c.     Security and operations lighting for public facilities.

16       **22.44.560   Requirements for Specific Uses.**

17       A.     Street lighting for rural areas.

18           1.     Street light(s) may be installed at intersections along County roads  
19 and at driveways on County roads where the Director of Public Works determines that  
20 street lighting would be beneficial due to the proposed use of the property to alleviate  
21 traffic hazards, improve traffic flow, and promote safety and security, while maintaining  
22 to the maximum extent possible the dark skies characteristics of the area. Such new  
23 street lighting shall utilize full-cutoff (flat glass lens) luminaries as approved by the  
24  
25

1 Director of Public Works. For existing street lighting with drop glass luminaries,  
2 shielding approved by the Director of Public Works shall be utilized.

3 2. Street lights shall be compatible with the road section as required  
4 by the Director of Public Works.

5 3. Street lights shall be placed apart at distances that meet the  
6 minimum average foot-candles required by the Department of Public Works.

7 B. Outdoor recreation facility.

8 1. Fields.

9 a. High pressure sodium or metal halide lamps are the  
10 preferred lighting source;

11 b. Where playing fields or other special activity areas are to be  
12 illuminated, lighting fixtures shall be mounted, aimed, and fully shielded so that their  
13 beams fall within the primary playing/activity area and immediate surroundings to  
14 prohibit light trespass onto adjacent properties;

15 c. The height for outdoor lighting for recreational fields shall be  
16 the minimum necessary to illuminate the field in compliance with subsection b. above,  
17 but shall not exceed 75 feet;

18 2. Facilities.

19 a. Outdoor lighting shall be shut off by 10:00 p.m., or within one  
20 hour after the completion of the activity; and

21 b. All site lighting not directly associated with the fields shall  
22 conform to the lighting standards of this Part.

1 C. Signs. Outdoor lighting for all new signs, including outdoor advertising  
2 (billboards), business signs and roof and freestanding signs, installed after the effective  
3 date of this Ordinance shall be as follows:

4 1. Any externally-mounted light fixtures shall be mounted to the top of  
5 the sign and shall be oriented downward;

6 2. The lights shall be fully shielded; and

7 3. Externally-mounted bulbs or lighting tubes that are not filled with  
8 neon, argon or krypton shall not be visible from any portion of an adjacent public right-  
9 of-way or adjoining property.

10 **22.44.570 Prohibited Lighting.** The following types of outdoor lighting shall  
11 be prohibited:

12 A. Drop-down lenses;

13 B. Mercury vapor lights;

14 C. Ultraviolet lights; and

15 D. Searchlights, laser lights, or any other lighting that flashes, blinks,  
16 alternates, or moves.

17 **SECTION 2.** Section 22.44.122 is hereby amended to read as follows:

18 . . .

19 C. Community-Wide Development Standards.

20 . . .

21 4. ~~Exterior~~ Outdoor Lighting. ~~Public street lighting shall be prohibited~~  
22 ~~except where necessary to comply with safety lighting standards as determined by the~~  
23 ~~department of public works. Lighting on private parcels shall be designed to prevent off-~~  
24  
25

1 ~~site illumination. Hooding may be used to deflect light away from adjacent parcels and~~  
2 ~~public areas. Outdoor lighting shall be in conformance with Part 9 of Chapter 22.44.~~

3 . . .

4 **SECTION 3.** Section 22.44.126.is hereby amended to read as follows:

5 . . .

6 C. Community-Wide Development Standards. Except where a more specific  
7 application is prescribed, or prior to the approval of a new structure or addition to an  
8 existing structure where the cumulative area of all additions made after the adoption of  
9 this section adds at least 400 square feet to the footprint of either primary or accessory  
10 structures, a site plan shall be submitted to and approved by the planning director to  
11 assure compliance with the following development standards:

12 . . .

13 8. ~~Exterior~~ Outdoor Lighting. ~~Exterior Outdoor~~ lighting shall be in conformance  
14 with Part 9 of Chapter 22.44. ~~designed to minimize off-site illumination, within the~~  
15 ~~requirements for public safety.~~

16 a. ~~Exterior lighting on residential parcels shall be of top-shielded design to prevent direct~~  
17 ~~off-site illumination; hoods shall be used to direct light away from adjacent parcels.~~  
18 Exterior Outdoor lighting on nonresidential parcels shall be prohibited except where  
19 necessary for the safety of pedestrian and vehicular traffic, as determined by the  
20 County. To minimize off-site illumination where lights are required, cut-off fixtures in  
21 keeping with the Western frontier architectural style will be specified.

22 9. Street Improvements. Street improvements shall complement the rural  
23 character of the Acton community.

24 a. Street lighting shall be in conformance with Part 9 of Chapter 22.44. ~~in~~

1 ~~new subdivisions where lots exceed an area of 20,000 square feet, streetlights on local~~  
2 ~~streets will be required only where necessary for the safety of pedestrian and vehicular~~  
3 ~~traffic, as determined by the department of public works. . . .~~

4 **SECTION 4.** Section 22.44.133 is hereby amended to read as follows:

5 . . .

6 D. Community-wide Development Standards.

7 . . .

8 2. ~~Exterior~~ Outdoor Lighting. ~~Exterior~~ Outdoor lighting shall be in conformance  
9 with Part 9 of Chapter 22.44. ~~low intensity, directional and/or screened to prevent glare~~  
10 ~~or direct off-site illumination. Street lighting shall be permitted only where required by~~  
11 ~~the department of public works or Caltrans for public safety.~~

12 . . .

13 **SECTION 5.** Section 22.44.137 is hereby amended to read as follows:

14 . . .

15 D. Community-wide Development Standards.

16 . . .

17 2. Street improvements. In residential land divisions where at least 75 percent of  
18 the lots exceed a net area of 15,000 square feet, local streets shall comply with the  
19 following standards, as approved by the county department of public works and the  
20 county fire department:

21 . . .

22 d. Regardless of lot size, street lights shall:

23 . . .

24 ii. ~~Be placed the maximum distance apart with~~

1 ~~the minimum lumens allowed by the county department of public works. Shall be in~~  
2 ~~conformance with Part 9 of Chapter 22.44.~~

3 . . .

4 3. Trails

5 . . .

6 10. Lighting. ~~Exterior~~ Outdoor lighting shall be in conformance with Part 9 of  
7 Chapter 22.44. ~~designed to prevent off-site illumination and glare upon adjacent parcels,~~  
8 ~~public areas, environmentally sensitive areas, and the night sky.~~

9 **SECTION 6.** Section 22.44.140 is hereby modified as follows:

10 . . .

11 E. Community-wide Development Standards.

12 . . .

13 3. Street Lighting.

14 . . .

15 c. Street lights shall be in conformance with Part 9 of Chapter 22.44.

16 ii. ~~Street lights shall be placed the maximum distance apart with the minimum~~  
17 ~~lumens allowable by the department of public works; and~~

18 ~~iii. Street lights shall be designed to prevent off-street illumination and glare.~~  
19 ~~Hooding and shields shall be used to deflect light away from adjacent parcels.~~

20 . . .

21 12. Lighting. ~~Exterior~~ Outdoor lighting ~~to be installed in new development shall~~  
22 ~~be designed to prevent off-site illumination and glare. Hooding and shields shall be used~~  
23 ~~to deflect light away from adjacent parcels and public areas~~ shall be in conformance  
24 with Part 9 of Chapter 22.44.

**SECTION 7.** Section 22.44.141 is hereby modified as follows:

...

D. Community-wide Development Standards.

...

3. ~~Exterior~~ Outdoor Lighting. New ~~exterior~~ outdoor lighting shall be in conformance with Part 9 of Chapter 22.44. ~~designed to minimize off-site illumination and glare by deflecting light away from adjacent parcels, public areas, and the night sky, using shields and hoods such that the lighting source is not visible outside the site.~~

...

5. Street Lights. Street lights shall be in conformance with Part 9 of Chapter 22.44. ~~To preserve the community character, the following shall apply:~~

—— a. ~~Street lights shall be required only where necessary for the safety of pedestrian and vehicular traffic, as determined by the department of public works; and~~

—— b. ~~Street lights shall be placed the maximum distance apart with the minimum lumens allowable by the department of public works.~~

...

**SECTION 8.** Section 22.44.143 is hereby modified as follows:

...

D. Community-wide Development Standards.

...

2. Street Lighting. The addition of street lights is prohibited unless deemed necessary by the Department of Public Works. Where installed:

...

b. Street lights shall be in conformance with Part 9 of Chapter 22.44. ~~Street lights~~

1 shall be placed the maximum distance apart with the minimum lumens allowable by the  
2 Department of Public Works; and

3 ~~—— c. Street lights shall be designed to prevent off-street illumination and glare. Fully~~  
4 ~~shielded fixtures shall be used to deflect light away from adjacent parcels.~~

5 3. ~~Exterior~~ Outdoor Lighting. ~~(Reserved)~~ Outdoor lighting shall be in conformance  
6 with Part 9 of Chapter 22.44.

7 ...

8 **SECTION 9.** Section 22.44.144 is hereby modified as follows:

9 ...

10 D. Community-wide Development Standards.

11 ...

12 2. Street Lighting. The addition of street lights is prohibited unless deemed  
13 necessary by the Department of Public Works. Where installed:

14 ...

15 b. Street lights shall be in conformance with Part 9 of Chapter 22.44. ~~placed the~~  
16 ~~maximum distance apart with the minimum lumens allowable by the Department of~~  
17 ~~Public Works; and~~

18 ~~c. Street lights shall be designed to prevent off-street illumination and glare. Fully~~  
19 ~~shielded fixtures shall be used to deflect light away from adjacent parcels.~~

20 3. ~~Exterior~~ Outdoor Lighting. ~~(Reserved)~~ Outdoor lighting shall be in conformance  
21 with Part 9 of Chapter 22.44.

22 ...

23 10/26/2011

# EXHIBIT D



# U.S. Physicians Join Light-Pollution Fight

by Mario Motta

There's good news to report in the fight to preserve the night sky! On June 16, 2009, the American Medical Association (AMA) voted unanimously to support efforts to control light pollution. What makes this new policy particularly important is that the AMA encompasses the medical societies in all 50 U.S. states and more than 120 specialty societies.



Why has the AMA, a powerful and influential group, decided to support light-pollution legislation? There are multiple reasons.

First, the glare from bad lighting is a public-health hazard — especially the older you become. Glare light scattering in the eye causes loss of contrast and leads to unsafe driving conditions, much like the glare on a dirty windshield from low-angle sunlight or the high beams from an oncoming car. Second, wasted light represents unnecessary energy and CO<sub>2</sub> production. Finally, many species (including humans) need darkness to survive and thrive.



Mario Motta, a cardiologist and avid amateur astronomer, addresses delegates at the American Medical Association's 2009 national meeting.  
*AMA / Ted Grudzinski*

In my capacity as president of the [Massachusetts Medical Society](#), and as an elected member of the AMA's Council on Science and Public health, I had submitted a resolution for consideration at the association's 2009 annual meeting. The proposal came before a Reference Committee, and to my delight those who testified during its presentation were all in favor of the resolution. For example, the committee heard from two representatives from Barrington Hills, Illinois, a community that has declared itself a dark-sky haven.

After deliberating, the Reference Committee forwarded the proposal for a floor vote, noting, in part, that "Excessive light pollution comprises an inefficient use of energy and is a public health hazard for drivers, as well as an environmental disruption for several species. In addition, it was acknowledged that several states have light-pollution measures currently enacted and that national legislation on this issues is pending. Your reference committee recognizes the important environmental and public health implications of this resolution."

Based on that report, the entire House of Delegates of the AMA — 540 attendees representing physicians from the entire country — voted unanimously in favor of the proposal, now designated [Resolution 516](#).



Mario Motta in his  
Wingaersheek Observatory, near  
Gloucester, Massachusetts.  
*Babak Tafreshi*

I'm thrilled that this prestigious organization has adopted a light-pollution policy, which is quoted below. Dark-sky advocates may quote this in the current and future legislative efforts to enact outdoor-lighting laws in your localities.

*RESOLVED That our AMA advocate that all future outdoor lighting be of energy-efficient designs to reduce waste of energy and production of greenhouse gases that result from this wasted energy use; and be it further*

**RESOLVED That our AMA develop and enact a policy that supports light-pollution reduction efforts and glare-reduction efforts at both the national and state levels; and be it further**

RESOLVED That our AMA support that all future streetlights will be of a fully shielded design or similar non-glare design to improve the safety of our roadways for all, but especially vision impaired and older drivers.

---

*Mario Motta has been active in fighting light pollution for two decades. A member of the New England Light Pollution Advisory Group ([NELPAG](#)), he recently spearheaded the effort to adopt an outdoor-lighting bylaw in his hometown of Gloucester, Massachusetts.*

i

**Find this article at:**

<http://www.skyandtelescope.com/news/48814012.html?showAll=y&c=y>



Check the box to include the list of links referenced in the article.

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# EXHIBIT E

## Our Vanishing Night

Most city skies have become virtually empty of stars.

By Verlyn Klinkenborg

If humans were truly at home under the light of the moon and stars, we would go in darkness happily, the midnight world as visible to us as it is to the vast number of nocturnal species on this planet. Instead, we are diurnal creatures, with eyes adapted to living in the sun's light. This is a basic evolutionary fact, even though most of us don't think of ourselves as diurnal beings any more than we think of ourselves as primates or mammals or Earthlings. Yet it's the only way to explain what we've done to the night: We've engineered it to receive us by filling it with light.

This kind of engineering is no different than damming a river. Its benefits come with consequences—called light pollution—whose effects scientists are only now beginning to study. Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it's not wanted, instead of focusing it downward, where it is. Ill-designed lighting washes out the darkness of night and radically alters the light levels—and light rhythms—to which many forms of life, including ourselves, have adapted. Wherever human light spills into the natural world, some aspect of life—migration, reproduction, feeding—is affected.

For most of human history, the phrase "light pollution" would have made no sense. Imagine walking toward London on a moonlit night around 1800, when it was Earth's most populous city. Nearly a million people lived there, making do, as they always had, with candles and rushlights and torches and lanterns. Only a few houses were lit by gas, and there would be no public gaslights in the streets or squares for another seven years. From a few miles away, you would have been as likely to *smell* London as to see its dim collective glow.

Now most of humanity lives under intersecting domes of reflected, refracted light, of scattering rays from overlit cities and suburbs, from light-flooded highways and factories. Nearly all of nighttime Europe is a nebula of light, as is most of the United States and all of Japan. In the south Atlantic the glow from a single fishing fleet—squid fishermen luring their prey with metal halide lamps—can be seen from space, burning brighter, in fact, than Buenos Aires or Rio de Janeiro.

In most cities the sky looks as though it has been emptied of stars, leaving behind a vacant haze that mirrors our fear of the dark and resembles the urban glow of dystopian science fiction. We've grown so used to this pervasive orange haze that the original glory of an unlit night—dark enough for the planet Venus to throw shadows on Earth—is wholly beyond our experience, beyond memory almost. And yet above the city's pale ceiling lies the rest of the universe, utterly undiminished by the light we waste—a bright shoal of stars and planets and galaxies, shining in seemingly infinite darkness.

We've lit up the night as if it were an unoccupied country, when nothing could be further from the truth. Among mammals alone, the number of nocturnal species is astonishing. Light is a powerful biological force, and on many species it acts as a magnet, a process being studied by researchers such as Travis Longcore and Catherine Rich, co-founders of the Los Angeles-based Urban Wildlands Group. The effect is so powerful that scientists speak of songbirds and seabirds being "captured" by searchlights on land or by the light from gas flares on marine oil platforms, circling and circling in the thousands until they drop. Migrating at night, birds are apt to collide with brightly lit tall buildings; immature birds on their first journey suffer disproportionately.

Insects, of course, cluster around streetlights, and feeding at those insect clusters is now ingrained in the lives of many bat species. In some Swiss valleys the European lesser horseshoe bat began to vanish after streetlights were installed, perhaps because those valleys were suddenly filled with light-feeding pipistrelle bats. Other nocturnal mammals—including desert rodents, fruit bats, opossums, and badgers—forage more cautiously under the permanent full moon of light pollution because they've become easier targets for predators.

Some birds—blackbirds and nightingales, among others—sing at unnatural hours in the presence of artificial light. Scientists have determined that long artificial days—and artificially short nights—induce early breeding in a wide range of birds. And because a longer day allows for longer feeding, it can also

affect migration schedules. One population of Bewick's swans wintering in England put on fat more rapidly than usual, priming them to begin their Siberian migration early. The problem, of course, is that migration, like most other aspects of bird behavior, is a precisely timed biological behavior. Leaving early may mean arriving too soon for nesting conditions to be right.

Nesting sea turtles, which show a natural predisposition for dark beaches, find fewer and fewer of them to nest on. Their hatchlings, which gravitate toward the brighter, more reflective sea horizon, find themselves confused by artificial lighting behind the beach. In Florida alone, hatchling losses number in the hundreds of thousands every year. Frogs and toads living near brightly lit highways suffer nocturnal light levels that are as much as a million times brighter than normal, throwing nearly every aspect of their behavior out of joint, including their nighttime breeding choruses.

Of all the pollutions we face, light pollution is perhaps the most easily remedied. Simple changes in lighting design and installation yield immediate changes in the amount of light spilled into the atmosphere and, often, immediate energy savings.

It was once thought that light pollution only affected astronomers, who need to see the night sky in all its glorious clarity. And, in fact, some of the earliest civic efforts to control light pollution—in Flagstaff, Arizona, half a century ago—were made to protect the view from Lowell Observatory, which sits high above that city. Flagstaff has tightened its regulations since then, and in 2001 it was declared the first International Dark Sky City. By now the effort to control light pollution has spread around the globe. More and more cities and even entire countries, such as the Czech Republic, have committed themselves to reducing unwanted glare.

Unlike astronomers, most of us may not need an undiminished view of the night sky for our work, but like most other creatures we do need darkness. Darkness is as essential to our biological welfare, to our internal clockwork, as light itself. The regular oscillation of waking and sleep in our lives—one of our circadian rhythms—is nothing less than a biological expression of the regular oscillation of light on Earth. So fundamental are these rhythms to our being that altering them is like altering gravity.

For the past century or so, we've been performing an open-ended experiment on ourselves, extending the day, shortening the night, and short-circuiting the human body's sensitive response to light. The consequences of our bright new world are more readily perceptible in less adaptable creatures living in the peripheral glow of our prosperity. But for humans, too, light pollution may take a biological toll. At least one new study has suggested a direct correlation between higher rates of breast cancer in women and the nighttime brightness of their neighborhoods.

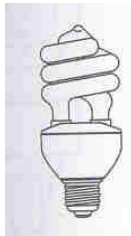
In the end, humans are no less trapped by light pollution than the frogs in a pond near a brightly lit highway. Living in a glare of our own making, we have cut ourselves off from our evolutionary and cultural patrimony—the light of the stars and the rhythms of day and night. In a very real sense, light pollution causes us to lose sight of our true place in the universe, to forget the scale of our being, which is best measured against the dimensions of a deep night with the Milky Way—the edge of our galaxy—arching overhead.

# EXHIBIT F

# GUIDELINES FOR GOOD OUTDOOR LIGHTING PRACTICES

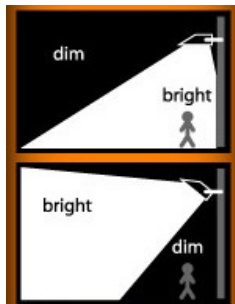
Good lighting practices provide a wide range of benefits for you and your neighbors. The following are some things you can do that take little effort and no expertise.

- **Save Energy.** To reduce energy consumption you can either reduce the wattage of the lamps or reduce the hours of operation. Wattage can be reduced by replacing lamps with more-energy-efficient counterparts; the hours of operation can be reduced using time controls. Pole lights and porch lights with a 15 or 25-watt incandescent bulb give off plenty of light. Anything higher wastes energy, money and creates unnecessary glare.
- **Replace incandescent bulbs with energy-efficient compact fluorescent bulbs.** They save energy and last much longer. The 7- and 9-watt versions give plenty of light for home applications. Adhering to professionally recommended light levels provides adequate illumination.



- **Floodlights.** Aim floodlights down to at least 45° so the light stays on your property and out of the night sky.

PERMITTED →



PROHIBITED →

- **Shielding Floodlights.** Buy an inexpensive shield to clip on to your floodlights to block them from neighbors' view and to keep light from going up.

Shields are available in home improvement stores or online sources including the following:

[www.greeneearthlighting.com](http://www.greeneearthlighting.com)

[www.britelitesout.com](http://www.britelitesout.com)



- **Shielding Porch Lights.** Design a shield or buy an inexpensive shield or shade to block view of the bulb in porch lights.

Fixture shields can be made from household objects. This shield is made from a rain gutter.





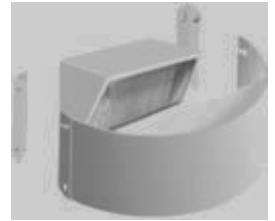
Lamp sleeve for single lamp fixtures

Shields and shades available in home improvement stores or online sources including the following:

[www.greenearthlighting.com](http://www.greenearthlighting.com)

[www.rabweb.com](http://www.rabweb.com)

Shades slip over wall mounted fixtures



Shade fits over existing barn lights



- **Solar Lights.** Use solar lighting for pathways. It's easy to install and costs nothing to operate. Install a shielded post light that aims the light down and shields the bulb from view.



- **Motion Detectors.** Install a motion detector on your shielded floodlight or porch light so it only comes on when you, your guests or an intruder enters your property. Make sure the light turns off within 10 minutes after the area has been vacated.



- **Be a Good Neighbor.**
  - ✓ Excessive or misdirected lighting can intrude on the privacy of others where light or glare trespasses over property lines.
  - ✓ Inappropriate or excessive lighting wastes our limited natural resources and pollutes our air, land, and water by burning fossil fuels for electricity.
  - ✓ Our clear view of the stars in the night sky is a resource to be preserved and protected. Stray and excessive lighting contributes to light pollution and unnatural sky glow.
  - ✓ Artificial night lighting disrupts the migrating, feeding, and breeding habits of many wildlife species, as well as growth pattern of trees.
  - ✓ Light at night not only disrupts your sleep but interferes with your immune system.

# EXHIBIT G

## Lighting Design: Considering the Impacts of Light Pollution (Dark Sky)

by Yvonne English, RLA, LEED AP, ASLA, IDA, IES



The [International Dark-Sky Association \(IDA\)](#) has a “[Glare Metrics](#)” program , a joint effort between IDA and Ian Lewin, of Lighting Sciences, Inc. This program is designed to create a standard of accurately and uniformly measuring glare, primarily by looking at intensity, luminance, and luminance contrast.

“□The problems of light pollution first became an issue in the 1970s when astronomers identified the degradation of the night sky due to the increase in lighting associated with development and growth. As more impacts to the environment by lighting have been identified, an international “dark sky” movement is advocating for the precautionary approach to outdoor lighting design.”

— *Model Lighting Ordinance*

What is light pollution? It's any adverse effects resulting from not properly shielded outdoor lighting. An unshielded light source allows light directed where it is not wanted—into people's eyes and the night sky.

There are four forms of light pollution:

*Sky glow*: light shining into the night sky above the horizon. This is the brightening of the night

<http://www.landscapeonline.com/research/article/17650> September 18, 2013, 5:02 pm EST

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sky by artificial light. Contributors are uplighting and reflected light.

*Light trespass:* light directed into areas where it is not intended, wanted, or needed, such as poorly shielded or poorly aimed fixtures.

*Glare:* light that shines into our eyes, causing visual discomfort and decreased visibility.

*Clutter:* a combination of all three, bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas

### **Why Is Light Pollution a Threat?**

Light pollution causes multiple issues. Some are obvious, but many are not, and not easily related to light pollution. The obvious threats:

1. Our views of the skies have drastically changed over the past 60 years. The view from a mountain top may be similar to night sky views from the 1950s, but the views of the urban skies are much different. The children's song "Twinkle, Twinkle, Little Star" has little meaning during the night in urban cities. Views are impacted primarily by the sky glow and clutter of artificial light.
2. Light trespass is a violation of property rights. An example is the typical spot light on the side of a home, which usually produces light that crosses into the neighbor's property. Such lighting can penetrate bedroom windows and disrupt sleep.
3. Our safety is greatly impacted by glare, which can temporarily blind people, particularly youngsters and the elderly. Glare is harmful, not protecting.

Our health, the health of wildlife (which impacts the health of our planet) and wasted energy are the less understood threats of light pollution. How does light pollution impact our health? Light affects our natural circadian biological rhythms, which in turn impacts our health. In 2012, the American Medical Association issued a report on the health effects of light pollution, which in part stated: "The natural 24-hour cycle of light and dark helps maintain precise alignment of circadian biological rhythms, the general activation of the central nervous system and various biological and cellular processes, and entrainment of melatonin release from the pineal gland. Pervasive use of nighttime lighting disrupts these ... processes and creates potentially harmful health effects ..."

The report further states: "More direct health effects of nighttime lighting may be attributable to disruption of the sleep-wake cycle and suppression of melatonin release. Even low intensity nighttime light has the capability of suppressing melatonin release. In various laboratory models of cancer, melatonin serves as a circulating anticancer signal and suppresses tumor growth. Limited epidemiological studies support the hypothesis that nighttime lighting and/or repetitive disruption of circadian rhythms increases cancer risk."

Nocturnal mammals, birds, amphibians, reptiles, insects, and fish experience similar

disorientation as humans when there is too much artificial nighttime light. Behavior governing mating, migration, sleep and finding food are determined by the length of nighttime. Light pollution negatively disrupts these age-old patterns, which in turn causes habitat disturbance, changes in behavior and impacts survival.



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The MLO will allow communities to drastically reduce light pollution and glare and lower excessive light levels. The recommended practices of the IES can be met using readily available, reasonably priced lighting equipment.

### Energy

Energy, of course, is a big environmental concern, as is the pollution associated with fossil fuels and generating electricity.

Editor's note: The IDA information sheet "[Economic Issues in Wasted and Inefficient Outdoor Lighting](#)" notes the 175 watt dusk-to-dawn mercury vapor light is a common outdoor fixture used throughout the U.S. Such a system actually uses about 210 watts of overall energy (when considering the ballast and other factors). This paper contends that at least 30 percent of such lighting is totally wasted. Tucson, Ariz. had over 20,000 such lights until a mass change out to better lighting was made. The annual operating cost of those mercury fixtures in Tucson was nearly \$1.4 million. The projected extrapolation for that kind of lighting across the U.S. is \$700 million!

### **What Can We Do?**

Some simple steps during designing the outdoor lighting can make a big difference. Establish careful lighting goals; use less light; and direct light carefully.

With careful planning, we can mitigate light pollution risks in several ways:

**Establish Your Lighting Goals:** Lighting for safety means illuminating pathways, stairways or changes in elevation. Security lighting means providing a soft light along the borders of a property. Remember to carefully place spot lights, which can add glare and actually attract intruders. Provide task lighting where needed, such as cooking, dining, entertaining spaces. And of course, provide beauty and interest at night.

**Less light is more effective:** Light only the goals. Use lower wattage lamps and beam spreads. Direct light only where it is needed, which minimizes "spill" and increases safety from glare. Down lighting should be almost straight down to reduce clutter, and uplighting straight up to reduce scatter. Hide the light bulb source to reduce glare. Incorporate zone controls to turn off unnecessary light and energy.

*About the author: Yvonne English has been adding nighttime dimension to her landscape designs since 1995. She is a member of International Dark-Sky Association (IDA), the first organization in the dark-sky movement, and the Illuminating Engineering Society (IES). IDA and IES worked together to write the Model Lighting Ordinance (MLO)*

*[www.darksky.org/assets/documents/MLO/MLO\\_FINAL\\_June2011.pdf](http://www.darksky.org/assets/documents/MLO/MLO_FINAL_June2011.pdf), which could affect future lighting design. It defines lighting zones and a luminaire rating system.*

## Lighting Design: Considering the Impacts of Light Pollution (Dark Sky)

by Yvonne English, RLA, LEED AP, ASLA, IDA, IES



The [International Dark-Sky Association \(IDA\)](#) has a “[Glare Metrics](#)” program , a joint effort between IDA and Ian Lewin, of Lighting Sciences, Inc. This program is designed to create a standard of accurately and uniformly measuring glare, primarily by looking at intensity, luminance, and luminance contrast.

“□The problems of light pollution first became an issue in the 1970s when astronomers identified the degradation of the night sky due to the increase in lighting associated with development and growth. As more impacts to the environment by lighting have been identified, an international “dark sky” movement is advocating for the precautionary approach to outdoor lighting design.”

— *Model Lighting Ordinance*

What is light pollution? It's any adverse effects resulting from not properly shielded outdoor lighting. An unshielded light source allows light directed where it is not wanted—into people's eyes and the night sky.

There are four forms of light pollution:

*Sky glow*: light shining into the night sky above the horizon. This is the brightening of the night

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sky by artificial light. Contributors are uplighting and reflected light.

*Light trespass:* light directed into areas where it is not intended, wanted, or needed, such as poorly shielded or poorly aimed fixtures.

*Glare:* light that shines into our eyes, causing visual discomfort and decreased visibility.

*Clutter:* a combination of all three, bright, confusing, and excessive groupings of light sources, commonly found in over-lit urban areas

### **Why Is Light Pollution a Threat?**

Light pollution causes multiple issues. Some are obvious, but many are not, and not easily related to light pollution. The obvious threats:

1. Our views of the skies have drastically changed over the past 60 years. The view from a mountain top may be similar to night sky views from the 1950s, but the views of the urban skies are much different. The children's song "Twinkle, Twinkle, Little Star" has little meaning during the night in urban cities. Views are impacted primarily by the sky glow and clutter of artificial light.
2. Light trespass is a violation of property rights. An example is the typical spot light on the side of a home, which usually produces light that crosses into the neighbor's property. Such lighting can penetrate bedroom windows and disrupt sleep.
3. Our safety is greatly impacted by glare, which can temporarily blind people, particularly youngsters and the elderly. Glare is harmful, not protecting.

Our health, the health of wildlife (which impacts the health of our planet) and wasted energy are the less understood threats of light pollution. How does light pollution impact our health? Light affects our natural circadian biological rhythms, which in turn impacts our health. In 2012, the American Medical Association issued a report on the health effects of light pollution, which in part stated: "The natural 24-hour cycle of light and dark helps maintain precise alignment of circadian biological rhythms, the general activation of the central nervous system and various biological and cellular processes, and entrainment of melatonin release from the pineal gland. Pervasive use of nighttime lighting disrupts these ... processes and creates potentially harmful health effects ..."

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