

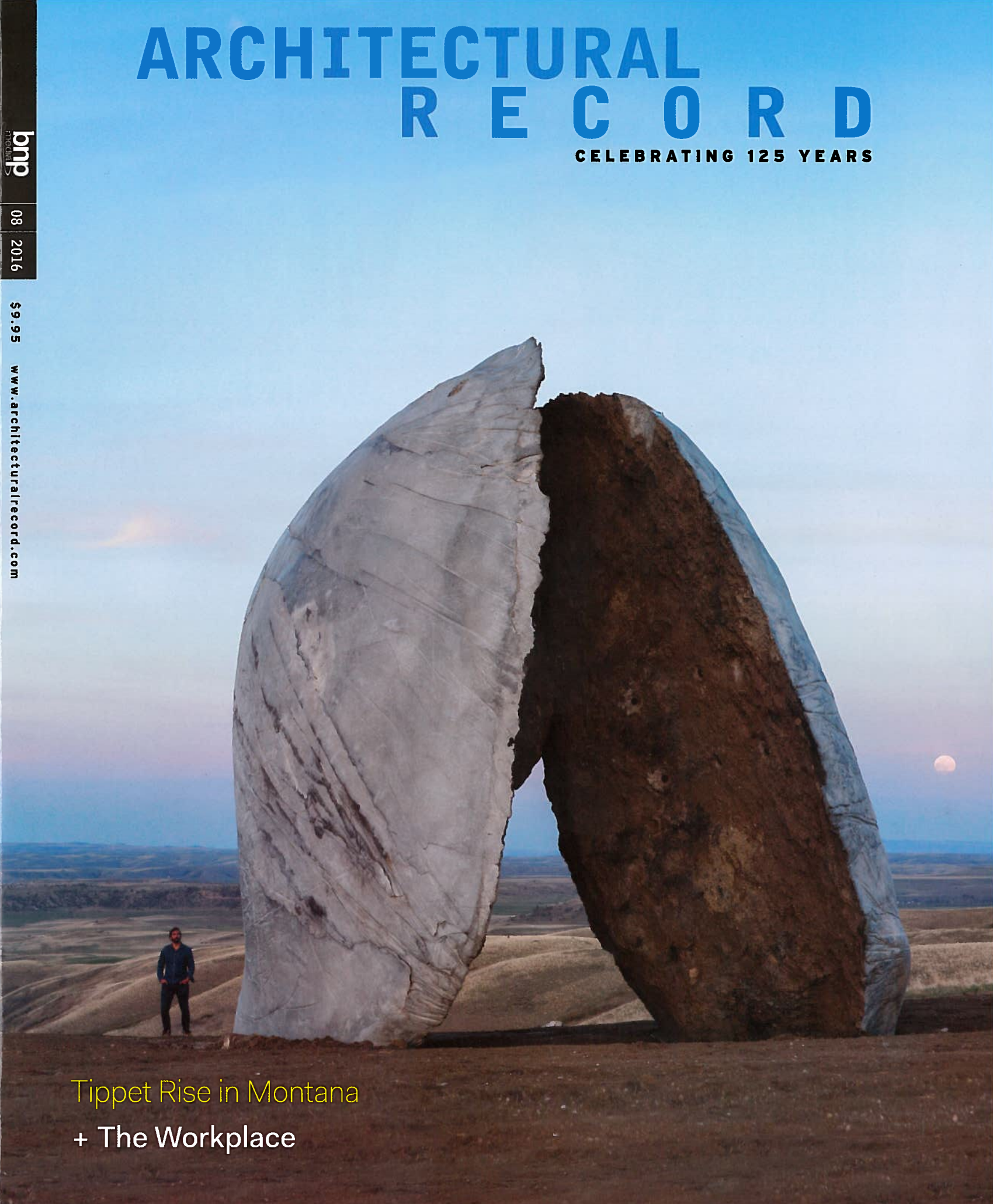
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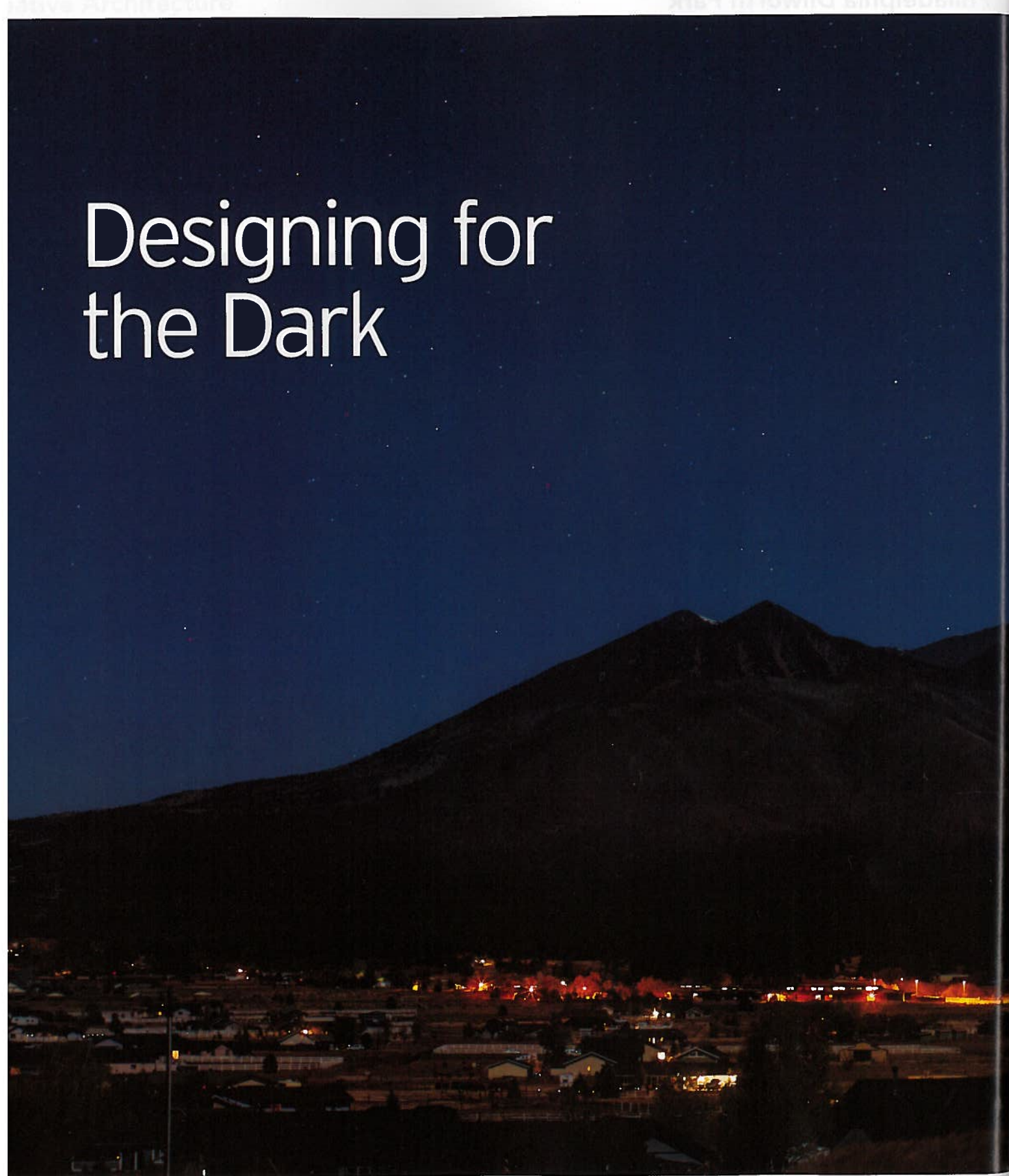
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Designing for the Dark



Light pollution hides views of the cosmos and causes a host of environmental problems. But architectural and landscape lighting can be designed so that it is sensitive to the night sky and ecosystems yet still responds to clients' requirements. On the following pages, RECORD explores projects that do just that.

By Joann Gonchar, AIA, and Linda C. Lentz

ELECTRIC LIGHTING has allowed us to transform the night. It extends our workday and permits us to punctuate the nighttime landscape with illuminated buildings. Roadway lights allow us travel on foot and by car safely from point A to B. And illuminated signs and advertisements help businesses sell their products and services.

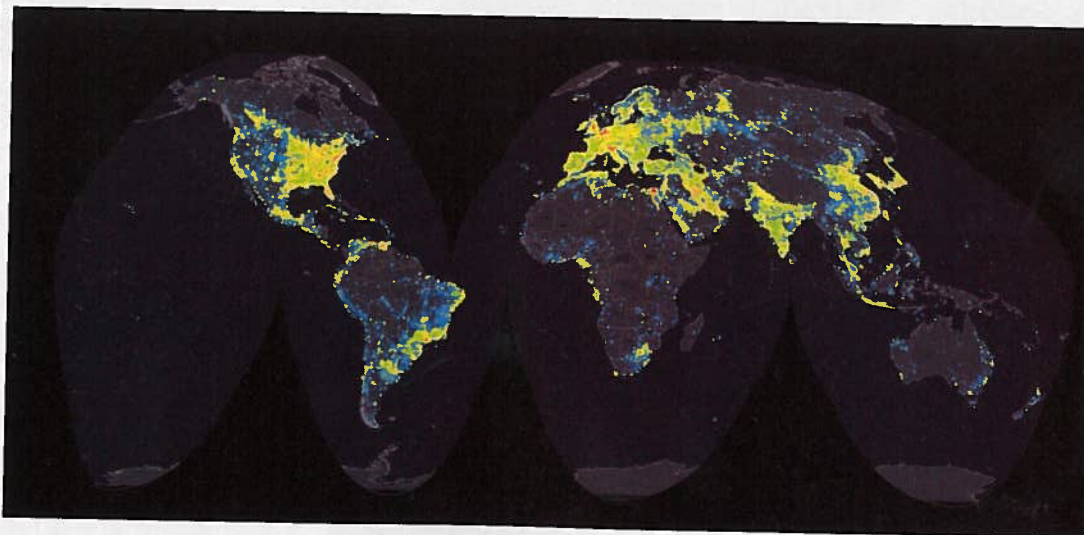
But too much outdoor lighting can have deleterious effects. One of the most obvious is that it masks our view of the stars. An international group of scientists recently attempted to quantify the magnitude of this long-acknowledged problem with an in-depth study that relied on high-resolution satellite data and sky brightness measurements to map the impact of light pollution around the globe. Their research, published in June in the journal *SciencesAdvances*, determined that the Milky Way is invisible to more than one-third of the world's population, including 60 percent of Europeans and nearly 80 percent of North Americans.

However, masking the stars and other celestial bodies from humans is only one of the consequences of light pollution. It can also affect both wildlife and ecosystems.

Bright beachfront lights can attract just-hatched sea turtles, drawing them inland rather than toward the water, making them easy marks for predators. City lights can disorient migratory birds, causing them to fly off course or crash into over-illuminated buildings. Light pollution can even interfere with the tiniest of creatures, including *Daphnia*, a type of zooplankton that helps keep algae blooms in check. The marine organisms, which dwell deep below the surface of the water during the day, float up at night to consume the algae. Nighttime light can prevent them from doing so. There is also research suggesting that too much exposure to certain types of artificial light can negatively affect human health by disrupting the production of melatonin, a hormone that regulates our circadian rhythms and adjusts our internal clocks.

What is light pollution? Mark Major, principal of London-based lighting design firm Speirs + Major, explains simply that since illumination is a byproduct of energy, if you are using more than is required, or you are putting it where it isn't desired or necessary, "by definition, that is pollution."

IMAGES: © ARNE KAISER (LEFT); FALCHI, ET AL., SCIENCEADVANCES 10, JUNE 2016 (RIGHT)



Flagstaff, Arizona (left), was the first city to be recognized as a Dark-Sky Community, in 2001. Since then, 65 other locations around the world have been designated Dark-Sky Places by the IDSA for their outdoor-lighting policies. An international group of scientists recently quantified the magnitude of the light-pollution problem, creating a series of maps. In the one above, the natural sky, or the Milky Way, is not visible from areas that are yellow, red, or white.

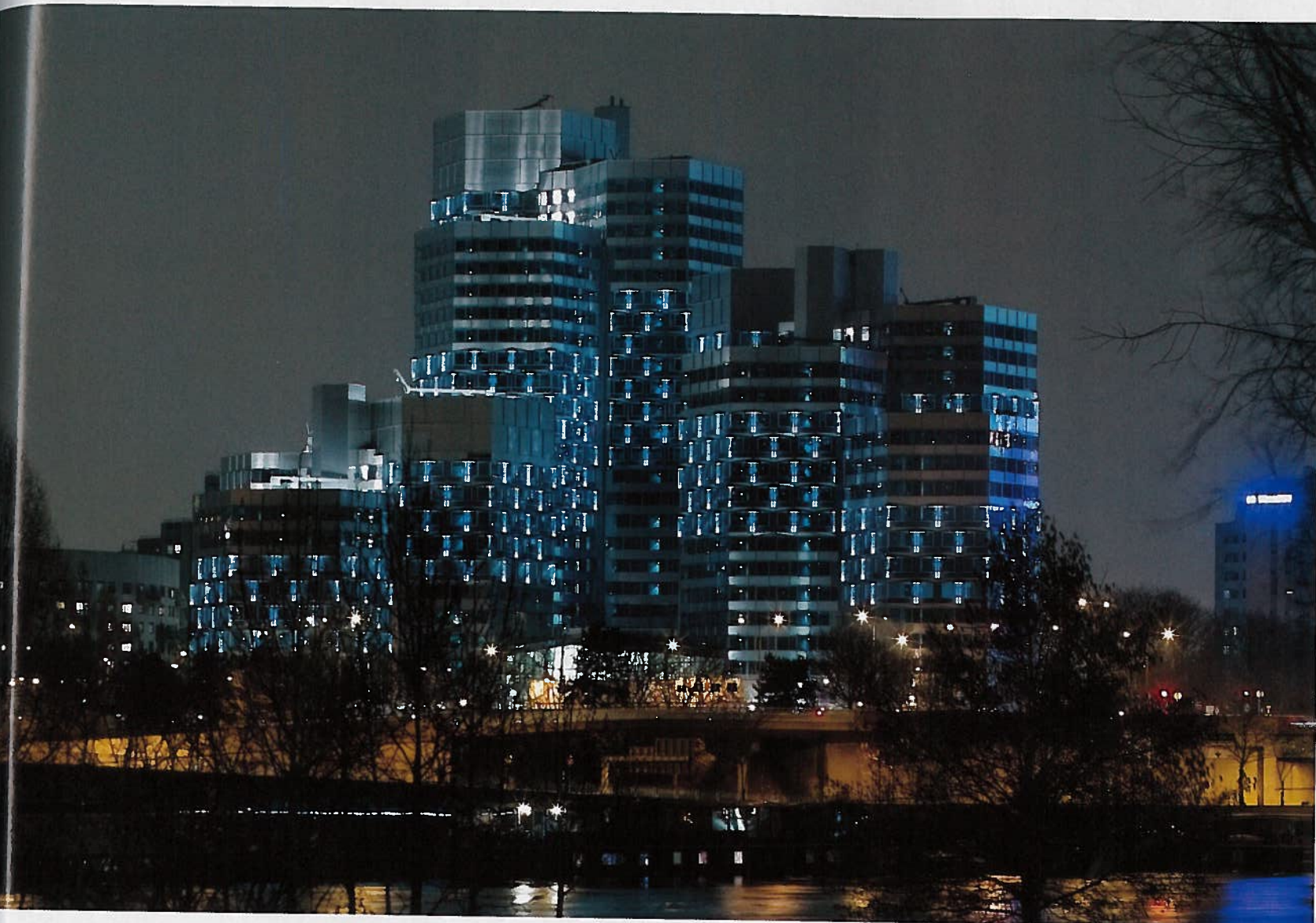


In only slightly more technical terms, light pollution is the excessive or inappropriate use of artificial illumination. A few of its manifestations are urban sky glow, which is a brightening of the night sky over inhabited areas; glare, or brightness that causes visual discomfort or loss of visibility; and light trespass, the term for light cast where it is not wanted or needed, such as illumination from a streetlight cast into a bedroom, making it difficult to sleep.

Not surprisingly, professional and amateur stargazers were among the earliest proponents for controlling light pollution. One example is the International Dark-Sky Association (IDSA), which was founded in the late 1980s by astronomers. The Tucson-based nonprofit organization advocates for smart lighting laws and policies and has an outdoor-fixture-certification program, as well as an initiative that recognizes towns, parks, and developments for responsible lighting practices. "We are not about

806 House Borrego Springs, California

A two- to three-hour drive from the bright lights of Southern California's largest cities, Borrego Springs—a small town bordering the Anza-Borrego Desert State Park in northern San Diego County—became the world's second official Dark-Sky Community in 2009. Drawn to the area's austere beauty and beautiful night sky, L.A. transplant Richard Orne, an architect, and his wife, Susan Hancock, a landscape designer and color consultant, bought 10 acres five miles from the center of town and built a sustainable house. The glazed moment-frame structure is 142 feet long by 28 feet wide, with deep overhangs on the northeast and southwest sides. In compliance with the community's guidelines, derived from county codes and International Dark-Sky Association lighting basics, Orne used as little lighting as possible. He limited the outdoor fixtures to shielded 2700K downlights under the overhangs and over four decks on the building's northwest. These are tied to photosensors programmed to turn them on at dusk and off at dawn. (A manual override allows them to be shut anytime.) The interior, divided into five sections along its length, is illuminated by recessed 2700K to 3000K LEDs on dimmers. In the evening, when a particular zone is not in use, it remains dark. "Very little light escapes from the house," says Orne. "It's more like a low-glowing lantern." There are even nights they turn all of the lights off. During a full moon, he adds, there is plenty of light without them.



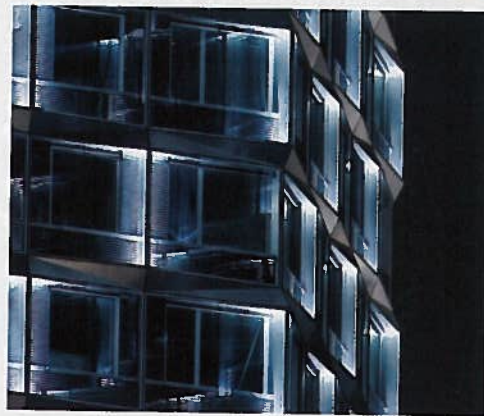
turning out the lights," says Pete Strasser, the organization's technical director. "We are about doing lighting appropriately."

The outdoor lighting strategies recommended by IDSA include luminaires that are shielded to direct light downward rather than up into the sky, are only as bright as necessary, and shut off or dim after hours. Strasser sums up the basics of outdoor lighting as "light where you need it, when you need it, and no more. Everything else is just waste." The organization estimates that 30 percent of outdoor lighting in the U.S. is wasted, amounting to \$3.3 billion and 21 million tons of carbon dioxide emissions per year.

Proponents of turning down the volume on outdoor light point out that more illumination doesn't necessarily mean greater security. For instance, bright lighting that causes glare is likely to have the opposite

Citylights Paris

Located in a previously industrial part of Paris, the 1975 Pont de Sèvres Towers, designed by Badani and Roux-Dorlut, have been reimagined by French architect Dominique Perrault. Renamed Citylights, the once detached office complex now embraces the city with sustainable prism-shaped buildings that illuminate the rapidly developing district (dubbed Trapèze) with a gentle luminosity. The design team's goal was to enhance the towers with discreet yet precise lighting that respects area residents and the ecosystem of the Seine's riverbanks. To do this, they encircled one-third of the aluminum facades, at different heights, with a "bracelet" comprising folded modules (above) made of pronounced metal aprons, two layers of glass (an extra-clear, single-glazed pane forming an outer skin and a double-glazed window within), and an LED system. Sandwiched between the glass, recessed LEDs radiate toward the lintels and metallic facade, which then casts indirect light toward the mullions. Passersby are never dazzled. They see only luminous reflections that, within this urban context, bring a human scale to the architecture.





Queen Elizabeth Olympic Park London

After the London 2012 Summer Olympics, lighting design firms Speirs + Major and Michael Grubb Studio worked with landscape architect James Corner Field Operations to transform what had been an open concourse in the Olympic Park into a 1,600-foot-long promenade. To illuminate the path, the team created 56 galvanized 3-foot-diameter metal spheres hung from a catenary wire. These spheres are perforated with almost 800 holes of three different sizes and fitted with a custom LED module that includes a diffuse lens. The LEDs illuminate the interior surface of the balls—each of which is powder-coated in a different hue of blue or green—and shine through the holes to create a dappled effect reminiscent of sunlight filtered through a tree canopy. The spheres are connected to a site-wide lighting control system that dims promenade lighting levels from approximately 15 lux during prime hours of occupancy to about 10 lux later at night. The scheme, says Mark Major, Speirs + Major principal, is so effective because it “uses darkness as well as light.”

effect and make occupants feel unsafe, points out lighting designer James Benya, a principal and partner at Benya Burnett Consultancy in Davis, California. And the IDSA maintains that there is no clear correlation between increased outdoor illumination and crime deterrence. It cites research including a 2015 study of street lighting in England and Wales that found little evidence of increased collisions or crime when lights were dimmed, turned off at certain hours, or

replaced with more energy-efficient fixtures.

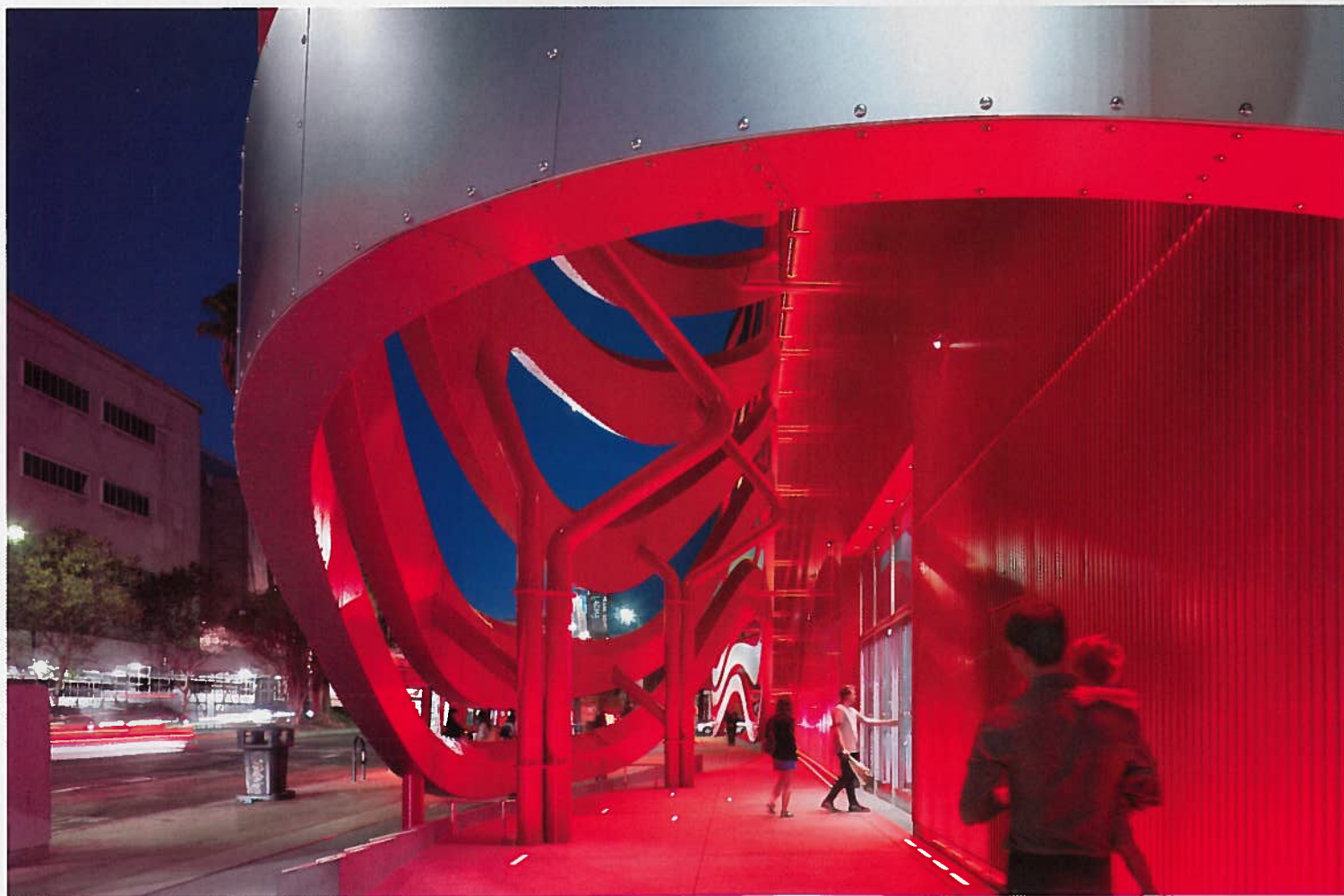
To encourage lighting that protects the night sky and is energy efficient but also provides sufficient illumination levels to make users feel comfortable and secure, IDSA and the Illuminating Engineering Society of North America (IES) developed a model lighting ordinance (MLO) that communities can adopt in whole or in part. The document is intended to address inconsistencies in lighting ordinances across the country

that vary in technical quality and often use outdated or incorrect terms, says Nancy Clanton, president of Boulder, Colorado-based lighting design firm Clanton & Associates. “Since they are different everywhere, designers don’t know how to comply,” explains Clanton, who chaired the MLO development committee with Benya.

Among the MLO’s key features is the use of five different lighting-zone categories. These range from wilderness, preserves, and unde-

Petersen Automotive Museum Los Angeles

The steely body of KPF's new shell for this museum's existing structure is vibrant, yet the lighting was configured to minimize light pollution. This is largely due to the California Title 24 CalGreen section, which limits the amount of uplight per fixture to discourage facade uplighting, floodlighting, or other potentially invasive illumination sources. Horton Lees Brogdon lighting designer Clifton Manahan says, "The brief was to create something mysterious that hints at movement inside the building." So the team employed dynamic color-changing LEDs, working with one manufacturer for consistent quality. For a wide range of colors and effects, he opted for four-color RGBW LEDs with optics that provide maximum light spread across the facade while minimizing glare. The output of each uplight was coordinated with the architectural shell, which serves as shielding to ensure the state's limits were met. "Saturated-color light is more visible to the human eye than just white light," says Manahan. "So the measured output of the fixtures and brightness of the building are fairly low but still visible." This gives it a strong identity yet also curtails glare and light pollution.



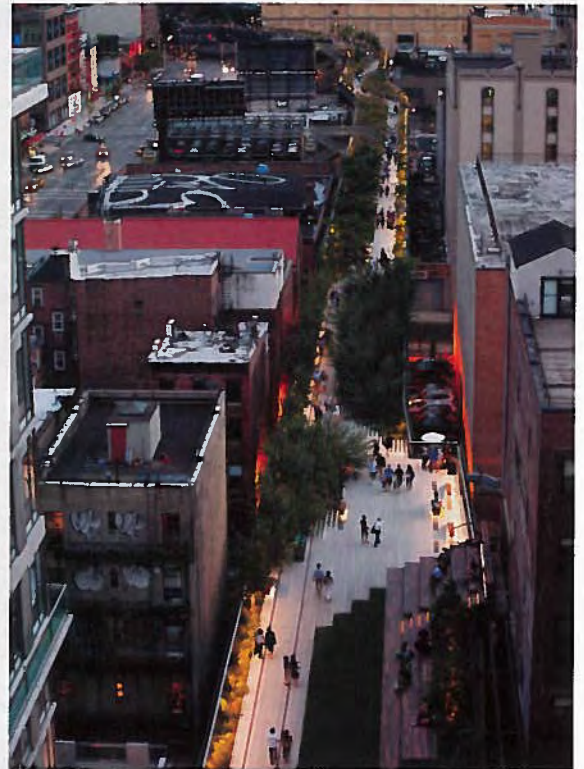
veloped rural areas, which would be the darkest, to areas that could have very high ambient light levels, such as an entertainment district. The zones provide planning officials with a tool for varying the stringency of lighting restrictions depending on the sensitivity of an area or the preferences of the community. The MLO also relies on a method for rating luminaires, known as BUG (for backlight, uplight, and glare).

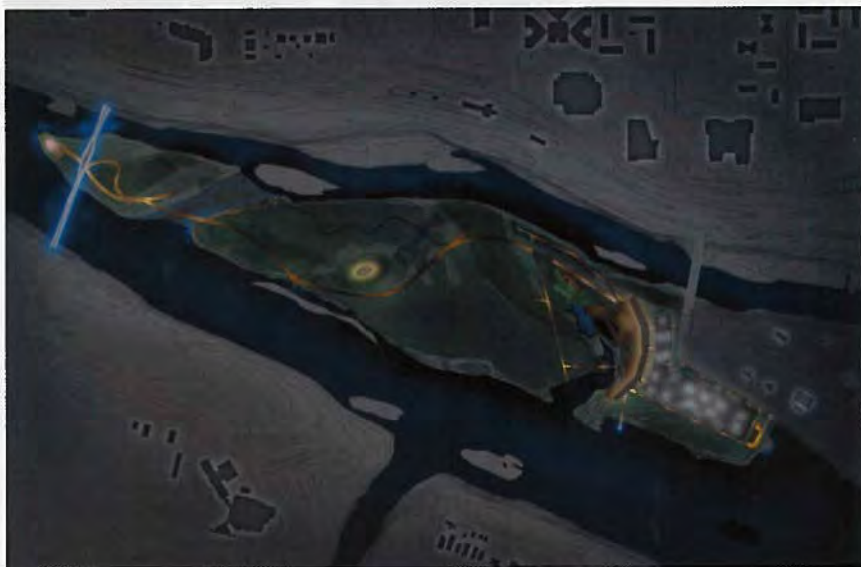
Although the MLO has not been widely adopted since its release in 2011, its language, including the lighting zones and the BUG rating system, has been incorporated into a LEED credit for light-pollution reduction, helping focus project teams' attention on responsible outdoor-lighting design. "It has created an awareness of the problem," says lighting designer Glenn Heinmiller, a principal at the lighting-design firm Lam Partners in Cambridge, Massachusetts.

One aspect of outdoor lighting that isn't covered by either LEED or the MLO is the color of the light source. But color is an increasingly controversial topic, especially as traditional halogen sources are replaced with

The High Line New York City

"The idea was to create a ribbon in the middle of the canyon," says Hervé Descottes, principal of L'Observatoire International, about the High Line project. His firm worked with the team leader, landscape architect James Corner Field Operations, architect Diller Scofidio + Renfro, and plant designer Piet Oudolf to convert an abandoned freight line on Manhattan's far west side into the wildly popular 1½-mile-long elevated park, completed in stages between 2009 and 2014. New York has no restrictions on uplight, as many cities do, according to Descottes. But here the light sources—a combination of metal-halide lamps and LEDs for the first phases and all LEDs for later ones—are hidden, directed downward, and placed low to the ground. "The approach makes the landscape appear to glow all by itself."



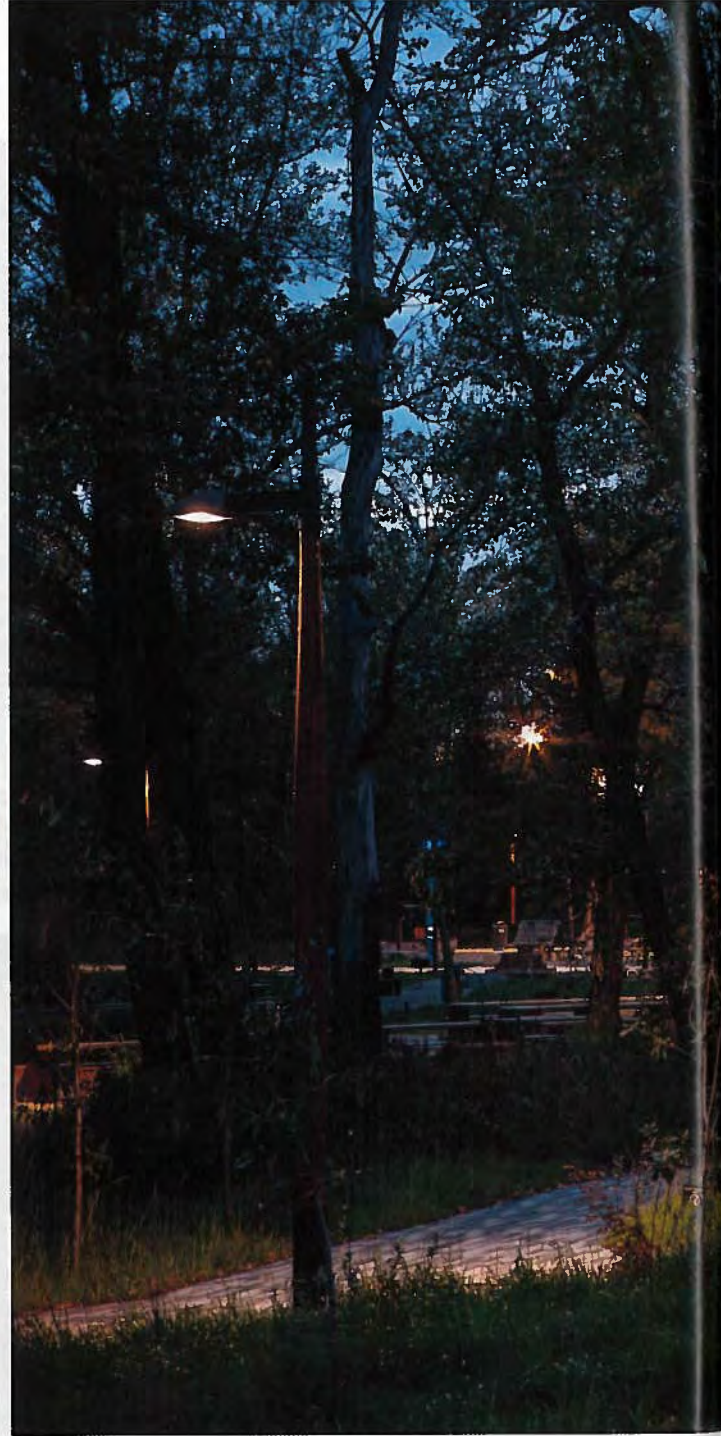


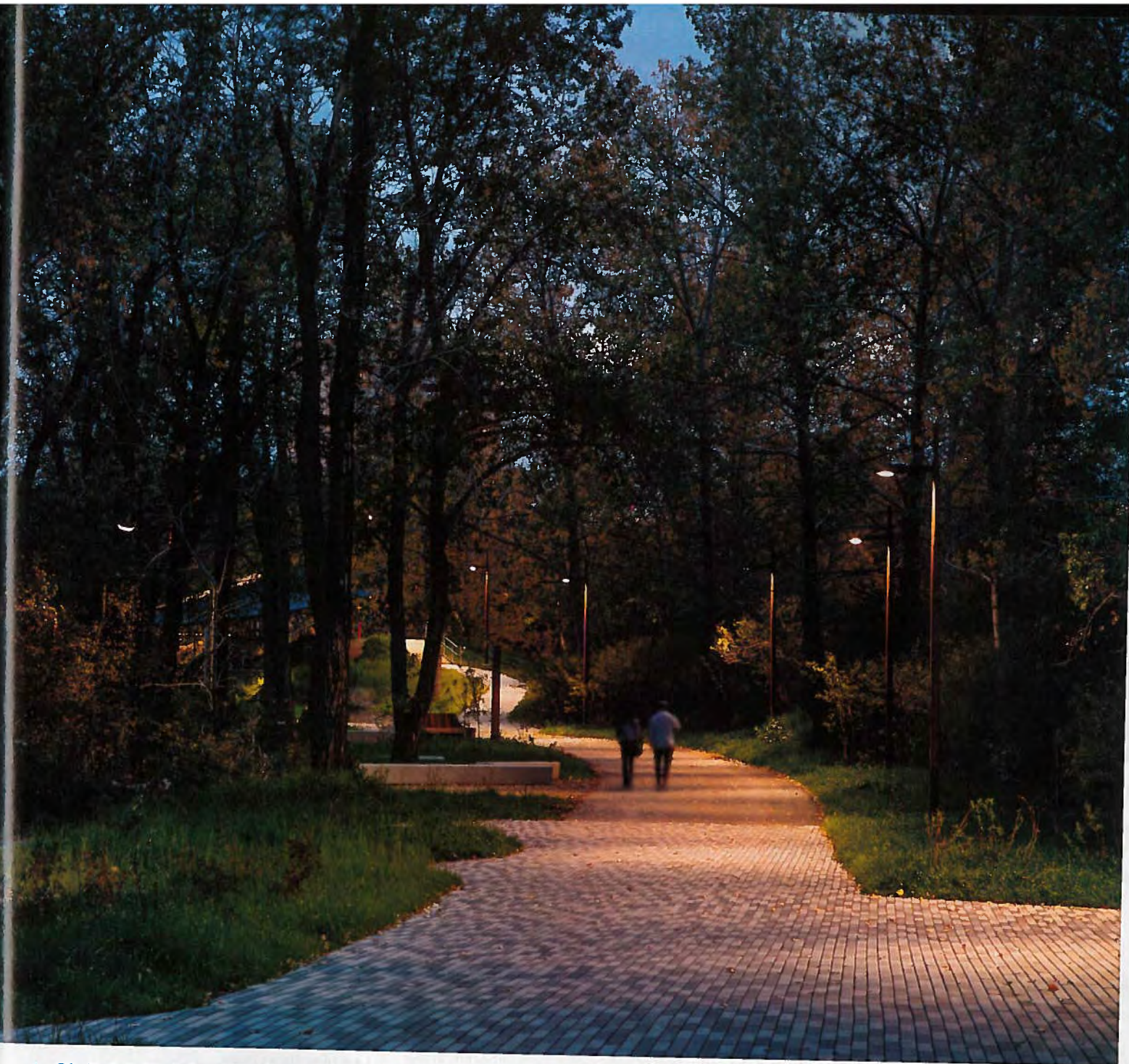
The rendering (above) illustrates Tillet Design Associates' discreet distribution of light throughout Calgary's St. Patrick's Island Park, a strategy conceived to sustain the island's wildlife population.

more energy-efficient and longer-life LEDs, which, at least until recently, tended to be cooler or seemingly whiter. In mid-June, the American Medical Association (AMA) released a statement warning of potential health hazards associated with high-intensity bright-white LED streetlights. According to the report, such a lamp "is at least five times more powerful in influencing circadian physiology than a high-pressure sodium light, based on melatonin suppression." The statement cited recent studies that found that greater residential nighttime lighting is associated with such ill effects as reduced sleep time, dissatisfaction with sleep quality, impaired daytime functioning, and even

obesity. The AMA's recommendations include use of shielded streetlighting, with a correlated color temperature (CCT) of 3000K or lower. (CCT is a specification of the color appearance of light emitted from a lamp measured in degrees Kelvin. Lamps with a higher CCT rating are considered cooler.)

Although the IDSA called the report "groundbreaking" on its website, not all lighting professionals are as enthusiastic. Mark Rea, the director of the Lighting Research Center at Rensselaer Polytechnic Institute, in Troy, New York, says that the AMA analysis is "oversimplified." Rea and Mariana Figueiro, the research center's program director, issued a response that





St. Patrick's Island Park Calgary, Alberta

When the Calgary Municipal Land Corporation tapped Civitas and W Architecture & Landscape Architecture to create a nature-based park on a 31-acre island in the city's Bow River, the landscape architects called upon Tillet Lighting Design to provide contextual illumination with the delicate touch for which the firm is known. St. Patrick's Island had been a park for over a century but suffered from neglect and disuse in recent decades. One of the goals of the design team was to maintain a viable habitat for birds, bats, and other wildlife. To achieve that, principal Linnaea Tillet and her team first identified how much of the park they could reserve as dark space. They layered this approach by also looking at how little light they could use, and only where it was essential for people using the park at night so that they would feel at ease and be able to find their way out. The lighting designers used a warm 3000K CCT for all the lamping, defining a major path (above) through the length of the park with well-shielded metal halide fixtures on tall wood poles. With two 50-foot-tall poles, each supporting four shielded adjustable metal-halide floodlights, the designers cast a moonlike glow on a central berm (opposite, top), used for nighttime sledding. Typically, the floodlights are shut off when the area is not in use. They also scattered low-level LED luminaires along secondary paths and LED wood bollards (right) in more open areas. Says Tillet, "We absolutely minimized our participation to maximize the territory left light-free for the birds."





Msheireb Doha, Qatar

Msheireb Properties is revitalizing Doha with an eponymous new downtown that has an ambitious sustainable agenda. Asked to create a master plan for the lighting of the 77-acre development, Arup worked with architectural master planner Allies and Morrison to create standards that are compatible with the desired Qatari building style and minimize the number of illuminated facades throughout the project's various zones—mixed-use and residential, business, retail, heritage, and government. Employing the LEED light-pollution-reduction credit as a reference, lighting designer Emily Dufner and her team devised a concept called Light, Dark, Light that illuminates rooflines—comprising roof terraces and shade structures—as well as ground-level colonnades with shielded downlights, leaving the facades dark. All of the utilitarian luminaires, such as streetlights, are full-cutoff. LEED does allow a certain percentage of uplighting, however, so allowances were made for landmark buildings, structures on key public spaces, and decorative lighting. In all these cases, controls play a critical role in shutting them off at predetermined times. "Sustainability and the reduction of light pollution is inherent in our approach," says Dufner, "but in this project, it was client-driven."

criticized the AMA report on a number of fronts, but one of the main arguments is that CCT is not appropriate for characterizing the potential health impacts of lighting since the metric "is independent of nearly all of the important factors associated with light exposure, namely its amount, duration, and timing."

Meanwhile, Lam's Heinmiller calls the issue of circadian rhythms "huge and important," but says the focus on CCT is "missing the forest for the trees." He points out that converting street lamps to 3000K will not by itself solve the problem. "If we are still over-

illuminating the environment, we will be creating light pollution."

Clearly, the science behind outdoor lighting and its environmental and human health implications is complex. But aesthetics should not get lost in the debate, say advocates of sensitive nighttime illumination. Architects and lighting professionals should not think of lighting after the sun sets as an extension of the day, says Travis Longcore, assistant professor of architecture and spatial sciences at the University of California, Los Angeles. Instead, he says, their goal should be "nocturnal place-making." ■

Continuing Education



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Learning Objectives

- 1 Define light pollution and related terms, such as sky glow, glare, and light trespass.
- 2 Discuss the ecological and human-health consequences of light pollution.
- 3 Discuss policy efforts aimed at reducing light pollution.
- 4 Discuss the methods used to minimize light pollution in recent outdoor lighting projects.

AIA/CES Course #K1608A

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