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Designers Lighting Forum

Stargazing Versus Safety: The Dilemma of Exterior Lighting

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AIA

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of the this course, participants will be able to:

1. *Review environmental consequences of lighting pollution.*
2. *Understand the driving factors of the Model Lighting Ordinance.*
3. *Incorporate lighting for security based on current technology.*
4. *Applying controls to benefit security and the environment.*

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Can safety and stargazing coexist? Can a security light expose a trespasser without creating light trespass?

Designers today are faced with a challenge of balancing best practices in security lighting without flooding the neighbors with light, all while maintaining a view of our night's sky. While the Model Lighting Ordinance (MLO) restricts light where it is not needed, guidelines for security lighting are often in contradiction. The seminar will cover current practices for Dark Skies and security lighting, challenges with adaptation, and the use of controls to bridge the gap.

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SAFE·TY

/ˈsāftē/

noun

the condition of being protected from or unlikely to cause danger, risk, or injury.
"they should leave for their own safety“

Synonyms: welfare, well-being, protection, security

"the safety of the residents”

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Photographs courtesy of Scott Troost

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Photographs courtesy of Shaun Fillion

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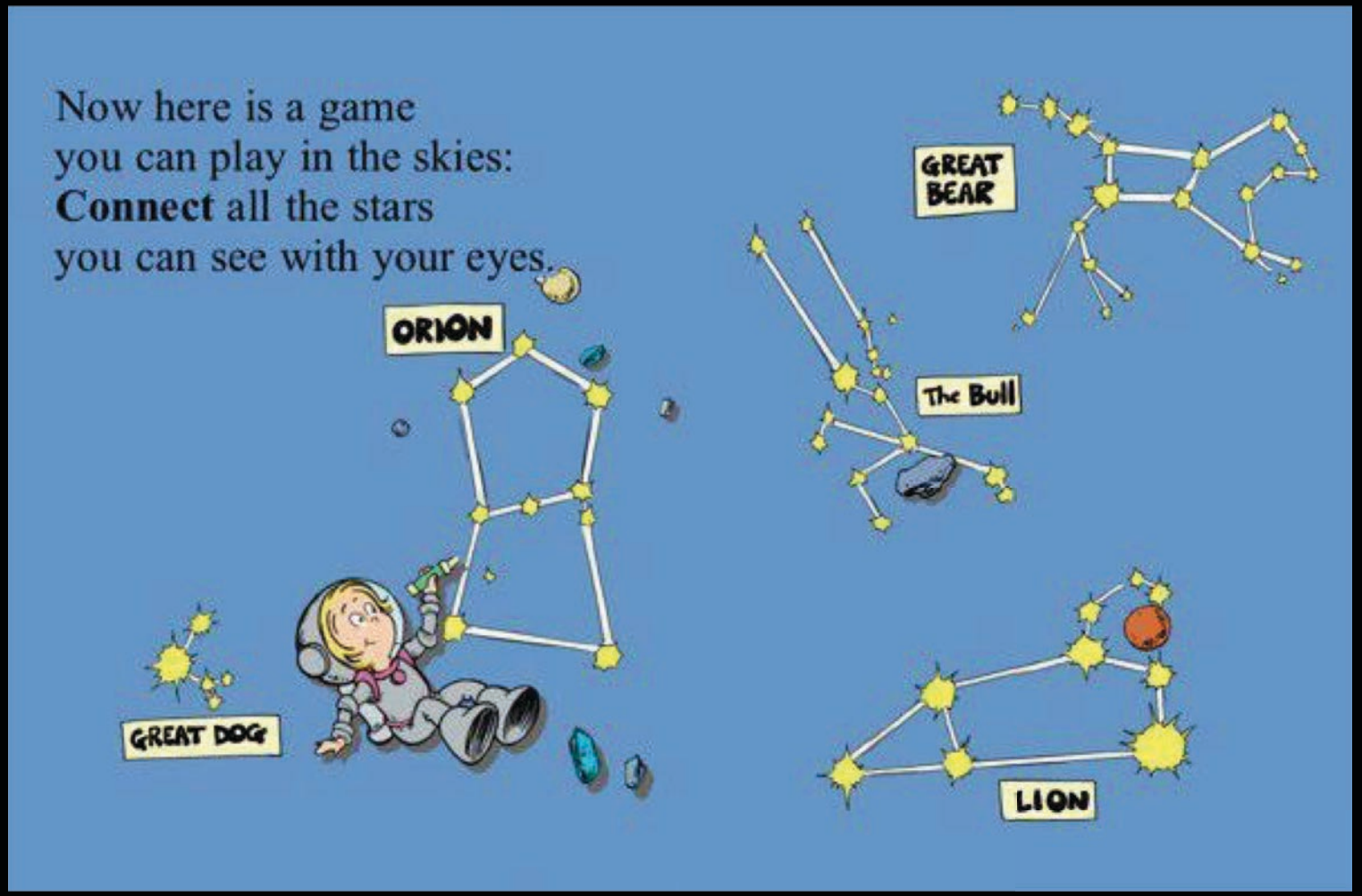

There's No Place Like Space, Tish Rabe, Cat in the Hat Learning Library


Am I ruining my daughter's astronomical ambitions?


Why Dark Skies?
What happens when we lose the counterpoint to our days?

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"For my part I know nothing with any certainty, but the sight of the stars makes me dream."

"The night is more alive and more richly colored than the day."

– Vincent van Gogh

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What is Light Pollution?

"Light pollution is an unwanted consequence of outdoor lighting and includes such effects as sky glow, light trespass, and glare."[1]

1. "Light Pollution." Lighting Research Center. Rensselaer Polytechnic Institute, February 2007. Web. 9 February 2016.

Hong Kong Harbor

What is sky glow?

Brightening of the sky caused by outdoor lighting and natural atmospheric and celestial factors.

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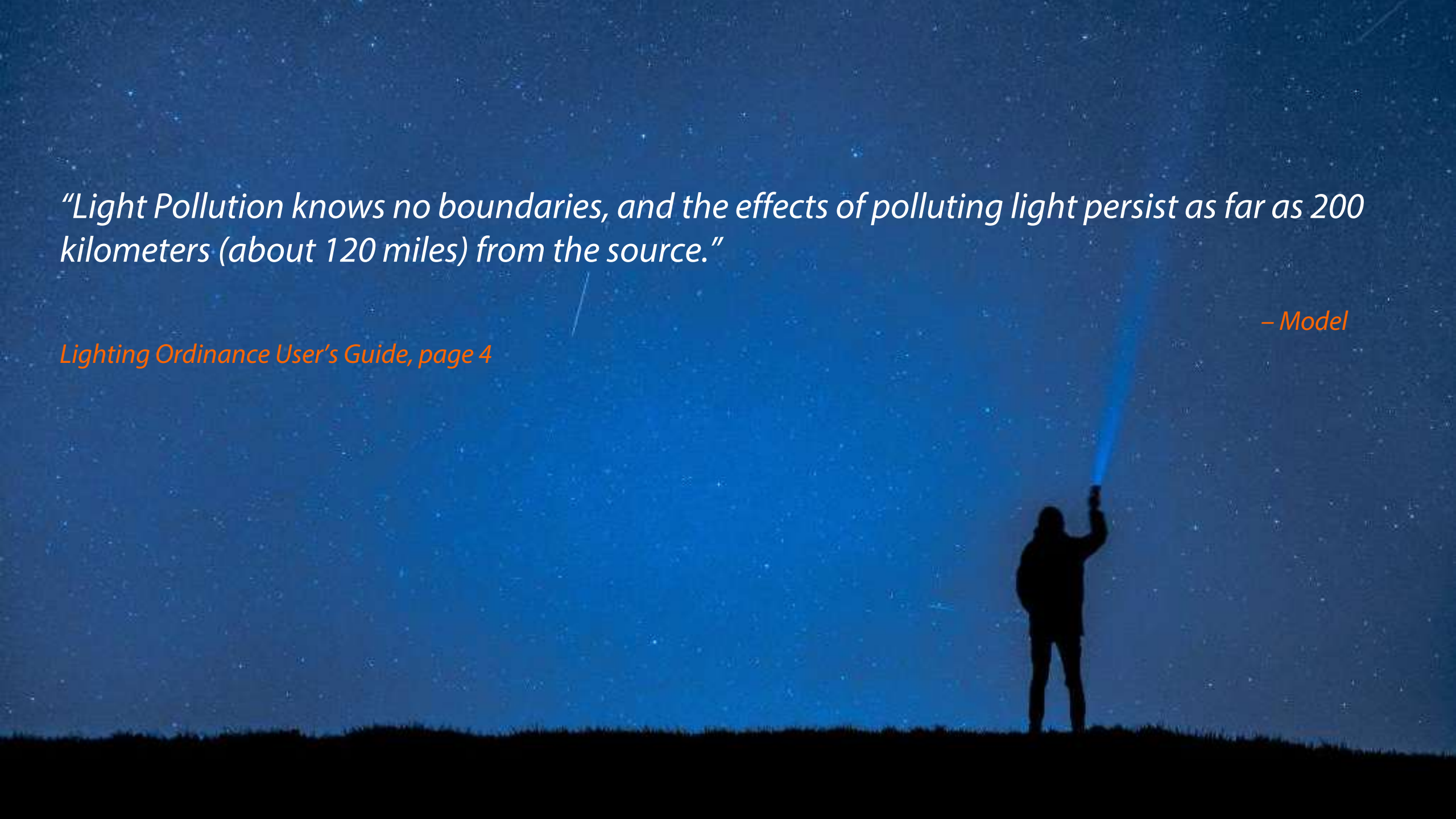
The Mechanics of Light Pollution

The air, seemingly invisible, is filled with soft particulate.

These particles serve as trillions of tiny little mirrors, re-reflecting light from the original light sources.

This re-reflection creates clouds of light that obstruct darkness, the natural rhythm of light, and the night's sky.



"Light Pollution knows no boundaries, and the effects of polluting light persist as far as 200 kilometers (about 120 miles) from the source."

– Model

Lighting Ordinance User's Guide, page 4

Vancouver

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"The problem with plastic is that you can do anything with it."[1]

- Charles Eames

1. Demetrios, Eames. An Eames Primer. New York: Universe, 2013. Print.

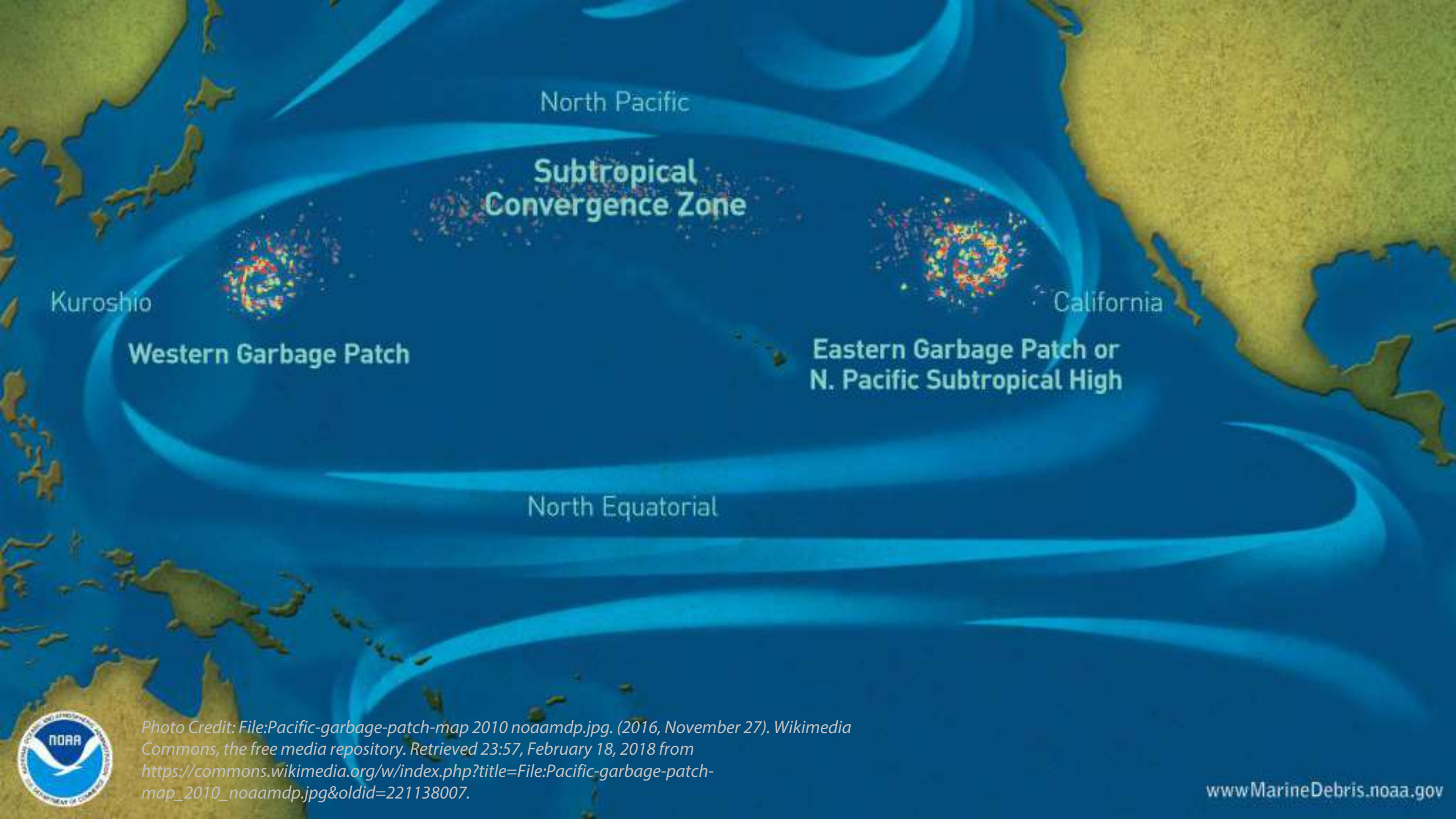

Photo Credit: File:Pacific-garbage-patch-map 2010 noaamdp.jpg. (2016, November 27). Wikimedia Commons, the free media repository. Retrieved 23:57, February 18, 2018 from https://commons.wikimedia.org/w/index.php?title=File:Pacific-garbage-patch-map_2010_noaamdp.jpg&oldid=221138007.

www.MarineDebris.noaa.gov

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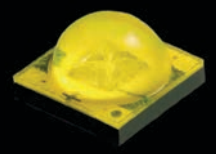
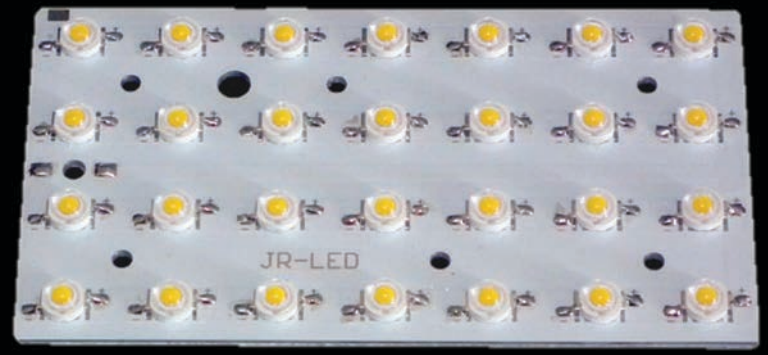
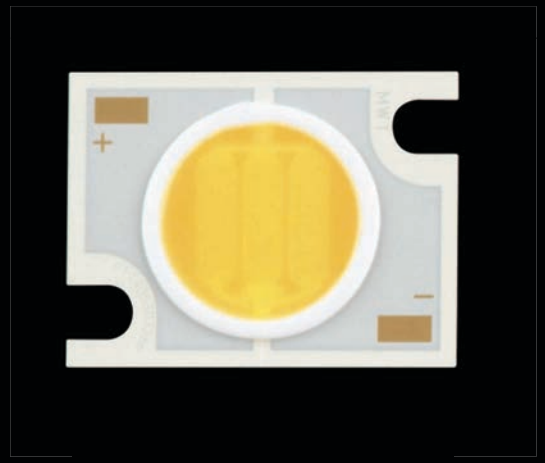
LEDs – Powerful and Tiny







Without proper design, they are a threat to our night

Why does darkness matter?


The eye is not
just for seeing.

Cross Section of the Retina

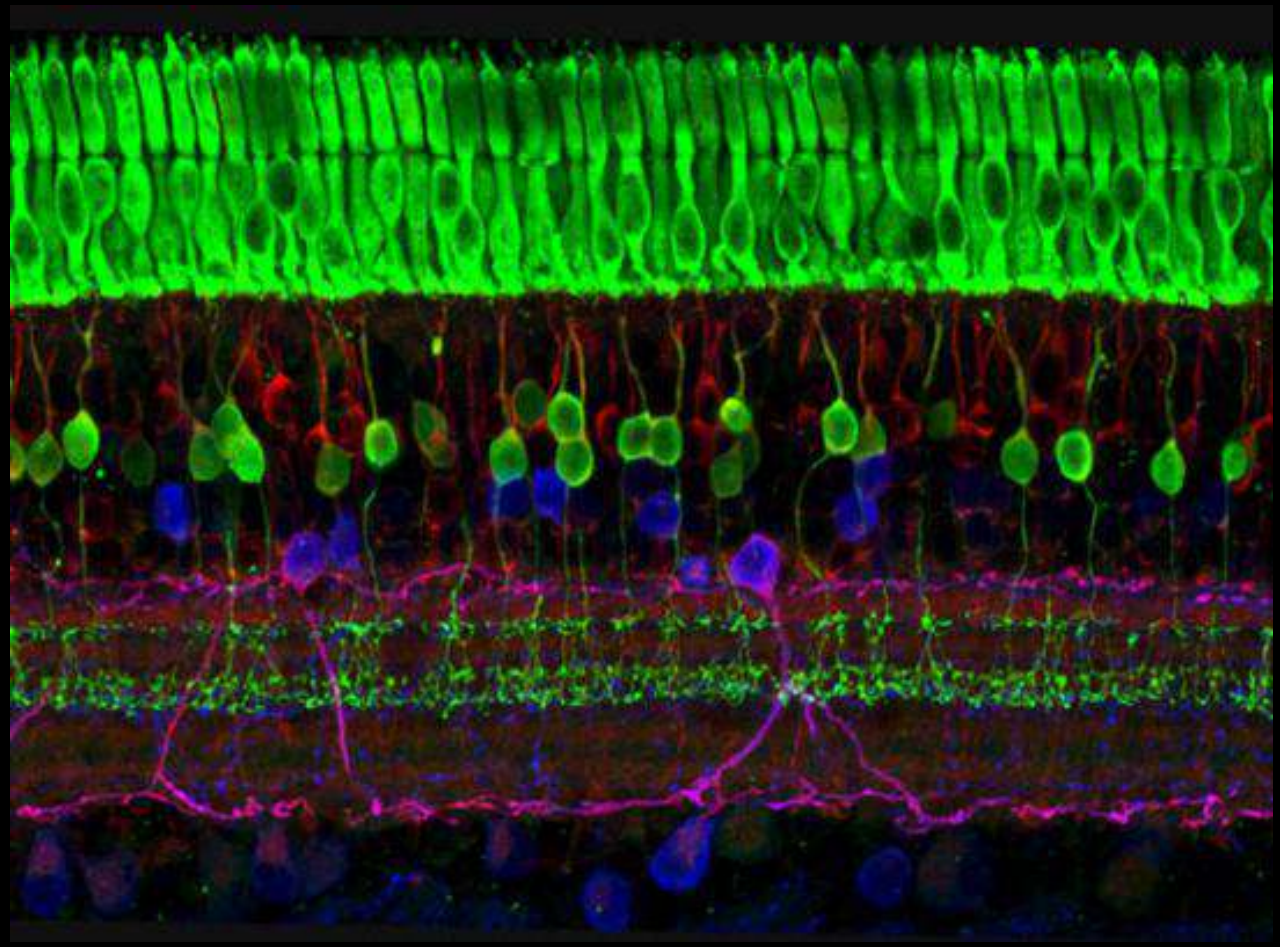
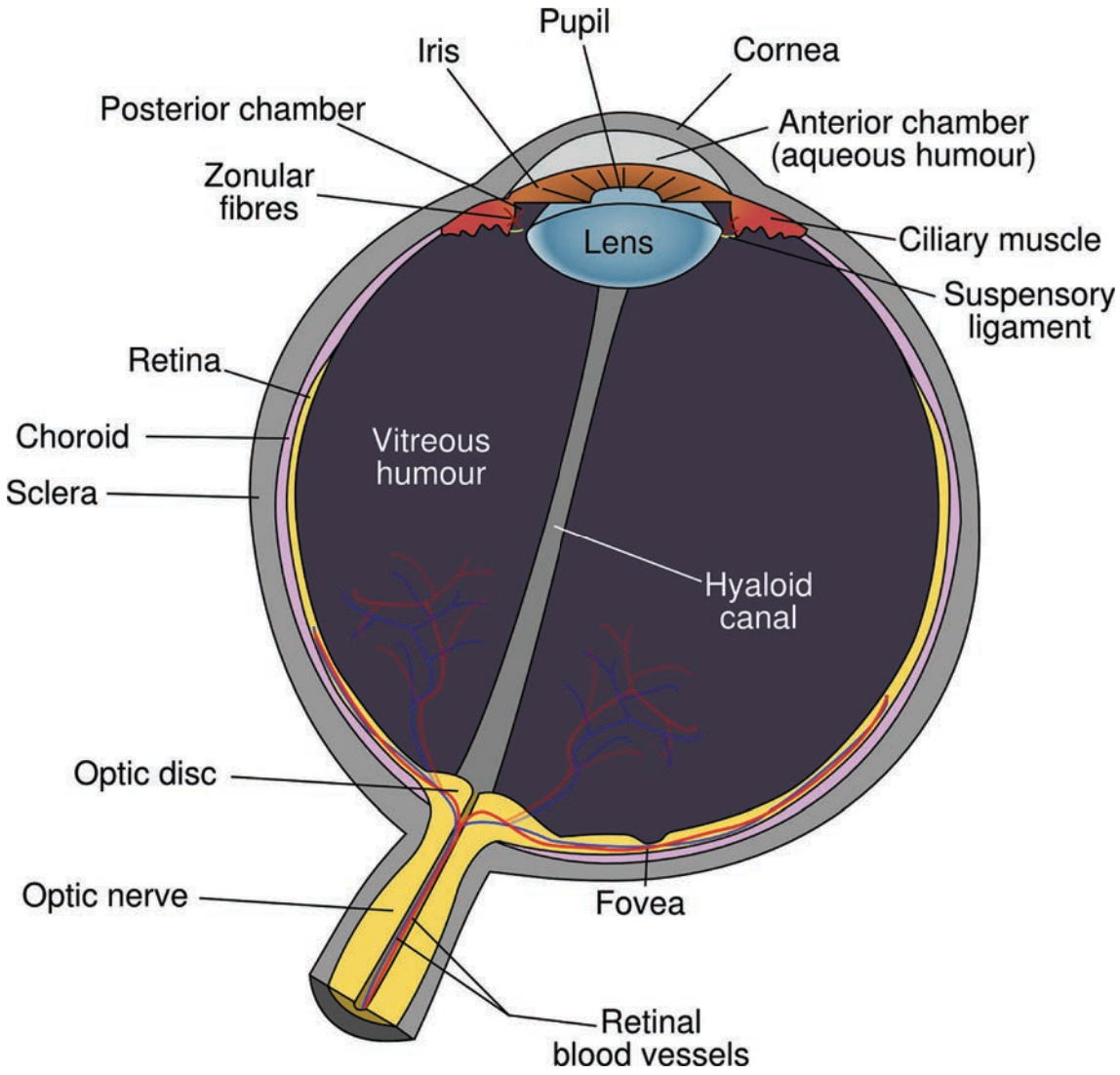


Photo Credit: Wei Li. (2017, November 6). Layers of nerve cells in the retina [This image captures the many layers of nerve cells in the retina. The top layer (green) is made up of cells called photoreceptors that convert light into electrical signals to relay to the brain. The two best-known types of photoreceptor cells are rod- and cone-shaped. Rods help us see under low-light conditions but can't help us distinguish colors. Cones don't function well in the dark but allow us to see vibrant colors in daylight.]. Retrieved February 21, 2018, from https://www.flickr.com/photos/nihgov/20495442268. License: https://creativecommons.org/licenses/by/2.0/

The Eye, Retina & the Suprachiasmatic Nucleus



The Eye, Retina & the Suprachiasmatic Nucleus

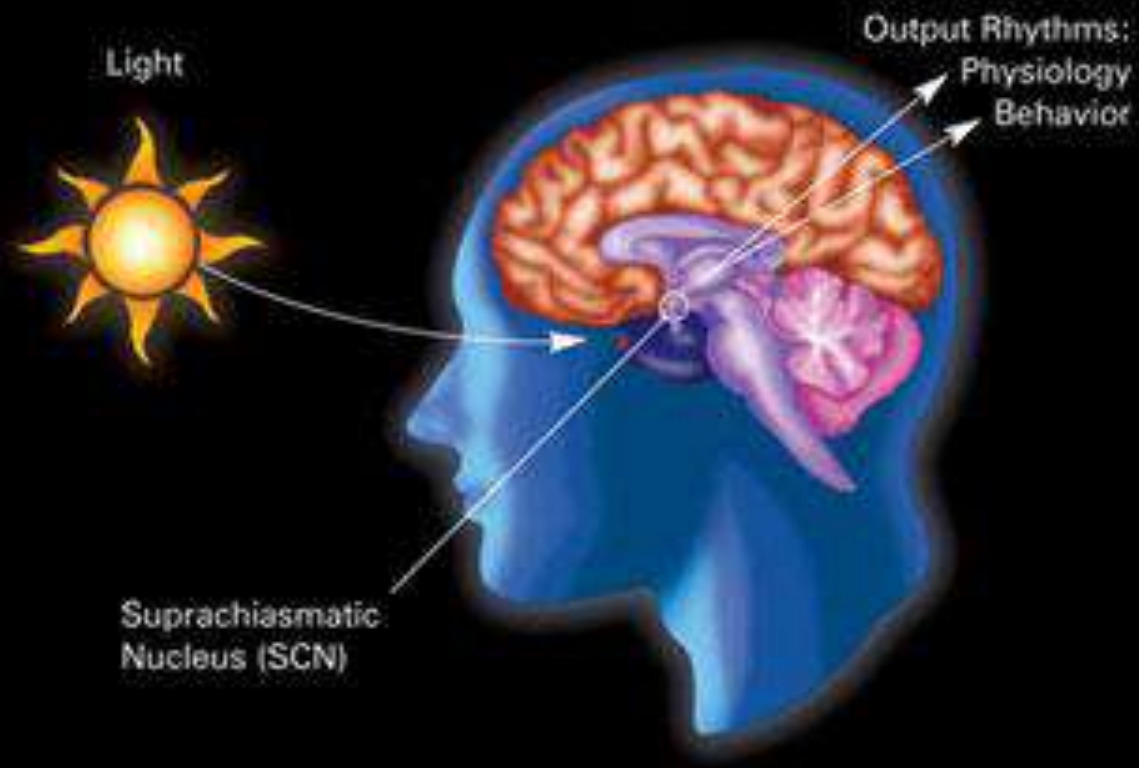


Photo Credit: File:Circadian rhythm labeled.jpg. (2017, July 16). Wikimedia Commons, the free media repository. Retrieved 10:30, February 19, 2018 from https://commons.wikimedia.org/w/index.php?title=File:Circadian_rhythm_labeled.jpg&oldid=251971445.

How does light pollution effect human beings?

"In recent decades, sleep disorders have emerged as the most prevalent health concern in the industrialized world, affecting not only our health, welfare, and safety, but also our very consciousness."[1]

1. Naiman, R. R. (2014). Healing night: the science and spirit of sleeping, dreaming, and awakening. Tucson, AZ: NewMoon Media. Page xiii.

Serotonin and Melatonin

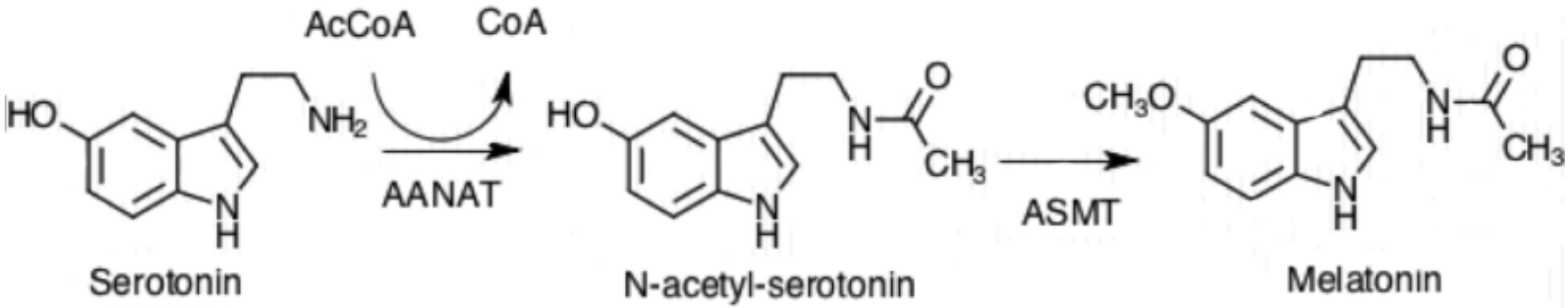


Photo Credit: File:Synthesis of Melatonin from Serotonin through two enzymatic steps.png. (2017, February 4). Wikimedia Commons, the free media repository. Retrieved 10:55, February 19, 2018 from https://commons.wikimedia.org/w/index.php?title=File:Synthesis_of_Melatonin_from_Serotonin_through_two_enzymatic_steps.png&oldid=232389703.

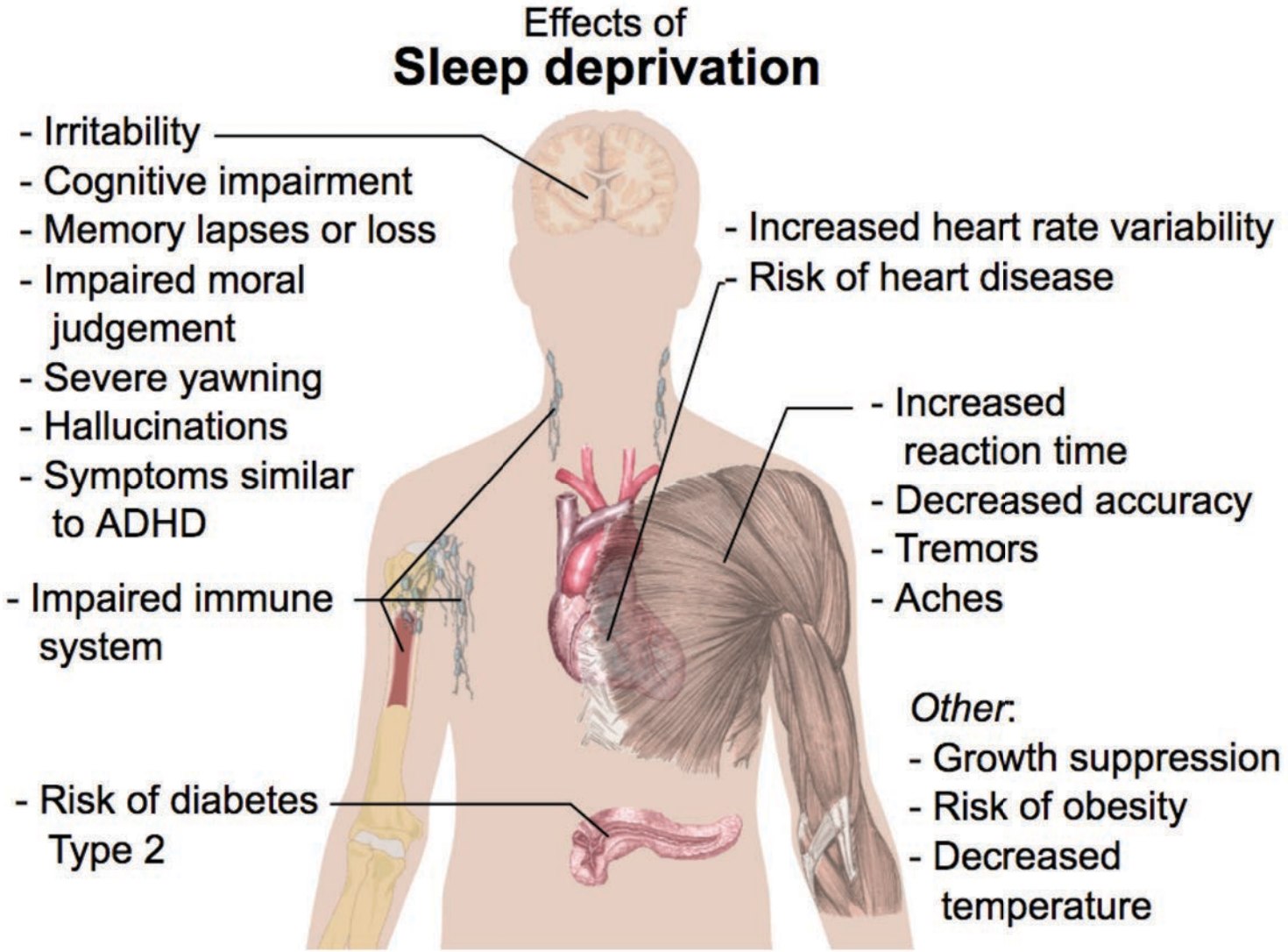


Photo Credit: File:Effects of sleep deprivation.svg. (2018, January 14). Wikimedia Commons, the free media repository. Retrieved 00:26, February 24, 2018 from https://commons.wikimedia.org/w/index.php?title=File:Effects_of_sleep_deprivation.svg&oldid=279524154.

"The connection between artificial light and sleep disorders is a fairly intuitive one."[1]

1. Chepesiuk, R. (2009). Missing the Dark: Health Effects of Light Pollution. Environmental Health Perspectives, 117(1). doi:10.1289/ehp.117-a20

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How does light pollution effect wildlife?

The Birds & The Bees

Pollinating Insects

To make a prairie (1755)

To make a prairie it takes a clover
and one bee,
One clover, and a bee.
And revery.
The revery alone will do,
If bees are few.

-Emily Dickinson

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According to Naturalist E. O. Wilson, Harvard University:

If all mankind were to disappear, the world would regenerate back to the rich state of equilibrium that existed ten thousand years ago.

If insects were to vanish, the environment would collapse into chaos.

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According Albert Einstein:

> *If the bee disappeared off the surface of the globe, then man would have only four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.*

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Pollination

- *Necessary for plant/ crop reproduction*
- *Most plants rely on insects more than any other pollination sources such as wind, water, or other animals.*
- *Most common pollinators are bees, wasps, moths, butterflies, flies, and beetles*
- *Pollination occurs during both day & night, by diurnal pollinators and nocturnal pollinators.*

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Impacts of Exterior Lighting on Pollination

In one study[1], lit meadows as compared to unlit meadows:

- *Received 62% less visits by nocturnal insects*
- *Had 29% fewer pollinating insects*
- *Bore 13% less fruits in the plant studied, cabbage thistle*

1. Knop, E., Zoller, L., Ryser, R., Gerpe, C., Hörler, M., & Fontaine, C. (2017). Artificial light at night as a new threat to pollination. Nature. doi:10.1038/nature23288


Bird Migration & Disorientation


Tribute in Light, NYC

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The Impacts of High-Intensity Light on Bird Migration[1]

- *Memorial illuminated during peak Northeast bird migration*
- *Group of scientists created a relationship with facilities to help the birds who were trapped in the vortices of light*
- *Lights were turned off at peak moments to release birds*
- *Created a unique opportunity to study birds with the lights both on and off*

1. Schader, Meg. (2017, October 18). Bird Migration Dramatically Altered by High-intensity Urban Light Installation. The International Dark-Sky Association. Retrieved February 23, 2018 from http://www.darksky.org/bird-migration-dramatically-altered-by-high-intensity-urban-light-installation/

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The Impacts of High-Intensity Light on Bird Migration[1]

- *The study spans the years of 2008 through 2016*
- *The 4 mile high beams attract up to twenty times the normal amount of birds, then disorienting them*
- *Birds fly in circles and vocalize their distress*
- *Some birds are killed from exhaustion while others are made more susceptible to predators on long migrations*
- *Birds are literally blinded to the surrounds as their eyes adapt to the higher light levels*

1. Schader, Meg. (2017, October 18). Bird Migration Dramatically Altered by High-intensity Urban Light Installation. The International Dark-Sky Association. Retrieved February 23, 2018 from http://www.darksky.org/bird-migration-dramatically-altered-by-high-intensity-urban-light-installation/

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The Impacts of High-Intensity Light on Bird Migration[1]

- *The good news: bird behavior immediately normalized when lights were shut off*
- *This points to the ability of lighting controls to bridge the gap between lighting for human safety & enjoyment, and lighting for the environment*

1. Schader, Meg. (2017, October 18). Bird Migration Dramatically Altered by High-intensity Urban Light Installation. The International Dark-Sky Association. Retrieved February 23, 2018 from http://www.darksky.org/bird-migration-dramatically-altered-by-high-intensity-urban-light-installation/

It is estimated that nearly one billion birds die from flying into buildings and windows in the United States every year.[1]

1. Milius, S. (2014, February 4). Stop Blaming Cats: As Many as 988 Million Birds Die Annually in Window Collisions. The Washington Post. Retrieved February 23, 2018, from http://www.highbeam.com/doc/1P2-35659146.html?refid=easy_hf

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Low Light Levels and Avian Reproduction

"Birds exposed to light at night developed their reproductive system up to one month earlier, and also moulted earlier, than birds kept under dark nights."[1]

Dominoni, D., Quetting, M., & Partecke, J. (2013). Artificial light at night advances avian reproductive physiology. Proceedings of the Royal Society B: Biological Sciences, 280(1756), 20123017-20123017. doi:10.1098/rspb.2012.3017

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Model Lighting Ordinance (MLO), 2011

Created as a joint effort of:

The International Dark-Sky Association (IDA)

The Illuminating Engineering Society of North America (IESNA)

AIA

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Model Lighting Ordinance (MLO)

- *Loss of the night's sky first began to be noticed in the 1970's*

Astronomers are Fleeing to the Far Corners of the Earth

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In the United States, Few Locations Lack Light Pollution:

- *Sky Village, Arizona: Considered to be the darkest place in the South West*
- *Bar Harbor, Maine: Passed lighting ordinances to protect the Night's Sky*

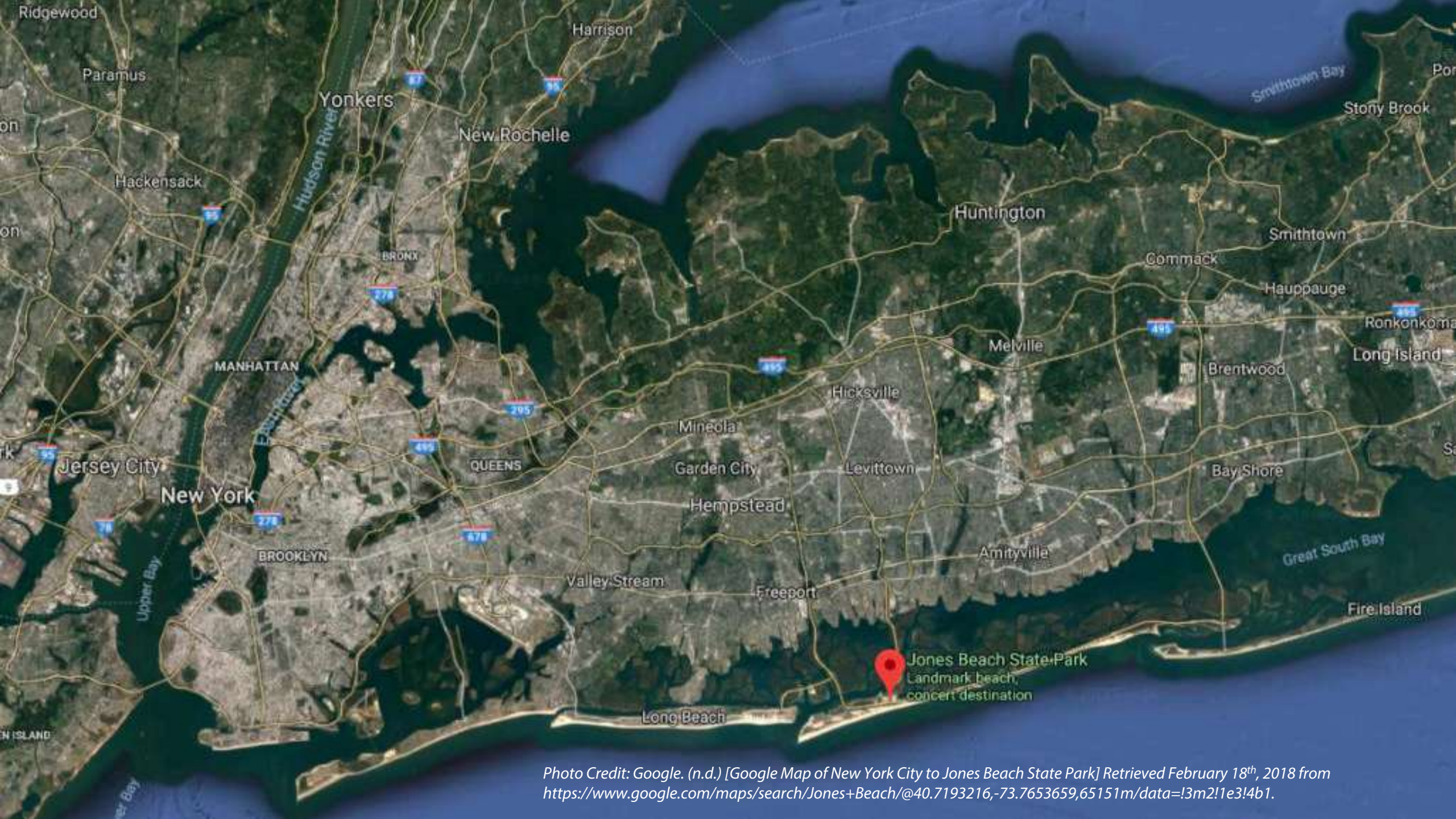

Photo Credit: Google. (n.d.) [Google Map of New York City to Jones Beach State Park] Retrieved February 18th, 2018 from https://www.google.com/maps/search/Jones+Beach/@40.7193216,-73.7653659,65151m/data=!3m2!1e3!4b1.

Model Lighting Ordinance (MLO)

- *Loss of the night's sky first began to be noticed in the 1970's*
- *Little to no consensus or understanding across lighting practices, laws, and ordinances*
- *This document is an effort to find consensus among lighting guidelines and to greatly reduce light pollution*

MLO Preamble[1]

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

a. 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.

b. Minimize adverse offsite impacts of lighting such as light trespass, and obtrusive light.

c. Curtail light pollution, reduce skyglow and improve the nighttime environment for astronomy.

d. Help protect the natural environment from the adverse effects of night lighting from gas or electric sources.

e. Conserve energy and resources to the greatest extent possible.

1. Model Lighting Ordinance Preamble Text, page 5

MLO – Lighting Zones as a Design Tool

- *Within the MLO, Lighting Zones are used to create different levels of ambient exterior light based on the needs of different communities and the environment.*
- *Lighting Zones are divided into groups 0 through 4.*
- *MLO recommends in general to prescribe lower light zones, and to base design on the light levels desired, not the current levels of light.*
- *Zones can be mixed and matched to customize the ordinance for a municipality's needs and goals*

Language taken directly from the Model Lighting Ordinance User's Guide, page 5

Lighting Zone 0

- *No Ambient Lighting*
- *The needs of the natural environment are paramount*
- *Designated for areas where lighting will negatively impact flora and fauna, and detract from human enjoyment*
- *Residents and users are adapted to low light levels, expecting little to no lighting*
- *When not needed, lighting should be extinguished or reduced*

Language taken directly from the Model Lighting Ordinance Text, page 5

Lighting Zone 1

- *Low Ambient Lighting*
- *The needs of the natural environment are a concern*
- *Designated for areas where lighting might negatively impact flora and fauna*
- *Residents and users are adapted to low light levels*
- *Lighting may be used for safety/ convenience, but is not necessarily uniform/ continuous*
- *After curfew, most lighting should be extinguished*

Language taken directly from the Model Lighting Ordinance Text, page 6

Photo File:Overlook Mountain Fire Tower View 1.JPG. (2017, July 13). Wikimedia Commons, the free media repository. Retrieved 16:46, February 18, 2018 from https://commons.wikimedia.org/w/index.php?title=File:Overlook_Mountain_Fire_Tower_View_1.JPG&oldid=251487529.

Lighting Zone 2

- *Moderate Ambient Lighting*
- *Residents and users are adapted to moderate light levels*
- *Lighting may be used for safety/ convenience, but is not necessarily uniform/ continuous*
- *After curfew, most lighting should be extinguished or reduced*
- *Environment is not an outright factor*

Language taken directly from the Model Lighting Ordinance Text, page 6

Lighting Zone 3

- *Moderate Ambient Lighting*
- *Residents and users are adapted to moderate light levels*
- *Lighting may be used for safety/ convenience, but is not necessarily uniform/ continuous*
- *After curfew, most lighting should be extinguished or reduced*
- *Environment is not an outright factor*

Language taken directly from the Model Lighting Ordinance Text, page 6

Lighting Zone 3: Temple Bar, Dublin

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Lighting Zone 4

- *High Ambient Lighting*
- *Residents and users are adapted to high light levels*
- *Lighting considered necessary for safety, security, and/ or convenience, and is mostly uniform/ continuous*
- *After curfew, lighting may be extinguished or reduced in some areas*
- *Environment is not a factor*
- *NB: The MLO does not consider Lighting Zone 4 to be a default zone or goal of a municipality**

*Language taken directly from the Model Lighting User's Guide Text, page 7**
Language taken directly from the Model Lighting Ordinance Text, page 6

Photo courtesy of Jane Slade, Times Square

Lighting Zone 4: Times Square

MLO – Lighting Controls

"Controls shall be provided that automatically extinguish all outdoor lighting when sufficient daylight is available"[1]

Language taken directly from the Model Lighting Ordinance Text, page 9

MLO Allowances: Parking Space Method

> Simplest method meant for small businesses

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

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

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MLO Allowances: Hardscape Method

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
Base Allowance				
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

Tradable

	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Additional allowances for sales and service facilities. No more than two additional allowances per site, Use it or Lose it.					
Outdoor Sales Lots. 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
Outdoor Sales Frontage. 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
Drive Up Windows. 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
Vehicle Service Station. 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)

Non-tradable

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

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MLO Allowances: Performance Method

> For the most complex sites

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

Tradable

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

MLO Allowances: Performance Method

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
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".					
Building Entrances or Exits. 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
Building Facades. 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

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Sales or Non-sales Canopies. 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
Guard Stations. 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
Outdoor Dining. 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
Drive Up Windows. 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
Additional Lumens Allowances for Service Stations only. Service stations may not use any other additional allowances.					
Vehicle Service Station Hardscape. 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

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Vehicle Service Station Canopies. 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
Additional Lumens Allowances for Outdoor Sales facilities only. Outdoor Sales facilities may not use any other additional allowances. **NOTICE:** lighting permitted by these allowances shall employ controls extinguishing this lighting after a curfew time to be determined by the Authority.					
Outdoor Sales Lots. 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
Outdoor Sales Frontage. 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

Non- tradable: "Use it or lose it"

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

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BUG Ratings

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

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

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

Control of Light Leaving the Site

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

MLO – Other Considerations

Horizontal vs. Vertical Zoning:

For example, ground floor retail (LZ2) with residences above (LZ1)

Glass Box Method:

Lighting software used to calculate that total light escaping site is not more than 15%

Illuminating Engineering Society, Joint IDA-IES Model Lighting Ordinance, http://www.ies.org/PDF/MLO/MLO_FINAL_June2011.pdf 15 June 2011.

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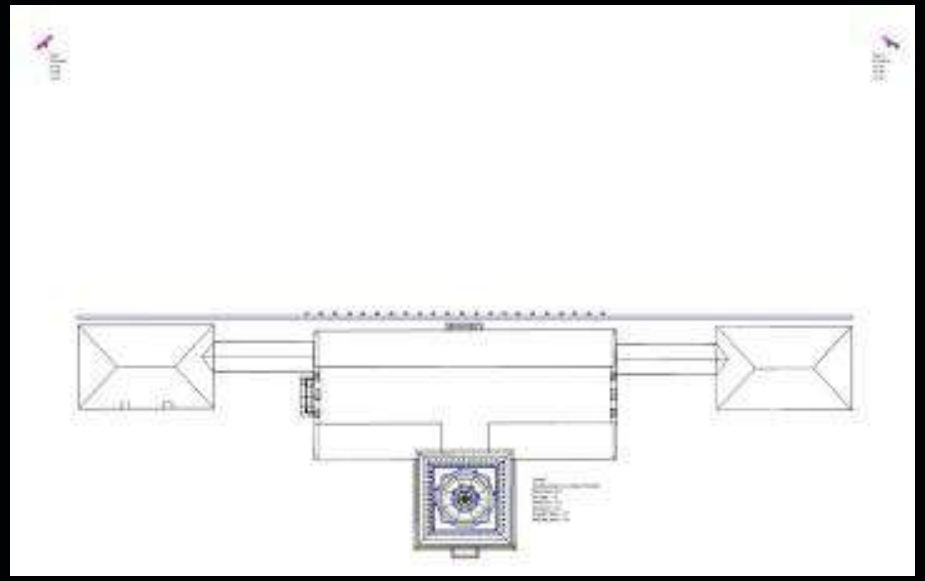

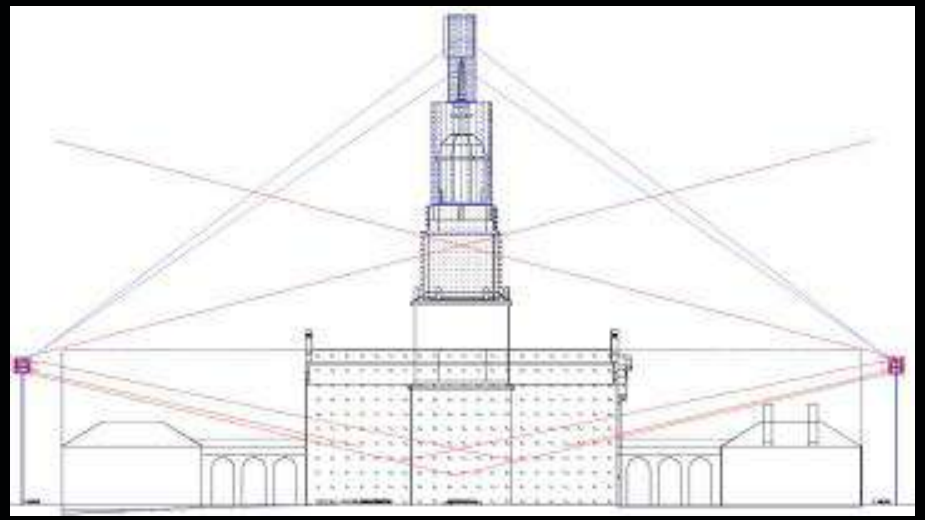

Photos courtesy of Tyler Garlock

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Unshielded Floodlights

Shielded Floodlights

Photos courtesy of Tyler Garlock

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Photo: http://gabisworld.com/photo/places/independence-hall/03/

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LIGHTING FOR SAFETY AND SECURITY

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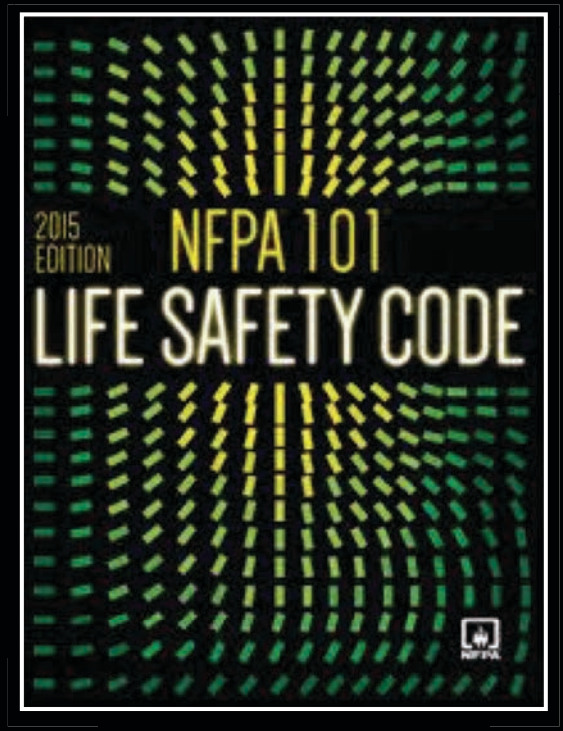
LIFE SAFETY CODE

Not in scope for this presentation.

We'll focus on perceived safety and security, for exterior applications.



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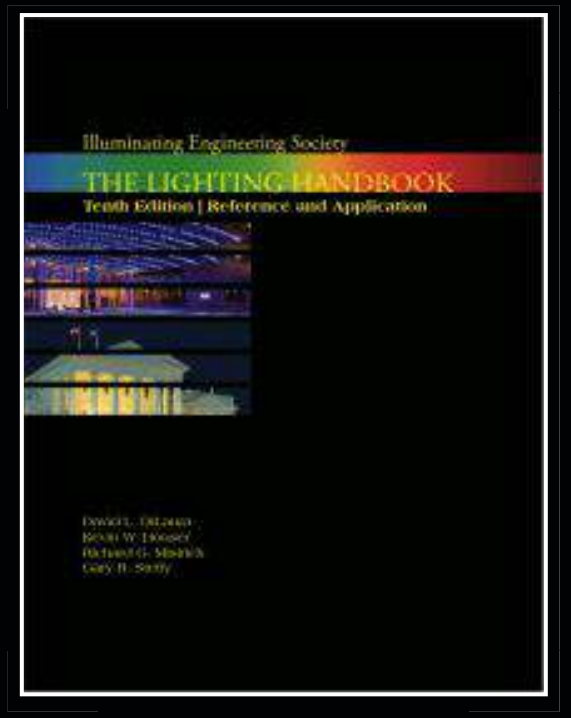
IES Lighting Handbook and Recommended Practices

Application specific recommendations based on consensus of balanced committees of professionals.



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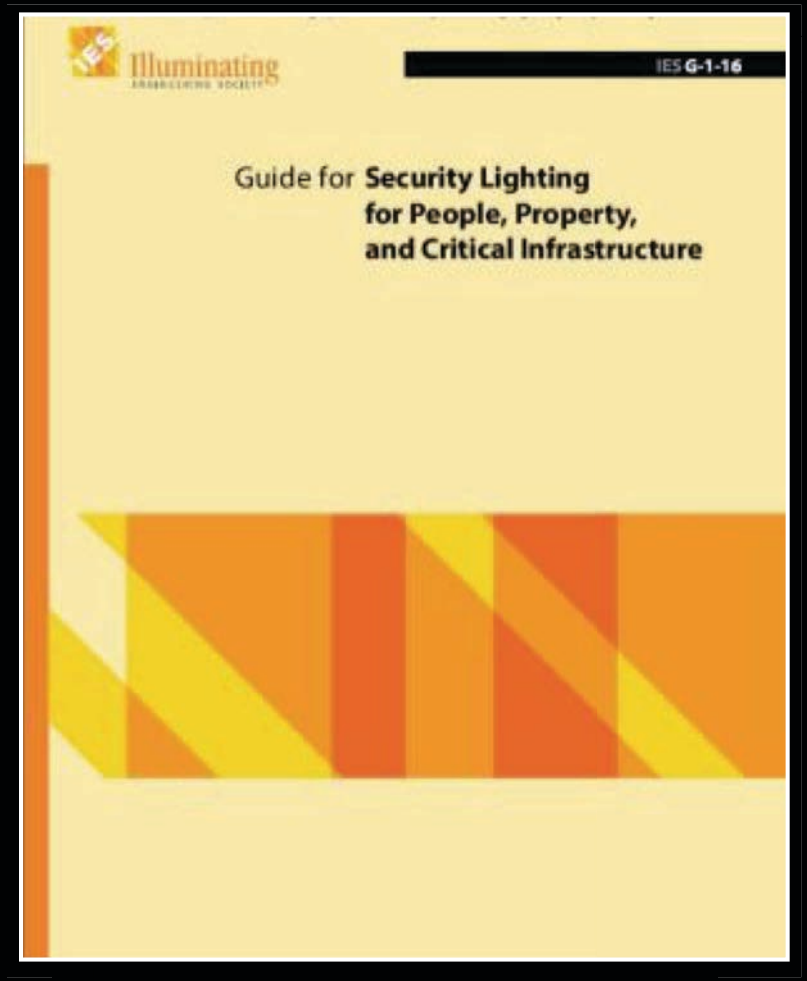
IES G-1-16

Guide for Security Lighting for People, Property and Critical Infrastructure



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Crime Deterrent

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Facial Recognition

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Interaction with Surveillance Systems

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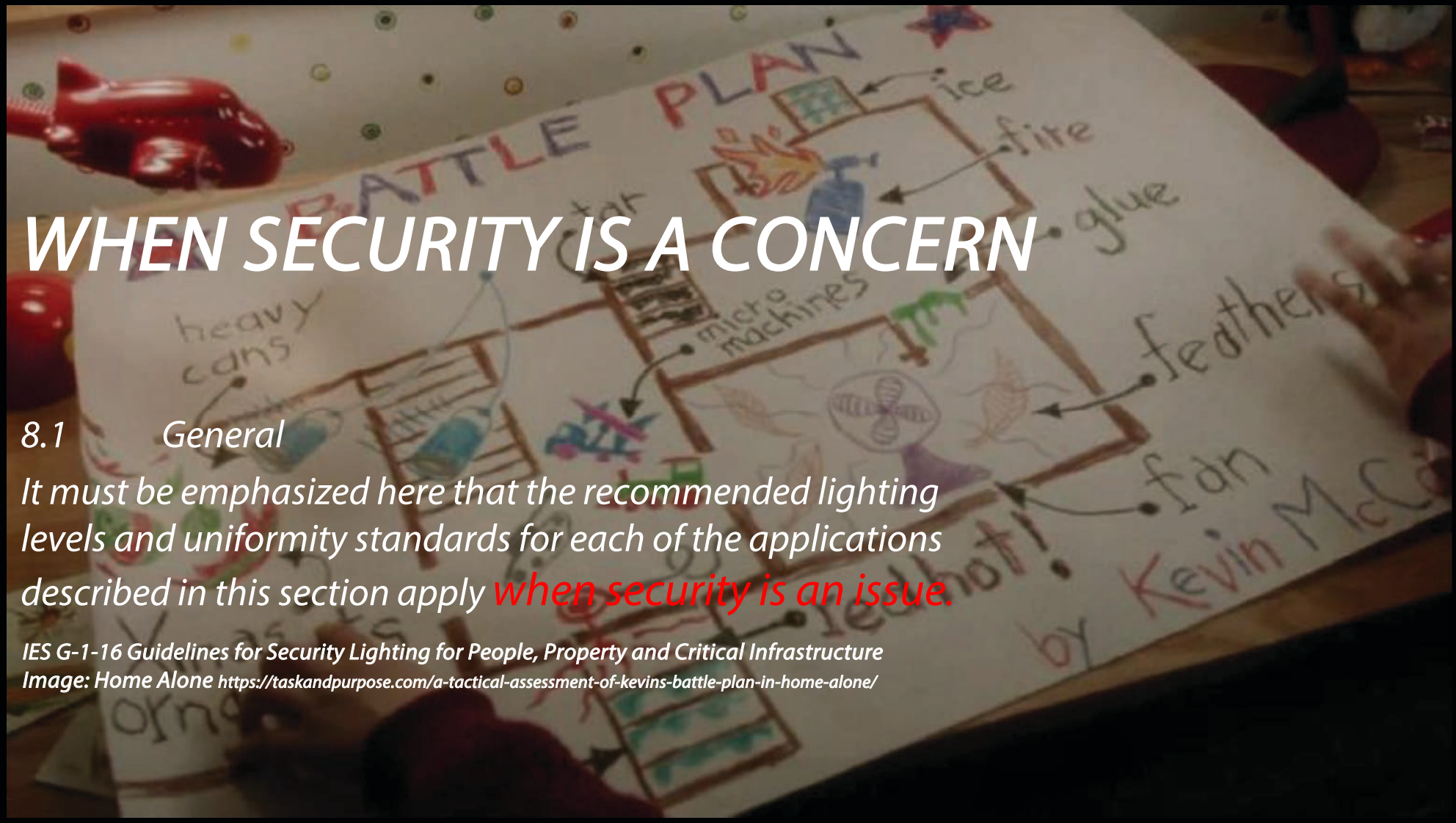
WHEN SECURITY IS A CONCERN



8.1 General

It must be emphasized here that the recommended lighting levels and uniformity standards for each of the applications described in this section apply when security is an issue.

IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Home Alone https://taskandpurpose.com/a-tactical-assessment-of-kevins-battle-plan-in-home-alone/

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CONDITIONS CALLING FOR SECURITY

- *The property is a desirable target for criminals or terrorists.*
- *Vulnerable members of society or leaders are on the premises.*
- *The property represents critical infrastructure for national defense.*
- *There is a history of crime on the property or in the neighborhood.*
- *The property is a high profile or troublesome enterprise like a nightclub.*
- *The property is located in a restricted area.*

IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Ocean's Eleven (2001) blog.vegas.com

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Risk Assessment Venn Diagram

Image from threatsketch.com

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SECURITY ZONES

IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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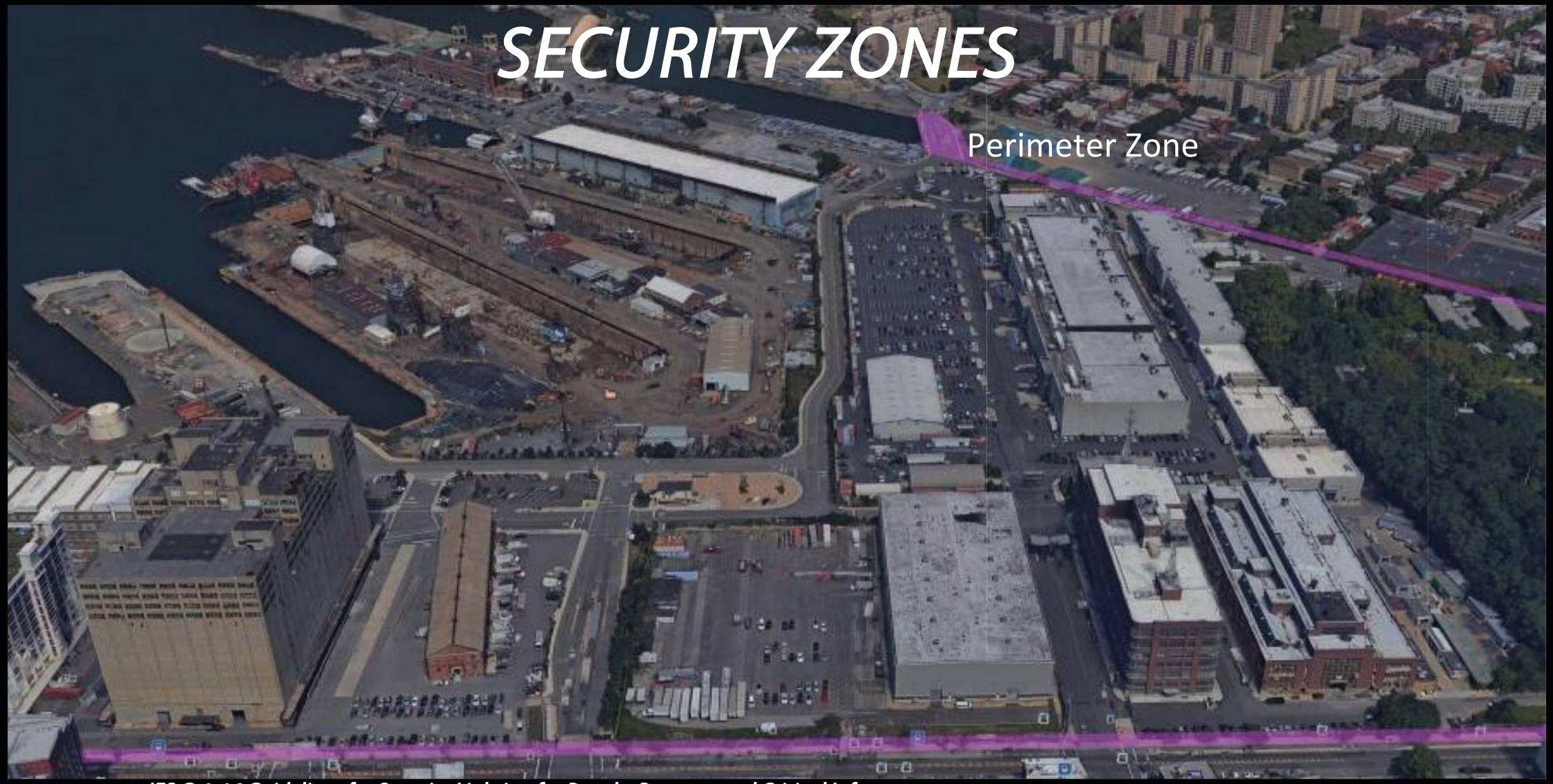
SECURITY ZONES



IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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SECURITY ZONES

IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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SECURITY ZONES

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Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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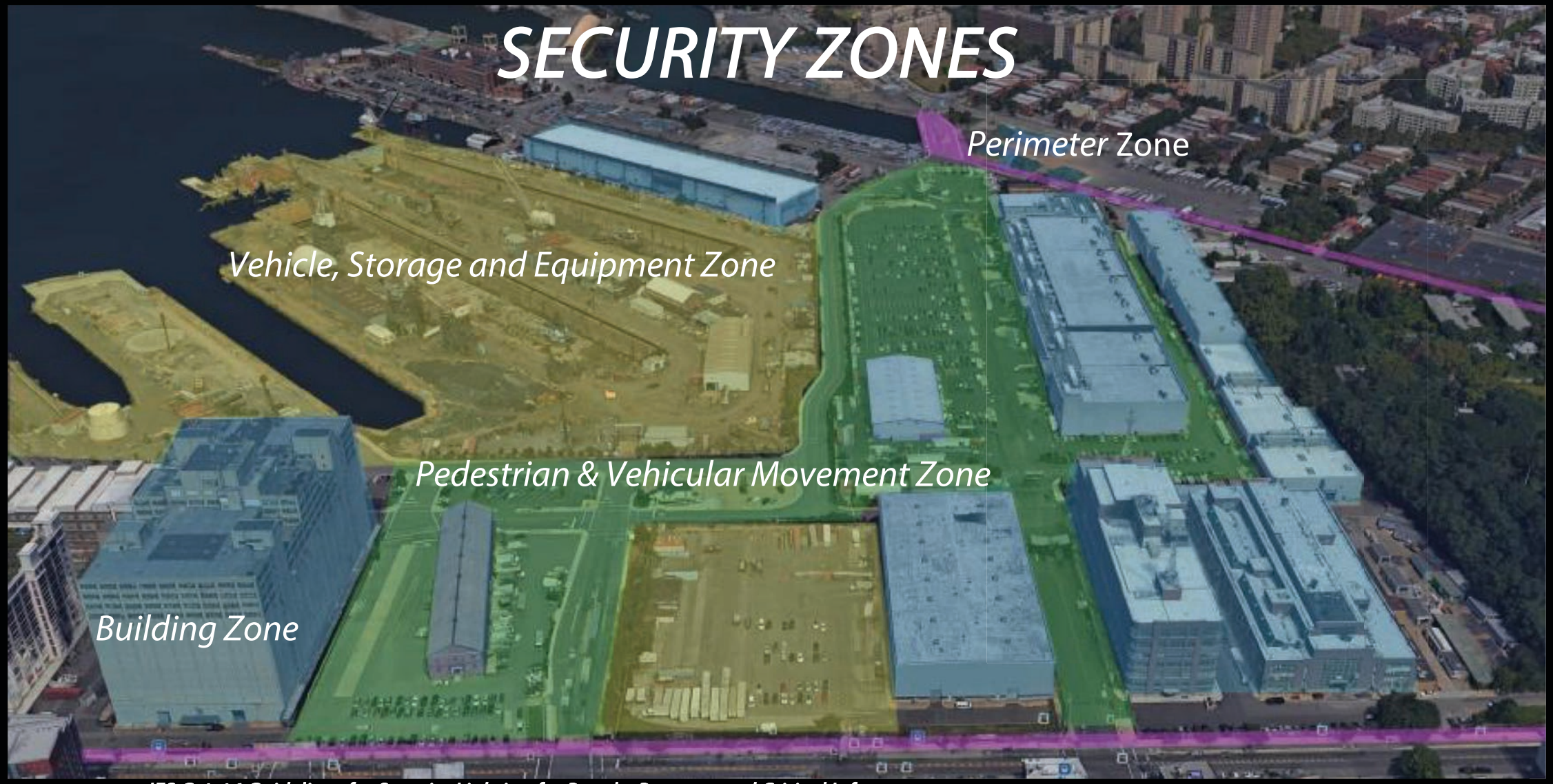

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Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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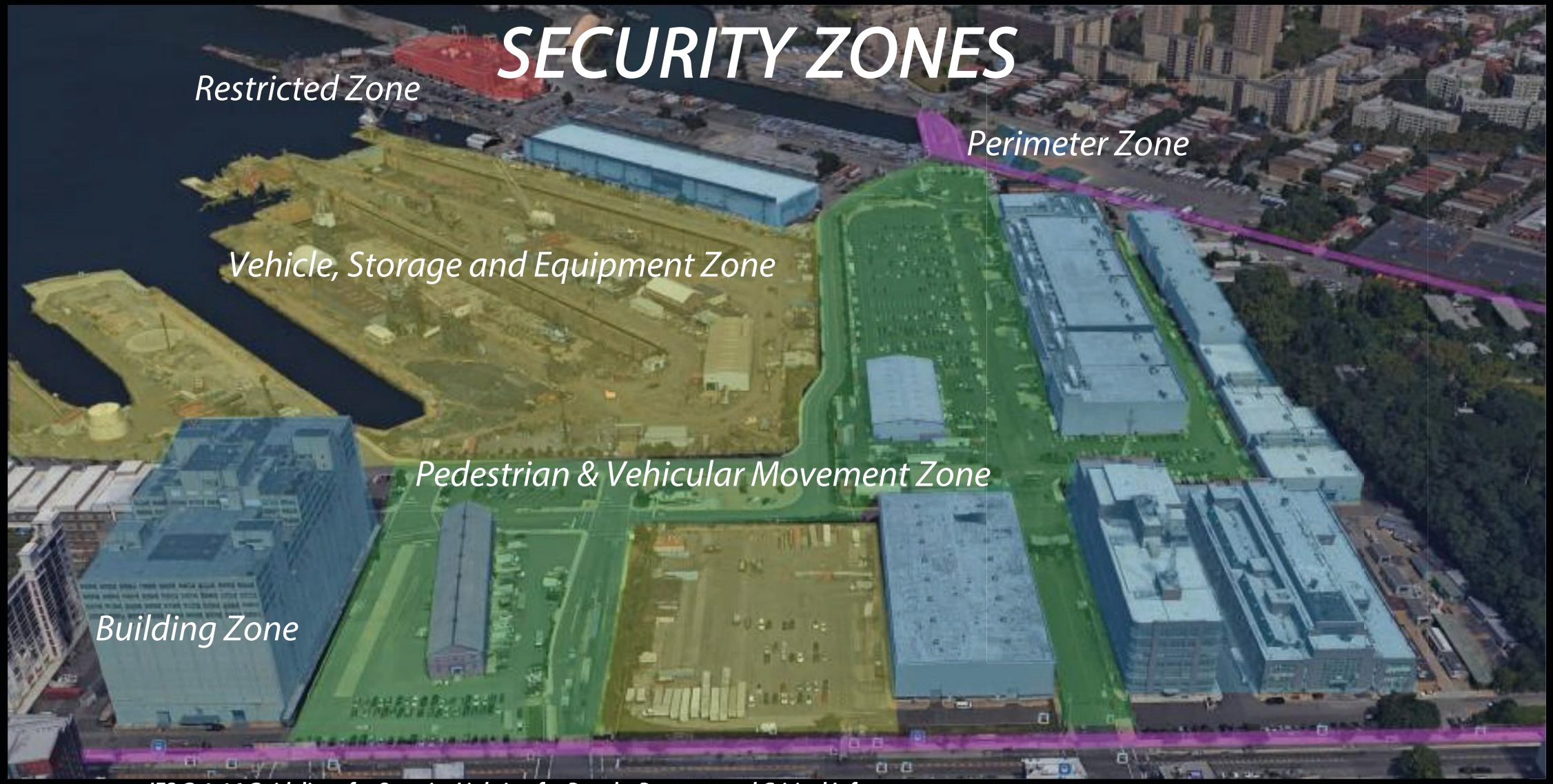
SECURITY ZONES



IES G-1-16 Guidelines for Security Lighting for People, Property and Critical Infrastructure
Image: Google Earth – Brooklyn Navy Yard, Brooklyn NY

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CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

CPTED uses overlapping disciplines to deter criminal behavior.

Environmental design elements are used to influence offender decisions that precede criminal acts.

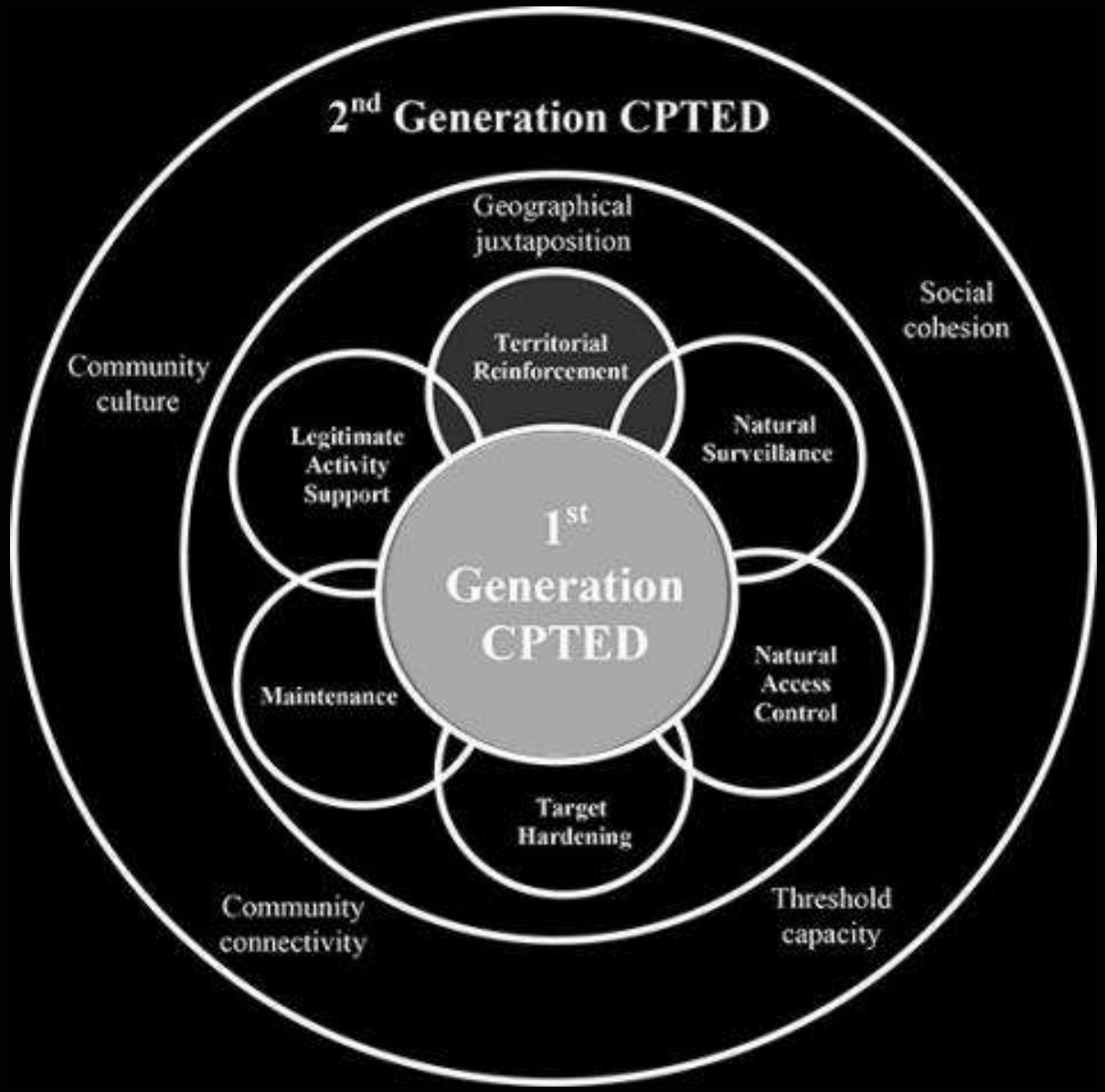

Image: criminology.oxfordre.com

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CRIME PREVENTION THROUGH

Ista.com.au Perception Change of Site Security Vulnerabilities

CPTED for a public park should consider:

- Prior history of crime in the park and surrounding area
- Social conditions and citizen use of the park
- Hours of public access
- Local cultural values
- Traffic patterns and access
- Patrol frequency
- Light pollution and trespass

G-1-16 – image courtesy of RAB Lighting

STREET LIGHTING FOR SAFER STREETS?

Street Lighting and Crime: Diffusion of Benefits in the Stoke-On-Trent Project

Institute of Criminology, University of Cambridge, 1999

Kate Painter and David P. Farrington

FINDINGS

- *2 year study, implemented with adjacent and control areas in addition to the area where streetlighting was installed. Data was collected through victimization surveys.*
- *Incidence of crime decreased by 43% in the experimental area and 45% in the adjacent area, compared with 2% in the control area.*
- *Cited as a key study to support streetlighting as a crime deterrent.*

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Table 3: Changes in the Incidence of Victimization

	Experimental			Adjacent			Control		
	Before (317)	After (278)	% Change	Before (135)	After (121)	% Change	Before (88)	After (81)	% Change
Burglary	38.5	32.7	-15	31.1	24.8	-20	15.9	16.0	+1
Outside theft/vandalism	43.8	27.0	-38	65.2	38.8	-40	26.1	34.6	+33
Vehicle crime	47.6	25.5	-46*	34.8	18.2	-48	17.0	11.1	-35
Property crime	130.0	85.3	-34*	131.1	81.8	-38*	59.1	61.7	+4
Personal crime	43.8	14.0	-68*	48.9	16.5	-66*	10.2	6.2	-39
All crime	173.8	99.3	-43*	180.0	98.3	-45*	69.3	67.9	-2

Note: Mean offence rate per 100 households
*Change significant on t-test ($p<.05$, two-tailed)
Change in Experimental area significantly different from change in Control area:
Outside theft, LRCS=5.91, p=.015
Property crime, LRCS=4.69, p=.030
All crime, LRCS=7.17, p=.007
Change in Adjacent area significantly different from change in Control area:
Outside theft, LRCS=5.74, p=.017
Property crime, LRCS=4.82, p=.028
All crime, LRCS=7.19, p=.007
LRCS = Likelihood Ratio Chi-Squared = Interaction term in Poisson regression

Kate Painter and David P. Farrington

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QUALITATIVE RESULTS

"If you hear a noise outside and you look outside, you can recognise who they are."

"Stronger light means less people hang around to be seen."

"It's safer because you can now recognise who is walking towards you."

"You can see where you are walking. You can see anybody. All the little walkways are lit up."

"You can see more of the area in the dark alleyways. Nobody can hide. You can see where you are walking now. You can see if anybody is loitering about."

"You can see people from a distance now and recognise them as well."

Kate Painter and David P. Farrington

STREET LIGHTING FOR SAFER STREETS?

The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis

Journal of Epidemiology & Community Health, 2015

Rebecca Steinbach et al. J

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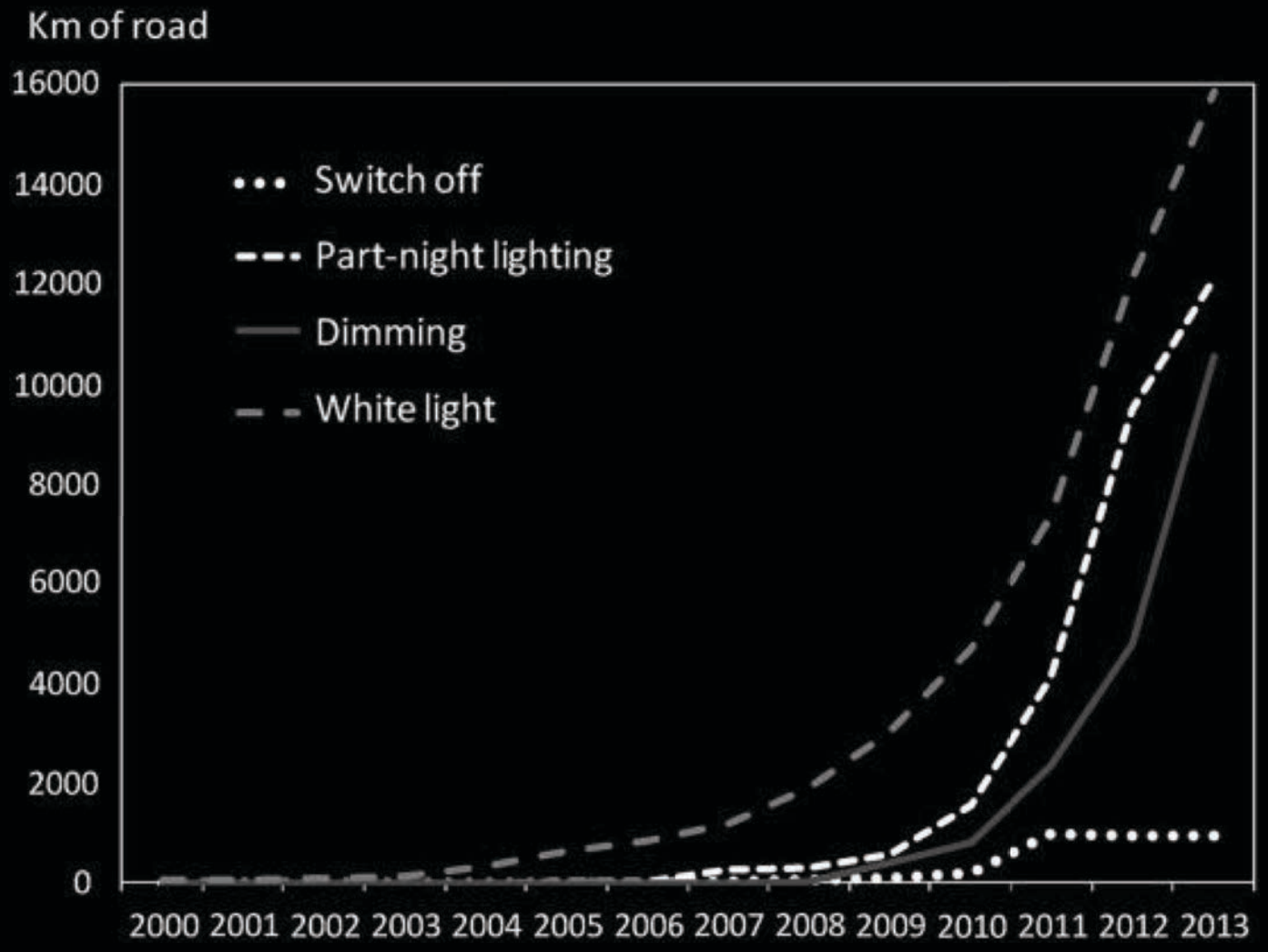
Kilometres of road with lighting adaptation strategies implemented in participating local authorities.



Rebecca Steinbach et al. J Epidemiol Community Health 2015;69:1118-1124

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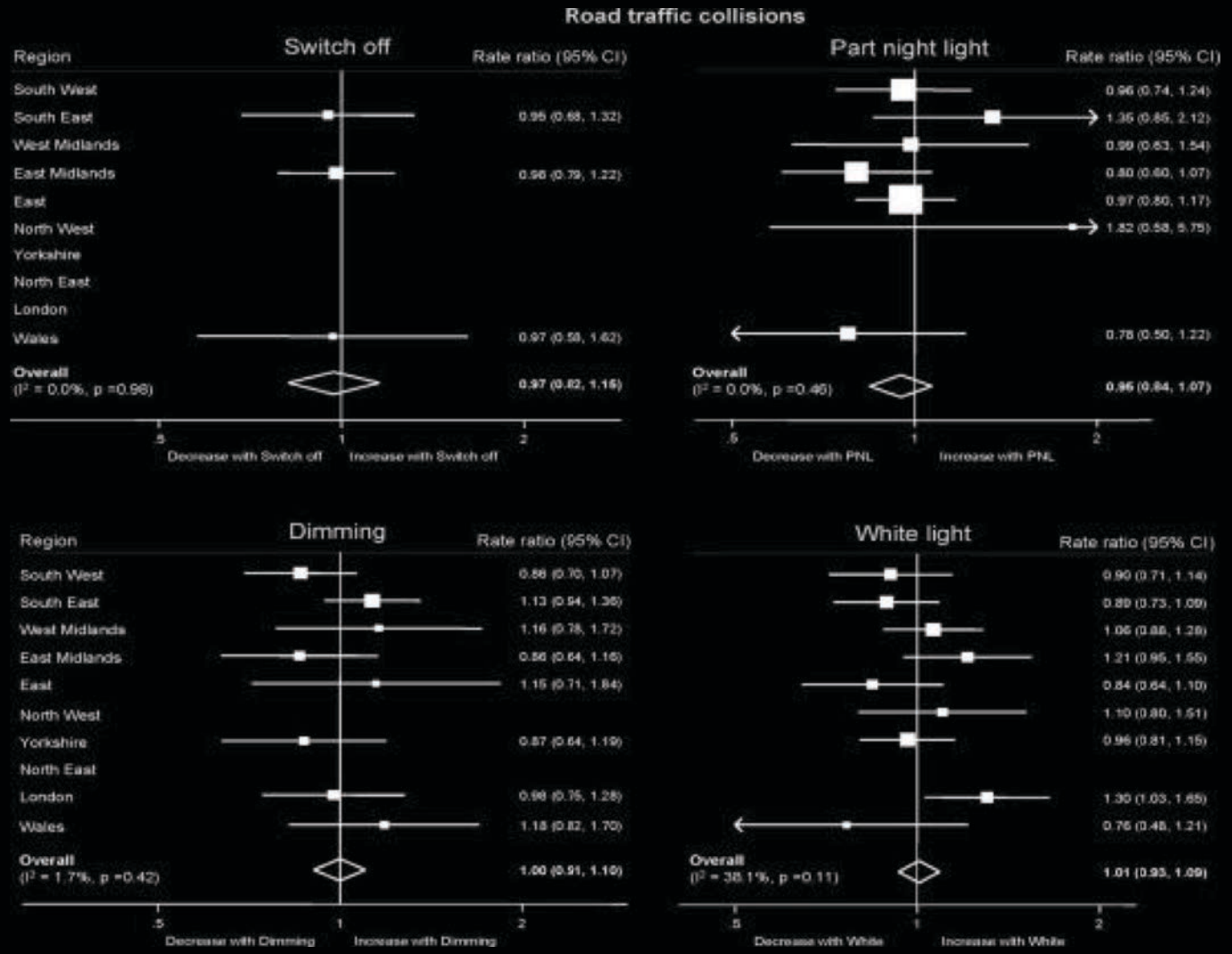
Associations between street light adaptation strategies and night-time road traffic collisions.



Rebecca Steinbach et al. J Epidemiol Community Health 2015;69:1118-1124

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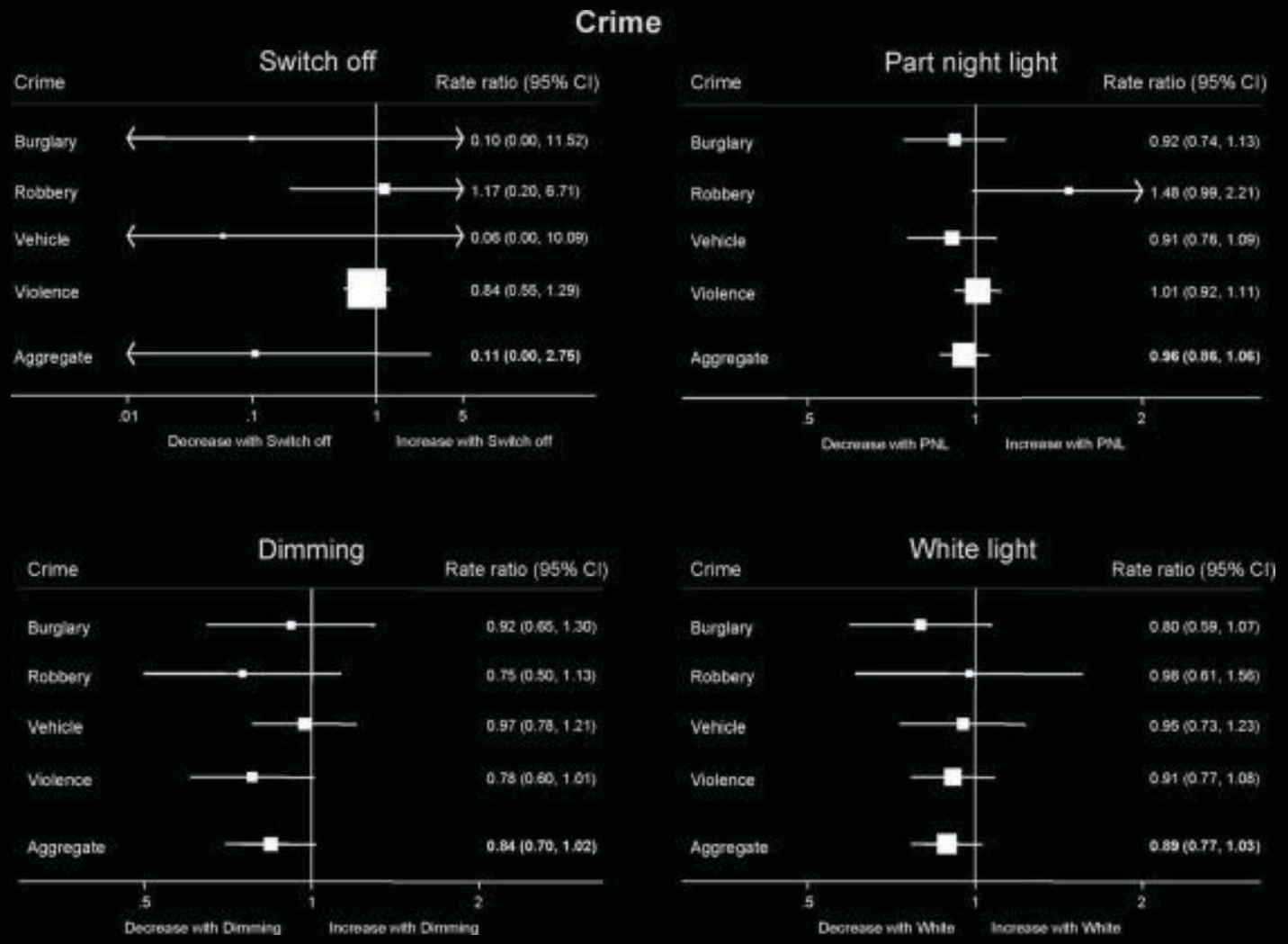
Associations between street light adaptation strategies and crime.



Rebecca Steinbach et al. J Epidemiol Community Health 2015;69:1118-1124

What is already known on this subject

- *There is evidence that introducing street lighting at night is associated with reductions in road traffic crashes and crime.*
- *Many local authorities in England and Wales are reducing street lighting at night to save energy costs and reduce carbon emissions.*

What this study adds

- *There is no evidence that reduced street lighting is associated with increases in road traffic collisions or crime.*
- *Dimming the amount of light or switching to white light/LEDs may reduce crime in an area.*
- *When risks are carefully considered, local authorities can safely reduce street lighting, saving energy costs and reducing carbon emissions, without impacting negatively on traffic collisions and crime.*

Rebecca Steinbach et al. J Epidemiol Community Health 2015;69:1118-1124

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How About Parking Facilities?

- *In 1992, parking facilities represented the third most frequent place in which violent crime (e.g. rape, robbery, assault) occurred, averaging about 1,400 violent crimes per day.*
- *The risk of being attacked in a parking facility, 4 in 1 million, is really quite low.*
- *In spite of parking lots being statistically safer than residential streets, the average American believes themselves to be safer in their neighborhood than in a parking facility.*

Image courtesy of RAB Lighting

Crime Prevention Through Environmental Design in Parking Facilities
National Institute of Justice, 1996

Mary S. Smith

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Liability & Safety – The Decision Maker Matters

"I'd rather be on the overlit side." – A property owner concerned with security

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Current Exterior Lighting Habits & Consequences

- *The general sentiment is “safety first”*
- *Uplighting is a common default installation style*
- *Light is relative/ addictive: light begets more light*

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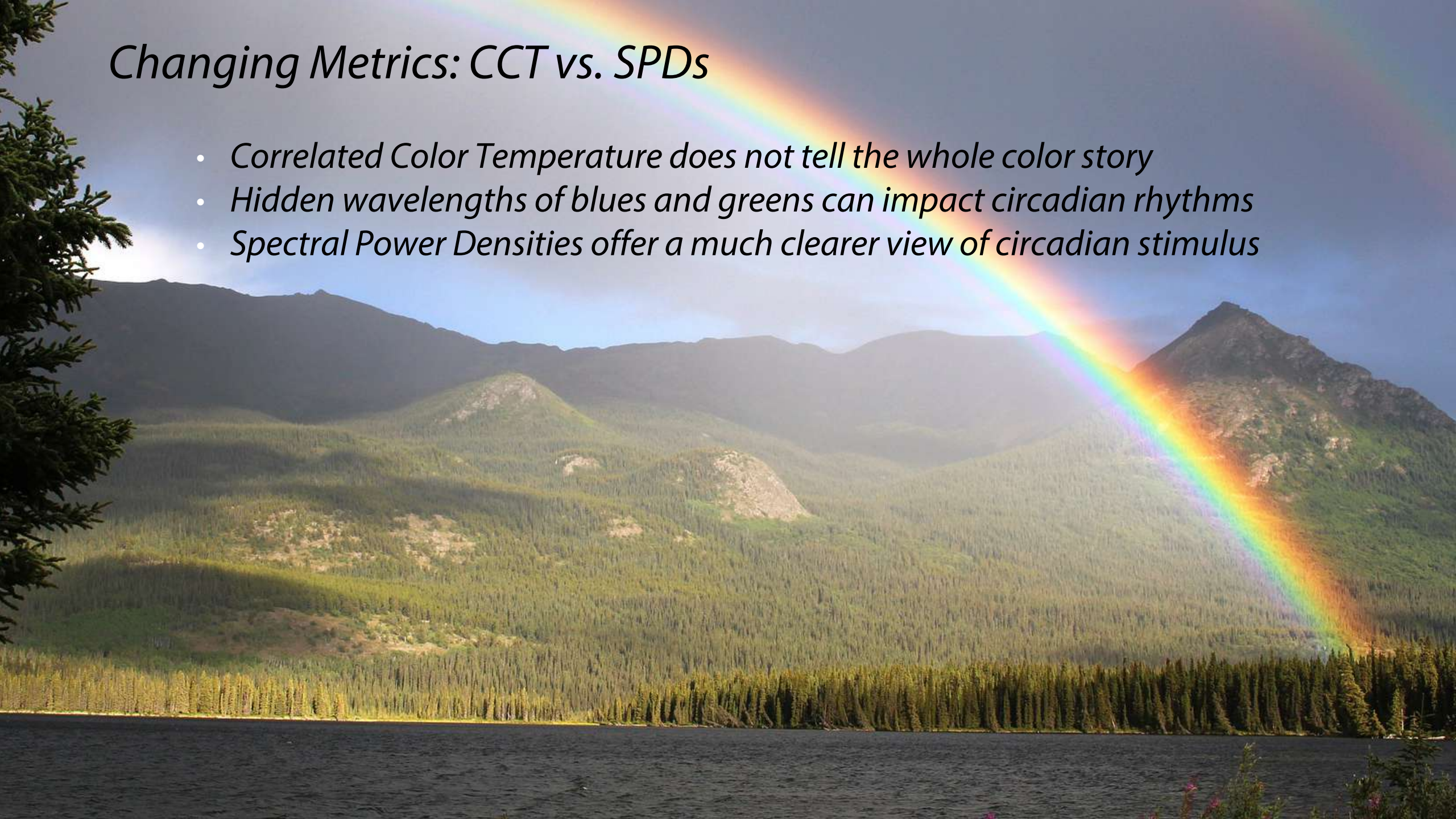
Psychology of Light Pollution

- *A lack of understanding about the environment's need for natural daylight cycles*
- *The environmental parameter is not understood, therefore not considered*
- *More light results in increased time needed for adaptation, creating blind spots*
- *Studies show that more light is not safer*



Changing Metrics: CCT vs. SPDs

- *Correlated Color Temperature does not tell the whole color story*
- *Hidden wavelengths of blues and greens can impact circadian rhythms*
- *Spectral Power Densities offer a much clearer view of circadian stimulus*

Caught Between a Rock and a Dark Place

Municipal ordinances struggle with dual requirements

Municipal Ordinances often include recommendations from IES and MLO.

The ordinances intend to serve both the safety of citizens and reduce light at night.

The city engineer can be unfairly tasked with evaluating cases where the minimum and maximum illumination levels are in conflict.

	Residential Zones or Uses	*Nonresidential Uses Within 300 Feet of Protected Residential Uses*	*Office/ Industrial Uses*	*Retail and Service Oriented Uses*
Special controls	All lights required for security must be on an alternate circuit. All other exterior lighting must be illuminated no earlier than one hour before the start of business and must be extinguished no later than one hour after the end of business.			
Minimum illumination on surface (up to a 50% reduction allowed for the perimeter 25 ft. of parking, loading, access or other surfaced areas along the property line)	1.0 FC	As required for the specific uses	1.5 FC	2.0 FC
Maximum illumination at property line (no limit along public street)	0.5 FC		2.0 FC	

Code of Ordinances, Chapter 21. City of Bloomington, MN

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Interaction with Surveillance Systems

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What is Invisible Illumination?

- *Active or near Infrared illumination*
- *Energy invisible to the human eye*
- *Visible to b/w cameras*
- *Light is measured in Nanometers (nm)*
- *Infrared light is 700nm - 1000nm*
- *Ideal source of illumination for security cameras:-*
  - *Ideal as a covert form of illumination*
  - *No light pollution*
  - *Longer range than visible light*
  - *"Don't illuminate those assets you are trying to protect"*

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Visible or Invisible Lighting?

	Advantages	Disadvantages	Camera Type Suitable
Visible Light	Visible Deterrent	Light pollution	Color
	True color rendition	Reduced distances (v invisible light)	B/W
Invisible Light	Covert	No deterrent factor	Day/Night
	Longer Distances		B/W
	No light pollution		

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How to Specify Lighting for CCTV

- *Angle of illumination should match camera/lens angle*
- *Too narrow*
  - *camera will see bright spot in middle of scene*
  - *contrast between light & dark areas on scene will be too great*
- *Too wide wastes energy & reduces distance*
- *Table below shows the FOV angle for different lenses*

Fixed Lenses		Varifocal Lenses	
Lens (mm)	Horizontal FOV 1/3" CCD	Lens (mm)	Horizontal FOV 1/3" CCD
2.8	92°	2.8-6	92° - 44°
4	64°	3.5-8	78° - 38°
6	44°	3.5-10	78° - 27°
8	38°	4.5-12.5	60° - 23°
12.5	22°	8.5-40	34° - 6°
16	17°	10-30	20° - 7°
25	11°		
50	6°		

How to Specify Lighting for CCTV

- *Angle of illumination should match camera/lens angle*
- *Too narrow*
  - *camera will see bright spot in middle of scene*
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8	38°	4.5-12.5	60° - 23°
12.5	22°	8.5-40	34° - 6°
16	17°	10-30	20° - 7°
25	11°		
50	6°		

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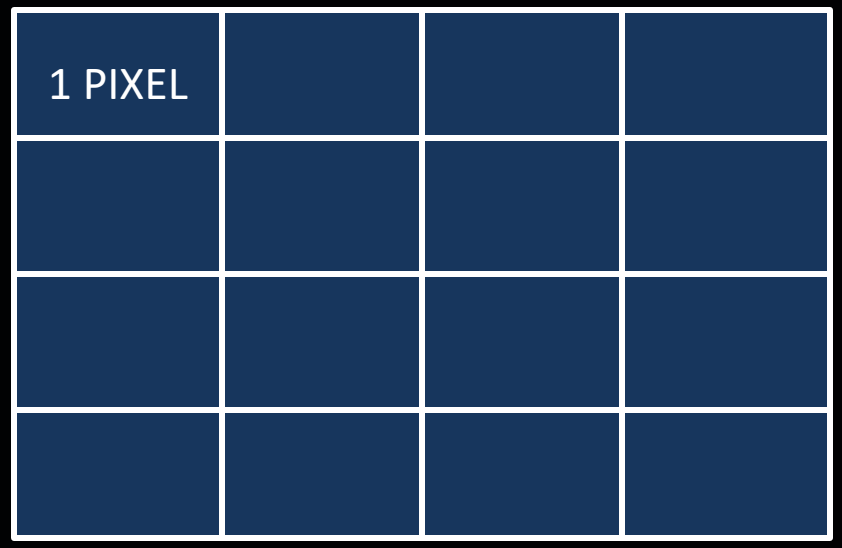
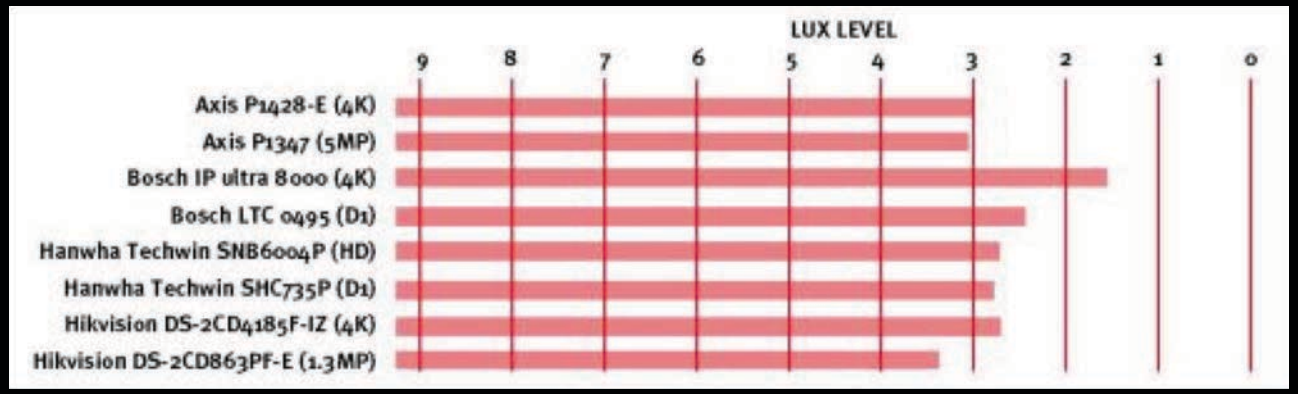
More Megapixels Need More Light



Low Light Camera Technology Improvements

Testing Low Light Vs Image Quality IPVM Author: Ethan Ace, Published on Jan 07, 2013



Benchmark CCTV Test: Low Light, High Resolution, published Nov 21, 2016

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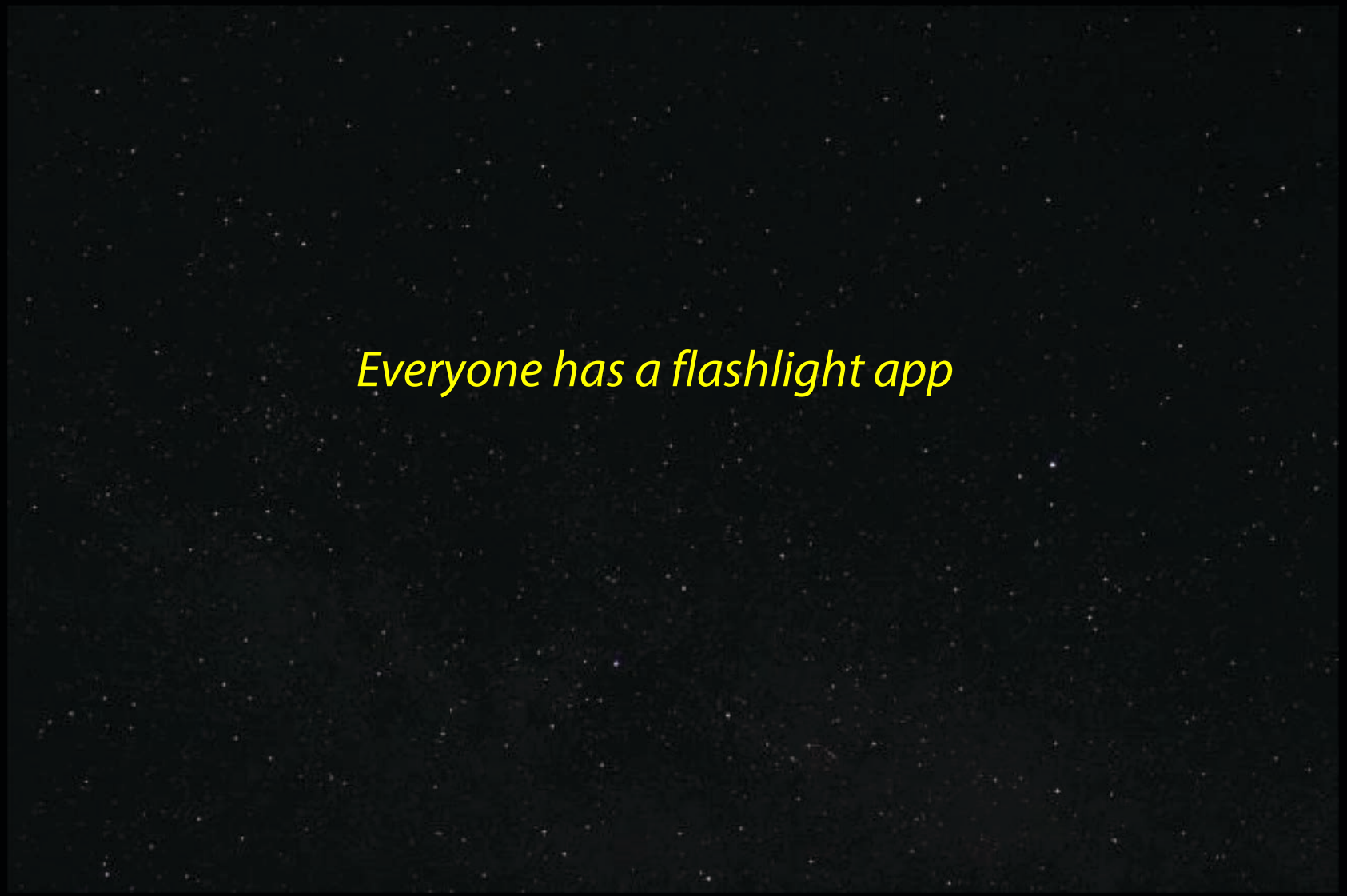

Everyone has a flashlight app

Photo from Nps.gov

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The Best Prescriptions For Exterior Lighting

1. *Design for specific applications*
2. *Conduct photometric studies to provide the right amount of light: not more, not less*
3. *Use Dark-Sky Compliant fixtures, and shielding when appropriate*
4. *Utilize warmer CCTs, or SPDs with higher wavelengths*
5. *Utilize Controls to limit impact*
6. *Avoid Uplighting*

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It was the possibility of darkness that made the day seem so bright.

– Stephen King

Stargazing Versus Safety: The Dilemma of Exterior Lighting

Questions?

Shaun Fillion, LC Educator IALD
Jane Slade, MID LC LEED AP

March 13, 2018

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This concludes The American Institute of Architects Continuing Education Systems Course

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