

Efficiency Works

February 6, 2018

Night Sky Initiative





Nature in the City Objective CP2:

Work cross-departmentally and with external partners toward a darker night sky.

Night Sky Initiative Goals:

- Maintain safety and security
- Develop and implement best practices in outdoor lighting
- Reduce light pollution
- Support human and ecological health

Sustainable Approach

TRIPLE BOTTOM LINE

Outdoor Lighting Considerations

lins

SOCIAL

Safe and effectively lit roadways and other areas, minimized light pollution and glare, and a visible night sky.

ECONOMIC

Energy cost, replacement cost, installation cost, maintenance cost.



ENVIRONMENTAL

Human and wildlife health, energy efficiency.



Education

- Lighting Series
- Saddlebrook retrofit
- Local business & resident outreach/rebate opportunities
- Articles for Neighborhood Newsletter, Soapbox, CityNews
- Social media campaign
- Citizen science



Technical/Code Work

Code changes:

- 2017-Night sky friendly lighting on all residential and commercial buildings
- 2018- site lighting

Monitoring Work:

- Establish baseline and benchmarks
- One monitor currently (Hilton)

IDA Certification

- Soapstone and Red Mountain
- Continue Citizen Science opportunities





What is Light Pollution?

- Sky glow
- Light trespass
- Glare
 - Nuisance
 - Discomfort
 - Disability
- Clutter





What is Light Pollution?

- Sky glow
- Light trespass
- Glare
- Clutter









Best Practice Principles

Outdoor Lighting Best Practices:

- Light only where you need it
- Light only when you need it
- Shield lights and direct them downward
- Use the minimum amount of light needed
- Select the most energy efficient lighting
- Select lamps with warmer colors

Lighting Best Practices



lins



Lighting Facts Label

Lighting Facts[™]

LED Product

City of

llins

| Light Output (Lumens) | 336 | | |
|---|--|--|--|
| Watts | 6 | | |
| Lumens per Watt (Effic | acy) 60 | | |
| Color Accuracy Color Rendering Index (CRI) | 86 | | |
| Light Color Correlated Color Temperature (CCT) | 3013 (Bright White) | | |
| Werm White Bright White | Daylight | | |
| 2700K 3000K | 4500K 6500K | | |
| Visit www.lightingfacts.com for th | e Label Reference Guide, | | |
| All results are according to IESNA LM-79-2008. A | oproved Method for the Electrical | | |
| and Photometric Testing of Solid-State Lighting | PhilMCIX, 8 Wast Derevative LED Burb (A19) | | |

http://www.lightingfacts.com/¹³



Night Sky Initiative – Focus Areas

- Land Use and Building Code Updates
- Pursue International Dark Sky Certification for Soapstone Natural Area
- Monitoring for sky quality in key locations throughout the City
- Education, training and outreach
- Pilot projects and case studies
- Consider other actions and future ordinances to support night sky objectives

How the City Regulates Lighting

| | Residential Code | Energy Code | Land Use Code |
|------------------------|---------------------|-------------|---------------|
| Single-Family Detached | Х | | X |
| Single-Family Attached | Х | | X |
| Duplex | Х | | X |
| Multi-Family | | Х | Х |
| Commercial | | Х | Х |

X - Likely to be added in 2018

Citvof

lins

What the City **DOES** Currently Regulate

Light Placement:

- Buildings, parking lots, walkways, plazas, landscape areas
- Spillover lighting (foot-candles)
- Impacts to adjacent properties
- Impacts to natural features

Light Fixtures:

- Efficiency
- Shielding
- Glare
- Brightness

Operations

- Timing
- Dimming

What the City **DOES NOT** Currently Regulate

Light Fixture Specifications:

 Color temperature (Kelvin)

Collins

- Lumens
- Wattage
- Pole height
- Specific technology (e.g., LEDs)





Potential Land Use Code Updates

- Creation of lighting zones and/or limits specific to different land use types
- Maximum pole height/mounting height
- Limits on color temperature
- Limits on lumens emitted
- Limits on backlight, uplight and glare (BUG ratings)
- Hours of operation, automatic controls
- Require full cutoff and down directional fixtures for single family residential development
- Exemptions for holiday decorations, string lights, sculptures, etc.



Comparable Communities

- Flagstaff, AZ (first Dark Sky Certified city)
- Tucson, AZ
- Boulder, CO
- Eugene, OR
- Plymouth, MN
- Homer Glen, IL



Pop Quiz!



Select all that apply:

- A. Development review (pre-hearing)
- B. Final plan compliance
- C. Building permit review
- D. Post-construction



Which types of outdoor lighting are regulated by Fort Collins codes?

Select all that apply:

- A. Building lighting
- B. Parking lot lighting
- C. Street lighting
- D. Pedestrian walkway/plaza lighting
- E. Decorative/landscape lighting
- F. Canopies/outdoor sales areas





Select all that apply:

- A. Color temperature <3000K
- B. Full cutoff, fully shielded fixtures
- C. Automatic dimming after business hours
- D. Motion sensors on the back side of buildings
- E. No light spill into natural areas





- Minimum & maximum foot-candle levels
 depending on location
- Light fixtures must be:
 - Concealed
 - Fully shielded
 - Full cut-off
- Up-light, spill-light, glare, contrast & brightness should be minimized
- Natural areas/features should be protected from light spillage





Choose your top 3:

- A. Energy efficiency
- B. Public safety
- C. Security (for properties)
- D. Saving money (upfront or over time)
- E. Public health
- F. Wildlife health
- G. Aesthetics / design
- H. Other





Night Sky Website

www.fcgov.com/nightsky















Bright light glare makes traffic signage hard to read.



Land Use Code Requirements

*Commercial & Multi-Family Projects

Land Use Code Section 3.2.4 – Site Lighting

- Lighting evaluated in the development review process
- Applies to lighting for:
 - Buildings
 - Parking lots
 - Walkways
 - Plazas
 - Landscape
- Ensure that functional/security needs are met without adversely impacting adjacent properties & neighborhood
- Considers light source, level of illumination, hours of illumination & need for illumination

Energy Code Requirements

*Commercial & Multi-Family Projects

- Applies to:
 - Building façades
 - Parking lots & garages
 - Canopies (sales and non-sales)
 - Outdoor sales areas
- Requires:
 - Automatic controls to dim lighting by at least 50% two hours after normal business closing
 - Outdoor lighting must be turned off 30 minutes after sunrise



*Commercial & Multi-Family

Dark Night Skies:

- Light should be shielded so the lamp itself is not visible beyond the property line
- All exterior lighting fixtures (new buildings) shall have the "Fixture Seal of Approval" from the International Dark-Sky Association (IDA)
- Lighting placement shall conform to IDA Model Lighting Ordinance for Lighting Zone 1 (low ambient lighting):
 - 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



Residential Code Requirements

*Single-Family Detached, Attached & Duplex Housing

Dark Night Skies:

- Light should be shielded so the lamp itself is not visible beyond the property line
- All exterior lighting fixtures (new buildings) shall have the "Fixture Seal of Approval" from the International Dark-Sky Association (IDA)
- Lighting placement shall conform to IDA Model Lighting Ordinance for Lighting Zone 1 (low ambient lighting):
 - 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



*Single-Family Detached, Attached & Duplex Housing

Energy Efficiency:

ollins

 A minimum of 75% of light fixtures should be high efficiency lamps

OR

 A minimum of 50% of lighting fixtures shall contain only LED lamps



Understanding Night Sky Resources and the Impacts of Light Pollution



February 6th 2018

Jeremy White – Colorado State University
Light Pollution Research and Management



NPS Natural Sounds and Night Skies Division CSU Sound and Light Ecology Team

Describing and Quantifying Light Pollution

Local Night Sky Conditions

Impacts of Light Pollution – Human and Ecological

Local Conditions

Fully sustainable outdoor lighting







What is Light Pollution

The inappropriate or excessive use of artificial light which brightens the natural sky and surrounding environment. Light Pollution is primarily composed of:

• Glare - excessive brightness that causes visual discomfort

Skyglow - light scattered and reflected off of air molecules and atmospheric aerosols

• Light Trespass - light falling where it is not intended or needed







VIIRS Day / Night Band Radiance Data









Data collected by: C Moore, M Nijuis Data processed by: B Meadows

Hammer-Aitoff Equal Area Projection South Centered

Bryce Canyon National Park, UT



Light pollution is amplified locally from cloud cover, fog, and haze.

This low cloud bank increased overhead sky brightness by 15x



16 bit monochrome image, photometric calibration from standard stars



Calibration applied to each pixel gives brightness measurement (luminance)



Same system to measure local scene luminance







Data collected by: C Moore Data processed by: J White Hammer-Aitoff Equal Area Projection





Violet Blue Green Yellow Orange Red 100 Relative sensitivity 80 Scotopic Photopic 60 40 20 400 450 500 550 600 650 700 Wavelength, nm

Sky Quality Meter

Lux Meter

Human Vision (Photopic = Color Vision)



Spectrometers

Impacts of Light Pollution



83% of World Population Lives Under Light Polluted Skies 99% of U.S. and Europe Live Under Light Pollution Skies

2012 Satellite Image of Anthropogenic Light

Falchi et al. 2016 Science Advances

Impacts of Light Pollution







U.S. National Park Service Night Skies Program

Data collected by: A Pipkin, D Duriscoe Data processed by: D Duriscoe All-sky Mosaic – B Band

Hammer-Aitoff Equal Area Projection

All Lights Are NOT Created Equally



Human Health



Claude Gronifer. Points de Vue, International Review of Ophthalmic Optics, N68, Spring, 2013

Human Health







International Agency for Research on Cancer



U.S. Department of Health and Human Services National Institutes of Health National Institute of Environmental Health Sciences











Human Vision (Photopic = Color Vision)







Foraging

Movement

Migration

Fragmentation

Predator Prey

Competition

Community Structure



Communication

Reproduction

Physiology

Local Conditions



Soapstone Prairie





Data collected by: L Hung, D Duriscoe Data processed by: L Hung

Hammer-Aitoff Equal Area Projection

1.4x brighter than natural
.7x zenith brightness
1.7x vertical illuminance
0.6x horizontal illuminance
78% stars visible

Bobcat Ridge





Data collected by: J White, C Moore, S Moore Data processed by: J White Hammer-Aitoff Equal Area Projection

3.5x brighter than natural 1x zenith brightness
3.5x vertical illuminance
2x horizontal illuminance
54% stars visible

Coyote Ridge





Data collected by: B Meadows, J White, B Seymoure Data processed by: B Meadows

Hammer-Aitoff Equal Area Projection

7.4x brighter than natural
3.5x zenith brightness
7.8x vertical illuminance
4.4x horizontal illuminance
58% stars visible

Horsetooth Reservoir



29x brighter than natural 3.9x zenith brightness 8.7x vertical illuminance 3.8x horizontal illuminance 35% stars visible






Fully Sustainable Outdoor Lighting

- Light only where you need it
- Light only when you need it

Shield lights and direct them downward

- Use the minimum amount of light necessary
- Select lamps with warmer colors
- Use the most energy efficient lamps and fixtures

Thank You

Jeremy White Research Associate Colorado State University – Biology Department Jeremy.M.White@colostate.edu

