STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

IN RE: INVENERGY THERMAL DEVELOPMENT LLC's APPLICATION TO CONSTRUCT THE CLEAR RIVER ENERGY CENTER IN BURRILLVILLE, RHODE ISLAND	**DOCKET No. SB-2015-06**

PRE-FILED DIRECT TESTIMONY OF TREVOR HOLLINS

(JUNE 30, 2017)

SUMMARY

Trevor Hollins, P.E. is the Lighting Design Manager for HDR, Inc. and testifies regarding the lighting analysis for the Clear River Energy Center ("CREC"). He describes the lighting plans prepared for CREC and the analysis prepared regarding the Project. Mr. Hollins, relying on his experience and expertise, the Application as supplemented, and lighting analysis conducted, opines that CREC's lighting design will not cause unacceptable harm to the environment or the public in terms of visual impacts.

LIST OF EXHIBITS

TH-1	*Curriculum Vitae*
TH-2	Revised Lighting Technical Memorandum, dated April 19, 2017

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INVENERGY THERMAL DEVELOPMENT LLC'S PRE-FILED DIRECT TESTIMONY OF TREVOR HOLLINS OF HDR, INC.

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, BUSINESS TITLE AND BUSINESS ADDRESS.

A. My name is Trevor Hollins. I am a Lighting Design Manager, at HDR Architecture, Inc. ("HDR"), located at 8404 Indian Hills Drive, Omaha, NE. 68114.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. My testimony is on behalf of the applicant, Invenergy Thermal Development LLC ("Invenergy"), in support of its application (the "Application") for a license from the Rhode Island Energy Facility Siting Board ("EFSB" or "Board") to construct the Clear River Energy Center project in Burrillville, Rhode Island ("Clear River" or "CREC").

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I received a master's degree in architectural engineering from the University of Nebraska. I have 13 years of experience in creating exterior site lighting designs for many commercial, healthcare, education, civic and federal projects. A component of these designs has been documenting exterior lighting compliance with local lighting ordinances, building codes, energy codes, and LEED (Leadership in Energy and Environmental Design) light pollution reduction credits. I am a registered LEED AP BD+C (Accredited Professional Building Design +

Construction) professional. A detailed description of my educational background and professional experience is included in my CV attached as **Exhibit TC-1**.

II. ANALYSIS

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. My testimony addresses the lighting impact associated with the CREC. I will testify regarding the Rhode Island Department of Environmental Management ("RIDEM") advisory opinion and the technical memorandum issued on April 19th 2017 regarding the CREC – RIDEM Opinion on light pollution mitigation.

Q. WHAT DID YOU REVIEW WHEN CONDUCTING YOUR ANALYSIS?

A. I reviewed the following:

(1) RIDEM's advisory opinion to the EFSB regarding Impacts on Habitat from Light Pollution.

(2) Rhode Island Department of Health ("RIDOH") EFSB Advisory Opinion: Clear River Energy Center

(3) Local Regulations

- i. Burrillville, Rhode Island – Code of Ordinances
- ii. SBC-8 Rhode Island State Energy Conservation Code
- iii. SBC-5 Rhode Island State Electrical Code

(4) Industry Group Design Standards

- i. Illuminating Engineering Society of North America (IESNA)
  1. Lighting Handbook 10th Edition
  2. Technical Memorandum TM-11-00 Light Trespass: Research, Results and Recommendations

ii. International Dark-Sky Association

1. LED Practical Guide
2. Outdoor Lighting Basics
3. U.S. Green Building Council LEED, Sustainable Site Credit 8: Light Pollution Reduction

iii. Other State and Federal recommendations evaluated:

1. National Park Service, Night Skies Best Practices
2. U.S Fish and Wildlife Service and Florida Fish and Wildlife Conservation Commission, Wildlife Lighting Certification Program

Q. PLEASE EXPLAIN THE METHODOLOGY UTILIZED WHEN CONDUCTING YOUR ANALYSIS.

A. We performed the following to address the lighting designs for the Project. I, along with the design team, reviewed relevant regulations and identified the applicable regulatory and design criteria. We found that the applicable regulations did not address exterior lighting or, in the case of SBC-8, the Industrial nature of the CREC would exempt the majority of the site from exterior lighting requirements.

I also identified industry best practices. Specifically, in response to RIDEM's request that steps be taken to mitigate light pollution at the CREC, research was undertaken to create a set of guidelines that could be used to reduce the amount of light pollution from the CREC, making the Facility less intrusive than the existing Algonquin Facility. I also reviewed Guidelines and programs from lighting industry groups and state and federal departments to identify wildlife friendly light pollution reduction strategies that could be implemented at the CREC.

Next, I reviewed lighting design best practices. Based upon the findings from the industry best practices review, three strategies were identified to reduce light pollution and lighting impact on the environment: (1) lowering of illumination intensity; (2) controlling direction of emitted illumination; and (3) minimizing the spectrum of emitted light.

Q. AFTER CONDUCTING YOUR ANALYSIS, DID YOU MAKE ANY FINDINGS REGARDING CREC'S VISUAL IMPACT?

A. Yes.

Q. PLEASE SUMMARIZE YOUR FINDINGS FOR THE BOARD.

A. Steps were taken to modify the lighting concept to minimize impacts on plants and animals in areas surrounding the CREC. As mentioned previously, the CREC lighting design will incorporate three methods of minimizing lighting impact: (1) lowering intensity, (2) controlling direction of illumination, and (3) minimizing the spectrum of emitted light.

The first method incorporated is lowering intensity. When less light is emitted into the environment, there is less potential for that light to become light pollution. Overall exterior illumination levels can be reduced by requiring light levels to be within 10% of specified foot candle requirements. In areas where increased light levels will be required for safe maintenance or visual inspection of equipment, a second lower or dimmed level of illumination will be specified for the light fixtures to minimize the impacts of lighting when these areas are only being used for access. In areas where sensor coverage patterns are sufficient to cover the illuminated area, exterior occupancy sensors can be used to reduce exterior lighting levels to a minimum of one foot-candle or 50% of design illumination level, whichever is lower when occupancy is not detected. The sensors would generally operate in this manner except during the following conditions: (1) Manually increasing lighting levels for maintenance will override occupancy sensor operation; and (2) Emergency or security events will override occupancy sensor operation and raise all exterior lighting to full on.

The second method incorporated is controlling direction of exterior lighting. When light is directed down, light must interact with a surface where its intensity is reduced before it can become light pollution. This can be achieved by the following provisions:

1) Outdoor lighting zone LZ1 is defined by the IESNA as, "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, security and/or convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline." The CREC lighting system will be designed such that the IESNA recommended light impact illumination levels for outdoor lighting zone LZ1 at a point five feet beyond the Project property line is not exceeded.
2) The lighting technical memo[1] originally stated that light trespass illumination levels would comply with IESNA outdoor lighting zone LZ0. Upon further review of the site and operation of the CREC it was determined that LZ1 was the appropriate outdoor lighting zone designation as it allows for more flexibility in light fixture selection within the site while maintaining the same light impact illumination levels at the fence line as required for IESNA outdoor lighting zone LZ0.
3) Use of luminaires that carry the IES U0 or fully shielded designation can eliminate direct light above the horizontal plane and limit sky glow.

The third method incorporated is minimizing light spectrum to the ranges least detectable by wildlife. This is typically accomplished through the following design provisions:

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[1] The revised lighting technical memorandum is attached as **Exhibit TH-2**. **Exhibit TH-2** supplements and updates the lighting technical memorandum attached to Invenergy's Supplemental Responses to RIDEM's 3rd Set of Data Requests, filed with the Board on June 19, 2017.

1) All exterior lighting used for general area illumination will only emit light in the 590-610 nm range. This range is within the visible range of light in human vision while remaining outside of the majority of visual sensitivity to most animals. A floor of 590 nm places the spectral distribution of the light source above the visual sensitivity of bees and many birds. A ceiling of 610 nm places the spectral distribution at the edge of visual spectrum for humans while eliminating deep red wavelengths or infrared light emission above 610nm which are visible to some animals.

2) Reducing the amount of blue light in a light source will reduce sky glow, contain less energy in the spectrum of light visible to animals, and reduce glare to humans. To lower the amount of blue light, areas where visual acuity is important such as areas where equipment maintenance or inspection activities will be performed will have a correlated color temperature (CCT) of less than 3000K and a scotopic to photopic (S/P) ratio of less than 1.2. Light sources with a CCT above 3000K are often perceived as blue and "cool" in appearance. Light sources with a CCT of 3000K and below are often perceived as yellow and "warm" in appearance. A light source with a 3000K or less CCT will contain a smaller amount of blue light than a light source with a higher CCT while maintaining a high level of visual acuity. The S/P ratio is the ratio of scotopic to photopic lumens of a light source and is independent of CCT. Scotopic vision is color blind and well suited for the low light levels required for night vision. Photopic vision is color vision and well suited for the high light levels of day light. Photopic and Scotopic lumens are calculated by multiplying the spectral power distribution of a light source by the photopic luminous function and the scotopic luminous function. Because the scotopic and photopic luminous functions are

different, they will calculate different values for scotopic and photopic lumens. In general, light sources with a high S/P value will contain high amounts of blue light. Thus, requiring a low S/P ration will reduce the amount of blue light.

III. ADVISORY OPINION

Q. HAVE YOU REVIEWED THE RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT'S ADVISORY OPINION?

A. Yes.

Q. DO YOU HAVE AN OPINION REGARDING RIDEM'S ANALYSIS OF CREC'S LIGHTING IMPACTS?

A. Yes, RIDEM's Advisory Opinion includes a discussion of light pollution and its effects on human health. In their opinion RIDEM identifies many of the concerns that are generally understood to be the impacts that lighting may have on the nighttime environment. Invenergy intends to incorporate design features into the CREC lighting systems to mitigate light pollution and the impacts of lighting on the surrounding plant and animal life. The lighting design will incorporate features such as luminaire shielding, limited wavelengths, correlated color temperature, and adaptive lighting controls to minimize light pollution from the site and minimize disruption of the surrounding habitat by lighting. The proposed design features will reduce the impact of light pollution on the surrounding habitats while allowing the CREC to operate as intended, meeting the needs and safety of the personnel of the CREC.

IV. CONCLUSIONS

Q. DO YOU HAVE AN OPINION TO A REASONABLE DEGREE OF CERTAINTY IN YOUR FIELD REGARDING WHETHER CREC'S LIGHTING IMPACTS WILL CAUSE UNACCEPTABLE HARM TO THE ENVIRONMENT?

A. I do. We will develop an exterior lighting design for the CREC that conforms to Federal, State and local regulatory rules and codes, and incorporates the latest recommendations for reducing light pollution and mitigating the impacts of lighting systems on wildlife. When designed and operated based on the recommendations discussed above, the CREC will produce far less light pollution in a much narrower spectrum band than comparable facilities. Consequently it is my opinion that the lighting designs will have minimal impact on surrounding plant and animal life.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

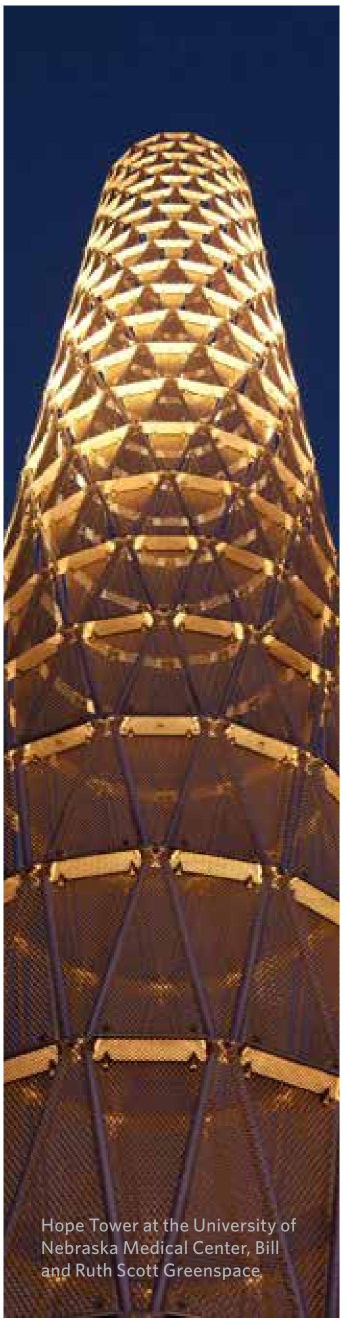
A. Yes.

EXHIBIT TH-1

Trevor Hollins, PE, LEED AP BD+C

Lighting Design Manager

As a lighting design manager, Trevor has more than 15 years of experience in the industry focusing on academic, healthcare, civic and commercial projects. Trevor is a passionate advocate for the ability of great lighting to positively impact architecture and community. From the conceptual stages of a project, he works closely with project stakeholders to develop integrated cost-effective lighting design and control solutions. Trevor has demonstrated a commitment to stewardship of natural resources. He is focused on reducing light pollution and mitigating the impact lighting has on the natural environment. Trevor's work has been featured in multiple publications, including LD+A magazine, and has won numerous awards, including multiple IES Awards of Merit.



Hope Tower at the University of Nebraska Medical Center, Bill and Ruth Scott Greenspace

CURRICULUM VITAE

EDUCATION

Bachelor of Architectural Engineering, University of Nebraska System, 2003

Master of Architectural Engineering, University of Nebraska at Lincoln, 2004

REGISTRATIONS

Professional Engineer, Nebraska, No. E-12986

LEED Accredited Professional, Building Design and Construction, #10319817

Lighting Certified (LC) by the National Council on Qualifi cations for the Lighting Professionals (NCQLP)

PROFESSIONAL MEMBERSHIPS

International Association of Lighting Designers (IALD)

INDUSTRY TENURE

17 years

HDR TENURE

12 years

OFFICE LOCATION

Omaha, NE

PROJECT AWARDS

IES Illumination Award of Merit | 2010
Joslyn Art Museum Façade and Sculpture Garden

IES Illumination Award of Merit | 2014
Ovations Lounge at the Holland Performing Arts Center

IES Illumination Award of Merit | 2015
Joslyn Art Museum, Art Works

IES Illumination Award of Merit | 2015
HDR Office Remodel

IES Illumination Award of Merit | 2016
Do Space

PROJECT PUBLICATIONS

LD+A Magazine | February 2011 – Artful Reflections, Josyln Art Museum Sculpture Garden

Erco, Lichtbericht 93 | November 2011 – Vertical Illuminance for Exterior Lighting: Joslyn Art Museum

Interior Design | March 2015
Playground, underground

RELEVANT EXPERIENCE

Missoula Redevelopment Agency South Reserve Crossing, *Missoula, MT*
HDR provided architectural structural and lighting design for a pedestrian bridge over US HWY 93/South Reserve. Design considerations for the bridge included architectural lighting to emphasize the bridge as a gateway to Missoula. The bridge lighting was designed to meet the safety requirements for pedestrians and bike riders traveling over the bridge as well as drivers of automobiles traveling on the highway under the bridge. The functional trail lighting and decorative architectural lighting of the main span arch superstructure was designed to comply with the City's dark sky ordinance and fulfill MRA's architectural vision.

West Virginia DOT, Wheeling Suspension Bridge Rehab, *Wheeling, WV*
Rehabilitation and relighting of a 170 year old suspension bridge that spans the main channel of the Ohio River. Bridge lighting balanced the environmental requirements of the river below the bridge with the project goal of celebrating the architecture of this Historic Bridge. Tasks included rehabilitation inspection study and preparation of final plans. While being designed to allow traffic to safely travel the length of the bridge design of the lighting system also included extensive detailing of luminaire mounting and aiming in order to avoid damaging the bridge structure through lighting system installation and minimize spill light into the surrounding environment.

Noddle Companies, HDR New Global Headquarters, *Omaha, NE*
The new headquarters will be ten stories and 228,218 square feet, which can immediately house 1,150 employees. Exterior building and site lighting was designed to give the building a night time presence and activate a small entertainment district located between the Headquarters and nearby parking garage. Innovative solutions were implemented to provide lighting that met the project safety and aesthetic goals within the entertainment district while meeting the project environmental considerations. **LEED Gold V.4 goal.**

Omaha's Henry Doorly Zoo Entry Plaza, *Omaha, NE*
This 14,000 SF sustainable entry building addition and public plaza for the Omaha Zoo, with a pedestrian path, guest services, and gift shop, is linked by a 100-foot gateway, incorporates natural light, uses solar energy, and is built with regionally produced materials.

Renown Regional Medical Center, Parking Garage, *Reno, NV*
Building additions included a 12-story patient bed tower, 7-story parking structure, 125,000 SF medical office building, and a new central utility plant. Impact of the building on the nighttime environment was kept to a minimum through the use of internal building illumination and focused accenting of architectural features that limited spill light balancing functional and environmental concerns. The project also included lighting design for a new interim entrance, healing garden and streetscape improvements.

Lauritzen Gardens, Marjorie K. Daugherty Conservatory, *Omaha, NE*
The 14,849 SF conservatory creates a unique and memorable visitor experience and will encourage visits throughout the seasons. A dynamic lighting control system was provided to automatically alter the lighting based upon the time of day or occupant request. The lighting control system was also integrated with the automated environmental control system to illuminate the conservatory at night while limiting spill light to the night environment through the use of automated shading. Care was taken during the design to select luminaires that will stand up to the harsh environment of high moisture content in the interior.

University of Colorado Hospital Expansion, *Aurora, CO*
The $400 million academic medical center Expansion adds capacity to Anschutz Inpatient Pavilion Phase I & II, both designed by HDR. Main features of the Expansion include 240 new inpatient beds, expansion of the diagnostic and treatment areas, a new emergency department and two new parking structures. **LEED Gold Certified**

University of Nebraska Medical Center, Bill & Ruth Scott Greenspace, *Omaha, NE*
The 7.4 acre Student Green project was accomplished by vacating two streets and reconfiguring another to provide a pedestrian path with seven gathering plazas, which connects both new and existing education facilities on the UNMC campus. All paths lead to the 120-high Hope Tower (pictured left) sculpture on the top of the hill, the highest point on the campus. The tower was illuminated to create a beacon for students, serving as both a navigational tool and an artistic centerpiece. Lighting design of the tower included the use of complex computer simulations to verify that spill light and light pollution would be minimized.

Nebraska Medicine Bellevue, *Bellevue, NE*
$100 million, four-story, 250,000 SF, full-service community hospital and attached three-story, 60,000 SF medical office building. **LEED Gold Certified.**

New Hanover Health Network - Surgical Pavilion, Women and Children's Pavilion and Patient Tower Renovation, *Wilmington, NC*
Various phases of this expansion and renovation project, which include a new Womens and Children's Center, a new Surgical Center, a new Mental Health facility and renovations of the existing tower such as patient rooms, the Pharmacy, ER, and Cath Lab. Also included site and landscape lighting.

Reid Hospital and Health Care Services, *Richmond, IN*
A 750,000 SF healthcare campus that includes a free-standing rehabilitation facility, a medical office building, a outpatient care center and a replacement hospital with 238 beds. Site lighting for the entire campus where the buildings are located was also designed.

Noddle Companies, Noddle Companies, Gordmans World Headquarters + Retail, *Omaha, NE*
This 120,000 SF five-story sustainable building incorporates mixed-use office, research, technology, retail, entertainment, and residential space, along with a 900-stall parking structure on a prominent greenfield site close to the University of Nebraska Campus. Sustainable features include a building façade carefully illuminated to reduce light pollution. **LEED Silver Certified**

Joslyn Art Museum, Peter Kiewit Foundation Sculpture Garden, *Omaha, NE*
The highlight of the 1.2 acre sculpture garden is a 170' long reflecting pool, whose edges were lit to discretely accentuate the form at night. In order to minimize the Gardens impact on the night environment general area lighting was omitted from the garden and illumination was provided solely by light reflected of various surfaces, such as the building facades, a waterwall, and the canopies of uplighted trees. Lighting for the garden was designed to minimize spill light and reduce light pollution and succeeded in creating an inviting nighttime environment for the museum's growing outdoor art collection.

EXHIBIT TH-2

Date: April 19, 2017

To:

From: Trevor Hollins, PE, LC, LEED AP

RE: CREC – RIDEM Opinion

1 Introduction

This technical memo has been prepared in response to Rhode Island Department of Environmental Management (RIDEM) request for a detailed light pollution mitigation plan for the Clear River Energy Center (CREC) and summarizes the steps taken to create a compliant specification.

2 Background

The Rhode Island Department of Environmental Management (RIDEM) issued an advisory opinion to the Energy Facility Sitting Board (EFSB) raising concerns of the level of light pollution that will be created by the Clear River Energy Center (CREC) and its impact on the environment surrounding the facility including the nearby George Washington Management Area. RIDEM requested information detailing the steps that Invenergy would take to mitigate light pollution at CREC stating that the CREC should be substantially less intrusive than the Algonquin Facility. Specifically RIDEM requested information on the following strategies:

- Specification of Adaptive Controls
- Specification of Light Shielding
- Specification of Light Correlated Color Temperature (CCT) and Wavelength to limit impact of lighting on nearby wildlife.
- Extent of light trespass from the facility

In order to clarify the lighting design strategy for the CREC and show compliance with RIDEM's requests the lighting specification has been provided to highlight the environmentally sensitive lighting design

3 Lighting and Impact on the Environment

Sensitivity of the lighting design to the surrounding environment is important due to the impact that lighting has on the nighttime environment. Excessive lighting can obscure views of the stars and have negative impacts on plants and animals in areas surrounding excessive lighting [7].

The three methods of minimizing the impact of light trespass are lowering intensity, controlling direction of illumination and minimizing the spectrum of emitted light [1].

- Lowering Intensity is a simple concept, when less light is emitted into the environment there is less potential for that light to become light pollution.

- Controlling direction is important because for light to become light pollution it must leave the confines of the project site. When all light is directed down, light must interact with a surface where its intensity is reduced before it goes into the sky and becomes light pollution. Directing illumination down also creates a more efficient design.

- Minimizing the spectrum of emitted light has positive impacts on plants and wildlife. The vast majority of common wildlife animals, including those that populate the Northeastern United States have spectral sensitivity up to about 580 nm on the color spectrum. This means that these animals cannot see wavelengths of light above 580 nm. Birds are an exception to this trend. Birds' vision is tetrachromatic which means that they have four types of photoreceptive cone cells, each with a distinct maximal absorption peak. For reference, humans only have three photoreceptor cone types, and other animals have three or less. Because of this, birds have a peak photo-sensitivity at around 630nm unlike other animals, therefore they can see some of the red-colored spectrum that humans can see. However, birds are less sensitive at approximately 590-610nm on the spectrum than they are anywhere else within human range of vision (400-700nm), excluding the very red region of 650-700nm [3].

4 Recommendations

It is recommended that the following solutions are implemented to address the three methods of reducing light trespass described above. Compliance with the solutions outlined below will be documented by the design engineer.

4.1 Lowering intensity

- Overall exterior illumination levels shall be reduced by requiring light levels to be within 10% of specified foot candle requirements. This is in contrast to typical light level requirements that specify a minimum light levels requirement with no maximum and will ensure that spaces are not over lit [4].

- There are areas where increased light levels will be required for maintenance or visual inspection. Exterior platforms and exterior equipment areas will require 5fc and 30fc of illumination, respectively, when maintenance is being performed. In order to minimize the impact of these increased light levels a second lower level of illumination has been specified when these areas are only being used for access, 2fc and 5fc.

- A networked lighting control system will be provided with dimmable luminaires that will further reduce lighting levels through the following control strategies [2].

- A high level trim control strategy will be implemented during system commissioning to ensure that installed exterior light levels do not exceed specified illumination levels.

- When areas where sensor coverage patterns are sufficient to cover area illuminated, IP65 rated exterior occupancy sensors will be used to reduce exterior lighting levels to a minimum of 1fc or 50% of designed illumination level whichever is lower when occupancy is not detected.

- In areas where maintenance/inspection activities will be performed dimmed lighting levels will be raised or additional luminaires may be provided to allow the normal lighting levels to be manually increased during periods of maintenance to provide a safe environment for workers of the facility. Manually increasing lighting levels for maintenance will override occupancy sensor operation. Emergency or security events shall override occupancy sensor operation and raise all exterior lighting to full on.

4.2 Controlling Direction

- Light trespass will be minimized by designing a lighting system that does not exceed the IES recommended light trespass illumination levels for lighting zone LZ1 at a point 5 feet beyond the project property line [6].

- Sky glow will be minimized by providing luminaires that carry the IES U0 or fully shielded designation to eliminate direct light above the horizontal plane and limit light emitted directly to the atmosphere [5].

4.3 Minimizing Spectrum

- All exterior lighting used for general area illumination will only emit light in the 590-610 nm range as this range is the least sensitive to most animal's vision [2].
- Areas where visual acuity is important such as areas used for maintenance or inspection will have a correlated color temperature (CCT) of less than 3000K and a scotopic to photopic (S/P) ratio of less than 1.2 [2].

5 References

[1] "Outdoor Lighting Basics." ida, 19 April. 2017, www.darksky.org/lighting/lighting-basics.

[2] "LED Practical Guide." Ida, 19 April. 2017, www.darksky.org/lighting/led-guide.

[3] Rijchard, J. "Ultraviolet (UV) Light Perception by Birds: A Review." Veterinarni Medicina 54 (2009): 351-59.

[4] UFC 3-350-01, Unified Facilities Criteria. Interior and Exterior Lighting Systems and Controls

[5] DiLaura, David L. The lighting handbook: reference and application. 10th ed. New York, NY: Illuminating Engineering Society of North America, 2011.

[6] Joint Task Force. Joint IDA-IESNA Model Outdoor Lighting Ordinance (MLO), 2011.

[7] "About Lighting Pollution." Florida Fish and Wildlife Conservation Commission, 19 April. 2017, www.myfwc.com/conservation/you-conserve/lighting/pollution.