CITY OF LINCOLN
NEBRASKA
MAYOR COLEEN J. SENG

LINCOLN

# *Outdoor Lighting Study*

## Final Submittal

1/3/08

OLSSON ASSOCIATES

I. TABLE OF CONTENTS ..... 1

II. EXECUTIVE SUMMARY ..... 2

III. PURPOSE OF THE COMPREHENSIVE OUTDOOR LIGHTING STUDY ..... 6

IV. ACKNOWLEDGEMENTS ..... 11

V. A BRIEF HISTORY AND REVIEW OF LINCOLN'S LIGHTING STANDARDS ..... 14

VI. THE STUDY PROCESS ..... 22

VII. THE OUTDOOR LIGHTING ADVISORY TASK FORCE ..... 29

VIII. THE NIGHT TIME SURVEYS ..... 33

IX. THE SAMPLE CODES/ORDINANCES ..... 36

X. GOALS AND EXPECTATIONS OF THE COMPREHENSIVE OUTDOOR LIGHTING STUDY ..... 39

XI. DRAFT DESIGN STANDARDS FOR OUTDOOR LIGHTING ..... 41

XII. IMPLEMENTATION, ENFORCEMENT, EDUCATION AND TRAINING ..... 42

C:\WINDOWS\temp\notes6C2F42\ComprehensiveLightingStudyFINALJan'08_108.wpd

## II. EXECUTIVE SUMMARY

The City of Lincoln has had outdoor lighting guidelines since the late 1970's. Currently there are six documents dealing with outdoor light and or signage scattered in various locations throughout the Municipal Code. Although much of the content of Lincoln's existing lighting requirements is fundamentally sound, there is a need to update language, correct miscues and insert enforcement criteria. It would be very desirable to consolidate all lighting requirements in one location rather than the multiple locations where they are currently found. In addition to the above, a variety of outdoor lighting situations where it has been suggested that the City needs clearer and/or more effective guidelines have been identified. These include lighting that may impact the Salt Creek Tiger Beetle (SCTB) habitat, outdoor auto display areas, convenience store canopies, ornamental street lights and "wallpacks" used for residential and business security lighting.

Recognizing these needs, the City of Lincoln commissioned a comprehensive outdoor lighting study. The study was to examine current lighting standards in Lincoln, observe and record outdoor lighting practices in the area, review standards in other communities and make recommendations.

The Comprehensive Outdoor Lighting Study and the proposed lighting standards are the result of the collaboration of the consultant with staff from several departments/agencies plus the Outdoor Lighting Advisory Task Force. The Task Force, whose members represented the interests of a variety of stakeholder groups including business groups, neighborhood groups and "dark sky" advocates, met 25 times over a period exceeding a year, to assist in developing the report.

The shared purpose of the Outdoor Lighting Advisory Task Force members is best exemplified by their goals and expectations for this study. The membership was unanimous in their commitment that each part of the proposed standards be measured against the stated goals and expectations.

The initial step in the study process was the review of Lincoln's current lighting standards. This review identified where the standards were unclear, ineffective, or unenforceable.

The second step in the study process was a survey of a variety of existing outdoor lighting installations in Lincoln. The survey data provided answers to questions such as: What are the current practices in Lincoln? What is happening at locations that have generated citizen complaints? Are current regulations being complied with? What is working?

The survey findings served as a reference datum for the Outdoor Lighting Advisory Task Force as they considered the possible content of the proposed new lighting standards.

The third step in the study process was the review of lighting codes/ordinances actually used by other communities. Five copies of lighting codes or ordinances from a national cross-section of other communities were provided to the Outdoor Lighting Advisory Task Force early in the process. The Task Force used these documents to become familiar with how other communities approach compiling a code and to see the fairly broad spectrum of outdoor lighting situations covered or not covered by codes.

Some of the codes were very technical and detailed concerning what could be done, what equipment could be used, when lighting systems could be on, and the type of submittals that were required to prove a project's compliance with the code requirements. Other codes were written more for non technical audiences and with less intense submittal requirements.

From their assimilation of this information and the discussions that it generated, the Outdoor Lighting Advisory Task Force identified the following goals and expectations for the Comprehensive Outdoor Lighting Study and the proposed lighting standards it is to provide:

<u>Study Goals and Expectations</u>

1. The intent of the proposed standards and the history of the Outdoor Lighting Advisory Task Force process should be in the study document.

2. Glare should be addressed for each type of outdoor lighting covered by the proposed standards.

3. Light trespass should be addressed for each type of outdoor lighting covered by the proposed standards.

4. Correct known deficiencies in existing ordinances in appropriate sections of the proposed standards.

5. The proposed standards will need to include provisions for lighting near SCTB habitat that addresses U.S. Fish & Wildlife Service (USFWS) recommendations with respect to SCTB breeding areas and property abutting breeding areas.

6. Simplicity, practicality, enforceability and protection of Lincoln's quality of life should all be guidelines by which the proposed standards content is evaluated.

The Outdoor Lighting Advisory Task Force believes that a study and standards that meet these goals and expectations will address the citizen concerns while limiting upward waste light (sky glow) and encouraging energy conservation.

The draft standards include the following features:

- Standards are organized around several different "classes" of outdoor lighting situations. Maximum average illumination is specified for each of these classes.
- Light fixtures generally must be designed and constructed or shielded to meet national standards for controlled ("cutoff") light emission. Lamps not meeting these standards are limited in intensity (to 2850 lumens, equivalent to a 35 watt HPS lamp, or 150 Watt incandescent lamp).
- "Glare" is controlled indirectly, by limiting the allowed illumination at the property lines, measured vertically. Light "trespass" is controlled by a horizontal measurement of illumination at the property lines. The proposed standards expand on the current application of these two measurements.
- Some sections specify the hours of operation within which lighting levels for the different classes of lighting may be in use.

Implementation of the proposed standards will require adoption through the hearings of the Planning Commission and the City Council. Proof of compliance with the standards generally is placed on the professional engineer, National Council on Qualifications for the Lighting Professions (NCQLP) certified lighting designer or licensed electrician who signs the submittal material.

Enforcement after lighting is installed will be based largely on follow-up complaints, as with other types of City standards. However, random checks are also recommended. These could include requiring confirmation that construction complies with submittal material from the entity who signed the submittal material. City staff or a consultant could also perform random checks of light trespass and glare at selected property lines of selected projects.

City staff should develop educational materials based on information collected for this study, to provide the public with non-technical information on outdoor lighting practices that would conform to the standards. Such material could also include lighting terms and outdoor lighting equipment.

Training needed for City staff who may be asked to verify lighting project compliance with adopted standards could also be provided by a consultant to the City.

## III. PURPOSE OF THE COMPREHENSIVE OUTDOOR LIGHTING STUDY

The City of Lincoln is a leader in environmental management. The City has been very active in developing an environmental data base and in establishing policy to preserve and protect our natural environment. The Lincoln/Lancaster County Comprehensive Plan includes a chapter devoted to “Green Print” and environmental resources.

The SCTB was listed by the Department of the Interior as an endangered species on October 6, 2005. The SCTB is known to be sensitive to light and will require special protective regulations.

Lincoln has had outdoor lighting guidelines and standards for many years now. The City Council adopted lighting requirements for roadways and streets in the late 1970’s. Parking lot lighting standards for Lincoln were first put in place in the mid 1980’s. Modified parking lot lighting standards and new outdoor recreational lighting guidelines were adopted in the early 1990’s. More detailed information on these and other lighting related standards in place for the City of Lincoln can be found in Section V, A Brief History and Review of Lincoln’s Lighting Standards.

Outdoor Lighting management to preserve the night, promote energy efficiency and provide for the appropriate use of lighting for safety and commerce is an enhancement of these environmental efforts and the community quality of life.

In April of 2005, the City of Lincoln issued a “Request for Proposals” seeking the services of a qualified lighting research specialty firm to assist in the preparation of a Comprehensive Outdoor Lighting study for the Lincoln area.

The consultant was responsible for providing specific professional services to support the formulation of recommendations for new lighting ordinance/standards. The resulting Outdoor Lighting Study recommendations are expected to become a key base to an integral element of revised City of Lincoln standards.

City of Lincoln groups that participated in the study process are the Planning Department, the Parks and Recreation Department, the Police Department, the Building and Safety Department and various interested citizen organizations. An Outdoor Lighting Advisory Task Force was formed as the vehicle for all groups to have an input forum on the issues to be examined by the study and the content of any proposed code language. Section VII, The Outdoor Lighting Advisory Task Force, of this study provides more detail on members of the Outdoor Lighting Advisory Task Force.

The consultant selected had a specific list of services to provide to the City, the Outdoor Lighting Advisory Task Force and the Community. Those services included the following:

A. Consultation with City regarding the planning process, issues, and other matters relating to the development of a Comprehensive Outdoor Lighting Study for the City of Lincoln.

B. A review of current lighting related provisions and regulations and identification of potential deficiencies.

C. On site visit (s) to Lincoln, visit with appropriate staff and Outdoor Lighting Advisory Task Force.

D. Plan and execution of a field survey to establish base line examples of Lincoln outdoor lighting levels at different locations for different purposes (eg security lighting, vehicle display lots, gas stations canopies, and similar sites). At least 20 locations were to be in the survey.

E. Provide samples of at least five example comparable community ordinances that might be applicable to Lincoln.

F. Propose preliminary lighting technical information.

G. Prepare written reports summarizing and evaluating research findings.

H. Consultation on research findings with staff and other individuals and local groups as appropriate.

I. Conducting meetings with an Outdoor Lighting Advisory Task Force, public workshops and presentations, and other community activities as applicable to the Comprehensive Outdoor Lighting Study process, for the purpose of;

- Educating the participants on principles of lighting.
- Evaluating the existing regulations based on the field work
- Options for fixes, and a priority of recommended changes
- Respond to the impact of these proposed changes on the community, including business costs and security.

J. Preparation of graphic and textual materials illustrating study concepts and findings, principles, and recommendations.

K. Preparation of all necessary written and graphic documents of the process including the formulation of all interim reports and final report and presentation materials throughout the process.

L. Preparation of proposed ordinance amendments.

M. Preparation of a final print ready draft and final report.

N. One training session for enforcement officials.

City staff was available though out the course of the study to furnish support and direction for the successful preparation of the Comprehensive Outdoor Lighting Study. In general, local staff was available and assisted the consultant in the following types of activities:

1. Serve as the sole point of contact for the consultant team in conducting the study.

2. Provision of overall study management and guidance concerning the execution of the scope of work, work products, contractual considerations, budget, and day-to-day process concerns.

3. Support the administration of the Outdoor Lighting Advisory Task Force set up to oversee the completion of the study, including completing all communications with the Outdoor Lighting Advisory Task Force (e.g., e-mailings, postal mailings, and phone contacts), arranging meetings, responding to Outdoor Lighting Advisory Task Force inquiries with consultant assistance, and other general support.

4. Scheduling of public meetings and private interviews relating to the study, including securing meeting locations, conducting applicable publicizing of the meetings, and confirming interview sessions.

5. Gathering of information pertinent to the study effort. This included assembling secondary data sources such as completed or in-process study results and plans, and original data collection.

6. Collaboration in the production of geographic information systems (GIS) mapping and analysis efforts if applicable. This may include the production of applicable mapping and imagery products necessary to the successful undertaking of the study.

7. Strategize with the consultant team on policy and substantiate plan recommendations and approaches.

8. Provision of timely review of draft materials to the consultant team for materials generated as part of study process.

9. Completion of other support tasks and functions as mutually agreed to in undertaking the overall study process.

The original schedule for the completion of the study process was five months with final study product available for public review no later than six months after initiation of the study process. The consultant's original proposal followed the proposed timeline and allowed for five scheduled meetings with the Outdoor Lighting Advisory Task Force with a sixth optional meeting, if necessary. The study process began in late August 2005. The consultant met with the Outdoor Lighting Advisory Task Force over twenty-five times and performed several requested data gathering, presentation and research projects for the edification and understanding of its membership. The extra time and meetings were considered by most as well worth the effort for the value contributed to the study process.

The Planning Department worked on shaping the Design Standards for the Outdoor Light document, submitted with the study, into a format with language that was consistent with other Lincoln guidelines, understandable by the anticipated users and enforceable. The final draft of the "Design Standards for Outdoor Lighting" was sent to the Task Force membership for comments in early December 2007. A copy of this final draft is included in Section XI for this study.

## IV. ACKNOWLEDGEMENTS

This Comprehensive Outdoor Lighting Study and the draft "Design Standards for Outdoor Lighting" are the result of the efforts of many people over a two year period. These people, representing the interests of a variety of the groups, associations, institutions and neighborhoods, volunteered their time to assist in the process. City staff and the consultant were very encouraged with the level of interest in the project and the quality of the comments and concerns shared as different aspects of the work were discussed and illustrative presentations were made.

The shared purpose of this group is best exemplified by their goals and expectations for the task. These are set forth in Section X of this study. The group's unanimous commitment was that each part of the proposed design standards had to be measured against the stated goals and expectations.

It is with great and sincere appreciation that "Thank You" is extended to:

1. The Lincoln Development Community
2. The Lincoln Business Community
3. The Lincoln Independent Business Association
4. The Lincoln Neighborhood Associations
5. University of Nebraska Department of Physics and Astronomy
6. Lincoln City Staff
7. Hyde Observatory

The vision, leadership and knowledge of Lincoln history that Mike Dekalb brought to the process were invaluable assets to the day-to-day development of the study and the proposed design standards for outdoor lighting.

GLOSSARY OF LIGHTING TERMS

The process of developing an outdoor lighting design standard involves many tasks. The final success of the design standards development process is directly related to how successful those engaged in the process are at completing each of the many tasks.

One of those tasks is that the intent of the proposed standards and each of its individual parts is as clear and understandable as it is possible to make it. The challenge of accomplishing this task is more formidable than may be initially perceived. There are many words in the language we speak that have a specific meaning to a profession or practice, but a very different meaning when used in our everyday written/oral communication with others. There are also words used by those involved in lighting that are unknown or ambiguous to those not involved in lighting.

In order to assist those reading this report, we offer the following list of definitions for some more frequently encountered lighting terms as related to this study. The attached draft standards have their own technical definitions.

LIGHTING TERMS

"IESNA" means Illuminating Engineering Society of North America.

"Lumen" means a unit of light (luminance) emitted from a source (lamp or bulb).

“Foot-candle”, abbreviated fc, is a unit of measure of illumination (number of lumens per area) or how much light is on a surface. A foot-candle is defined as one lumen per square foot. The original definition was in reference to a standardized candle burning one foot from a given surface.

“Cutoff" means outdoor light fixtures shielded or constructed by the manufacturer so as to allow only a very small amount of light above the horizontal plane at the bottom of the fixture.

"Mounting Height" means the distance from finished grade to the bottom most portion of a light fixture, (e.g. lamp, surface of lens).

"Light trespass" means direct or indirect artificial light that originates on one property but falls on an adjacent or abutting property.

"Glare" means direct or indirect artificial light visible from light sources not obscured from view.

"Luminaire" means a lighting unit (fixture) consisting of a lamp or lamps (light source), together with the parts designed to distribute the light (optical assembly).

Brightness is a perception based on the extent to which an object (e.g. lamp, sign, headlight) is judged by the viewer to be emitting (sending out) more or less light.

## V. A BRIEF HISTORY AND REVIEW OF LINCOLN'S LIGHTING STANDARDS

BRIEF HISTORY

Lincoln has had lighting design standards since the 1970's. The first standard adopted by the City Council concerned allowable levels of light and the uniformity of that light as it related to the streets of Lincoln. The oil embargo by the OPEC coalition in 1972 was the most significant driver in the creation of Lincoln's street lighting design standards. The City Council mandated that Lincoln streets be lighted with High Pressure Sodium (HPS) sources at levels no more than 70% of IESNA recommended levels. Residential streets were to be lighted with 70 watt HPS lamps on 20 foot high poles at 240 foot spacing's. There is no reference to IESNA recommendations for residential streets.

Growing commercial development near or abutting residential areas and a lighted golf driving range bordering an existing residential development were significant reasons behind the development of Lincoln's second and third lighting standards (parking lot and outdoor recreational lighting).

The parking lot lighting standard was formulated "to assure parking lot lighting that provided adequate visibility within the lots, to deter crime and to not cause visual interference on public thoroughfares or encroach on the visual privacy of adjacent residents". It also addressed the minimization of light pollution because of its detrimental effect on astronomical observations. These goals were achieved by limiting the average maintained foot-candle level of the lot, the average maintained foot-candle level at the property line of a residential zoning district, specifying the use of cutoff luminaries and mandating parking lot lighting uniformity ratios.

The outdoor recreational lighting standard was developed with the intent to provide outdoor recreational lighting systems that create "appropriate light environment so the event will appear clear and sharp to the players and spectators". It limited the hours of use to no later than midnight except for the conclusion of an activity that began prior to midnight. Its goals also included limiting light trespass and glare at the property lines in residential zoning districts and minimizing light pollution (sky glow) by way of requiring sports light fixtures to meet IESNA cutoff criteria when installed and aimed. Aiming angles were limited to 28 degrees or more down from the horizontal as a glare control measure.

The updated parking lot lighting standard and a new outdoor recreational standard were adopted by City Council in November 1994.

The City's standards for lighted signage are focused on the brightness of the surface of the sign. The lighting technical term for "brightness" is luminance. It is the level of brightness that creates the visual discomfort that we call glare. A sign's surface brightness can be the result of internal or external sources and Lincoln's current standards cover each of these possibilities. The amount of brightness (luminance) allowed for any sign was limited by the code to a maximum level (300 foot lamberts) (now 10,000 nits) measured at the property line of the property on which the sign is located. The two chapters of Lincoln's sign code were originally adopted in May 1979 and updated in 2006 with partial input from this study.

Another document with lighting standards is the Environment Performance Standards. This document defines enforcement responsibilities for Lincoln's design standards and codes as well as performance standards for noise, emission/dust/odor, outdoor nighttime lighting and heat. This document was adopted circa 1980.

The final document with lighting standards is the DESIGN STANDARDS FOR OUTDOOR LIGHTING. This document references the other standards, previously described above and details their location in the City of Lincoln Municipal Code.

Copies of the existing standards can be found in Section 2 of the Appendix to this study. All sections of the Appendix are in a separate binder.

STRENGTHS AND WEAKNESS OF EXISTING STANDARDS

The following discussions on the strengths and weakness of existing City of Lincoln outdoor lighting related standards are from a perspective with the following questions:

1. Are conformance requirements clear?
2 Are conformance requirements achievable?
3. Are conformance requirements technically correct?
4. Can the standards intent be improved and at what cost?
5. What are the enforcement provisions?

STREET LIGHT DESIGN STANDARDS

The conformance requirements of this Lincoln standard are clearly stated and long time practice has proven that the requirements of the standard are achievable.

Based on the heavily researched, extensively field-tested, recommended roadway lighting practices of the Illuminating Engineering Society of North America (IESNA), Lincoln's Street Light Design standards cannot be called technically correct. The standards do refer to the IESNA recommended light levels for roadway lighting design but mandate that Lincoln's non-residential roadway lighting systems, be designed to 70 percent of IESNA recommended light levels. For residential roadways the standards do not include a reference to an IESNA recommended practice. They specify a 70 watt, HPS, pole top, fixture mounted generally 20 feet above grade at all intersections and approximate mid-block spacing of 240 feet.

This design standard was written and adopted in the 1970's. It seems heavily influenced by the energy concerns that arose after the first oil embargo of 1972. In fact, the document's main focus appears to be the reduction of energy consumption by roadway lighting systems and other budget control measures. The quality, quantity and safety of roadway lighting systems are not mentioned in the document except by reference to using 70% of IESNA recommended light levels.

The present Street Lighting Design Standards can be improved technically by adoption of the IESNA recommended practices for roadway lighting. These practices would require more fixtures to be used in residential areas with an increase in installation, operation and maintenance costs. There should be little or no cost increases for other Lincoln roadways since designers are asked by LES to meet IESNA recommended uniformities which often produces light levels at or near IESNA recommended levels.

This standard has no post construction enforcement provisions.

## DESIGN STANDARDS FOR PARKING LOTS

Section 3.8 of this City of Lincoln standard sets forth the Design Standards for Parking Lots. This standard does clearly state the conformance requirements for parking lot lighting systems. The current standard has been in effect since late 1994 without amendments. The conformance requirements are based on the recommended practices of IESNA except as noted in the standard.

The noted provisions in the standard that augment the IESNA recommended practices limit the maximum and minimum light levels, the horizontally measured light level at property lines is restricted to a specified level, minimum uniformity is specified and the fixture optical performance with respect to light above the horizontal is defined. Practical applications over the years have proven that these conformance criteria are achievable.

The technical weaknesses of this standard are its reference to the IESNA Lighting Handbook, 8$^{th}$ Edition and the lack of a specified maximum vertical foot-candle (glare) level at the property line. The reference to the IESNA handbook is to be commended but the reference should be amended to say “current edition”. Inclusion of a maximum level for property line vertical foot-candles would limit both light trespass (horizontal foot-candles) and glare (vertical foot-candles). Consideration should be given to making these levels “initial” in lieu of “average maintained”. The cost impacts of these amendments would be zero to negligible.

The standard has no post construction enforcement provisions and does not address hours of operation by all or part of such systems.

## DESIGN STANDARDS FOR RECREATIONAL FACILITIES

Section 5 of this City of Lincoln standard sets forth the Design Standards for Outdoor Recreational Lighting. It also specifies how long such systems may remain on for any given activity. As with the Design Standards for Parking Lots, the conformance requirements for this standard are clearly stated and have been in effect since late 1994 without amendments. The standard’s conformance requirements are based on recommended practices of IESNA except as noted in the text of the standard.

The noted provisions in the standard that augment the IESNA recommended practices limit the maximum light levels, the horizontal and vertical measured light levels at property lines is restricted to specified levels, and the fixture optical performance with respect to light above the horizontal is defined. Practical applications over the years have proven that these conformance criteria are achievable.

The technical weaknesses of this standard are its reference to the IESNA Lighting Handbook, 8th Edition and the lack of a specified maximum aiming angle down from horizontal. The reference to the IESNA handbook should be amended to say "Recommended Practice for Sports and Recreational Areas RP-6, latest edition. The standard now limits both light trespass (horizontal foot-candles) and glare (vertical foot-candles). Consideration should be given to making both these levels "initial" in lieu of "average maintained" for the horizontal level. The cost impacts of these amendments would be zero to negligible.

The standard has no post construction enforcement provisions although all Parks and Recreation projects completed since 1994 have required post construction proof of performance testing as part of the construction documents.

LINCOLN SIGN CODE

The Lincoln Sign Code applies to all outdoor signs within the City of Lincoln and within three miles of the corporate limits of Lincoln.

Electrical references can be found throughout this document. These references deal with the requirements of electrical components and materials as well as the need for compliance with the National Electrical Code (NEC) and the Lincoln Electrical Code. There are no references to the performance of lighted signs.

This standard has no post installation enforcement provisions.

SIGNS

Sections 27.69.30 (a), (b) & (c) and 27.69.35 (c) of this standard have specific requirements for performance and operation of lighted (illuminated) signs.

The lighting requirements of Section 27.69.30(a) restrict the brightness (luminance) of the sign at the property of the property on which the sign is located. The restriction is to 300-foot lamberts or less.

Section 27.69.30(b) prohibits blinking or flashing of the sign or by devices used to illuminate the sign. Mobile signs are exempted.

Section 27.69.30(c) prohibits a sign from moving, rotating, revolving or having such movements simulated by reflective devices or lighting.

The conformance requirements of these sections are reasonably clear and have been in effect since 1979. The use of the word illumination to refer to the sign brightness limitation is technically incorrect. The reference to the brightness restriction as 300 foot lamberts or less employs a term no longer used by the lighting industry. The current IESNA term (candela/sq meter) or the sign industry's term ("Nits") are used in the 2006 update to this code.

Employing the correct term for brightness and the modern units in lieu of foot-lamberts will not increase costs.

Consideration should be given to limiting the surface brightness of the sign face rather than at the property line since other sources could influence that measurement making testing and enforcement difficult.

The allowable brightness limit should be reviewed. An adjustment of this brightness limit should not impact costs.

Section 27.69.35(c) restricts the hours of operation for off-premise signs and requires such signs to be illuminated by "down lighting" methods, if illuminated at all.

The term "down lighting" should be defined more clearly and signs that generate their own

luminance should be dealt with.

The sign code (27.69 LMC) was amended in December 2006 to reflect LED technology and sign animation.

ENVIRONMENTAL PERFORMANCE STANDARDS

Outdoor lighting references in the Environmental Performance Standards for B-2 Planned Neighborhood Business District, B-5 Planned Regional Business District, I-2 Industrial Park District, I-3 Employment Center District, O-3 Office Park District are in Section 8 of the document.

The conformance requirements in Section 8.1 include light fixture performance requirements in technical language using terms such as candlepower per 1000 lamp lumens, nadir, and foot-lamberts per unit projected surface area.

Section 8.1 also contains language restricting sign and building facade “brightness” (luminance). One of the sign restrictions conforms to the level mentioned in the sign code. The other two sign restrictions appear only in this section. The building façade brightness restriction appears only in this section.

Another paragraph talks about lighted streets and pathways used by the public at night needing to conform to City of Lincoln standards for residential ornamental lighting. It then states these requirements as 15 average maintained foot-candles at a uniformity ratio of 10:1. The 15 number would seem to be a typographical error. The street light standards previously discussed do not mention a foot-candle level or uniformity ratio for residential streets.

The last paragraph of Section 8.1 calls for a restriction of 0.5 horizontal foot-candles at property liens of these districts if they abut a residential district. This restriction includes direct and indirect illumination and does not specify whether or not the level is to be initial or maintained foot-candles.

Section 8.2 of this standard defines the capabilities of meters used to verify the performance standards.

The requirements of this standard for outdoor nighttime lighting clearly stated, have conflicts with other standards and are not easily complied with. The description of the capabilities of the meter used for verification of conformance needs updating and clarification.

The improvements to the wording of this standard should not increase costs if the requirements are not changed but are made easier to understand and comply with.

DESIGN STANDARDS FOR OUTDOOR LIGHTING

Design Standards for Outdoor Lighting is a one-page document that identifies the other Lincoln standards related to outdoor lighting. It also specifies a 0.5 foot-candle limit for light trespass at a residential property line. All of these standards have been addressed in the preceding discussions. With the completion of the proposed design standards, this Standard will not be required.

## VI. THE STUDY PROCESS

Lincoln's decision to execute a comprehensive outdoor lighting study and propose a set of design standards, while not unique, certainly kept the City in the vanguard of forward looking communities whose vision is centered on the quality of life to be enjoyed by its citizens. That Lincoln also decided to do a study of existing outdoor lighting in the community as an integral part of developing the proposed standards is unique from this consultant's perspective. The soundness of looking at where you have been and where you are now as the platforms for visioning where you should be in the future is fundamental.

As the precursor to developing proposed design standards for outdoor lighting, the comprehensive study of outdoor lighting was implemented to gather information from areas identified as beneficial to the development of any standards. These areas included:

1. A night time survey of lighted outdoor venues in Lincoln.
2. A review of Lincoln's existing lighting standards.
3. A review of lighting codes from other communities.
4. The SCTB's potential impact on night lighting close to SCTB breeding areas.

### THE SURVEY

The survey of existing outdoor lighting installations in Lincoln is the subject of its own section of this report, (Section VIII). The importance of this survey lies in the information gathered. The data provides answers to questions such as: What are the current outdoor lighting practices in Lincoln? What is happening at locations that have generated citizen complaints? Are current regulations being complied with? What is working?

The information gathered from the survey was shared with the Outdoor Lighting Advisory Task Force. The information and discussions of the survey findings served as a reference datum for the Outdoor Lighting Advisory Task Force as they considered the possible content of the proposed new standards for outdoor lighting.

## EXISTING LINCOLN LIGHTING STANDARDS

As detailed in Section V of this study, the City of Lincoln has had outdoor lighting standards since the late 1970's. With the single exception of the street lighting standard, Lincoln's existing outdoor lighting standards were developed in response to citizen complaints about lighting system impacts on their quality of life.

A primary emphasis on the existing regulations, from this study's perspective, was identification of strengths and weaknesses. The objective was to utilize the strengths and correct any weaknesses through the proposed code.

The table below summarizes the findings of the review of Lincoln's existing outdoor lighting standards. For detailed information on the review see Section V of this study.

## EXISTING LIGHTING STANDARDS – REVIEW SUMMARY

| Standard | Requirements Clear | Requirement Achievable | Technically Correct | Content Be Improved | Enforcement Provisions |
|---|---|---|---|---|---|
| Street Lighting | Yes | Yes | No | Yes | No |
| Parking Lot | Yes | Yes | Yes | Yes | No |
| Recreational | Yes | Yes | Yes | Yes | No |
| Sign Code | No | Yes | No | Yes | No |
| Environmental Performance | No | No | No | Yes | No |
| Design Standards | Yes | Yes | Yes | Yes | No |

## STREET LIGHTING RECOMMENDATIONS

The Outdoor Lighting Advisory Task Force found that current design practices for non residential roadways in Lincoln create lighted environments that closely comply with IESNA recommendations for these types of roadways. They concluded that there would be little or no cost impacts to the City to require that all non residential roadway lighting in Lincoln comply with the recommended criteria of IESNA. It is the Task Force recommendation that roadway lighting levels comply with IESNA recommendations.

Prototype design models were used for analysis of Lincoln's current residential street lighting parameters and those recommended by the IESNA. The Outdoor Lighting Advisory Task Force's analysis of the residential street lighting prototype designs found that the existing Lincoln parameters, while not meeting IESNA recommended levels, have performed acceptably for nearly 30 years. Police data does not indicate that current residential street lighting practice has a negative effect on traffic incidents nor citizens' sense of safety.

The Outdoor Lighting Advisory Task Force found, by way of prototype designs, that requiring residential street lighting to conform to IESNA recommended criteria always increased the number of pole/fixture units required which equated to higher costs for a betterment with little or no perceived benefit to the quality of life in Lincoln.

Lincoln also has in place two ways that neighborhoods can increase the number of street lights if they elect to as a neighborhood. One way is by direct petition to LES. The second way is through Urban Development revitalization projects, when funding is available for such projects. Should neighborhoods elect to pursue either of these options it is conceivable that the outdoor lighting system's design will want to address other criteria in addition to lighting of roadways. It seems prudent that the proposed outdoor lighting design standards allow for the consideration of these additional criteria.

PARKING LOT RECOMMENDATIONS

The requirements of Lincoln's parking lot lighting standard have stood the test of time. The Outdoor Lighting Advisory Task Force considered other approaches found in codes and ordinances from communities across the nation. Elements considered from these codes and ordinances included maximum allowed pole heights near residential land uses, allowing only low pressure sodium lamps as the source of light and the inclusion of a vertical foot-candle maximum limit at the property lines for parking lots.

To properly assess the impact of these additional light control parameters on parking lot lighting design, the Outdoor Lighting Advisory Task Force was provided with prototype designs for a "typical" parking lot (See Section 7, Items II and VII of the Appendix). The prototype lighting designs were done to reflect a parking lot conforming to Lincoln's existing requirements and a parking lot that would conform to the additional light control parameters under consideration. The two designs were evaluated by the Outdoor Lighting Advisory

Task Force with respect to the quantity of light, the quality of the light produced, the light trespass and glare and the number of pole/fixture units required to satisfy the criteria.

The consensus of the Outdoor Lighting Advisory Task Force after evaluating the prototype designs was that Lincoln's existing parking lot standard performed the best overall. The Lincoln based design provided a very adequate quantity of light with better uniformity and used only nine pole/fixture units compared to fifteen for the other prototype design. The non Lincoln based design had a lower vertical foot-candle number at the property line but the Lincoln based design's vertical foot-candle number was less than currently required at the property line by Lincoln's "Outdoor Recreational Lighting Standard" and "Design Standards for Outdoor Lighting".

## OUTDOOR RECREATION RECOMMENDATIONS

Discussions in the Outdoor Lighting Advisory Task Force meetings with respect to Lincoln's existing standard for "Outdoor Recreational Lighting" concluded that all City projects completed in conformance with the existing requirements have been well received by neighbors and sports participants. Updated wording was recommended for one criteria.

## CODES FROM OTHER COMMUNITIES

Five copies of lighting codes or ordinances from other communities were provided to the Outdoor Lighting Advisory Task Force early in the process. These documents, selected from a national cross section, were used by the Outdoor Lighting Advisory Task Force to become familiar with how other communities approach compiling a code and to see the fairly broad spectrum of outdoor lighting situations covered or not covered by codes. Copies of these codes can be found in Section 4 of the Appendix.

The sample codes distributed to the Outdoor Lighting Advisory Task Force members came from the following communities:

1. Flagstaff, Arizona
2. Palm Desert, California
3. Manatee County, Florida
4. Centre County, Pennsylvania
5. The Model Wisconsin Exterior Lighting Code

The most restrictive sample codes were the Model Wisconsin Exterior Lighting Code which borrowed heavily from the International Dark-Sky Association (IDA) model code and the Flagstaff code. Flagstaff, Arizona is known as the "The First International Dark Sky City". There are two astronomical observatories in or near Flagstaff. A physicist who works at Flagstaff's U.S. Naval observatory chaired IDA's model lighting code committee. These two codes had many similarities.

The codes from Palm Desert, Manatee County and Centre County did have some similarities, but different approaches and different levels of detail and definition.

Some of the codes were very technical and detailed concerning what could be done, what equipment could be used, when lighting systems could be on, and the type of submittals that were required to prove a project's compliance with the code requirements. Other codes were written more for nontechnical audiences and with less intense submittal requirements.

The Outdoor Lighting Advisory Task Force was asked for input as to which code's approach and language would be best suited to Lincoln.

Subsequent to their initial review of the five documents the Outdoor Lighting Advisory Task Force met to discuss their individual reactions to the various formats, the different content and the perceived philosophy of the documents. Most members of the Outdoor Lighting Advisory Task Force were of the opinion that the Flagstaff, Arizona lighting code and the Model Wisconsin Exterior Lighting Code contained requirements and limitations that took the control of exterior lighting systems considerably beyond the present and perceived future needs for Lincoln, Nebraska. Examples of the requirements and limitations that the Outdoor Lighting Advisory Task Force considered beyond Lincoln's needs included:

1. Requiring all street and parking lot lighting to be done with low pressure sodium (LPS) lamps and fixtures.

2. Allowed maximum number of total lumens per acre for land development or redevelopment. Maximum lumens allowance was dependent on which astronomical zone the land was located in.

3. Curfew for the use of illuminated signs.

The discussions in regard to the other sample codes also included some of their requirements that the Outdoor Lighting Advisory Task Force strongly believed were not needed in Lincoln. These included:

1. A complete ban on the use of search lights.

2. Discouraging the use of street lights.

3. Geographic specific language and limitations such as “Toe of Slope” and trigonometric calculations concerning direct sight to a fixture’s lamp.

Several of the sample codes contained illustrations as graphic examples of definitions and terms in the codes. A few of the codes contained lengthy sections devoted to discussions of human visual mechanisms, lighting design, lamps and fixtures. The Outdoor Lighting Advisory Task Force generally found these sections of the sample codes to be interesting and informative. The consensus, however, was that although potentially beneficial to the publics understanding of lighting terms and considerations, these efforts were best kept completely separate from the code itself.

At least one half of the sample codes reviewed by the Outdoor Lighting Advisory Task Force contained statements or sections explaining the philosophy or collective philosophies behind the lighting code. A few contained philosophy statements directly preceding significant requirements or restrictions in the code. As with the educational efforts previously discussed, the majority of this Outdoor Lighting Advisory Task Force believes philosophy statements or discussions should be separate from the code.

All of the sample codes had definition sections wherein were contained that code's particular meaning for terms or language used in the body of the code. The Outdoor Lighting Advisory Task Force quickly noticed that some apparently identical terms had somewhat different definitions in different codes. Many of the definitions are terms commonly used in lighting texts and by lighting designers. They are in fact the lexicon of the lighting industry and are formally defined by the IESNA Lighting Handbook, latest edition. Dr. Kevin Houser with the Consultant Team strongly recommended that the Outdoor Lighting Advisory Task Force not include definitions in the proposed standards and by reference use the industry standard definitions found in the IESNA Lighting Handbook, latest edition. Dr. Houser added that lighting and lighting design are technical areas. Trying to reword these definitions almost always leads to confusion when applying the standards and often provides loopholes that could allow designs that do not comply with the intent of the standard. Although the proposed design standards do include definitions, they use IESNA language.

As a result of reviewing the five sample codes and the many discussions that were part of the review process, the Outdoor Lighting Advisory Task Force agreed to proceed with developing a proposed lighting standard under the following criteria:

1. The proposed standard's approach would be based on the approach used for the Palm Desert, California "Outdoor Lighting Requirements" but the layout would follow that of the Lincoln Design Standards.

2. The IESNA Lighting Handbook, latest edition would be the technical reference for definitions and recommended practices for the proposed standards.

3. All content of the proposed standards would be measured against the Outdoor Lighting Advisory Task Forces goals and expectations for the proposed code. These goals and expectations are set forth in Section X of this study.

## VII. THE OUTDOOR LIGHTING ADVISORY TASK FORCE

The City of Lincoln Planning Department understood from the beginning that the successful preparation of an outdoor lighting design standards for the community would need to be a team effort. That team would need to have a component that provided for input to the process from the major sectors of the community which would be impacted by any lighting code submitted for adoption. In concert with this understanding, the Planning Department as the lead agency for the City of Lincoln, created an Outdoor Lighting Advisory Task Force to assist staff and the consultant in identifying issues and developing language for an outdoor lighting design standard.

The Outdoor Lighting Advisory Task Force would be comprised of citizens and City staff who had an interest and expertise in lighting issues. The expectations for which the Outdoor Lighting Advisory Task Force would be in charge were:

- Review and provide information
- Provide comment, insight and suggestions
- Assist in the process
- Assist in identifying future challenges
- Assist in reviewing and providing comment on portions and elements of the studies
- Evaluate and make recommendations to the Planning Department regarding all aspects of the study

Based upon the experience of staff and input from various other sources, the Outdoor Lighting Advisory Task Force membership became as follows:

<u>Neighborhood Representatives</u>

Terry Adair (Holmes Lake Area)
4200 Ridgeview Drive
Lincoln, NE 68506

Clark DeVries (Near South Area)
1844 Washington ST.
Lincoln, NE 68502

Business Representatives

Allen Wachter
Valentinos Corporate
2601 S 70th Street
Lincoln, NE 68506

Craig Mason (later Peter Katt)
Lincoln Independent Business Association
620 N 48th Street, Suite 205
Lincoln, NE 68504

Don Linscott
MEGA Commercial Corp
300 N. 44th St., Suite 100
Lincoln, NE 68503

Astronomical Community

Dr. Martin Gaskell
UNL Department of Physics & Astronomy
Lincoln, NE

Erik Hubl
Hyde Observatory
Lincoln, NE

Lincoln City Staff

Steve Young
Lincoln Electric System

Terry Kathe
Building and Safety

Mike DeKalb
Planning Department

Tom Cajka
Planning Department

Sgt. Don Scheinost for - Capt. Terry Sherrill
Police Department

J.J. Yost
Parks Department

Rick Peo
City Attorney's Office

Over the course of nearly 17 months the originally proposed 6 meetings of the Outdoor Lighting Task Force grew to a total number of 25. The need for additional meetings arose from the task force members desire to be well grounded in current Lincoln outdoor lighting practices and equipment and to be more comfortable with lighting terminology related to the proposed outdoor lighting design standards. Over the course of the meetings the members of this Outdoor Lighting Advisory Task Force participated in the following:

1. Review and analysis of lighting codes from across the United States.

2. Development of a nighttime survey that eventually grew to 39 locations in Lincoln as a bench mark for reference to night lighting practices in Lincoln.

3. Watched several power point presentations relating to light fixture types and photometric characteristics, light sources, wall mounted fixture types, lighted sign types and surface brightness.

4. Examples of cost impacts as a result of certain code criteria and the photometric (lighting) difference to the various approaches.

5. Presentations by various Outdoor Lighting Advisory Task Force members on their own research into particular topics that had come up in discussion.

Outdoor Lighting Advisory Task Force discussions were always interesting, often resulting in consensus on issues, sometimes drawing sharp lines of disagreement on points and invaluable sources of input for the Planning Department and the consultant.

## VIII. THE NIGHT TIME SURVEYS

From the onset of the study process a survey of exterior commercial lighting practices in Lincoln has been deemed critical to the successful preparation of a proposed outdoor lighting design standard. Those involved in preparing the proposed design standards were committed to the belief that being familiar with a significant sample of existing exterior commercial lighting installations in Lincoln was a prerequisite to beginning the process of preparing a proposed lighting standard for Lincoln, Nebraska.

One key element of the survey was the identification of information to be gathered from each site. Since most complaints received by the City involved various levels of annoyance with glare or light trespass, it seemed logical that data on these two parameters be collected at the survey sites. Glare would be recorded as vertical foot-candles at 5'-0" above grade. Light trespass would be recorded as horizontal foot-candles at 3'-0" above grade. The location on the site where these parameters were recorded would be the surveyor's best approximation of the property line of the site.

Critical to the Outdoor Lighting Advisory Task Force's viable use of the data gathered by the survey was the relevance of the locations chosen to be surveyed. Lincoln's lighting related complaints history once again provided guidance to the type of sites that should be included in the survey. That history indicated the following types of sites should be included in the survey:

1. Automobile Dealerships
2. Convenience Stores
3. Lighted Athletic Fields
4. Wall Mounted Lighting Locations
5. Parking Lots

One of the survey locations was chosen because it is in the heart of known SCTB breeding areas.

Twenty-one sites were originally identified to be included in the survey. The final number of sites surveyed was forty one. Members of the consultant study team and their point of contact with the City toured the original twenty-one sites for the purposes of determining, in the field, the points at which the foot-candle readings would be taken. As a part of the survey, digital photographs were taken at the location for the foot-candle readings, looking back to the source of the light. The data from each site in the survey, the digital photographs taken, and a vicinity graphic showing where foot-candle readings were taken are displayed on separate sheets in Section 3 of the Appendix to this study.

Subsequent to completion of the original survey, three bank ATM sites were added to provide information on a site type where good visibility and a sense of security are important. These sites are included as sheets in Section 3 of the Appendix.

Of the sites surveyed, those which would comply, if compared to the light trespass (horizontal foot-candles) and glare (vertical foot-candles) restrictions for parking lots and outdoor recreational lighting, are:

Appendix 3

| Photograph Number (s) | Location |
|---|---|
| 6 | Arbor Lakes |
| 7 | 27th & Arbor Road |
| 12 | Walgreen's at 27th & Vine |
| 14, 15 & 16 | Apartment Complexes near 27th, R & S Streets |
| 18 | St. Elizabeth Campus |
| 20 & 21 | Chateau South at 27th & Van Dorn |
| 22 & 23 | Talent + at 65th & Pioneers |
| 24 | Car Wash at 70th & Highway 2 |
| 25 | On The Go Convenience Store at 48th & Highway 2 |
| 26 | Super "C" Convenience Store at 3100 Village Drive |
| 28 | South Pointe Parking Lot 27th & Pine Lake |
| 29 & 30 | Duteau Auto Dealership at 27th & Pine Lake |
| 32 | U-Stop Convenience Store at 27th & Stockwell |
| 33 | Kabredlo's Convenience Store at 17th & Washington Streets |
| 34 & 35 | Nebraska Wesleyan Football Stadium at 56th & Baldwin |
| 36 | Union College Athletic Fields at 56th & Calvert |
| 37, 38, & 39 | 3 Stand Alone ATM Locations |

When the Outdoor Lighting Advisory Task Force considered design standards language for different exterior lighting locations, the results of the night time survey proved very useful in providing a reference of what exists in Lincoln today and what light level parameters should be suggested for use in the proposed design standards.

During the development of the draft Outdoor Lighting Design Standards, the consultant team and various task force members made follow up visits to some survey locations.

## IX. THE SAMPLE CODES/ORDINANCES

The process for development of a proposed Design Standard for Outdoor Lighting in Lincoln, Nebraska began with the concept that others had been through it all before and the Outdoor Lighting Advisory Task Force stood to benefit from a review of existing lighting codes and ordinances. Early research of available codes indicated the existence of a large number of lighting codes/standards, some “model lighting ordinances” and articles offering guidance on “how to” put together a lighting code or ordinance. These were all in addition to the ordinances already obtained by the Planning Department and the several ordinances that the consultant had experience complying with.

The consultant was directed by the Planning Department to select five sample ordinances or codes from different geographic regions of the United States and representing a wide variety of formats and approaches. These five samples would be given to the Outdoor Lighting Advisory Task Force who would, after review and consideration, make a recommendation to the Planning Department as to the preferred format/approach for the Lincoln code.

The five sample codes/ordinances selected for consideration are listed below. Copies of the five codes/ordinances may be found in the Appendix to this study:

<u>Sample Lighting Codes/Ordinances</u>

1. Centre County, Pennsylvania
2. The Model Wisconsin Exterior Lighting Code
3. Palm Desert, California
4. Manatee County, Florida
5. Flagstaff, Arizona

The Centre County ordinance is a concise, six page document that utilizes a table to identify the allowable light levels (foot-candles) and fixture mounting heights for different zoning districts and other specific uses. The table has six footnotes and an additional section that contains fourteen specific situation requirements or exclusions.

The Model Wisconsin Exterior Lighting Code is a document produced by the University of Wisconsin Extension Solid and Hazardous Waste Education Center. It was written as a guide for communities, agencies, governmental subdivisions and other organizations, primarily in Wisconsin, to use when authoring an exterior lighting code or ordinance. As stated in the Acknowledgments section of the document, this work is comprised of much adapted material from the “Outdoor Lighting Code Handbook” put out by the International Dark Sky Association (IDA). The entire document is over sixty-five pages in length. It is a very detailed work whose first twenty pages are a tutorial on lighting terms, lamps, fixtures and “good” and “bad” exterior lighting practices. The ordinance has verbiage on a lighting philosophy of what is acceptable and non-acceptable practices as well as what is the intent of the model ordinance. The actual ordinance language defines lighting “zones” and “classes” of lighting (general illumination, decorative, etc.) and the allowable “lumens per acre” for each zone type and all classes of lighting within the particular zone.

The Palm Desert outdoor lighting document is a chapter in the Palm Desert Municipal Code. It is an eighteen page document with sixteen sections ranging from “Purpose and Intent” to “Violations Constitute Public Nuisance”. The code is based on definitions of classes of lighting. For each class of lighting the code specifies the allowable number of non cutoff fixtures, light trespass and glare limits, pole height limitations and allowable hours of operations. This code does not specify allowable illumination (foot-candle) levels or other lighting design criteria.

The Manatee County Outdoor Lighting regulations are part of their Land Development Code. It is a thirteen page document. The first six pages of the code are definitions of terms relating to lighting, lamps, fixtures, and shielding. Many of the definitions have graphics to highlight details of the definitions. This code does not specify allowable illumination (foot-candle) levels or other lighting design criteria. The focus of this code was on defining what type of lighting equipment is or is not allowed to be used and sharply limits the use of light fixtures or equipment that is not “fully shielded” as spelled out in the definitions section of the code. It deals with allowable pole heights and calls for the use of lighting controllers. The language is often vague or confusing as to exact compliance requirements.

A welcome sign for people entering Flagstaff, Arizona identifies this community as the “The First International Dark Sky City”. Flagstaff is home to two astronomical observatories and the lighting code for the City is a sixty-one page chapter in its Land Development Code. All of the terms used in the lighting section are defined in a separate thirty-five page chapter of the Land Development Code. The lighting code establishes Astronomical Zones and defines allowable amounts of outdoor light per acre for each of the zones. The most restrictive zone is the one that contains the two astronomical observatories. The restrictive level of each zone is reduced by distance from the observatories. The code is very detailed about what is allowed for outdoor lighting and specifies the type of source (lamp) which may be used as well as the types of fixtures, pole heights, and signage. Outdoor lighting is divided into three classes primarily to allow specification of light source and fixture type by Astronomical Zone.

## X. GOALS AND EXPECTATIONS OF THE COMPREHENSIVE OUTDOOR LIGHTING STUDY

A review of Lincoln's existing outdoor lighting standards and citizen concerns related to outdoor light sources negatively impacting their personal lives and property led to the City of Lincoln's commissioning of this study. Lincoln's existing ordinances related to outdoor lighted venues, although fundamentally sound, are limited in scope and do not apply to many of the situations now generating citizen complaints. Lincoln's existing standards do not have enforcement clauses.

As a part of the Comprehensive Outdoor Lighting Study an Outdoor Lighting Advisory Task Force was assembled. The members of this task force were asked to become acquainted with a broad range of information relating to outdoor lighting. Information was gathered from national and local sources. The material included samples of existing ordinances from a geographic cross section of the nation, night lighting information from more than 39 locations in and around Lincoln and research results on the attractive effect of artificial light sources on the endangered SCTB. From the assimilation of this information and the discussions that it generated, the Outdoor Lighting Advisory Task Force identified the following goals and expectations for the Comprehensive Outdoor Lighting Study and the proposed lighting standards it is to provide:

1. The intent of the proposed standards and the history of the Outdoor Lighting Advisory Task Force process should be in the study document, not the proposed standards.

2. Glare should be addressed for each type of outdoor lighting covered by the proposed standards.

3. Light trespass should be addressed for each type of outdoor lighting covered by the proposed standards.

4. Correct known deficiencies in existing standards in appropriate sections of the proposed standards.

5. The proposed standards will need to include provisions for lighting near SCTB habitat that addresses USFWS recommendations with respect to breeding areas and property abutting breeding areas.

6. Simplicity, practicality, enforceability and protection of Lincoln's quality of life should all be guidelines by which the proposed standards content is evaluated.

The Outdoor Lighting Advisory Task Force believes that a study and proposed standards that meet these goals and expectations will address the citizen concerns while limiting upward waste light (sky glow) and encouraging energy conservation.

## XI. DRAFT DESIGN STANDARDS FOR OUTDOOR LIGHTING

PREFACE

The draft design standards for outdoor lighting included in this section are the product of many hours of research, study and discussion by the members of the Outdoor Lighting Advisory Task Force, City of Lincoln staff and the consultant. The final draft sent to Task Force members in December 2007 was a product of many additional hours of refinement by Planning Department staff.

## XII. IMPLEMENTATION, ENFORCEMENT, EDUCATION AND TRAINING

Completion of the "Comprehensive Outdoor Lighting Study" and the proposed standards is just the first step in a process whereby Lincoln may end up with new outdoor lighting standards. The next step involves a meeting to introduce the proposed standards to the community. This meeting will also present graphics used to demonstrate points to the Outdoor Lighting Advisory Task Force and the outdoor lighting survey results for viewing by the community.

Subsequent to receiving and evaluating comments from the community, the proposed outdoor lighting design standards will be presented to the Planning Commission. The Planning Commission will review and evaluate the proposed standards. Should the proposed standards secure the approval of the commission they will be sent on to the Lincoln City Council for it's consideration as an addition to the City of Lincoln Design Standards. Approval by the Council would make the standards a part of the City's design standards.

Implementation of the outdoor lighting design standards would begin with development and redevelopment projects that are submitted after the effective date of the ordinance adopting those standards. Compliance with the requirements of the standards would be established by way of the submittals specified in Section 11, Submission of Plans and Evidence of Compliance of the proposed design standards. This section places proof of compliance on the professional engineer, NCQLP certified lighting designer or licensed electrician who signs the submittal material. This requirement is very similar to the submittal requirements already in place for parking lots and outdoor recreational facilities. The City may want to consider a fee that would allow for a 3rd party overview and compliance analysis.

Enforcement could be through a process of random checks of light trespass and glare limits on constructed projects. Enforcement of the outdoor lighting design standards requirements could include requiring confirmation from the entity who signed the submittal material that construction complies with submittal material. City Staff or a City Consultant could perform random checks of light trespass and glare at selected property lines of selected projects. Complaints would be followed up on as they are confirmed as legitimate by City Staff. Non compliant projects would be required to achieve compliance.

The Lincoln Parks and Recreation Department currently requires a “Proof of Performance” test on all new and replacement sports lighting projects. This test requires meter readings on the field or fields as well as trespass and glare readings at all property lines not abutting road right of ways.

The benefits of an outdoor lighting code are not usually self evident to the community at large. Education materials that explain common lighting terms, demonstrate the benefits of good lighting practices, make a case for better utilization of lighting while reducing wasteful lighting and lift up the rewards of a quality lighted outdoor environment have been used with success in other communities. An example of one such pamphlet is included in the appendix to this study. Similar material is contained in the first twenty pages of the Model Wisconsin Exterior Lighting Code. A pamphlet or similar handout is being considered by the Planning Department as a means of providing the public with non technical information on outdoor lighting practices and equipment. Similar information could be posted on the City’s website.

Training for City Staff who may be asked to verify lighting project compliance with code requirements could be provided by a consultant or a previously trained staff member. Training would include appropriate methods for obtaining foot-candle readings as well as the types of equipment necessary for valid results. Standardized documentation of the results of field investigations would need to be developed.

C:\WINDOWS\temp\notes6C2F42\ComprehensiveLightingStudyFINALJan'08_108.wpd

**January 3, 2008**
**Final Lighting Study Report**

**Amendments will be required to 2.30,3.00,3.45 and 3.55 in the Design Standards and 27.LMC**

# Chapter 3.100

# DESIGN STANDARDS FOR OUTDOOR LIGHTING

*The Building and Safety Department is assigned responsibility for administration of these design standards.*

## Section 1. GENERAL PROVISIONS

All outdoor luminaires installed after the effective date of the resolution, shall be installed in conformance with the provisions of this chapter and the applicable provisions of the City of Lincoln regulating the installation of such fixtures.

No illumination source shall exceed initial output of 2850 lumens unless it is within a cutoff or full cutoff luminaire, except for luminous tube lighting such as neon, cold cathode and fiber optic cable, or as specified for Class II or Class III lighting, or as otherwise provided in this chapter.

All fixtures greater than 2850 lumens ,except as specifically provided for in this chapter, shall be mounted level in the horizontal and vertical axis with the central part of the beam directed vertically downward.

The installation of any mercury vapor luminaires for use as outdoor lighting is prohibited.

## Section 2. MATERIALS AND METHODS OF INSTALLATION

The City of Lincoln encourages the use of quality materials, methods and designs. It is not the intent of this chapter to prevent the use of any design, material or method of installation not specifically forbidden; provided, any such alternate has been approved. The Building and Safety Department may approve any such proposed alternate if manufacturers' documentation provides satisfactory evidence that the proposed alternate is equivalent to the applicable requirements of this chapter.

## Section 3. DEFINITIONS

The following terms and definitions shall apply in the enforcement and interpretation of this chapter:

**Class I lighting (Commercial)** shall mean all outdoor lighting used to illuminate commercial outdoor areas including, but not limited to lighted canopies, (e.g. service stations, convenience stores and banks) restaurant areas, auto impoundments, automotive dealership display and assembly and repair areas.

**Class II lighting (Walkways, Security and Accent/Decorative)** shall mean all outdoor lighting used to illuminate walkways, provide security and used for accent or decorative effects. Examples of Class II lighting include, but are not limited to, illumination for walkways, equipment or material storage yards, outdoor security and the illumination of landscape features, flags, pennants or banners, fountains, statues, art work, and building walls.

**Class III lighting (Street Lighting)** shall mean all outdoor lighting used to illuminate public streets or highways and private roads subject to public access easement.

**Class IV lighting (Off-Street Parking)** shall mean all outdoor lighting used to illuminate off-street parking in public or private parking areas.

**Class V lighting (Outdoor Recreational Facilities)** shall mean all outdoor lighting used to illuminate outdoor recreational facilities.

**Class VI lighting (Salt Creek Tiger Beetle Environ)** shall mean all outdoor lighting used to illuminate the area with Salt Creek Tiger Beetle environs (this is a holding class for anticipated Federal Standards).

**Cutoff and Full-Cutoff** shall mean outdoor light fixtures shielded or constructed by the manufacturer so as to comply with the Illuminating Engineering Society of North America (IESNA) definition for cutoff and full cut-off outdoor lighting fixtures as found in the IESNA Lighting Handbook, 9$^{th}$ edition.

**Display Area** shall mean the area used for the outdoor display of merchandise for sale including aisles between the display.

**Field Angle** shall mean the angle of the cone of light from reflector lamps or flood luminaires encompassing the central part of the beam out to the angle where the intensity is 10 percent of maximum.

**Foot-candle (abbreviated fc)** shall mean a unit of measure of illumination (number of lumens per area) or how much light is on a surface. A foot-candle is defined as one lumen per square foot.

**Glare** shall mean the amount of direct or indirect artificial light (measured with the meter vertical at 5 feet above ground level and facing the brightest source) in excess of the vertical foot candle limits allowed by Section 10 of this chapter.

**IESNA** shall mean Illuminating Engineering Society of North America.

**Illuminance** shall mean the amount of light falling onto a unit area of a horizontal surface (luminous flux per unit area) measured in lumens per square foot (foot-candles) at 3 feet above ground level.

**Light trespass** shall mean the amount of direct or indirect artificial light (measured with the meter horizontal and facing upwards) in excess of the horizontal foot candle limits allowed by Section 10 of this chapter.

**Lumen** shall mean a unit of light emitted from a source. Where used in this chapter, lumen shall mean the "initial" manufacturer published amount emitted from the lamp or lamps constituting the source. (Note; 2850 lamp lumens is generally equivalent to one 35 watt high pressure sodium or one 150 watt incandescent lamp.)

**Luminaire** shall mean a complete manufactured and UL listed lighting unit consisting of a lamp or lamps, together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

**Mounting height** shall mean the distance from finished grade to the bottom most portion of any light emitting source, (e.g. lamp, surface of lens).

**Nit** is a unit of luminance equal to one candela per square meter.

**Outdoor recreational facilities** shall mean public, or private facilities designed and equipped for the outdoor conduct of sports, leisure time activities, and other customary and usual recreational activities. Outdoor recreational facilities include, but are not limited to, fields or stadiums for softball, baseball, football, soccer, golf courses, driving ranges and other "field sports," and courts for tennis, basketball, volleyball, handball and other "court sports."

**Parking area** shall mean an area, other than a street, designed or used primarily for parking of vehicles. This includes both "required" and "surplus" parking areas for residential, commercial and industrial uses, and inventory storage areas for automobile dealerships, but not display areas.

**Person** shall mean any natural person, firm partnership, association, corporation, company, or organization of any kind.

**Private** shall mean an area, street or facility that is not available for use by the general public.

**Public** shall mean an area, street or facility, whether publicly or privately owned, that is available for general public use, either free or for remuneration.

**Residential** shall mean an area or development in which the land use is zoned or used for single family, two-family or multi-family dwelling units. It shall include public streets and private roads within such areas.

**Wall pack** shall mean a luminaire mounted on a wall or soffit for the purpose of lighting the adjacent ground areas, walkways, streets or parking lots.

## Section 4. CLASS I LIGHTING (COMMERCIAL)

### 4.1 Requirements

A. Exterior lighting for outdoor auto display area and similar areas shall not exceed an average maintained illuminance of 20 footcandles.

If any portion of the outdoor auto display area is within 500 feet of residential zoning, the average maintained illuminance shall not exceed 20 footcandles and the luminaires shall be full cutoff for the entire outdoor auto display area.

B Outdoor areas under lighted canopies, such as gas pump islands and ATM bays, shall not exceed average maintained illuminance of 20 footcandles.

If any portion of the canopy area is within 500 feet of residential zoning, the average maintained illuminance shall not exceed 20 footcandles and the luminaires shall be full cutoff for the entire canopy area.

C. All other Class I lighting shall not exceed average maintained illuminance of 6 footcandles.

D. All Class I lighting levels shall be reduced to an average maintained illuminance level of 4 footcandles after business hours.

E. All Class I lighting shall have a maximum mounting height of 20 feet in residential zoned areas and a maximum mounting height of 30 feet in all other areas.

F. Design shall be done in accordance with the IESNA except as specifically provided in this section.

## Section 5. CLASS II LIGHTING (WALKWAYS, SECURITY, ACCENT/DECORATIVE)

### 5.1 Requirements

A. All luminaires used primarily for walkway or trail lighting shall have a mounting height no higher than 14 feet.

B. Luminaires used to illuminate buildings, flagpoles or landscape features may have lamps exceeding an output of 2850 lumens and be non-cutoff in design and aimed upward, but the field of angle of the lamp may not extend beyond the surface to be illuminated, or the luminaire must have shielding to provide the same limiting effect.

C. All Class II lighting must be selected, installed and aimed so that the amount of light trespass and glare beyond the area intended to be lighted is minimized or eliminated.

D. Illuminance on any lot shall not exceed 4 footcandles average maintained.

E. Design shall be done in accordance with the IESNA except as specifically provided in this section.

## Section 6. CLASS III LIGHTING (STREET LIGHTING)

### 6.1 General Requirements

A. This design standard recognizes that the City of Lincoln owns and is responsible for all costs of construction, operation and maintenance of class III lighting on public streets. Since the Lincoln Electric System (LES) has staff expertise in the area of lighting standards, design, operation and maintenance, LES has agreed to act as an advisor and contractor to the City for Class III lighting on public streets as described in this design standard. The City here by agrees to reimburse LES for the costs of these services provided to the City for lighting on public streets.

B. The (LES) shall prepare or approve all designs for all lighted streets. The LES will install and/or operate and maintain City of Lincoln street lighting for all lighted streets. LES shall establish, encourage, promote and employ energy conservation measures in the design, operation and maintenance of these street lighting systems.

C. Only high-pressure sodium (HPS) sources or an equivalent or higher efficiency source shall be used.

D. Street lighting may exceed trespass and glare standards.

E. All luminaires for street lighting shall be mounted level in the horizontal and vertical axis.

### 6.2 Design Requirements

Street lighting design shall be done in accordance with the IESNA "AMERICAN NATIONAL STANDARD PRACTICE FOR ROADWAY LIGHTING", latest edition, except as specifically provided in this section

## 6.3 Standard Street Lighting

LES may install/replace and maintain, "standard lighting" in any area where the City Council has not provided for "ornamental street lighting." Informal petitions signed by affected property owners or requests by the Mayor, City Council, Police Department or Public Works Department will precipitate investigation by LES Street Light Engineering to design and order the installation of justifiable lighting

The standard street light shall normally consist of a wood pole and bracket with a pendant luminaire. Wiring will be underground in areas with an underground source and overhead in areas with an overhead source. Whenever directed by the Public Works Department, wiring shall be installed underground.

For local residential streets**,** lamps shall be 70 watt high pressure sodium sources or equivalent efficiency sources. Poles shall generally be twenty feet high mounting height and placed at street intersections and mid-block with normal interval spacing of 240 feet.

For all other streets, the street lights intensity will be designed to 70% or higher of IESNA recommended practices depending on the uniformity.

## 6.4 Ornamental Street Lighting

Ornamental Lighting shall be constructed in areas designated by the City Council as "Ornamental Lighting Districts" or mayoral "Executive Order" areas and shall be of a design specified to provide illumination in accordance with these standards. Such systems are to be served by underground wiring and design/construction will consist of a metal, concrete or fiberglass Standard (pole).

For local residential streets the standard street lamp/luminaire will be post top with a 70 watt high pressure sodium vapor type light, or an LES approved lamp/luminaire source of equal or greater efficiency, mounted generally 20 feet above grade. The units shall be located at all intersections and at approximate mid-block normal interval spacings of 240 feet.

For all other streets, the street lights intensity will be designed to 70% <u>or higher of</u> IESNA recommended practices depending on uniformity. The City Council authorizes the City Engineer or subdivision developer (in the case of "Executive Order" areas) to advertise for equipment and installation-construction bids for ornamental lighting. LES is responsible for inspecting and monitoring work done by contractors and maintaining the lighting after its installation.

## 6.5 Supplemental Streetscape Lighting

Supplemental streetscape lighting shall be for decorative purposes only and are not intended to light the street. No supplemental streetscape light shall exceed 2850 lumens unless it is within a cutoff luminaire.

## 6.6 Existing Street Lighting (replacement)

LES will replace existing street lighting if it has been determined that maintenance of the existing system is no longer economically feasible. LES will replace the system with standard components equivalent to those currently being installed. Requests for special lighting equipment requires specific action by property owners/developers and approval by the LES Engineering staff.

If an existing wood pole (bracket style) area desires ornamental lighting, the property owners in that area shall pay the difference between such "standard street lighting" and "ornamental residential street lighting."

## 6.7 Arterial Street Lighting

"Permanent" arterial lighting consists of metal, concrete or fiberglass poles specifically designed to support bracket mounted pendant street lights, generally served with underground wiring. The street lights intensity will be designed to 70% or higher of IESNA recommended practices depending on uniformity.

"Temporary" arterial lighting may consist of wood utility poles supporting bracket mounted fixtures served overhead. Such systems will be converted to permanent at such time as roadway improvement factors, capital improvement funds and system age priorities permit.

## 6.8 Street Light Maintenance

LES will responsibly maintain street lighting in a manner recognizing public safety and convenience needs of such systems.

The principal objective is to keep as many lights as possible functioning properly and responding promptly to "light-out" call-ins.

Lighting which becomes unreliable and maintenance prone will be replaced as expeditiously as possible, within budget limitations.

## Section 7. CLASS IV LIGHTING (OFF-STREET PARKING)

### 7.1 General Requirements

A. Pole mounted luminaires shall have a maximum mounting height of thirty feet above ground in non-residential districts and 20 feet above ground in residential districts.

B. All wall mounted luminaires shall be cutoff type and shall conform to the requirements in Section 10 (Light Trespass).

### 7.2 Design Requirements

A. Except as noted below, the off-street parking area shall be lighted in accordance with the (IESNA) Lighting Handbook, latest edition.

B. Light Intensity Level:

1. Illuminance level shall not exceed 4 footcandles average maintained on parking surface.

## Section 8. CLASS V LIGHTING (OUTDOOR RECREATIONAL FACILITIES)

### 8.1 Requirements

A. Except, as noted in this section hereinafter, recreational facilities shall be lighted in accordance with the IESNA RP-6 standards for "SPORTS AND RECREATIONAL AREA LIGHTING," latest edition, including standards for illuminance and uniformity ratio.

B. Glare Control

1. The luminaires shall meet, when installed and aimed, IES "Cutoff" type luminaire designation as defined in the IESNA Lighting Handbook, 9th edition.

2. Sports flood luminaires shall have a maximum aiming angle up from nadir (the point 90 degrees down from horizontal) of seventy-two (72 degrees) above nadir or two times the mounting heights out from the pole the fixture is mounted on, whichever is less.

C. Time of Operation

1. Outdoor recreational and sports facilities, except golf driving ranges, may remain lighted past 12:00 midnight to complete recreational and sports activities that are in progress and under illumination at 12:00 midnight and still be in conformance with this chapter, i.e., activities in progress may complete after 12:00 midnight, but they cannot start under illumination after 12:00 midnight, However, in no case shall the illumination stay on past 12:30 a.m..
   Lighting for golf driving ranges shall be off between 11:00 p.m. and sunrise.

**Section 9. CLASS VI LIGHTING (SALT CREEK TIGER BEETLE ENVIRONS)**

These requirements will be developed by the United States Fish and Wildlife Service and amended into this code when available.

**Section 10. LIGHT TRESPASS AND GLARE**

A. All lighting except, Class III (street lighting) or as otherwise exempted elsewhere in this chapter, shall meet the requirements for luminaire mounting heights, shielding, placement and aiming to minimize light trespass and glare such that:

1. No more than 2.0 foot-candles is measured on a vertical plane located at the property line of the adjacent property, and rotated in a horizontal plane for the maximum reading.

2. Light trespass from a non-residential use abutting, or across the alley from, a residential district shall not exceed 0.5 footcandles at the residential property line measured on a horizontal plane.

B. Glare from “wall pack” luminaires shall be minimized by compliance with the following:

All wall packs shall not have mounting heights higher above the ground than their distance to the lot (property) line unless they are mounted so as to direct the light away from the adjacent property, e.g., on a wall at the property line, but directed inward. Wall pack luminaires shall have a maximum mounting height of fifteen feet above ground to the luminaire in residential areas, and a maximum mounting height of twenty feet above ground to the luminaire in all other areas.

C. Exterior building surfaces shall not exceed an average surface brightness of 750 nits.

D. Signs are regulated for surface brightness by Chapter 27.69 of the LMC. Light trespass due to sign illumination shall meet these standards except at street property lines.

**Section 11. SUBMISSION OF PLANS AND EVIDENCE OF COMPLIANCE**

A. The application for any required City approval involving outdoor lamps (except Class III lighting) that exceed 2850 lumens shall include evidence that the proposed work will comply with this chapter. Single-family and two-family dwellings are exempt from the requirements of this section. The submission shall contain, but not be limited to, four complete sets of the following:

1. The location of the site where the outdoor luminaires or outdoor light fixtures will be installed;

2. Plans showing the location, type and the mounting heights of all fixtures, both existing and proposed, on the premises, including point-by- point lighting level (initial and maintained) printouts with calculation areas delineated and average values and initial horizontal and vertical values at 20 foot intervals across all property lines.

3. A description of the outdoor light fixtures including, but not limited to, manufacturer's catalog cuts, ITL photometric report with candela distribution, drawings, and shielding information;

4. Justification for light loss factors (LLF) utilized by the calculations for the light levels submitted.

B. The above required plans and descriptions shall be sufficiently complete to enable the City to readily determine whether compliance with the requirements of these design standards will be met. At a minimum, the plans shall show point-by-point foot-candle levels (initial and maintained) for all areas of the project subject to these Design Standards for Outdoor Lighting. The plans shall also include horizontal and vertical foot-candle levels at twenty foot intervals at all property lines. These horizontal and vertical levels shall be taken at the heights required by this code. If such plans and descriptions cannot enable the City to make a determination of compliance with the requirements of these design standards by reason of the nature or configuration of the devices, fixtures or lamps proposed, the applicant shall submit further evidence of compliance enabling such determination.

C. Submittal and drawings shall be signed by a professional engineer licensed in Nebraska, a lighting designer certified by the National Council on Qualifications for the Lighting Profession (NCQLP) or by the licensed electrical contractor that

is performing the work. This engineer, lighting designer or contractor shall certify that the submitted design meets these design standards. Submittal must contain the name of the company that prepared the drawings and the name, title and telephone number of the person that performed the design work.

D. All projects resubmitted for approval shall include a written description of all changes and comments keyed and attached to the plan check comments.

**Section 12. INSTALLATION**

The owner or contractor of record (except Class III lighting) shall install the approved outdoor luminaires or outdoor light fixtures in conformance to the listing, manufacturer's installation specifications, and all applicable local and state electrical codes. An electrical permit and inspection by the City of Lincoln Department of Building and Safety is required.

**Section 13. PERMANENT EXEMPTIONS**

A. Nonconformance. All outdoor luminaire existing and legally installed prior to the effective date of the ordinance/resolution, are exempt from the requirements of this chapter, except that when existing luminaires are reconstructed or replaced, such reconstruction or replacement shall be in compliance with this chapter.

B. Fossil Fuel Light. All outdoor light fixtures producing light directly by combustion of fossil fuels (such as kerosene lanterns and gas lamps) are exempt from the requirements of this chapter.

C. Holiday Decorations. Lights used for holiday decorations are exempt from the requirements of this chapter.

D. Flag Lighting. Lights used for illumination of flags of the United States, any State or Foreign Country as required by law are exempt from the requirements of this chapter.

E. Airport Lighting. Airport lighting which is required for the safe and efficient movement of aircraft during flight, take off, landing, taxiing, loading, unloading, and servicing areas is exempt from the provisions of this Chapter. All other outdoor lighting at airport facilities shall comply with the provisions of this Chapter.

F. This chapter shall not apply to portable temporary lighting used by law enforcement, utilities or emergency services personnel.

## Section 14. TEMPORARY EXEMPTIONS

A. General. Temporary exemptions are required to be approved for any situation that is not allowed by this chapter where temporary lighting is required including, but not limited to, search lights, road construction, parades, special civic or public events, special business events, grand openings of businesses, etc: The exemption shall be permitted on the premises for no more than two occasions and for no more than a combined total of ten days in any calendar year.

Q:\LIGHTINGSTUDIES\lighting Design Standards Jan. 3, 2008.tjc.wpd