CITY OF URBANA, ILLINOIS
DEPARTMENT OF PUBLIC WORKS

M E M O R A N D U M

TO: Mayor Prussing and Members of the City Council

FROM: William R. Gray, Director of Public Works
Elizabeth H. Tyler, Director of Community Development

DATE: January 10, 2008

RE: University District Street Lighting Project and Other Lighting Concerns

The following comments are in response to the discussion at the December 10th, Committee of the Whole meeting and Sense of the Council Resolution on Lighting:

- Use of LED lamps – the cities and university streetlight equipment standardization group will be studying the use of LED lamps as an option for lighting in the University District. Currently LED lamps do not meet photometric criteria as stipulated by the Illuminating Engineering Society of North America (IESNA).
- If council is mandating the use of LED lamps, finding a lamp and fixture to suit the project requirements may lead to a delay in implementing the first phase which is the Goodwin Avenue project which includes new street lighting and construction is scheduled to begin May, 2009.
- The group's consultant, Burtness Engineering Services (BES), is planning to attend the Committee of the Whole meeting this Monday night to help answer your questions. Tom Burtness will also attend a future committee meeting to discuss the Street Light Equipment Request for Proposal prior to its issuance. At this meeting, an in depth discussion of the pole type, fixture type, and lamp type can occur. It is premature to state that only a full cutoff fixture will be specified.
- The group's consultant, BES, will be considering LEED certifiable street lighting for designated areas in the University District. We must be careful however; our understanding of LEED requires darkness outside of the project boundary. Illumination beyond the width of a sidewalk for example may be desirable.
- Lighting standards within private developments (as opposed to street lights) are regulated by the City's building code series. The Illinois Energy Conservation Code includes provisions for energy efficiency in internal lighting for commercial and multi-family residential projects.

Regarding the Sense of the Council Resolution on Lighting, staff has the following comments:

- Staff needs to research just what is LEED street lighting and what is a LEED street lighting standard. To date, we have not found a "LEED certified lighting fixture". LEED

is an energy standard and not a lighting standard. One concern is that applying LEED may well violate IESNA standards.

- Discussion of a phase in plan of compliant lighting for all existing street lighting would have to compete with the replacement of existing series lighting, the installation of street lights on unlit arterial streets, and the installation of street lights at unlit intersections. We must also ask, is energy savings the ultimate criteria in selecting a lamp and fixture?
- Staff suggests a goal of using LED technology when it becomes technologically and aesthetically viable for roadway lighting use.

Lighting Nuisances:

In addition to safety standards and energy conservation, there are other factors to consider in the regulation of lighting as part of private developments. This includes the issues of nuisance lighting and light pollution. Nuisance lighting is the extent to which lighting poses a nuisance to other nearby sensitive land uses. Light pollution can also occur from excessive levels of lighting in certain areas. Limiting nuisance lighting and light pollution can involve tradeoffs with maintaining safety standards and crime prevention and must be carefully balanced. Currently, the Urbana Zoning Ordinance regulates nuisance lighting by requiring that exterior lighting be cast downward and not shine directly into nearby residential properties. Community Development addresses a handful of lighting complaints each year and has had good success in requiring mitigation of the offending lights. However, these regulations can be improved by providing more explicit guidelines and by offering some dark sky protections. The planning division work plan includes improvement of lighting regulations via a Zoning Ordinance Amendment. It is expected that this amendment will be completed in 2008. It should be noted that Champaign County is also currently proposing an improvement to their nuisance lighting standards in their zoning ordinance.

Campus Lighting Project

Introduction

Professor Gary Cziko's presentation on lighting in campus town, http://www.uiuclights.notlong.com to both CUATS and the Urbana City Council has raised a number of interesting points and generated quite a bit of discussion in the community. There are some long term issues and implications about choices made so it's important to discuss them now before we commit ourselves to something that will last many years. We have many examples of communities that have taken steps in a variety of areas that have huge payoffs 10 and 20 years down the road. Let's not miss an opportunity to have a big impact.

This effort can be couched in terms of having our cake and eating it too -- you can satisfy all sides. Even though research indicates that greater amounts of light make people feel safer without actually reducing levels of street crime (see references below), it's probably not worth much time arguing this because we know effective lighting is good for business, gets people out on the street, and makes pedestrians visible to vehicles at busy locations.

More importantly, from a public point of view, there's clearly money to be saved on energy costs by going the LED (or similar) route. Currently, 40% of the City of Urbana's energy costs are related to lighting. The cities and the University should not go forward with any more lighting until they can use LED or equivalent energy saving type lighting. Properly designed, effective lighting doesn't create harsh shadows or serious glare and at the same time, is not light polluting. Full cutoff fixtures are not a big deal and should be required across the board. You don't have to turn night into day to have effective lighting and evidence suggests it's not even healthy to do so.

The possibility of balancing the combinations of lights used in LED's to enhance night vision is intriguing. From a safety point of view, this could be a real selling point. We might be able to have lighting that isn't as bright but is more effective for both pedestrians and drivers. We have examples of cities that have saved money and the industry is maturing quickly with LED's appearing in many useful places.

For environmental reasons, this streetscape project should use LEED (Leadership in Energy and Environmental Design) for guidance. This green building rating tool developed by the US Green Building Council (USBGC) has a credit if you avoid light pollution. Each credit has an "intent" (tells you what is important), "requirements" (how to calculate if you've earned the credit or not) and "technologies strategies" (how to earn the credit). There are lots of communities and companies and at least 9 federal agencies who have adopted LEED. The U of I uses LEED and its use is now mandated by the State (http://www.cdb.state.il.us/green_initiatives.shtml). Nearby, the city of Normal, Illinois has adopted LEED (for its Uptown projects) including its streetscape: http://www.normal.org/Uptown/LEED.asp.

This document is an amalgamation of emailed research and ideas by those listed on the last page. Below we briefly discuss (with relevant links) LED lighting, Light Pollution, LEED Certification, a list of Lighting and Safety Studies, some links to what other communities are doing, and a discussion of issues by two contributing members. A live version of this document, which we hope to keep updating, can be found at http://www.charliesmyth.org/docs/lighting.html.

LED Lighting

LED Streetlights meet IES street lighting standards. February 17, 2004 - Series M400 CobraHead-Styled LED Streetlights shine light at ground level, eliminating unwanted glare, light trespass, energy waste, and sky glow. Containing 400 Warm Incandescent-White LEDs, cluster lamps draw 19 W, emit 3,200 K, and offer over 100,000 hr of life. Type 1 lamps have to be hardwired into cobra head fixtures, while Type 2 lamps feature male 39 mm mogul bases that screw into socket of fixture. Standard voltage is 120 Vac. **Source:** Architectural and Civil Engineering Products

The DarkSky.org website rates and lists appropriate light fixtures that avoid light pollution. The brightness of the light has to match the pole height to provide adequate lighting for the activity (usually measured in foot candles or lux). There are a lot of LED Streetlights available: http://www.darksky.org/lighting/ lists possibilities and Dark-sky friendly lighting products are linked to at the bottom of this page: http://www.darksky.org/programs/fixture-seal-of-approval.php

Illuminating Engineering Society of North America is the body that sets the lighting standards for different activities. http://www.iesna.org/. They have lists of LED light manufacturers as well.

Here's the only manufacturer listed on the IESNA site for LED lights, on high poles: http://www.lithonia.com/NightTimeFriendly/AreaLuminaires.asp

Deb Lovig (CREE, Deb_Lovig@cree.com) wrote:

> We make only the LED components, not the full fixture. I am attaching a list of LED fixtures makers we can recommend. I don't know if they are IDA approved but they are very good fixtures. I hope this is helpful. www.ledcity.org/fixture-contacts.html
>
> Most of the LED fixtures makers offer poles of different lengths or an attachment option for an existing pole. It's best to contact several directly to get product specs and comparison information.
>
> We simply attached LED fixtures to existing poles in our parking lot last month. However, the new pole designs are very nice and if you are buying poles anyway, I'd look into the options from the LED makers.

Light Pollution Issues

Local articles on light pollution with a nice introduction to the various aspects of good and bad lighting: http://environmentalalmanac.blogspot.com/2005/03/light-pollution.html and http://www.astro.uiuc.edu/~uias/lightpollution/

These local photos make the point very well:
http://www.astro.uiuc.edu/~uias/lightpollution/pics/panorama/
http://bi-staff.beckman.uiuc.edu/~melockwo/lp/lp.html

New Yorker article on light pollution:
http://www.newyorker.com/reporting/2007/08/20/070820fa_fact_owen

Website on light pollution and measures to combat it from a California perspective: http://www.skykeepers.org/ includes links to municipal codes in California, such as Oakland's requiring full cut-off luminaries and glare reduction.

Look at some of the photos of dark-sky friendly lighting here: http://www.darksky.org/programs/awards-2005.php

LEED explanation (Annette Stumpf)

There are several rating tools. For the LEED-NC (New Construction) tool, the credit is Sustainable Sites Credit 8, Light Pollution Reduction. Here's a link to LEED-NC rating tool: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220
(see page 23 of this file: http://www.usgbc.org/ShowFile.aspx?DocumentID=1095)

But the draft version of LEED-ND (Neighborhood Development) is probably even more relevant. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148
For this rating tool, we care about "Green Construction and Technology credit 20 - Light Pollution Reduction". (see page 141 of this file: http://www.usgbc.org/ShowFile.aspx?DocumentID=2845)

The part about using LEED that people don't understand well is that the design team PICKS which credits they want to earn to achieve a rating. There are Certified, Silver, Gold and Platinum ratings available depending on how many credits the team earns. Here's a chart made for the Army: https://eko.usace.army.mil/fa/sdd/leed/?syspage=Documents&id=33814 .
They require project teams to earn silver, but the only credits that are required by federal or Army policy are dark blue. The green credits are considered relatively easy to earn, and the Light Pollution credit is one of them.

We recommend project teams use this charrette checklist at the beginning of the project to identify which credits they want to earn to get the rating they need to get. (it has Army guidance embedded in it) https://eko.usace.army.mil/fa/sdd/leed/?syspage=Documents&id=33810

The light pollution credit should be chosen because it really wouldn't cost any more, you just have to pick lights that comply with the rules instead of lights that pollute. The easiest way to comply with the requirements is probably to pick a IDA approved light fixture, and then to design the light scheme so it complies with the LEED Light Pollution requirements.

US Green Building Council Documents on federal, state, and local governments including various schools: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1780 and other useful documents, https://www.usgbc.org/ShowFile.aspx?DocumentID=1741

From http://www.cdb.state.il.us/green_initiatives.shtml: New energy-efficient, environmentally-friendly guidelines for state construction projects have been adopted that will meet strict national “green” building standards, reduce the state’s energy usage, and make state buildings better for those who work in them and the area surrounding them…The Green Building Guidelines for State Construction, developed by the Illinois Green Building Advisory Committee, mandate that all new state-funded building construction and major renovations of existing state-owned facilities are required to meet current Leadership in Energy and Environmental Design (LEED) standards that are practical for that project. The Capital Development Board (CDB), which manages all state construction, repair and

renovation projects, developed the new guidelines and will oversee their implementation. The guidelines may be accessed at www.cdb.state.il.us.

Lighting and Safety Studies

An interesting paragraph from http://www.darksky.org/resources/information-sheets/is027.html

> "It appears that at Wesleyan there is no statistically significant evidence that outdoor lighting forms any deterrent to crimes of sexual assault. This supports the similar findings at a national level by a number of studies; the best known of which is probably the National Evaluation Program, Phase 1 Report, funded by the Law Enforcement Assistance Administration, U.S. Department of Justice (see Information Sheet No. 63). The conclusion of that report is that "there is no statistically significant evidence that street lighting impacts the level of crime", although it is recognized that increased lighting of almost any kind, good or bad, reduces the fear of crime. It is in society's interest to realize that feeling safe and being safe are not always the same, and different solutions may be needed to satisfy each condition. I believe that society would choose to be safe rather than just feel safe."

Some resources on crime and lighting:
http://www.darksky.org/news/newsletters/50-59/nl59.html
US Department of Justice Study: http://www.darksky.org/resources/information-sheets/is063.html
http://www.darksky.org/resources/information-sheets/is051.html
http://crimeprevention.rutgers.edu/brochures/lighting2/lighting.htm
More British and American studies:
http://www.homeoffice.gov.uk/rds/prgpdfs/fcpu28.pdf
http://www.britastro.org/dark-skies/crime.html
http://www.crimereduction.homeoffice.gov.uk/burglary/burglary45.htm
http://informedesign.umn.edu/Rs_detail.aspx?rsId=1548
http://www.astrolab-parc-national-mont-megantic.org/data/pollum/Lighting_and_crime.pdf
http://www.popcenter.org/Library/CrimePrevention/Volume%2010/index.htm
http://bjc.oxfordjournals.org/cgi/content/abstract/44/3/441
http://www.selene-ny.org/downloads/lightingandcrime.pdf
http://www.palgrave-journals.com/cpcs/journal/v5/n2/abs/8140143a.html
http://www.darksky.org/resources/links/crsesali http://amper.ped.muni.cz/light/crime/lp040_1h.html
(this particular study debunks many commonly cited references suggesting a significant lighting effect on crime deterrence. In fact, the major point here is that though the UK has made tremendous investments in lighting, crime is up 28 %.)
http://www.maltastro.org/lpag/

What other communities are doing

- Ann Arbor to install LED street lights downtown (Posted by Tom Gantert | The Ann Arbor News October 17, 2007 08:00AM) - Info on Ann Arbor's downtown LED plans: **http://www.mlive.com/news/annarbornews/index.ssf?/base/news-24/1192632347246110.xml&coll=2**

  Summary: Converting all its downtown lights will save the city $100,000 a year in energy costs and reduce greenhouse gas emissions by the equivalent of taking 400 cars off the road for a year.

Claim to be the first US city to move all downtown lights to LED light bulbs**.** Project will take 2 years at a cost of $630,000. Mayor says that eventually, the entire city will have LED lights. The LED lights also provide better light quality for improved visibility and safety, according to LED City, an organization of government and industry parties that is promoting their use.

Raleigh, N.C., and Toronto are two other cities that have installed LED lights in their downtown according to CREE, the company that manufacturers semi conductors in LEDs but haven't committed to doing entire downtown.

The older street lights have a two-year life after which they all had to be replaced. The LEDs have a seven-year warranty and are expected to last as long as 10 years and don't contain mercury.

According to reports, roughly 22 per cent of the US's total energy production goes on lighting. LED City initiative, the joint industry-government working group, was set up in February 2007 in Raleigh, North Carolina, to promote LED lighting as a way of reducing this figure.

According to the US Department for Energy, if LEDs were widely adopted, the amount of energy spent on lighting could probably be halved. Over the border in Canada, Toronto's officials estimate that replacing its street lights with LEDs will save it $6m a year in electricity costs, and cut CO2 emissions by 18,000 tons annually.

ALAN WARREN/ANN ARBOR NEWS: The LED street lights provide a whiter light compared to the existing incandescent ones. Note that these have been retrofitted and have something over the top half of the light to minimize light pollution upwards.

- Toronto's LED lights with photos: http://www.ledsmagazine.com/news/4/3/1
- Raleigh's use of LEDs (plus new video): http://www.wral.com/news/local/story/1201312/

- Calgary, Canada – a very early adopter planning to save millions: http://content.calgary.ca/CCA/City+Hall/Business+Units/Roads/Street+Lights/Technical+FAQ.htm and in particular: http://content.calgary.ca/CCA/City+Hall/Business+Units/Roads/Street+Lights/EnviroSmart+Photo+Gallery+.htm

- Torraca, Italy - From the Economist: http://www.economist.com/business/displaystory.cfm?story_id=10214726&CFID=27917664&CFTOKEN=95242352

  "Low-energy illumination is lighting up the Dutch electronics giant. THIS weekend the Italian village of Torraca proclaims itself the world's first "LED city", unveiling new streetlights that emit a bright, white and ecologically green glow. The new lights use light-emitting diodes (LEDs)…"

  See photos of Torraca's lights at http://www.cityledlighting.com/torraca/ . Note: These are not full cutoff or even shielded lights. We can do much better here, LEDs and AND full cutoff.

Thoughts about lighting from Gary Cziko

I think the issue can be broken down into four components:

1. The directionality of the lighting: So-called "full cut-off" lights will direct the light down to the street reducing glare and light pollution. I don't see why we should even consider any lights that are not full cut-off lights.

2. The quantity of light: How bright do the lights need to be? Should be bright enough to safely see pedestrians, but not bright enough to read a newspaper except in spot locations such as bus stops and ATM's.

3. The quality of the light: This has to with its color (temperature). Certain colors allow mesotropic vision, which is a combination of night (scotopic) and day (photopic) vision. Fewer lumens of the right color can appear brighter than more lumens of the wrong color.

4. How the light is generated, i.e., the type of light bulb: LED may have higher initial cost but use about half the energy of high-pressure sodium lights and last much longer, about 60,000 (that is almost 14 years if burned 12 hours/day). LED also allows more control of the lighting.

Gary's five E's for lighting:

Here's a simple scheme of five criteria, each starting with "e." Our outdoor lights should be:

1. **Efficient**. Getting the most light per watt (lumens per watt).
2. **Effective**. Putting all the light where we want it--down on the ground. Not sideways causing glare and light intrusion. Not up causing sky glow. The color of light produced also has an impact on effectiveness, with some colors allowing a combination of day of night vision.

3. **Economical**. Total cost of purchase, installation, operation, maintenance, and bulb replacement. Fully shielded lights also put more light per watt on the ground allowing use of lower wattages per lumen.
4. **Ecological.** Affect on birds and insects. Minimizing greenhouse gas emissions. Reduce mercury contamination (LED lights do not contain mercury, unlike mercury-vapor and sodium-vapor lights). Reducing sky glow.
5. **Esthetic**. Should look nice.

Whether LED lights will be best to satisfy these criteria is open to research and discussion. And tastes vary concerning what is aesthetic. But I don't see how or why there should be any debate about our lights being efficient, effective, economical and ecological, as described above.

Comments from Annette Stumpf

At a quick glimpse, I like the lights that Ann Arbor installed: http://www.treehugger.com/files/2007/10/asquared_michig.php. They look like a contemporary old-fashioned style. But one person who commented on this blog didn't like them at all, and further down it says they don't have the cut-off optics. I'm not sure about either comment. It would take a while to go through all the details and figure out what lights you want to select based on performance characteristics.

That is probably what should be established: performance criteria/characteristics for the lights you want to install, and then someone can assess available light fixture design to identify the options. Finally, you can pick the lights that best meet your performance criteria.

One of the things we talk about with respect to lighting design is the "color" or spectrum of the light. Sunlight has a lot of red in it, and is considered a "warm" color. For instance, warm white fluorescent bulbs are more popular in the north, and cool white are more popular in the south. Here's a chart showing the basic color temperature for typical lights: http://www.ledwaves.com/pages.php?pageid=24.

You want to pick a light color that lets the eye distinguish colors. For instance, I remember hearing that it was hard to figure out what color cars were at night when Low Pressure Sodium lights were used (because they are very yellow and don't give very good color rendition).

I don't know what colors are available with the LED's so you'd have to ask the vendors what the color spectrum is. How well can people see the neighborhood and car colors with their lights? Here's an example spec sheet that shows the light distribution (in Lumens, measured on the ground), the cutoff angles (above 90 degrees) and the color spectrum: http://www.lumecon.com/docs/R20_11_8_2007.pdf and here's the webpage with the details: http://www.lumecon.com/led_street_lights.html

Another informative article: http://www.patmullins.com/ledlightmyths.html http://www.patmullins.com/index.html (disclaimer, I don't know this person, who pays him, or how credible he is, but the info I saw on his website looks reasonable to me..... but who knows).

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Suggested motion for discussion by Charlie Smyth, Urbana City Council, on a sense of the council action directing staff to:

Add specific LEED Lighting standards to the Sustainable Urbana Report;

Develop effective, efficient, economical and ecological lighting ordinances and policies that incorporate LEED Lighting compliance and encourage the use of low energy solutions such as LED bulbs for all future developments as well as current and future city lighting projects;

As staff time permits in the near future, study a multi-year phase in of energy saving, compliant lighting for all current lighting in the City of Urbana, public and private.