

The LAN committee has listened to questions about light pollution in our town at public meetings. We would like to provide you with answers to these questions here.

Question: Aren't car lights, rather than street lights, the most significant source of glare?

Background information: One of the main goals of the Outdoor Lighting Bylaw is to reduce disability glare caused by municipal, street and commercial lighting that presents a danger to pedestrian and motorist safety. So this question is asking about the light spectrum of our street lighting. The higher the kelvin rating, the more "blue" the light.

Answer: Any unshielded light can be a source of glare that reduces visibility or even temporary blindness. This effect can be amplified if the light's spectrum is bluer. We measure this color temperature in Kelvin and the larger the number, the more blue that is being emitted by the light. The human eye has a difficult time contrasting blue light at night and this deficiency gets worse with age. Higher color temperature is a known cause of glare so as color temperature rises above 3000K, the impact of glare increases, making night vision more, not less, difficult. Therefore, car lights can be blinding especially when the manufacturer has chosen headlamps in the blue white spectrum (4000 - 8000 Kelvin).

In conclusion, people driving at night face three challenges: car head lamps, street lights, and unshielded lighting mounted adjacent to the roadway. Pepperell has the ability to regulate the latter two, but not headlights.

One goal of the bylaw is to ensure Pepperell makes a wise investment when it decides to replace old street lights. Note: existing high-pressure sodium streetlights that exist in Pepperell today are ~2000 K or amber-colored. As context, we know of towns prompted by the availability of State funding that chose lighting in the 4000K (blue white) spectrum. Groton is a good example having replaced their old street lights with new, unshielded, blue-white lights. Many older Groton residents are complaining these new lights are blinding, making night driving difficult. Should Groton choose to replace them it will have to do so on its own without state aid. This is the scenario we want to avoid.

A second related goal is to provide residents with an opportunity to offer input if major municipal projects are proposed in Pepperell, e.g. streetlights, walkway lighting, and municipal lighting.

Relevant definitions:

- **Glare:** Intense and blinding light that reduces visibility and creates visual discomfort and/or momentary blindness. For the purposes of this Bylaw, glare is declared to be a form of public nuisance as it creates a hazard for motor vehicle operators and pedestrians.
- **Correlated Color Temperature (CCT):** A specification of the color appearance of the light emitted by a lamp, measured in Kelvin (K). CCT values are typically provided in lighting manufacturer data sheets. For example, high pressure sodium streetlights are approximately 2000 K and warm-white bulbs are 2700 K.



Figure 1 How CCT or color temperature values change the appearance of an LED lightbulb. Lower Kelvin values produce a warmer or more red spectrum vs. higher values that produce a more blue spectrum.

Question: Why aren't herbicides and pesticides the cause of the decline in pollinators?

Background information: A goal of the Outdoor Lighting Bylaw is to reduce light pollution in our town, especially pollution from blue light (above 4000K) that we know has a serious impact on human health and all nocturnal wildlife.

Answer: The loss of pollinators and disruption of wildlife circadian rhythms should be of great concern to Pepperell residents. While residents should reduce the use of pesticides, ALL wildlife will benefit from a reduction of light pollution. Of particular concern is evidence of the beginnings of global insect population collapses - those same insects that pollinate the foods we eat and are themselves sources of food for predators. There are scientific studies noting the impact of artificial light at night (ALAN) on insect reproduction, foraging, movement and development. ALAN is also responsible for increased insectivore predation with the decline in nighttime darkness that hides insect activity. This threat is in addition to climate change, habitat loss, and indiscriminate use of pesticides.

Insects around the world are facing a veritable “perfect storm” and entire populations are beginning to disappear. Fireflies for example are in danger in Massachusetts. A recent study by Tufts University showed that light pollution is the #2 cause of population collapse - #3 was pesticides.

Relevant definitions:

- Light pollution: Any unintended, adverse and/or obtrusive effect of the use of outdoor light at night. Also, any inappropriate or excessive use of artificial light.

Relevant References:

- International Dark-Sky Association: <https://www.darksky.org/>

Question: Don't our current bylaws work? Aren't they sufficient?

Background information: As has been noted, our town's light pollution has increased faster than our state - which has seen a higher increase of light pollution than our country as a whole. Furthermore, we know that our town is on the cusp of losing being able to see the Milky Way at night - a significant Maginot Line in the loss of night skies. A major goal of the Outdoor Lighting Bylaw is to minimize skyglow to the greatest extent possible so that Pepperell residents will avoid the loss of their night sky.

Also note, Massachusetts is the only state in New England (plus NY) that does not have outdoor lighting regulations at the state level. That leaves towns and cities up to the task of writing regulations. Pepperell currently has some of the weakest in our immediate area.

Answer: The zoning Lighting Bylaw (sections 5510, 5520, 5521, but also sections 5326, 5334, 5341 reference lighting) does not work - as evidenced by the 6.6% yearly increase in light pollution between 2012 and 2019 vs. the established national average of 2.2% per year. There are a couple of reasons the above is ineffective.

First, its sections are poorly written (with other references scattered in different places). "Sky reflected glare," for example, is a nonsensical term, light trespass is not to be confused with glare, and statements regarding illuminated signs are inconsistent. The bylaw we have drafted for your consideration references industry standards and practices and clearly defines its intended purposes and operative terms. An addendum is available that shows shielding solutions to common lighting problems in an effort to provide further guidance.

Secondly, the current Bylaw's limited scope and incorrect definitions means Pepperell is ill-equipped to handle poorly implemented streetlight retrofits, or unforeseeable developments such as what happened in Shirley recently when LED-illuminated greenhouses turned the town's night sky pink. The Bylaw we've drafted directly addresses these concerns.

Finally, and most importantly, the above deficits of the current Bylaw means that enforceability is difficult, if not impossible. Section 5521 of the current Bylaw provides for no fines for light trespass or glare.



Figure 2 Skyglow originating from Little Leaf Farms in Shirley, MA.

Relevant definitions:

- **Glare:** Intense and blinding light that reduces visibility and creates visual discomfort and/or momentary blindness. For the purposes of this Bylaw, glare is declared to be a form of public nuisance as it creates a hazard for motor vehicle operators and pedestrians.
- **Light pollution:** Any unintended, adverse and/or obtrusive effect of the use of outdoor light at night. Also, any inappropriate or excessive use of artificial light.
- **Light trespass:** A condition in which artificial light emitted from a luminaire on one property, not inclusive of light incidentally scattered or reflected from adjacent surfaces, is directed in such a manner that it is visible from any other property, public road, sidewalk or highway. For the purposes of this Bylaw, light trespass is declared to be a form of public nuisance as it may disrupt the natural circadian rhythm of both humans and the environment as a whole and is a form of energy waste.
- **Skyglow:** a glow in the night sky deriving from an artificial source. For the purposes of this Bylaw, skyglow is declared to be a form of public nuisance as it disrupts the enjoyment of the night sky on adjacent properties and is indicative of energy waste. It can be minimized by using best practices as described in this bylaw.

Question: Aren't large cities like Nashua and Lowell responsible for most of the light pollution here in town?

Background information: NASA satellite images clearly show the amount of light generated in this town being sent into space. These images also show that, over the past 8 years, the amount of energy Pepperell is wasting (in the form of light pollution) has increased significantly.

A **answer:** This question speaks to the physics of light dispersal from point sources and the creation of local “light domes”. Our committee discussed this question at some length. What, if any, effect does an individual’s (or community’s) efforts to reduce light pollution have if neighboring towns’ light pollution is greater than ours? Isn’t their pollution the real reason we’re losing our night sky?

First, the NASA data collected by a satellite clearly shows that our light pollution is increasing and spreading. This is a local phenomenon. Similarly from the ground, most locations in Pepperell can barely if at all see the Milky Way – something that has changed significantly just in the past few years. The threshold of seeing the Milky Way with the naked eye is a commonly used indicator that correlates well with scientific data.

One reason we believe we have seen such a dramatic increase in light pollution is that residents have been aggressively switching to LED lighting without understanding the need for lower color temperature and shielding and lower intensity. So, unintentionally, folks have contributed to increased glare, light trespass and loss of our dark skies. It’s a rectifiable problem brought on by a new technology that promised significant cost savings. But in making lighting cheaper it also seems to have prompted more, rather than less, usage. If, as a collective effort, we dim or turn off lights when we’re not using them, we will go a long way to addressing light pollution everywhere.

That being the said, Littleton, Westford or Nashua may have some impact on our night skies but what we do locally has a much greater impact on our well-being. The committee concluded our community should do its part to mitigate the loss of our night skies and, ideally, become a model for other towns contemplating their own Dark Skies bylaws.

We are aware other towns are closely watching the passage of our Outdoor Lighting bylaw as it is recognized as being a “gold standard” for local bylaws addressing light pollution. To date, we count five other towns examining our bylaw to use it as a foundation for drafting similar local protections against light pollution.

Relevant definitions:

- **Skyglow:** a glow in the night sky deriving from an artificial source. For the purposes of this Bylaw, skyglow is declared to be a form of public nuisance as it disrupts the enjoyment of the night sky on adjacent properties and is indicative of energy waste. It can be minimized by using best practices as described in this bylaw.
- **Light pollution:** Any unintended, adverse and/or obtrusive effect of the use of outdoor light at night. Also, any inappropriate or excessive use of artificial light.

Q **uestion: Isn’t it better to educate Pepperell residents and businesses about light pollution rather than regulating them through another bylaw?**

Background: Pepperell's Zoning Bylaws were first codified in 1974, updated in 1999 and, since then, undergone many amendments. The Master Plan Advisory Committee in its 2020 Master Plan recommends a complete review and revision of the town's zoning bylaws. Should the Planning Board approve this recommendation, a complete review and revision process may take years to accomplish.

Answer: Pepperell has viewed regulations as essential to a smooth running town for many, many years. Fundamentally, bylaws reflect the desire for local control and protections and, therefore, are recognized by town residents and businesses to be of significant community benefit. Further more, bylaws, as enforceable rules, should reflect best practices, incorporate enforcement protocols and responsibilities, and describe resolution processes.

Zoning bylaws do not address community wide problems nor are they proactive. In contrast, general by-laws can be proactive and safeguard the entire community. For example, the Noise Bylaw which was passed last Fall is intended to protect all residents from intrusive, persistent and excessive noise. But while the motivation for that Bylaw developed from a desire to thwart potential exogenous threats, the Outdoor Lighting Bylaw recognizes its our own unwitting actions that must be addressed.

The Light Air Noise Bylaw committee believes the dramatic increase in light pollution has been caused by residents and businesses aggressively switching to LED lighting without understanding the need for lower color temperature and shielding. So, unintentionally, we have all contributed to increased glare, light trespass and loss of our dark skies. It's a rectifiable problem brought on by a new technology that promised significant cost savings. But in making lighting cheaper it seems to have prompted more, rather than less, usage.

If we continue flooding our community with unshielded, high temperature light our loss of dark skies is imminent. We must acknowledge the urgency of the problem and begin setting things right. Waiting for the town to re-write its zoning bylaws makes little sense when immediate steps can be taken to curtail the expansion of light pollution and reduce its detrimental effects while improving public safety and saving money.