INTRODUCTION

- As part of the Williamsburg Fields Evaluation Workgroup process, Musco was asked to provide HID and LED athletic field lighting information. Musco recommended “White” LED lights with a correlated color temperature (CCT) value of 5700 Kelvin (K) at Williamsburg Middle School to light the athletic fields at night. Questions have been raised by members of the working group about possible adverse health effects on humans from exposure to the light provided by these proposed LED fixtures.

- As Public Health staff understand it, there are three categories of people who could potentially be exposed to light coming from the proposed lights:

  1. Players and coaches
  2. Spectators
  3. Neighbors

NOTE: the information considered by public health for this analysis comes from three sources, which consider LED lights – though primarily addressing the concerns of LED street lights, not athletic field lighting.

  1. AMA 2016 report
  2. AMA 2012 report
  3. DOE 2013 report

BACKGROUND

- How White LED Lights work

  o Per the American Medical Association (AMA) report, White LED lights produce a white appearing light because phosphor layers are added to high frequency, shorter wavelength LED (e.g., a blue wavelength LED bulb). This combination produces the light that appears “white”

  o According to a Department of Energy (DOE) report, to compare light sources with respect to the proportion of blue light emitted in the light, DOE recommends comparing light sources that are at the same CCT. For reference –
<table>
<thead>
<tr>
<th>Light Source</th>
<th>CCT</th>
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</thead>
<tbody>
<tr>
<td>High pressure sodium lights (traditional)</td>
<td>2100 K (Per AMA report of street lights)</td>
</tr>
<tr>
<td>HID lights (County currently using)</td>
<td>4200 K (Per Musco re: athletic field lights)</td>
</tr>
<tr>
<td>Williamsburg recommended LED lights</td>
<td>5700 K (Per Musco)</td>
</tr>
<tr>
<td>Sun</td>
<td>6500 K</td>
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- Light we typically see is made up of a spectrum of color wavelengths – including blue. The proportion of blue light in the light spectrum produced increases as the CCT value increases. According to the DOE report, lights at equivalent CCT values emit roughly the same proportion of blue light.

- Adverse Health Effects Associated with Light – including LED light sources
  - There are three possible categories of health effects that the AMA and/or DOE report may be associated with external light sources. These are 1) radiation, 2) glare, and 3) circadian rhythm disruption.

1. **Retinitis** – light is a type of radiation, just a visual type. Tissue can be damage with too much radiation, including the radiation from light (e.g., sun burn). According to the DOE report, the radiation hazard associated with LED light sources is blue light hazard. However, with the natural human eye defense mechanisms the risk from blue light hazard is mitigated. These natural defense mechanisms are aversion response and continuous eye movement. Both of these biological mechanisms protect the retina from over exposure to optical radiation. These features are very important in daily life – without them, light from the sun could routinely damage our retinas. NOTE: Most light sources contain blue light, including the Sun.

2. **Glare** – there are two types according to the 2012 AMA report, disability and discomfort.
   - The report defines disability glare to be “unwanted and poorly directed light that temporarily blinds, causes poor vision by decreasing contrast and creates an unsafe viewing condition, especially at night, by limiting the ability of the person to see.”
     - Glare off the field should not be an issue because the light does not spill over creating unwanted light, because it is not poorly directed – per the information provided to DPR by the proposed contractor. Glare on the field should also be minimized given the design, as we understand it.
   - The 2012 AMA report acknowledges that discomfort glare is “less well defined but emanates from a glare source that causes the observer to feel uncomfortable.”
     - Glare off the field should not be an issue because the light does not spill over creating unwanted light, because it is not poorly directed – per the information provided to DPR by the proposed contractor.

3. **Circadian rhythm disruption** – in the 2016 AMA report, the authors remind us that “with waning ambient light, and in the absence of electric light, humans begin the transition to nighttime physiology at about dusk.” That is, after the sun goes down, sleep is initiated without an external light source greater than “wood fires or low wattage incandescent bulbs.”
MITIGATION

- As the AMA reports remind us, proper design of LED lights can reduce the risk of exposure to unwanted light exposure.

- As we understand the project details as provided by Musco to DPR, the proposed lights will be designed and engineered to focus the light onto the field, and will have proper shielding, eliminating light escaping the field.

ASSESSMENT

- Given this information about the light design and engineering for these proposed lights, here is our assessment of who is exposed and to what:

  - For neighbors of the field, there appears to be minimal to no risk for unwanted light – including blue – spilling into homes from the proposed field lights based on the foot candle charts comparing ambient only to ambient and field light readings provided by DPR from Musco. The highest foot candle readings in the area without and with the proposed field lights remains at 1.5 foot candles (NOTE: the 5700 K LED lights will produce a 30 foot candle level of light on the field per Musco. The highest foot candle on the field using these 30 foot candle sources per Musco will be 43 foot candles.)

    - Therefore, the adverse health risks – retinitis, glare, and circadian rhythm disruption - mentioned above are not expected because there is minimal to no light spilling into their homes. This only holds if the design and engineering holds. However, based on discussions with some authors involved with the AMA report as well as
places who have worked with the contractor in question, light scatter off the field can be prevented with proper design and engineering.

- **For players, coaches, and spectators**, we have considered the risk from light, though it may not be as true to call this risk “a risk from unwanted light” since it would seem the players, coaches, and spectators want to play, coach and/or watch games at night requiring an artificial light source.
  
  - Retinitis – given the natural human defense mechanisms in place, the risk from retinitis is quite unlikely.
  - Glare – with proper design and engineering, the risk from glare is unlikely.
  - Circadian rhythm disruption – given that any external light source beyond a low wattage incandescent bulb used after dusk can and usually does delay sleep onset, we expect that sleep onset will be delayed. Since there is some indication that blue light can more effectively delay sleep initiation, players, coaches, and spectators may experience more sleep delay than others for that particular evening. However, what each individual experiences for sleep delay will likely vary from person to person. And initiating good sleep hygiene upon return to home should help to alleviate this situation. Furthermore, this exposure is expected to be short lived unlike the situations in the studies where chronic exposure to light at night over years – typical of shiftwork – were examined. The frequency of exposure for players, coaches, and spectators is not expected to mirror night shift workers.

- **NOTE:** we have not considered the use of other mitigation measures outside of the design of the LED lights, such as blinds and curtains, as well as sleep masks, which are routinely used for those who are trying to prevent more traditional sources of unwanted light entering a home.

**QUESTIONS FROM WORK GROUP** - With the context above, here are our answers to the work group:

1. **How would public health characterize the degree of health risk to players, coaches, fans, and nearby residents from the effects of the 5700 K array of lights proposed to allow nighttime play on Williamsburg field?** Assuming the design and engineering elements (including shielding) are achievable as proposed, the light spillage off the field is minimal to none and is lower than the highest ambient source of artificial light. There appears to be minimal to no exposure to light spilling off the field; therefore, there appears to be minimal to no risk to neighbors from adverse effects of unwanted light spillage. As for the players, coaches, and spectators, the risk from glare and retinitis appears unlikely. Players, coaches, and spectators may experience delayed sleep onset - though sleep delay is not a certainty.

2. **Is it public health’s opinion that any health risks faced will be sufficiently small that the bodies of those exposed will adjust to avoid the health effects of concern?** Based on the health information summarized above and assuming the proper design and engineering will be done, the risks are as outlined in the answer to question #1.
3. **How can your conclusion be reconciled with the findings of other professional groups that there is “moderate overall weight of evidence” or “strong evidence” supporting health disorders associated with lighting with a significant blue light component?** Our previous statement as well as our current statement is based on the assumption that the design and engineering limits light spilling off the field, and reduce glares for those on the field, and that natural defense mechanisms protect against retinitis.

4. **How would you communicate the potential direct and indirect health risk to potentially affected children, parents, other participants, and neighbors in a way that is understandable to the average citizen, and is communicated reliably to all affected citizens (not just posted or sent but also received and understood) and in a timely fashion?** It is our understanding that the very process that the County Board has designed is the beginning of the public discussion of this issue, with the Williamsburg Fields Evaluation Work Group as the starting point. It is also our understanding that the WFWG will have a public process before creating a report with recommendations to be considered by the Board and our public. Your public process followed by the County Board’s public process are the processes where you can share and discuss these and other concerns.