Pedestrian Lighting, Acceptable Levels of Light: A Pilot Project

October 2019

Prepared by
William DeCoursey, Davis Braun, and Jeel Oza

Institute for Public Administration
Biden School of Public Policy & Administration
College of Arts & Sciences
University of Delaware

In coordination with
Delaware Department of Transportation
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Davis Braun, Public Administration Fellow
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Preface and Acknowledgements

As the director of the Institute for Public Administration (IPA) at the University of Delaware, I am pleased to present this report, “Pedestrian Lighting, Acceptable Levels of Light: A Pilot Project,” as part of IPA’s ongoing, on-call work with the Delaware Department of Transportation (DelDOT).

IPA and DelDOT both have long been interested in multi-modal transportation, healthy transportation options, mobility, interconnectivity, safe routes to school, low-stress cycling, and a host of similar transportation themes. In these discussions, one factor that often is not fully taken into account is, how well does the state’s transportation networks serve their users after sunset?

This pilot project study was intended to demonstrate that assessing the adequacy of an area’s pedestrian lighting need not be an expensive, time-consuming, or overly complicated process. Though the discussion of methods of pedestrian lighting can become quite technical and involved, as demonstrated in a 2016 IPA report on the topic, “Delaware Transportation Lighting Inventory & Assessment” (http://www.ipa.udel.edu/publications/transportation-lighting-2016.pdf), simply observing and recording light levels in a given study area is quite straightforward.

I would like to acknowledge IPA Associate Policy Scientist William DeCoursey who developed the framework and methodology. Additional thanks go to Public Administration Fellows Jeel Oza and Davis Braun who assisted with the site work, background research, and writing. Thanks also go to IPA Policy Scientist Lisa Moreland and Assistant Policy Scientist Sarah Pragg who provided editing and formatting support for the document.

Jerome R. Lewis, Ph.D.

Director, Institute for Public Administration
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Background of Pilot Study Area – Dewey Beach

Named after Spanish-American War hero Admiral George Dewey, the development of the Town of Dewey Beach began in 1855 when Clementine and Robert West purchased 135 acres of land off of Delaware’s Atlantic coastline. In 1879, Rehoboth Beach Lifesaving Station (today known as U.S. Life-Saving Station 141) was built on what is now Dagworthy Street. As local watermen worked at the station, a community grew around the area. The population continued to grow over the next few decades. In 1915, Morgan T. Gum developed a grid-system subdivision plan for the area, the layout that exists today in Dewey Beach. When Route 1 was built in 1944, it provided greater accessibility to the town. With the construction of the highway, visitors to Dewey Beach increased throughout the 1960s and 1970s. This tourism surge prompted Dewey Beach to become a formally incorporated town, which enabled it to create laws and hire police to enforce them. The Town of Dewey Beach became an incorporated municipality in 1981, making it one of the last towns to be officially recognized by the State of Delaware.¹

The modern-day Town of Dewey Beach is located just south of Rehoboth Beach. The town is bordered by the Atlantic Ocean to the east, Rehoboth Bay to the west, and unincorporated Sussex County to the north and south. The Town of Dewey Beach’s municipal boundaries encompass 300 acres.² The town has a population of 379 people,³ but during summer months over 30,000 people visit Dewey Beach.⁴

It is not difficult to see why visitors are drawn to the area. The National Resources Defense Council awarded Dewey Beach “Superstar Beach Status” in 2011, 2012, 2013, and 2014.⁵ Not only does Dewey Beach maintain beautiful beaches, the town has popular events year round. Every August, the Town of Dewey Beach hosts the annual East Coast Skimboarding Championships. The Dewey Beach Music Conference in September brings in unsigned bands from across the country.⁶ During the Greyhounds Reach the Beach event in October, thousands of greyhounds and their owners gather in the town. The annual Sandcastle Contest, the annual Sea Witch festival, the Elvis Festival, Jazz Festival, Film Festival, 5K races, pet events, and holiday tree lightings are just a few of the exciting events that occur in Dewey Beach each year.⁷

In addition to its fun family activities, Dewey Beach is famous for its animated nightlife. The Bottle and Cork, open during the spring and the summer, is a rock club that hosts a great variety of locally and nationally known bands, including Better Than Ezra, Sugar Ray, Lucinda

¹ https://imageserv11.team-logic.com/mediaLibrary/147/02-02-2016_2.pdf
² Ibid (1)
³ https://www.census.gov/programs-surveys/popest.html
⁵ Ibid (4)
⁶ Ibid (4)
⁷ https://www.beach-fun.com/
Williams, Fuel, and Gaelic Storm.\textsuperscript{8} The Rusty Rudder, another popular destination, often has live entertainment on its deck.\textsuperscript{9} The Starboard’s famous Bloody Marys and Nalu Surf Bar & Grill’s unique ambience draws thousands of visitors to Dewey Beach each year.\textsuperscript{10}

Live music, unique cocktails, and delicious food makes Dewey Beach one of the best nightlife scenes in the mid-Atlantic.

**Sidewalks and Bike Lane Infrastructure**

Route 1 is the main street in Dewey Beach. The highway bisects the town, and most major restaurants and stores are located on either side of it. There are several crosswalks along Route 1, but pedestrian safety in Dewey Beach is still a concern. Oftentimes, it is difficult for drivers to see pedestrians, especially in the lane furthest from the sidewalk. High instances of jaywalking serve to exacerbate pedestrian safety issues.\textsuperscript{11} Additionally, obstructions on sidewalks often prompt pedestrians to walk along the side of the street. Utility poles, in particular, are one of the main issues in Dewey Beach’s sidewalk infrastructure. As the pictures in Figure 1 demonstrate, utility poles are frequently located in the center of sidewalks. This can make maneuvering around Dewey Beach difficult for pedestrians, especially for families who may need to accommodate strollers.\textsuperscript{12}

\begin{flushright}
\textsuperscript{9} Ibid (8)
\textsuperscript{10} Ibid (7,8)
\textsuperscript{12} http://www.capegazette.com/node/95506
\end{flushright}
The absence of bike infrastructure in Dewey Beach heightens safety concerns. Legally, only children age 12 and under are allowed to ride their bikes on sidewalks. When adult cyclists ride on sidewalks, it decreases the space available for pedestrians, making it far more likely for a pedestrian to step onto the street. Riding bikes on the highway, on the other hand, can be confusing for cyclists because pedestrian traffic flow is opposite to cyclist and highway traffic flow.\(^\text{13}\)

Pedestrian lighting is also an important factor to evaluate pedestrian and bicyclist safety in Dewey Beach. The town has comparatively sparse lighting, with the end of many streets completely lacking streetlights.\(^\text{14}\) Luminaries are located far apart, which can lead to dim visibility for both pedestrians and cars on Route 1. Improved sidewalk lighting in Dewey Beach is important to ensure the safety of the town’s residents as well as that of the many visitors participating in Dewey Beach’s vibrant nightlife. Some Dewey Beach residents have advocated for greater pedestrian lighting in the town to promote feelings of pedestrian security. Other residents, however, oppose such initiatives due to concerns over glare from luminaires and increased light pollution.\(^\text{15}\)

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\(^{13}\) Ibid (11)

\(^{14}\) Ibid (12)

\(^{15}\) http://www.wboc.com/clip/11136983/dewey-town-council-to-consider-additional-street-lighting
Pedestrian Lighting Pilot Study

The University of Delaware Institute for Public Administration’s Walkability Assessment Tool provides a useful framework for designing walkability assessments. The guide suggests considering different seasons and times to conduct the assessment. It also encourages those performing the assessment to tour the area before assessment to identify critical spots and locations where participants can stop to take notes.16

The Wilmington Area Planning Council (WILMAPCO) advises that assessment routes cover no more than six blocks, with a total assessment time of no more than one hour. Since pedestrian lighting increases perceived safety and provides greater visibility, it is important to have adequate luminaires along major roads.17 The suggested pilot study route will thus follow Route 1, the coastal highway, since the most popular pedestrian destinations are located along this route. The Town of Dewey Beach’s zoning map shows that its commercial area is located between Van Dyke Avenue and Clayton Street, a distance of ten blocks.18 If both sides of Route 1 along this path were covered, the distance would be 20 blocks. To bring the assessment route closer to WILMAPCO recommendations, the pilot route should be shortened from Van Dyke Avenue to Salisbury Street. This route is shorter (8 blocks one way, 16 blocks total), but still covers the most popular nightlife locations, such as the Starboard. If during the pre-assessment the study participants determine that this route is too long, the route can be shortened further to both sides of Route 1 from Van Dyke Avenue to Bellevue Street.19 This, as seen in the zoning map in Figure 2, would still cover the densest commercial area in Dewey Beach.

17 Ibid (16)
18 Ibid (1)
19 https://www.google.com/maps/@38.6919837,-75.0744345,17z
Figure 2. Town of Dewey Beach’s Zoning Map

Two assessments should be conducted as part of the pilot study: one during the day and the second during the evening. Pedestrian lighting studies have found that conducting pedestrian lighting assessments only at night does not lead to accurate measurements of perceived safety due to lighting. There are several factors, other than lighting, that contribute to feelings of pedestrian safety. Conducting surveys during both the day and evening isolates lighting as the determinant factor. A lighting safety score can be obtained by determining the differential
between the daytime safety score and the evening safety score. Lower differentials indicate increased levels of safety.  

Pilot Study Methodology

In the interest of conducting an affordable and easily replicable trial study, IPA staff chose a $20 light meter, the LX1010B by Dr. Meter, pictured in Figure 3, and utilized a $10 smartphone app, MapIT GIS. MapIT GIS is an android app that enables effective field data collection and mapping. The app allows users to create surveys with several ordinal and numerical variables (for example, a survey of trees in an area could use the app to record both species type and tree height). These data points can be used to create a map layer. The app also has a tool to calculate areas and distances. MapIT GIS is a useful tool for conducting pedestrian lighting surveys because it has versatile data collection infrastructure and export capabilities. A screenshot of the app’s location function is also depicted in Figure 3.

Figure 3. Light Meter and MapIT GIS App

In this study, the GIS app was used to create a shapefile containing the locations of all light poles, significant obstructions or hazards encountered within the pedestrian network, and recorded light levels at regular intervals. The light meter was used to determine the level of illumination after sundown. These data were then projected geospatially and symbolized according to the light levels observed as compared to the light levels indicated in the literature for a variety of contexts.

Acceptable Levels of Light

Several studies have been done to analyze the impact of pedestrian lighting on the perception of safety. A German study found that safety perceptions are actually determined by a combination of lighting and feelings of “entrapment,” the feeling that one might not be able to escape from a place (often determined by the number of exits in a space). In areas with low levels of entrapment, increasing lighting does cause a significant increase in perceived safety. In areas with high levels of entrapment, changes in lighting do not make much of a difference. The study also found that men in general were less afraid than women in any given space, especially in regard to places with high entrapment. A Dutch study supports these findings. Researchers determined that bright lighting makes people feel safer than lower lighting, even if the bright lighting is considered excessive. They also found that although men in general feel safer than women in any lighting scenario, this does not mean that men find low-lighting settings more acceptable.

Studies in the United States have found that factors other than brightness are important to reach optimal pedestrian lighting levels. The City of San José, California, found that Metal Halide and High Pressure Sodium (HPS) lights have superior color rendering. This allows pedestrians to better see their surroundings and thus feel safer. A study at Virginia Tech found that continuity and evenness of brightness is important to perceived safety. Additionally, the ability to recognize faces improves perceived safety. Despite these other factors, the level of lighting is still of utmost importance. A study in Albany, New York, found that people care more about illuminance than lamp color.

Through research analysis and field studies, some cities have developed guidelines on adequate pedestrian lighting. Some follow IESNA (Illuminating Engineering Society of North America) guidelines, and others have created their own guidelines based on independent research. Other cities have also included qualitative guidelines, such as ensuring lighting is uniformly and continuously distributed and avoiding reliance on private business for lighting needs (because the municipalities do not have control over such sources). The table in Figure 4 below compiles the quantitative lighting guidelines developed by various cities.

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Figure 4. Quantitative Lighting Guidelines

<table>
<thead>
<tr>
<th>Location</th>
<th>Recommended Light Level (Footcandles)</th>
<th>Recommended Light Level (Lux)</th>
<th>Recommended Uniformity Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Structure</td>
<td>2.0 fc</td>
<td>22 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Downtown Pedestrian Path (High Foot Traffic)</td>
<td>2.0 fc</td>
<td>22 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Downtown Pedestrian Path (Medium Foot Traffic)</td>
<td>1.0 fc</td>
<td>11 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Urban Parks</td>
<td>1.0 fc</td>
<td>11 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Downtown Residential Area</td>
<td>0.4 fc</td>
<td>4 lux</td>
<td>6:1</td>
</tr>
<tr>
<td>Underpass</td>
<td>4.0 fc</td>
<td>43 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Bike Rack</td>
<td>5.0 fc</td>
<td>54 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Building Entrance</td>
<td>5.0 fc</td>
<td>54 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Bus Stop</td>
<td>2.0 fc</td>
<td>22 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Campus Edge</td>
<td>3.0–4.0 fc</td>
<td>32–43 lux</td>
<td>6:1 (max)</td>
</tr>
<tr>
<td>Campus Entrance</td>
<td>17.0 fc</td>
<td>183 lux</td>
<td>3:1 (max)</td>
</tr>
<tr>
<td>Emergency Entrance</td>
<td>15.0 fc</td>
<td>161 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Maintenance/Service</td>
<td>3.0 fc</td>
<td>32 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Parking Lot (open)</td>
<td>0.2–0.9 fc</td>
<td>2–10 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Parking Lot (covered)</td>
<td>4.0–5.0 fc</td>
<td>43–54 lux</td>
<td>4:1</td>
</tr>
<tr>
<td>Self-Parking</td>
<td>1.0 fc</td>
<td>11 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Attendant Parking</td>
<td>2.0 fc</td>
<td>22 lux</td>
<td>N/A</td>
</tr>
<tr>
<td>Fast Food Restaurants, Gas Stations,</td>
<td>2.0–3.0 fc</td>
<td>22–32 lux</td>
<td>3:1</td>
</tr>
<tr>
<td>Convenience Stores</td>
<td>1.0–2.0 fc</td>
<td>11–22 lux</td>
<td>3:1</td>
</tr>
</tbody>
</table>

Dewey Beach Pilot Study

As part of a pilot study on pedestrian lighting in Delaware, the Institute for Public Administration (IPA) assessed lighting levels in the most traversed areas of Dewey Beach. IPA staff assessed the quality of lighting along Dewey Beach’s State Route 1 from Saulsbury Street.

to Vandyke Street on both sides of the road. Researchers measured individual luminaire light levels for every five paces. They also gauged how safe a pedestrian might feel walking along Route 1 at night and noted the effect of commercial lighting on street-level lighting quality.

Results

Based on luminance data collected, IPA staff created two maps that show the differing lighting levels around Route 1 in Dewey Beach (see appendix). The first map simply shows the raw numeric values. The viewer can quickly see the widely divergent levels of light and see areas where, in fact, the levels were too low to be discerned by the light meter.

The second map simplifies and categorizes the observed values in line with the acceptable levels of light research noted earlier in this document. Yellow dots indicate insufficient pedestrian lighting (<4 lux), orange dots indicate lighting appropriate for downtown residential areas (4–11 lux), light brown dots indicate lighting appropriate for a downtown area with medium foot traffic (11–21 lux), and dark brown dots indicate lighting appropriate for downtown areas with high foot traffic (>22 lux).

Perhaps the most profound observation the researchers noted was that the streetlights were not a significant factor in luminance levels—public luminaires, at best, would provide a baseline illumination hovering between “too dark” and appropriate for “downtown residential” areas.

Most of the lighting variation along Route 1 was provided by commercial business. As shown in Figure 5, taken by IPA staff during the pilot assessment, there is illuminance in the area immediately around Hot Dog Johnny’s, but the area beyond it is almost completely dark.

The Route 1 illuminance map shows a similar result. Between Vandyke Street and Dickinson Street, lighting levels are between “downtown residential” and “downtown medium foot traffic” because this stretch includes light provided by Nalu Surf Bar & Grill, Ponos Hawaiian Fine Dining, Two Seas Restaurant, and Hyatt Place Dewey Beach. Meanwhile, between Rodney Avenue and Read Street, the only commercial location is Sharky’s Grill & BBQ.
Between these two streets, the pedestrian lighting on both sides of Route 1 is insufficient for almost the entire path. This pattern can be seen again on the left side of Read Avenue. Illuminance in front of Grotto Pizza is high enough to be appropriate for a downtown pedestrian area with high foot traffic. On either side of the restaurant, however, lighting levels drop significantly.

Several cities have determined that it is problematic to depend on commercial business to provide adequate commercial lighting. When Chapel Hill, North Carolina, for example undertook a project to improve its pedestrian lighting, the city cautioned against relying on commercial lighting to supplement luminaires. Retail establishments can change or remove lighting without notice, so it is important for a town to provide enough public lighting to make pedestrians feel safe.29

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Suggestions

There are several short-term, cost-effective changes the Town of Dewey Beach can make to significantly improve its pedestrian lighting.

1. **Install luminaire attachments on utility poles to increase the frequency and consistency of pedestrian lighting.**
   - Although there are many factors involved in creating effective pedestrian lighting, the first step is increasing illuminance levels and lighting consistency. Dewey Beach can do this by installing more streetlights.
   - When the City of San José, California, was improving its pedestrian lighting, it repurposed existing traffic signal poles to also accommodate new luminaires. Dewey Beach can take a similar approach by installing lighting attachments to existing utility poles and street lights, as depicted in Figure 6. If such luminaires are placed consistently along Route 1 at heights appropriate for pedestrian illumination, pedestrian lighting would be significantly improved.

![Figure 6. Example of Luminaire Attachment to Existing Street Light](https://hidot.hawaii.gov/highways/files/2013/07/Pedest-Tbox-Hawaii-Pedestrian-Toolbox-Low-Res.pdf)

Source: Hawaii Pedestrian Toolbox, 2013

2. Change luminaire types to maximize useful light.

- Many traditional luminaire designs, such as globe designs, provide light inefficiently. As Figure 7 shows, luminaires that are not angled downward can give off extra light that does not help pedestrian visibility but does contribute to glare and light pollution.

- Some Dewey Beach residents have expressed concern with increasing light pollution. Creating effective lighting that does not contribute to light pollution is an important step to improving feelings of pedestrian safety while still respecting the priorities of all Dewey Beach residents.

- Pedestrian lighting improvement projects in Iowa prioritized installing light cutoffs on existing globe luminaires to reduce wasted light, and projects in San José, California, and Hawaii ensured that all newly installed luminaires would be downward shielding.

- In its Pedestrian Lighting Working Paper, IPA advocated for light shielding luminaire styles, not only because they reduce light pollution, but also because they are more energy efficient. Since the town would not be wasting energy to provide ineffective light, such luminaires are also cheaper in the long run.
  - IPA noted that cobra head luminaire styles (with a refractor) are an effective light-shielding option.

- An example of a light-shielding luminaire is depicted in Figure 7.

Figure 7. Luminaire Angles and Cut-Off Luminaire

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32 https://www.colliergov.net/home/showdocument?id=71020
34 https://www.facilities.uiowa.edu/space/campus-planning/cpstudies/plight8.pdf
37 Ibid (14)
3. **Switch to High Pressure Sodium (HPS) or LED lights to improve light quality and lower long-term lighting costs.**

   - In Hawaii, pedestrian lighting projects switched many luminaires to LED light sources because LED lights make light distribution uniform, are energy efficient, and prove more cost effective in the long run than other light types.  

   - In its Pedestrian Lighting Working Paper, IPA suggested using LED lights if light pollution is a concern. Although HPS lamps are also an energy efficient alternative to other light types, it is easier to direct light from LED lights than HPS lamps.  

   - Since HPS lamps have a lower initial cost than LED lights but still provide some of the same benefits, many cities have utilized HPS lamps to improve pedestrian lighting.  

   - Pedestrian lighting improvement projects in Iowa, California (San José), Hawaii, and Florida have switched luminaires to HPS light sources.  

   - Pedestrian lighting improvement projects in North Carolina and Hawaii have switched luminaires to LED light sources.  

4. **Change zoning ordinances to require new buildings to incorporate efficient public pedestrian lighting in the design; work with development partners to install government-managed pedestrian lighting on the facades of existing buildings.**

   - In 2010, Amarillo, Texas, changed zoning ordinances to require new buildings to incorporate downward-facing pedestrian lighting on its street-facing exteriors. The city also encourages established buildings to install such lighting on their facades if they are part of the downtown.  

   - Figure 8 shows an example of Amarillo’s new developmental policy. The pedestrian lighting is incorporated into the building’s facade. The lighting fits the character of the building, provides necessary illuminance, and minimizes glare and light pollution.  

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38 Ibid (14)
39 Ibid (16)
40 https://www.colliergov.net/home/showdocument?id=71020
41 Ibid (13, 14, 15, 20)
42 Ibid (15, 16)
43 Ibid (17)
Conclusion

The amount and type of street lighting in a municipality has a significant impact on pedestrians’ feelings of safety. Luminaires that provide bright, even light while reducing glare and light pollution can substantially improve a pedestrian’s experience. A pilot lighting assessment in Dewey Beach showed that the town suffers from low and inconsistent pedestrian lighting. This stems in part from the town’s heavy reliance on commercial businesses lighting for nighttime visibility. The Town of Dewey Beach can take steps to improve its pedestrian lighting in a cost-effective way. Installing luminaire attachments on utility poles will increase the frequency and consistency of lighting—two factors that will make visitors and residents feel safer when walking. Changing luminaire types to downward-facing styles will maximize useful light, reduce energy costs, and assuage the light-pollution concerns voiced by Dewey Beach residents. Switching to High Pressure Sodium (HPS) or LED lights can improve light quality and lower long-term lighting costs. The Town of Dewey Beach should also consider working with zoning and development groups to incorporate efficient public pedestrian lighting on the facades of new and existing buildings.
Work Cited


Retzlaff, J. (0AD). *Outdoor lighting guidelines to be used in preparing lighting plans as part of the site plan review process*. *Outdoor lighting guidelines to be used in preparing lighting plans as part of the site plan review process*. (pp. 1–7). Germantown, WI: Planning Department. Retrieved from http://www.village.germantown.wi.us/DocumentCenter/View/44/planning-LightingGuidelines.pdf?bidId=


Appendix: Dewey Beach Lighting Maps
Town of Dewey Beach, Delaware
Transportation Map - Lighting Pilot Study
May 2018

Sources:
- Municipal Boundaries - Delaware Office of State Planning Coordination, FirstMap 11/17
- Lightposts - UD IPA 05/18
- Major Routes - Delaware Department of Transportation, FirstMap 11/17
- Centerline Roads - Delaware Department of Transportation (DelDOT), FirstMap 11/17
- Public State Parcels - Delaware Office of State Planning Coordination, FirstMap 11/17
- Water Bodies - USGS and EPA, FirstMap 11/17

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Town of Dewey Beach, Delaware
Transportation Map - Lighting Pilot Study
May 2018

Sources:
- Municipal Boundaries - Delaware Office of State Planning Coordination, FirstMap 11/17
- Lightposts - UD IPA 05/18
- Public and Residential - Delaware Department of Natural Resources and Environmental Control, FirstMap 11/17
- Public State Parcels - Delaware Department of Transportation (DelDOT), FirstMap 11/17
- Parking Boundaries - Sussex County Mapping & Addressing, FirstMap 11/17
- Hydrolgy - USGS and EPA, FirstMap 11/17

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