Pedestrian-Lighting Options and Roles of Responsibility Within Unincorporated Delaware Communities

A Working Paper

December 2011

written by
Theodore Patterson and **Ryan Gillespie**

project managed by
Edward O'Donnell, AICP

prepared by

Institute for Public Administration
School of Public Policy & Administration
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University of Delaware

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Preface

As Director of the University of Delaware's Institute for Public Administration (IPA), I am pleased to provide the *Pedestrian-Lighting Options and Roles of Responsibility Within Unincorporated Delaware Communities* working paper. Its development was supported by the Delaware Department of Transportation (DelDOT). Policy Scientist Edward J. O'Donnell, AICP, was the Principal Investigator for this work. Additional IPA project team members included Ted Patterson, Ryan Gillespie, Mark Deshon, and Marcia Scott.

Transportation infrastructure in Delaware is of vital importance as our state grows in the 21st century. To create a balanced approach to transportation infrastructure development, pedestrian, cyclist, bus transit, train transport, and automobile infrastructure must all be integrated into one interconnected network to provide the public with attractive options for getting from point A to point B. Historically, transportation planners have been more effective at designing the network to serve automobiles, trains, and buses—neglecting the need to develop bicycle and pedestrian facility infrastructure. Forward-thinking Delaware government officials are spearheading efforts to change course by developing and implementing bold new policies related to multimodal transportation systems such as DelDOT's new Complete Streets Policy.

This working paper addresses a key component to pedestrian and bicycle facilities—lighting. Not only can enhanced lighting encourage a safe and secure atmosphere for pedestrians and cyclists, it can improve energy efficiency in the 21st century. As Delaware officials grapple with air quality and climate change issues in the future, more sustainable lighting will prove to be a vital component in meeting environmental conservation objectives. This working paper highlights the opportunities and challenges related to enhancing pedestrian-lighting infrastructure in Delaware's unincorporated areas. Special attention has been given to examining green technology, light-fixture design, light planning, and light-pollution mitigation.

Providing Delaware citizens with accurate and complete information on important policy decisions is a core objective for IPA, and this research on pedestrian lighting provides necessary background and input from key stakeholders to move Delaware forward on transportation policy. This document offers a framework for discussion and action that we sincerely hope will support transportation network enhancement in Delaware in the future.

Jerome R. Lewis, Ph.D.
Director, Institute for Public Administration

Institute for Public Administration

The Institute for Public Administration (IPA) prepared this working paper. A unit within the College of Arts and Sciences' School of Public Policy & Administration at the University of Delaware, IPA links the research and resources of the University with the management and information needs of local, state, and regional governments in Delaware. IPA provides assistance to agencies and local governments through direct staff support and research projects as well as training programs and policy forums.

IPA Research Associate Theodore Patterson researched and authored this report with assistance from Graduate Research Assistant Ryan Gillespie.

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Funding from the Delaware Department of Transportation made this research possible. DelDOT Traffic Engineer Mark Luszcz participated in a conference call in November 2010 to talk with IPA staff about pedestrian lighting, and we thank him for taking the time to provide input on the project. Additionally, Sussex County Deputy Administrator Harold Godwin, Planning Director Lawrence Lank, and Assistant Director of Public Works Patricia Deptula provided IPA staff with in-depth information on their county's lighting policies; we thank them for their assistance. Research Assistant Ryan Gillespie performed initial research that laid the groundwork for the eventual completion of this report. Special thanks go to those who participated in IPA's project workshop held in April 2011. The input and discussion provided at the workshop were invaluable to the research efforts undertaken for this project. Workshop participants are listed in Chapter 3.

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Executive Summary

The purpose of this working paper is to document the research on the roles of responsibility and options for improving pedestrian lighting in unincorporated areas in Delaware. As a result of northern Delaware's unique location within the Northeast corridor and southern Delaware's tourist attractions and beaches, transportation challenges will revolve around improving current infrastructure to adapt and accommodate multiple modes of transportation in the 21st century. A road network that is accessible and integrated with bus routes, pedestrian connections, bike lanes, and rail transport is a network that will be well positioned to handle northern Delaware's growing demand for efficient transportation systems. Unincorporated areas of Kent and Sussex Counties will require enhancements to transportation networks as Delaware's population expands from urban northern Delaware to the more suburban and rural southern areas of the state. While pedestrian-lighting is desirable, there are several issues regarding lighting responsibilities within unincorporated areas of Delaware that include the following:

- Determining options for fixture-styles
- Financing capital costs for the purchase of poles and fixtures
- Installing and maintaining the fixtures over the long term
- Light-pollution mitigation
- Financing annual maintenance costs and improvements

This working paper reviews current practices in Delaware, explores topics and problem areas related to pedestrian lighting and provides a comprehensive set of recommendations and best practices for addressing pedestrian lighting in unincorporated areas of Delaware. This work includes input and recommendations from a working group of community representatives and government officials within unincorporated areas of Delaware who impact and are impacted by pedestrian-lighting policy.

Chapter 1. Introduction to Pedestrian Lighting

Chapter 1 introduces pedestrian lighting and discusses vital themes connecting pedestrian lighting to overall community walkability. "Pedestrian lighting," as a term, can be interpreted in various ways. One might define pedestrian lighting in terms of all lights that illuminate pedestrians or pedestrian facilities. Others may define pedestrian lighting by analyzing lighting that is specifically designed for illuminating pedestrians or pedestrian facilities. For all intents and purposes of this work, pedestrian lighting is defined as any type of lighting that illuminates pedestrians or pedestrian facilities. Therefore, pedestrian lighting includes residential light posts, commercial-storefront lighting, street lights, highway lighting, and bus-shelter lighting. Pedestrian facilities include, but are not limited to, sidewalks, multimodal paths, bus-shelters, park trails, and crosswalks. Specifically designed pedestrian-lighting is commonly characterized by lower-intensity light shining from fixtures on shorter "pedestrian-scale" poles designed to provide more specialized illumination of pedestrian facilities than do average street-lights.

Throughout the literature on lighting in communities, from local guidelines for pedestrian areas to research on walkable communities, it is clear that the right level of lighting is critical to ensuring that a pedestrian area is used and used safely. Communities must use their discretion in determining what pedestrian paths or trails are most likely to be used in low-light conditions and

whether lighting is needed to improve visibility and/or safety. Once a community has reached this conclusion, the type and level of lighting that is correct for the pedestrian environment must also be determined. This includes decisions concerning location of lighting and its timing. Timing issues include whether lamps should be activated using motion sensors or left on throughout the night. As with any community issue, maintenance and funding must be considered carefully when these decisions are being made. Detailed plans for increasing the walkability of a community and ensuring the safe travel of pedestrians are made in many communities and can help guide the process of installing new lighting. Communities that develop such a plan and gradually implement the changes will be safer and healthier as a result.

Chapter 2. Innovations in Pedestrian Lighting

Over the past century, innovations in outdoor-lighting technology have greatly enhanced the overall efficiency, utility, and aesthetic value of lighting. In Chapter 2, key innovations in pedestrian lighting are discussed and include the following: 1) green technology, 2) shielding, 3) energy efficiency, and 4) aesthetics. Green technologies, such as new light bulb design, solar power, and wind power, are reshaping the energy landscape throughout the world. Lighting is yet another sector to be positively impacted by green technology. Shielding practices have changed over time to direct light more effectively to areas where it is needed, thus saving energy and avoiding light pollution. More focus today has been directed toward mitigating light pollution; new and better ways of shielding light have been utilized in light fixture design. Energy efficiency is a continual concern from both a financial perspective and an environmental perspective. New lighting fixtures, although costly for initial installation, provide major opportunities for operational cost-savings over time. Communities interested in investing in pedestrian-lighting desire lighting that will reflect community character. To meet this need, new pedestrian-lighting styles are being developed to provide aesthetically pleasing atmospheres in historic residential communities as well as high-tech, bustling business districts.

Chapter 3. Project Workshop

Chapter 3 presents a vital component of this project—the stakeholder workshop. On April 12th, 2011, IPA, in coordination with DelDOT, hosted a stakeholder workshop to discuss the issue of pedestrian lighting in Delaware. Community, private-sector, government, and nonprofit representatives were invited to this workshop to provide a wide range of perspectives on pedestrian-lighting to highlight where potential opportunities exist and hurdles interfere with further enhancement of pedestrian-lighting in Delaware. The key discussion points focused on:

- Criteria for Determining Lighting Needs
- Financing Mechanisms for Installation / Maintenance
- Light Fixtures, Shielding, and Green Technology
- Possible Recommendations and Best Practices
- Moving Forward and Next Steps

Many stakeholders attended, a complete list of attendees is provided in Chapter 3. Chapter 3 provides the workshop notes, categorized according to the key discussion points listed above. The workshop agenda is attached as Appendix 2.

Chapter 4. Best Practices and Recommendations

Chapter 4 encompasses discussion of many key elements related to enhancing pedestrian lighting in unincorporated areas. The following key topics are discussed, with best practices highlighted and recommendations presented in each of the following areas:

- Roles and Responsibility
- Financing Mechanisms
- Light-planning
- Public Engagement
- Lighting Ordinances
- Light-Pollution Mitigation

Roles and responsibility speak to a crucial problem involved in lighting infrastructure—who is responsible for installation and maintenance? Setting clear responsibilities and roles for the private sector, residents, government, and utilities at the front end of the planning process mitigates potential problems after lighting is installed in a community.

Various financing mechanisms are available for consideration and use in Delaware. Examples from across the nation include 1) local assessment districts, 2) transportation-impact fees and excise taxes, 3) adequate public facilities ordinances, 4) tax-increment financing, and 5) grant funding. These financing mechanisms are discussed in detail in Chapter 4, providing readers with a reference for considering how to fund lighting infrastructure projects on the local level.

Communities of many sizes and from all over the country have completed light-planning exercises. Some localities created specific lighting plans and light master plans for parks, neighborhoods, and road segments. Others are including light-planning elements within streetscaping projects, neighborhood-redevelopment plans, and community master plans. Light-planning examples and templates are provided and discussed in Chapter 4.

Public-engagement strategies are also discussed, as public approval and support for lighting infrastructure is absolutely necessary during the early phases of a project.

Various examples exist for model lighting ordinances that address the connection between lighting infrastructures and various types of zoning, requirements for lighting and varying lighting levels, light-pollution mitigation and fixture-style regulation.

Light-pollution-mitigation strategies revolve around improving shielding, utilizing green technology and energy-efficient technology, use of dimming technology and day-night sensors, and use of less intense, softer color lighting in certain applications to compliment community character.

Chapter 1. Introduction to Pedestrian Lighting

The purpose of this working paper is to document the research on the roles of responsibility and options for improving pedestrian lighting in unincorporated areas in Delaware. Pedestrian lighting is crucial to creating a safe, multimodal environment in Delaware. The National Highway Traffic Safety Administration (NHTSA) reported in 2009 that nationally "almost 70 percent of pedestrian fatalities occurred during the nighttime."[1] The same was also true in 2008.[2] WHYY news reported in August 2010 that "16 pedestrians had died in traffic-related crashes in Delaware"[3]—a fatality total three times higher than the same time in 2009.[4] Seventy-five percent of the state's pedestrian fatalities as of August 2010 occurred in New Castle County "with most happening on or around the areas of Route 7 and U.S. Route 13 in low-light or dark conditions."[5] Transportation for America, a leading multimodal transportation advocacy organization, ranks Delaware's Pedestrian Danger Index (PDI) at 82.2, ranking 13th nationally.[6] Enhanced pedestrian lighting in Delaware can save lives. Beyond safety, Delaware's unique location should be considered when understanding the importance of pedestrian lighting.

As a result of northern Delaware's unique location within the Northeast Corridor and southern Delaware's tourist attractions and beaches, transportation challenges will revolve around improving current infrastructure to adapt and accommodate multiple modes of transportation. A road network accessible and integrated with bus routes, pedestrian connections, bike lanes, and rail transport is a network that will be well positioned to handle northern Delaware's growing demand for efficient transportation systems. Unincorporated areas of Kent and Sussex Counties will require enhancements to transportation networks as Delaware's population expands from urban northern Delaware to the more suburban and rural southern areas of the state. Additionally, as the population ages nationally and in Delaware—a primary challenge in this century will be to design roadway-and pedestrian-lighting systems that address the needs of older drivers.

Lighting improvements within a pedestrian environment will help foster complete streets within the state of Delaware. As a follow-up to Delaware Governor Jack Markell's 2009 complete streets executive order, the Delaware Department of Transportation (DelDOT) subsequently adopted a policy "to promote safe access for all users, including pedestrians, bicyclists, motorists and [transit] riders of all ages to be able to safely move along and across the streets of Delaware."[7] To encourage pedestrian use, complete streets have features that make people of all ages and abilities feel comfortable and safe—including streetscaping improvements and

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[1] U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts: 2009 Data*, (Washington DC: NHTSA National Center for Statistics and Analysis, 2009), http://www-

[2] Ibid.

[3] Cook, Bill, "Delaware Pedestrian Deaths on the Rise," *WHYY Radio*, 6 Aug. 2010, (Web. 26 Jan. 2011), http://whyy.org/cms/news/health-science/2010/08/06/delaware-pedestrian-deaths-on-the-rise/43165.

[4] Ibid.

[5] Ibid.

[6] Transportation for America, *Dangerous by Design 2011: Delaware*, (Washington DC: Transportation for America, 2011), http://t4america.org/docs/dbd2011/de-dangerous-by-design.pdf, 2.

[7] Delaware Department of Transportation, *Executive Order # 6: Complete Street Act of 2009*, (Dover: Delaware Department of Transportation, 2009).

pedestrian-friendly features such as lighting fixtures to illuminate pedestrians and/or pedestrian facilities.

The state of Delaware is also grappling with federal environmental regulations related to air quality that could be partially mitigated through more energy-efficient lighting as well as a transportation system offering zero-emissions travel options (i.e., walking and biking). According to DelDOT, Delaware is one of 35 states "with air pollution levels higher than federal health standards."[8] Motor vehicles in Delaware create approximately one-third of the "volatile organic compounds (VOCs)—mostly hydrocarbons—released into our atmosphere."[9] With improved pedestrian lighting, walking can become a more attractive option for people to utilize. While pedestrian-lighting is desirable, there are several issues regarding lighting responsibilities within unincorporated areas of Delaware, which include

- Determining options for fixture styles
- Financing capital costs of the purchase of poles and fixtures
- Installing and maintaining the fixtures and long-term maintenance
- Light-pollution mitigation
- Financing annual maintenance costs and improvements

For the past 18 years, the University of Delaware's Institute for Public Administration (IPA) has conducted a series of public policy forums, along with accompanying research and reports, focusing on infrastructure policy. The purpose has been to facilitate a continuing process of discussion, planning, and action for the formulation of policies and programs designed to meet the future infrastructure needs of Delaware as well as the development of long-term strategies for regional infrastructure priorities. Recent infrastructure policy forums and research have focused on the issues of walkability, mobility, interconnectivity, transit-oriented design, right-sizing Delaware's paratransit system, and Northeast Corridor transportation infrastructure issues.

This working paper reviews current practices in Delaware, explores topics and problem areas related to pedestrian lighting, and provides a comprehensive set of recommendations and best practices for addressing pedestrian lighting in unincorporated areas of Delaware. This working paper will include input and recommendations from a working group of community representatives and government officials within unincorporated areas of Delaware who are impacted by and impacting pedestrian-lighting policy.

[8] Delaware Department of Transportation, Division of Planning, *Delaware Transportation Facts 2009*, (Dover: Delaware Department of Transportation, 2009), http://www.deldot.gov/information/pubs_forms/fact_book/pdf/2008/2009_fact_book.pdf, 10.
[9] Ibid.

1-1. What is Pedestrian Lighting?

Figure 1 Pedestrian Lighting vs. Street Lighting

"Pedestrian lighting," as a term, can be interpreted in various ways. One might define pedestrian lighting in terms of all lights that illuminate pedestrians or pedestrian facilities. Others may define pedestrian lighting by analyzing lighting that is specifically designed for illuminating pedestrians or pedestrian facilities. For all intents and purposes of this work, pedestrian lighting is defined as any type of lighting that illuminates pedestrians or pedestrian facilities. Therefore, pedestrian lighting includes residential light posts, commercial-storefront lighting, street lights, highway lighting, and bus-shelter lighting. Pedestrian facilities include, but are not limited to, sidewalks, multimodal paths, bus-shelters, park trails, and crosswalks. The Lighting Design Lab, based in Seattle, Wash., defines pedestrian-lighting as follows:

> Pedestrian lighting includes all exterior lighting applications where people travel by foot or on bike along pathways, walkways, bikeways and roadways. As such it is an application within the larger discipline known as outdoor-lighting, and intersects with roadway and landscape lighting at times.
>
> Broadly speaking, pedestrian lighting falls into one of three categories:
>
> > When it is the only lighting present and must do all of the lighting tasks (security, hazards, way finding, and decorative)
> >
> > When it is part of a larger lighting system and is used as a beacon or supplemental lighting for way finding and other hazards
> >
> > When the pedestrian lights are low power and used primarily for decorative purposes while another system performs all other lighting functions.[10]

Specifically designed pedestrian lighting is commonly characterized by lower-intensity light shining from fixtures on shorter "pedestrian-scale" poles designed to provide more specialized illumination of pedestrian facilities than do average street lights. Fig. 1 above shows pedestrian lights on the right side along a walkway and regular street lights to the left closest to the road.

[10] University of Washington, Lighting Design Lab, *Pedestrian-lighting*, (Seattle: Lighting Design Lab), http://lightingdesignlab.com/articles/pedestrian/pedestrian.htm.

The University of Washington's Lighting Design Lab (LDL) defines three key types of pedestrian lighting—primary, supplementary, and aesthetic.[11] Primary pedestrian lights are the only lights present and, therefore, provide all lighting functions (i.e., security, hazards, way-finding, and decorative).[12] Supplementary pedestrian lighting is incorporated into a larger lighting system and is focused on lighting functions such as way-finding and illuminating possible hazards.[13] Aesthetic pedestrian lighting is used for decorative purposes, while other forms of lighting are used to perform all other lighting functions.[14] LDL also defines three mount types that provide insight into light height vs. function and application as shown in the table below.

Table 1 Pedestrian Light Mounting Heights and Applications

Mount Type	Pole Height	Function	Applications
High	20-30 ft.	Roadway	street-lighting, sidewalks
Medium	8-15 ft.	Pedestrian	sidewalks, paths, bikeways
Low	0-8 ft.	Pedestrian/Signage	bollards, small outdoor fixtures, residential lighting

Source: Lighting Design Lab, University of Washington

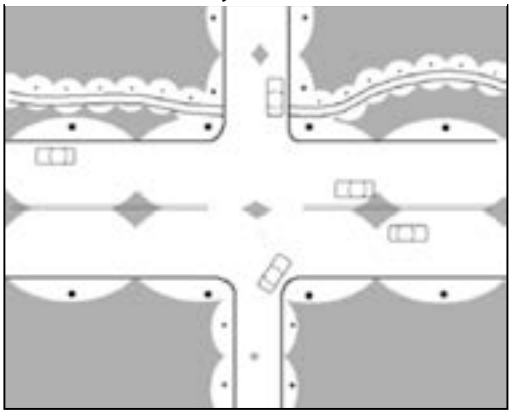
The city of Dallas, Tex., defines roadway lights as those that "illuminate roadways and are mounted 30 to 40 feet above the street."[15] Pedestrian lights are defined as those "mounted 13 to 16 feet above the sidewalk."[16]

1-2. Pedestrian Lighting and Community Walkability

Throughout the literature on lighting in communities, from local guidelines for pedestrian areas to research on walkable communities, it is clear that the right level of lighting is critical to ensuring that a pedestrian area is used and used safely. Communities must use their discretion in determining what pedestrian paths or trails are most likely to be used in low-light conditions and whether lighting is needed to improve visibility or safety. Figure 2 shows pedestrian, side street, and major roadway lighting differences. Once a community has reached this conclusion, the type and level of lighting that is correct for the pedestrian environment must also be determined. This includes

Figure 2 The Hierarchy of Illumination

Source: Green Valley Institute



[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Dallas, City of, *Pedestrian-lighting Policies – Enhanced Street-lighting: Briefing to Council Transportation and Environment Committee*, (Dallas: Department of Public Works & Transportation, April 24, 2006), http://www.dallascityhall.com/committee_briefings/briefings0406/20060424_TEC_PedLighting.pdf, 3.
[16] Ibid.

decisions concerning location of lighting and its timing, including whether lamps should be on motion sensors or on throughout the night. As with any community issue, maintenance and funding must be considered carefully when these decisions are being made. Detailed plans for increasing the walkability of a community and ensuring the safe travel of pedestrians are made in many communities and can help guide the process of installing new lighting. Communities that develop such a plan and gradually implement the changes will be safer and healthier as a result.

Before diving into the details of pedestrian lights, like fixtures and funding, it is important to understand the overall benefit a community receives by planning and implementing new pedestrian-lighting. The primary benefit is a healthier community. Lighted trails are used more, particularly in the early morning and dusk hours. Adding lighted hours to trail, path, or sidewalk use offers more exercise to those currently using the paths and further expands opportunity to those not exercising, perhaps adding additional users who have schedules that do not allow for exercise during daytime hours. The more these pieces of community infrastructure are used by walkers and runners, the healthier the community becomes overall.

A community whose residents walk and exercise more has several advantages over others with less opportunity to do so. The exercise helps with obesity, a growing problem in American communities, for both children and adults. Carrying less weight has a wide variety of health benefits, benefits that allow individuals to go to the doctor less often and use less medication.

Figure 3 A Well-Lit Storefront in Winter
Source: Green Valley Institute

Lighted paths also help keep kids active, potentially offering low-traffic areas in which to ride bikes or scooters with less risk in the evening. Some communities connect the paths to other lighted spaces that are either open or provide play equipment, giving the kids an extra incentive to use the path and parents a supervisory reason, not just for exercise, to walk the path or trail. Research has shown that children with ample opportunity to exercise benefit extensively when compared to those without. Furthermore, the obesity-related issues that are becoming more common among youth are combated by healthy exercise and higher activity levels. Nemours Health and Prevention Services reports that in the past 40 years childhood obesity has more than quadrupled among six-to-11-year-olds and more than tripled among 12-to-19 year-olds; the rates of childhood obesity have risen in all states, including Delaware; thirty-seven percent of children in Delaware are considered overweight or obese.[17] Research suggests that improvements to the built environment can provide more opportunities for both children and adults to engage in safe physical activity as part of an active lifestyle. With a significant problem and many experts pointing to the same solution, it is clear that providing extended and flexible hours for play can help to keep the children in a community healthy and active. Pedestrian lighting offers yet

[17] Nemours Health and Prevention Services, *Delaware Survey of Children's Health.* (Newark: Nemours, 2006).

another benefit, extending the useful hours of play areas and providing both children and parents more choices of when to exercise.

As part of the University of Delaware's Healthy Communities Initiative, and as an online component of the *Toolkit for a Healthy Delaware,* IPA has developed a *Walkability Assessment Tool* to help local governments consider strategies to improve local pedestrian networks. Within the *Walkability Assessment Tool* is Delaware's Walkability Checklist. The checklist is designed to help local officials determine an area's walkability and identify changes that might promote a healthier community. It specifically asks those conducting a walkability assessment of an area to consider factors—including lighting—that impact the overall walking experience.[18]

There is another major reason that lighting pedestrian paths improves a community. While it encourages more people to use paths and makes them healthier in the process, lights make the path significantly safer in the evening and at night. Unlit pedestrian paths can present a safety risk to anyone who uses them. Robbery and drug activity may be more likely in a pedestrian area with no light, where innocent civilians are less likely to identify the criminal activity or see an assailant coming. Streets in small, unincorporated communities can also be unsafe for similar reasons. Even if criminal behavior is not an issue, safety from motor vehicles improves significantly for pedestrians when sidewalks, roads, or driveways are illuminated by street or pedestrian lighting. Drivers are able to identify pedestrians sooner when lighting is provided. Technology has improved to also allow crosswalk lighting that minimizes light pollution while ensuring that anyone in the crosswalk is visible to oncoming motorists. If pedestrian accidents are already an issue or a concern for a community without pedestrian or street-lighting, improving that lighting is a great way to improve the safety of the community. As pedestrian accidents decrease or safety concerns lessen after light installation, community members will gradually begin using pedestrian paths more in the evenings. This safety benefit is a great example of how lighting can improve a community and, furthermore, how lighting directly impacts the walkability of a community.

In a society in which not everyone owns a car and a state in which darkness during winter months comes around 5:00 p.m., there is another important benefit to pedestrian lighting. In addition to promoting a healthier and safer community, lighting can help make the community more productive. For individuals who walk or ride bikes to local stores, healthcare providers, or restaurants, travel late in the day can be particularly concerning. Without light, many paths aren't safe (as discussed above) or navigable due to darkness. In small, unincorporated communities where most families have a car and few depend on pedestrian travel for necessities, this may not be an issue. However, any area that intends to connect paths to commercial facilities should consider whether some individuals using the path will need access to the path after sunset. If so, the businesses, community, and especially the pedestrians who depend on the path for necessities will all benefit.

[18] O'Hanlon, Julia and Jacquelyn Scott, *Healthy Communities: The Walkability Assessment Tool*, (Newark: Institute for Public Administration, University of Delaware, August 2010), http://www.ipa.udel.edu/healthyDEtoolkit/docs/WalkabilityAssessmentTool.pdf, 17-18.

1-3. Current Practices in Delaware

Delaware state law provides the regulatory framework for street-light policy in unincorporated areas. Appendix 1 features Title 9, Chapter 21 of the Delaware State Code pertaining to Street and Highway Lighting in New Castle County. Title 7, Chapter 71A: Regulation of Outdoor-lighting provides the regulatory framework for Delaware state-funded outdoor-lighting fixtures. Policies and procedures outlined by the counties provide additional context into street-light policy in Delaware.

New Castle County

New Castle County uses the process outlined in the state code to allow areas to petition for lighting improvements. Title 9, Chapter 21 in the state code, entitled Street and Highway Lighting, provides the framework for unincorporated communities in New Castle County to petition the county for street-lighting. Kent County, which will be discussed, uses a similar framework and calls on this state law; however, it is worth noting that the law specifically states in its first sentence that it applies to "any unincorporated community or village in New Castle County."[19] The community that wishes to install street-lighting must, according to section 2101, lay out the boundary lines and be approved by a majority of the home owners within the boundary. If a community achieves the majority needed through petition and submits the request to the County, the County can levy and collect a light-tax from all community members within the boundary outlined in the petition. This tax, according to section 2102, shall cover the full annual cost of the lighting. Additionally, the County may add up to ten percent onto this cost as payment for administration and billing. Farmland is exempt from the tax, even if it is within the boundaries of the newly lit area.

The light-tax that the state code allows for must be collected at the same time as the rest of the county taxes. However, if lighting is installed after the beginning of the fiscal year, the County may charge a supplemental light-tax to the community to cover the cost of the lighting for the remainder of the fiscal year. The light-tax is considered, according to section 2102, real property taxes and constitutes a statutory lien on any property until the tax is paid in full. Section 2103 explicitly forbids the county from being compensated beyond the cost of the lighting and ten percent administrative costs. In order to ensure this, the funds for the light-tax are required to be kept in a separate fund, and any surplus at the end of the year must be applied to reduce the light-tax rate for the following year.

Once lighting has been installed, the community that petitioned for it may not petition for its removal for at least three years. Any community petitioning for removal of lights must meet the same requirements as for installation, with a majority of the community signing in support of removal. Once removal has taken place, the light-tax is no longer charged to the community. However, tax payments will not be refunded if lights are removed in the middle of a fiscal year.

[19] Delaware, State of. *Delaware State Code, Title 9: Counties-New Castle County, Chapter 21 Street and Highway Lighting*. Dover: State of Delaware, 2011. http://delcode.delaware.gov/title9/c021/index.shtml.

The state regulations giving New Castle County the ability to levy a light tax are built upon further by the county's Unified Development Code, which incorporates subdivision and zone-code regulations. However, there are few substantial additions. The development code requires that public street lighting must, quite obviously, meet Delaware Department of Transportation standards. Light height and brightness regulations are also covered in the Unified Development Code. It reiterates that communities may petition the county for street lighting and that a special tax-assessment district will be used for the funding of such lighting. The creation of a light-tax district requires the approval of the County Council.

Kent County

Kent County also allows developers or residents to petition the county for a light district, although the requirements vary slightly depending on who is submitting the petition. Kent County Code outlines the county's basic regulations for street lighting in developments, stating that "streetlights shall be installed in major subdivisions with 51 or more lots and a density of 2.5 dwelling units per acre."[20] The code goes on to specify that lighting districts can be set up through the county process when subdivisions smaller than this want lighting, leaving the specific policies and regulations up to the Public Works Department.[21] Before exploring the Public Works Department's guidelines, it's worth noting that the code also specifies that all lighting fixtures be shielded or pointed downwards so as not to "disturb a person of normal sensibilities."[22]

The Kent County Public Works Department has developed procedures for the formation of a street-light district. To read the documents or obtain a petition, please visit the Kent County government website (http://co.kent.de.us). For a developer petitioning to get a lighting district for a community, 51 percent of the property owners must sign the petition except for in special situations where 65 percent may be required; for a resident the percentage of property owners required is always 65 percent. In either process a primary contact person must be established. For developers, the petition is submitted to the Kent County Levy Court for processing, and a detailed "Street-light Plan" is developed by the electric utility. Also, a "Construction Phase Plan" to install the lights is required from developers, and, for developers who have already begun constructing the subdivision, it is noted that additional charges may be encountered. There are further details for the process when initiated by developers, but the basic path is clear; for residents who need more pedestrian and street lighting in Kent County, the process by which they can petition for lighting is more important.

Once a resident has identified a primary contact person and gathered the required signatures from property owners, the resident must turn in the petition to the Kent County Levy Court and request a meeting with Kent County Engineers. During the meeting with engineers, the following is covered: "The primary contact person shall meet with Kent County Engineering to discuss, a) the type of street lights to be installed, b) the quantity and location of lights, c) installation fees, and d) and billing information."[23] It is also noted that the Department of Public

[20] Kent County Code, Chapter 187, Article X, Section 53, Part H (1).
[21] Kent County Code, Chapter 187, Article X, Section 53, Part H.
[22] Kent County Code, Chapter 187, Article X, Section 53, Part H (3).
[23] Ibid.

Works will send an engineer to assist the homeowners' association and/or residents to explain the process and expected changes. The next step is for the electric provider to develop a "Street-light Plan" and, once this is completed appropriately, for the Kent County Engineers to sign the "Agreement for Lighting Services" form that ensures the partnership between them and the electricity provider. Part of this agreement clarifies that the electricity provider will be responsible for installing the lighting, as it is for much of the lighting installed throughout the state. Once these are complete and the petition has been submitted and validated, Kent County Engineering files the proper resolution with the Kent County Levy Court so a public hearing can be scheduled. The County will then decide whether to accept, decline, table, or change the Resolution for Street-light District Formation. Residents are encouraged to attend this hearing, but the county engineers will contact the primary contact person about the hearing's outcome. Assuming the resolution is passed, Kent County Engineering also contacts the electric company to inform it that it can proceed with installation.

Paying for the lighting district in Kent County is similar to doing so in New Castle County. The tax to cover the upgrades is added to annual county tax billings, and, if installation occurs in between tax payments, a prorated tax bill may also be sent to the residents enjoying new lighting. Kent County currently has 122 active street-light districts totaling roughly 11,224 units.[24] Costs likely depend on the amount and type of lighting that is installed, as well as electricity costs. Below is an expense table created by Kent County government to show the costs associated with street lighting throughout the county.

Figure 4 Kent County Street-Lighting Fund Expenses

Departmental Expenses	Actual FY 2008	Actual FY 2009	Amended FY 2010	Adopted FY 2011
Indirect Costs	47,200	57,858	67,300	76,500
Administrative Services	44,976	39,789	76,600	65,000
Office Supplies	56	66	100	100
Legal & Contractual Services	1,006	934	2,500	2,500
Equipment	-	-	-	7,600
Electric Company Charges	521,847	567,185	589,000	591,000
Total	$ 615,085	$ 665,832	$ 735,500	$ 742,700

Source: Kent County Government

Sussex County

Sussex County code addresses lighting regulations in Chapter 95, titled Street-lighting. This chapter identifies the process for installing street lights in communities, providing residents with the template for requesting street lights for their community. Additional lighting regulations are

[24] Kent County Government, *Fiscal Year 2011 Budget: Street-light Fund*, (Kent County: Kent County Levy Court, 2011), 157.

located throughout the code, including the zoning chapter. For instance, *Article XXII Off-Street Parking* outlines lighting requirements for parking lots used at night. Provisions are also in place to restrict glare and light pollution. The Sussex County Board of Adjustment is given authority to oversee outdoor lighting and require it in certain circumstances relating to zoning issues for developments.

The Sussex County Utility Permits Division administers Sussex County's street-light district program. Appendix 6 provides a sample street-lighting-district cost estimate provided to IPA from Sussex County's Engineering Department. This sample cost estimate will provide readers with an excellent idea of what a standard street-lighting project might cost residents in an unincorporated community. Additionally, the sample cost estimate defines electric provider charges and charges assessed by Sussex County. Appendix 7 shows all existing Sussex County street-lighting districts. This listing provides readers with information about light type, number of lights installed, 2010 annual assessment per unit, electricity provider, and year the lighting district was formed. The table was last revised in June 2010 and does not reflect any new lighting districts approved or lighting installed after that time.

DelDOT

DelDOT has facilitated various projects over the past decade that incorporate installation of pedestrian-scale lighting as part of streetscaping projects in places like Dover, Georgetown, Marshalltown, Hockessin, and Newark. DelDOT is working to focus public investment on pedestrian lighting toward areas of most need for enhanced multimodal connectivity, which is reinforced within the state's Complete Streets Policy.

DelDOT's redevelopment of the Indian River Inlet Bridge has incorporated pedestrian-walkway and-lighting components that show a commitment to pedestrian-infrastructure development in Delaware. The below schematic shows the proposed pedestrian-lighting facilities to be installed across the Indian River Inlet Bridge. The lighting fixtures are directed downward so as to eliminate roadway glare and light-pollution.

Figure 5 New Indian River Inlet Bridge pedestrian lighting

Source: DelDOT

Chapter 2. Innovations in Pedestrian Lighting

Over the past century, innovations in outdoor-lighting technology have greatly enhanced the overall efficiency, utility, and aesthetic value of lighting. In the following chapter key innovations in pedestrian lighting will be discussed: 1) green technology, 2) shielding, 3) energy efficiency, and 4) aesthetics. Green technology, such as new light bulb design, solar power, and wind power, is reshaping the energy landscape throughout the world. Lighting is yet another sector to be positively impacted by green technology. Shielding practices have changed over time to avoid wasting energy and causing light-pollution. More focus today has been directed toward mitigating light pollution, so new and better ways of shielding light have been utilized in light-fixture design. Energy efficiency is a continual concern from a financial as well as an environmental perspective. New lighting fixtures, although costly for initial installation, provide major opportunities for cost-savings over time in operational costs. Communities interested in investing in pedestrian lighting want lighting that will reflect community character. To fulfill this desire, new pedestrian-lighting styles are being developed to provide aesthetically pleasing atmospheres in sleepy, residential communities as well as in high-tech, bustling business districts.

2-1. Green Technology

There are currently four types of lamps commonly used for modern street lighting and pedestrian-lighting applications. These include high-pressure sodium (HPS), metal-halide (MH), induction, and light-emitting diode (LED). Each of these common lamp technologies will be introduced and analyzed here. The longevity, initial costs, maintenance costs, light quality, and environmental impact will be considered for each type of lamp. Much of the information for this analysis will come from the detailed report developed by the Mascaro Center for Sustainable Innovation at the University of Pittsburgh entitled *Life Cycle Assessment of Streetlight Technologies.* Developed in 2009 to assist in choosing the technology for Pittsburgh's plan to begin replacing 40,000 streetlights in 2010, it provides some of the most up-to-date calculations concerning the overall cost and environmental impacts of the various technologies.

Several technologies that have been used in the past will not be discussed here, due to the lamps being outperformed by newer alternatives. The outdated lamp types include incandescent, halogen quartz (a brighter incandescent), and mercury vapor. In 2007 about 13 percent of the streetlights in the country used mercury-vapor lamps.[25] Additional bulbs are still available for this technology, and it continues to be used in some areas. Metal-halide lamps, which function similarly to the mercury-vapor models, are more commonly used now and will be discussed here in lieu of the older version.

Before diving into the details of each type of technology, two of the most common questions among municipalities interested in street or pedestrian-lighting can be answered using a single chart. First, how long will each bulb last? Second, which one ends up costing the most/least?

[25] Hartley, Douglass, Cassie Jurgens, and Eric Zatcoff, Mascaro Center for Sustainable Innovation, University of Pittsburgh, *Life Cycle Assessment of Streetlight Technologies*, (Pittsburgh: University of Pittsburgh), July 30, 2009, 7.

This chart, based on the Mascaro Center's report, will provide insight into each of these questions and will be referred to throughout the following section:

Table 2 Estimated Bulb Costs

Technology	Cost Per Bulb	Bulbs/100000 Hrs.	Total Price/100000 Hrs.
HPS	12.39	4.17	51.67
MH	27.29	8.28	225.96
Induction	280	1.0	280.00
LED	9-322*	1.7	486.20

*LED prices still fluctuate rapidly and may have changed since the report was finished in 2009.
Source: University of Pittsburgh, *Life Cycle Assessment of Streetlight Technologies*

High-pressure sodium (HPS) lamps are the technology commonly used in street lights and emit a light that is often more orange than other lamps, although some HPS lamps are color-corrected. They use high-intensity-discharge (HID) technology to create the light. A wide variety of wattages are available, allowing flexibility when choosing how much light is needed for a given area. Most retailers offer versions from 35 to 1,000 watts. HPS lamps do require an electronic ballast to function. A wide variety of fixtures, or housings, are available with HPS lamps. In addition to traditional streetlights, overhead and wall-mounted housings, which can be useful for pedestrian areas not near a road, are also an option. While the market is constantly changing, about 39 percent of streetlights in 2007 used HPS technology, which made it the most commonly used streetlight in the country then. Very likely, it is still the most commonly used technology.[26]

HPS lamps are the oldest technology generally considered for modern street- or pedestrian-lighting applications and, thanks to newer technologies and a developed production process, the least expensive bulbs to purchase. Table 2 shows that the average cost for an HPS bulb is $12.39, less than half the bulb cost for the metal-halide bulbs that have the next lowest cost. Lifespan, however, is not as long as induction or light-emitting-diode lamps, which means more frequent bulb replacement. For municipalities or power companies doing maintenance, replacing bulbs requires time and labor. This should not be forgotten when considering which type of lamp to use. Nonetheless, the total bulb cost will be lower than with any other technology. The Mascaro Center data from Table 2 suggest a lifespan of about 23,980 hours for each bulb or about 1998 12-hour cycles. Therefore, using the bulb-life estimates of the Mascaro Center Report and assuming a 12-hour cycle each day, HPS bulbs would require replacement about every 5.5 years.

The quality of light is often a concern in areas considering lighting upgrades, particularly for pedestrian lighting, where appropriate color is more noticeable because users are on foot rather than in cars. Color-rendering index (CRI), a measure of "how well a light source will make colors appear," is quantified on a scale up to a 100; the 100 rating represents the high-quality light and clear color that incandescent bulbs emit and against which other lighting technologies

[26] Ibid.

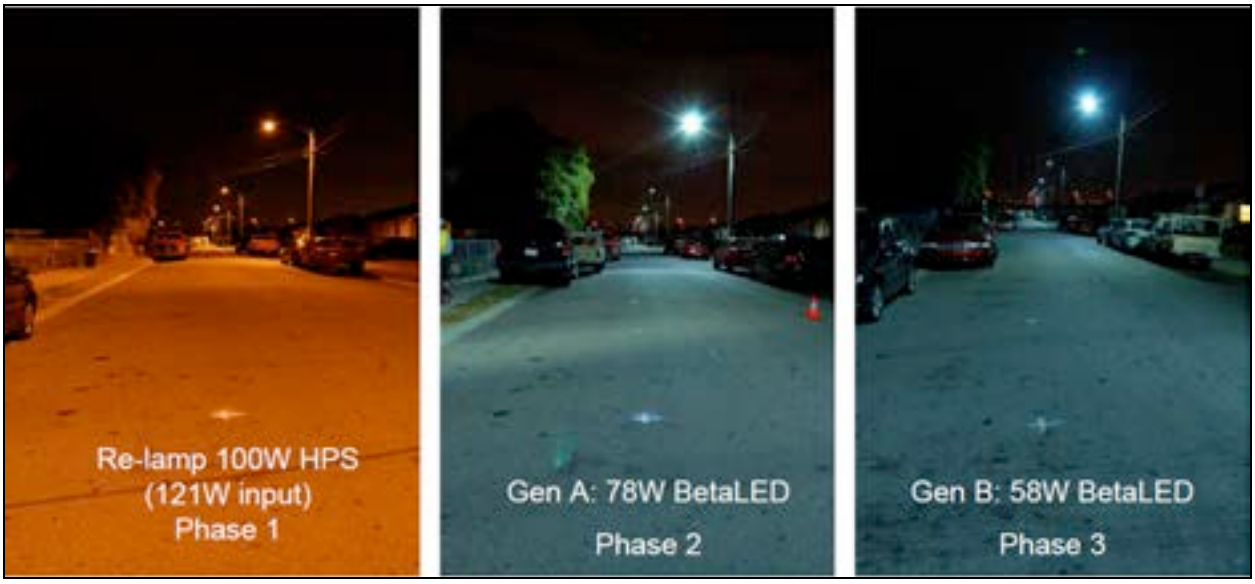
are measured.[27] HPS bulbs have the lowest CRI of the technologies commonly used for street and pedestrian-lighting, reaching ratings as low as 20.[28] Areas that will benefit from realistic color should consider using a lamp other than HPS. Generally, historic areas or business districts, where nicer finishes and many pedestrians make proper color important, shy away from HPS lamps.[29] Roads, however, can be lit with HPS lamps with minimal impact from the low CRI.

Color temperature describes the appearance or shade of the light coming from the fixture. HPS lamps have the lowest color temperature of the common streetlight technologies at around 2,000K.[30] The lower color temperature results in the strong yellow hue associated with many night skylines and roadways. Higher color temperatures result in whiter light. While some have suggested that higher color temperatures disturb the circadian rhythms of living things, it is not clear if there is empirical evidence to back up the claim.[31] If this is confirmed in the future, it would suggest that lamps like HPS with lower color temperatures may be healthier for plants and animals. A final light quality issue many areas consider when deciding upon street or pedestrian lighting is light pollution. While it is possible to minimize HPS light-pollution with shielded fixtures, the light from HPS fixtures is not as easy to direct as other technologies, particularly LEDs. Most HPS lamps today are at least partially shielded and emit a circular area of light downwards, which can allow some light to escape directly to the sides but minimizes (wasted) light shining into the night sky.

It is worth noting the environmental impacts of HPS lamps, as various technologies require the consumer to take various precautions. Ecotoxicity is a primary concern when handling and disposing of HPS lamps. The lamps contain chemicals that may be dangerous to the environment in particular. Each lamp holds about 15 milligrams of mercury, in addition to amounts of xenon or argon.[32] This level of mercury is not a major hazard for an individual lamp, but large projects that involve either removing or installing HPS lamps must involve the proper disposal of larger numbers of lamps without allowing their mercury content to damage the earth.[33] The primary environmental impact of these lamps is electricity use, which is higher for HPS lamps than for induction or LED lamps but slightly lower than MH lamps. Therefore, the global warming and ecotoxicity impacts, primarily arising from electricity generation, are ordered that way as well in the life-cycle assessment performed at the Mascaro Center.[34]

[27] Ibid., 38.
[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] Ibid.
[32] Ibid., 27.
[33] Ibid.
[34] Ibid., 35-36.

Figure 6 Light Color of HPS vs. LED Lights



Source: Dave Alexander, Pacific Gas & Electric Company, *LED Street & Area Lighting*

Metal-halide (MH) lamps are another option when deciding what lighting is the best fit for a project. Quite similar to the HPA lamps, MH uses HID technology to produce light and is available in a wide variety of models and wattages. Both use similar housings and require an electronic ballast to function. According to the University of Pittsburgh, the primary difference between the two technologies is that it "produces a wider range of wavelengths of light because there is more than one type of gas in the lamp."[35] However, what is gained in the wider range of light is paid for in bulb costs and longevity. The benefits have convinced many governments that it is worth the extra money. As of 2007, about 27 percent of streetlights in the country as were MH lamps, second only to HPS lamps.[36] Overall, the MH technology is remarkably similar to HPS but with a wider variety of ideal applications.

Table 2 indicates that the bulbs are more than twice as expensive as the HPS counterpart and last around half as long. The calculations suggest that each bulb would last about 12,077 hours, or 1,006 12-hour cycles. This would indicate that, assuming 12-hour cycles, MH bulbs would need to be replaced every 2.75 years. This is about half of the life of HPS bulbs and does not even approach half of the life of induction or LED lamps, making MH lamps the technology that requires the most frequent bulb replacement. Again, these maintenance costs should be considered when making lighting decisions. Varying wavelengths of light as an option also makes these bulbs more expensive than HPS bulbs. Even with the higher rates of replacement and bulb costs, Table 2 indicates that the total cost per 100,000 hours ($225.96) is less than induction ($280) or LED ($486) technology. This does not, of course, take into account maintenance or labor costs. Furthermore, the similar HPS technology only comes in at $51.67 per 100,000 hours, so the advantages of MH must be significant to warrant costs that more than quadruple this amount.

[35] Ibid., 5.
[36] Ibid., 7.

Light quality for MH lamps is better than for HPS lamps, a key difference when considering the extra cost. The CRI for MH lamps is generally in the 60s or 70s, although some bulbs perform in the 80s.[37] When compared to HPS lamps, which get down to 20, this higher CRI makes it clear why in areas where high-quality color is needed MH lamps are preferable to HPS models. Pedestrian areas, historic districts, or business districts are good examples of areas where the orange light of HPS lamps might distort color too much. In this situation, MH lamps provide a middle ground in CRI. The highest CRI still comes from induction and LED technologies, providing the most accurate color. However, MH lamps do offer a CRI almost as high as the induction and LED lamps. One added advantage of MH is that old HPS fixtures may be able to be retrofitted, resulting in better color in an area without the added expense of upgrading the entire fixture to more expensive LED or induction models.

Just as the CRI for MH lamps is in between that of HPS lamps and the newer induction and LED technologies, the same can be said for the color temperature of MH lamps. While the HPS lamps give off an orange-hued light and both induction and LED lamps give off an almost unnatural white light, MH lamps are right in between with a light that generally appears a bit yellow.[38] This makes MH relatively flexible, providing an alternative to the orange light and white light that can each seem unnatural. MH lamps can also be produced with a variety of halide combinations, altering the color temperature depending on the halides inside. This can produce bluer, whiter, or even redder light, depending on the desired effect.

The environmental impacts of HPS and MH are very similar as well. Properly disposing of used bulbs is critical, so as not to allow the mercury, xenon, and/or argon inside to damage the environment. The amount of mercury in a MH bulb, about 15mg, is the same as can be found HPS bulbs.[39] Companies that sell bulbs often have a recycling program, but retrofitting projects should include disposal of old materials as a term of the contract.[40] The impacts for electricity generation are the largest for MH lamps when compared to the other technologies generally considered, as MH lamps do require the most electricity. In addition to the additional electricity cost, the production and transmission of the electricity has environmental impacts, which vary according to electricity-generation methods.

Induction lamps use a technology very similar to fluorescent lighting that generally emits whiter light. The bulbs also last longer than fluorescent lamps. The technology still depends on exciting gas molecules to produce light, just as HPS and MH lamps do.[41] As of 2007, about six percent of lights in the country were induction, trailing HPS, MH, and mercury halide (an older version of MH and HPS using only mercury) lamps.[42] The high cost for bulbs and the emergence of LED as an option for similar light both make induction lamps relatively uncommon. Table 2 estimates bulb cost around $280, and some fixtures can hold up to four bulbs as needed.[43] These bulbs are much more expensive than the HPS or MH options but have

[37] Ibid., 38.
[38] Ibid.
[39] Ibid., 27.
[40] Ibid., 37.
[41] Ibid., 39.
[42] Ibid., 7.
[43] Ibid., 9.

one significant advantage. The Mascaro Center data from Table 1 estimates that bulbs will last about 100,000 hours, which would mean a single bulb could last 8,333 12-hour cycles. Assuming those 12-hour cycles, time for replacement would come only once every 22.8 years. Therefore, while bulbs are substantially more expensive up front, maintenance costs are minimal and municipalities or organizations should have little to worry about with their street or pedestrian lighting for at least two decades.

Induction lamps have better light quality, than HPS or MH lamps, although it's always important to remember that various types of light are suitable for various applications. The CRI of induction lamps is high, generally in the 70-90 range, and comparable to LED quality.[44] Areas where high-quality light that emits truer color is needed can benefit from the higher CRI provided by induction lamps. A high color temperature, around 5,000K, results in a whiter light than do HPS or MH bulbs. It is still unclear what effects color temperatures this high have on the circadian rhythms of living things.[45] It is worth noting that when the National Lighting Product Information Program (NLPIP) tested the bulbs on color temperature, they noticed that "large discrepancies in CCT [Correlated Color Temperature] (from 80K lower to 3,100K higher) were measured for nearly all LED and induction street-lights."[46] Also note that color temperature may not always be consistent. Regardless, the combination of a higher CRI and color temperature make induction ideal for some areas but may be unnecessary for the majority of pedestrian-lighting applications, particularly in rural areas.

The induction lamps use less electricity and have a correspondingly lower impact on the environment than HPS and MH lamps. The impact is similar to LED lamps. Wattage-to-lumens ratios are similar between HPS and induction lamps; for example, a 70-watt HPS bulb would put out about 5,670 lumens, while an 80-watt induction lamp emits 6,800 lumens. The difference in watts-per-lumen is negligible here. However, pupil lumens, which measure how the eye actually sees the light after it is produced, give induction light a much larger advantage. This means lower wattages can be used and people will still perceive an amount of light similar to a more powerful HPS or MH bulb, saving induction-lamp users money on electricity. Induction bulbs do contain small amounts of mercury and should be recycled or disposed of properly, although the long life span of the bulb should make this rare.[47]

LED technology is the newest technology commonly used in street lights, and it is growing in popularity. The University of Pittsburgh life-cycle analysis quoted so often here recommended LED technology for the large retrofit project in Pittsburgh because "it is felt that the rapid increase in LED lighting efficiency will soon surpass that of induction."[48] While several of the upsides leading to this recommendation will be explored, there are two important downsides to note about LED lamps. First, it is new technology that does not have the history of success that the other technologies discussed in this report have. This means it is unclear exactly how LED lamps will act long term. Secondly, the newest technology is, not surprisingly, the most expensive. LED prices are still fluctuating as new sellers flood the market. Therefore, the cost

[44] Ibid., 38.
[45] Ibid.
[46] Ibid., 21.
[47] Ibid., 16.
[48] Ibid., 44.

up front is difficult to pinpoint. Maintenance costs, on the other hand, should be reasonable, since bulbs are expected to last a long time. The estimates in Table 1 suggest the bulbs would last about 4,902 12-hour cycles, putting LED way out in front of HPS and MH in longevity but still trailing that of induction bulbs. An ongoing pilot project using LEDs in Dover, Del., appears to be going well, with a city official giving this assessment to Newstreetlights.com's staff for their article: "What we are hearing is that it's a better quality light but that, like anything new, it takes some getting used to."[49]

Figure 7 LED Lights and Dimming

Source: Dave Alexander, Pacific Gas & Electric Company, *LED Street & Area Lighting*

The high light quality of LED lamps is the primary advantage of the technology. Figure 7 shows how LED lights set on low (right) can provide a very comparable level of visibility as compared to LED lights set on high (left).[50] Dave Alexander from Pacific Gas & Electric Company reported that energy savings substantially increase by turning LED lights to low.[51] The CRI for LED bulbs is generally in the 70-80 range, making it similar in quality to the induction bulbs and much higher than HPS or MH bulbs.[52] Also similar to induction bulbs, the color temperature of LED lamps is very high, around 5,000K.[53] This results in light that appears whiter than that of HPS or MH bulbs. Again, when NLPIP tested the bulbs to ensure the advertised specifications were correct, they found that color temperature was substantially off for nearly all LED and induction lamps.[54] Therefore, be unclear exactly what color temperature can be expected in practice and how consistent this level will be among many lamps.

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[49] New Streetlights. *Dover pilot sets stage for first phase of LED streetlight retrofit*. New Streetlights Staff. October 12, 2009. http://newstreetlights.com/index_files/news_dover_delaware_streetlight_pilot_113.htm.
[50] Alexander, Dave. *PowerPoint Presentation on LED Street and Area Lighting*. Pacific Gas & Electric Company, 2010.
[51] Ibid.
[52] Hartley, Douglass, Cassie Jurgens, and Eric Zatcoff, Mascaro Center for Sustainable Innovation, University of Pittsburgh, *Life Cycle Assessment of Streetlight Technologies*, (Pittsburgh: University of Pittsburgh), July 30, 2009, 28.
[53] Ibid., 38.
[54] National Lighting Product Information Program, Lighting Research Center at the Rensselaer Polytechnic Institute, *Streetlights for Collector Roads: Volume 13 Number 1*, (National Lighting Product Information Program), November 2010, http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SRStreetlights.pdf.

LED lamps have the least impact on the environment of the four technologies we have considered here, just edging out induction lamps. Ecotoxicity and global warming numbers both show LED has the least negative impact over the entire life cycle of the lamps, from production to replacement, of any of the four lamp types, although the housing does contain printed circuit boards that add to ecotoxicity.[55] Much of this lower impact is due to lower power consumption. However, since the technology is new and production processes aren't perfected, it is worth looking for updates to these numbers as they may change over time.

LED technology is currently being installed in Asheville, NC. The City of Asheville reported the beginning of LED installation in May, 2011.[56] Roughly 900 street lights in Asheville are being replaced as part of Asheville's effort to modernize lighting systems.[57] Phase 2 of the project will include city workers replacing all of the roughly 9,000 street lights with LED technology.[58] This change will result in energy savings of over $600,000 per year.[59] The LED project was funded through grant funding from the American Recovery and Reinvestment Act.[60] Asheville's current lighting inventory includes roughly 2,500 HPS fixtures and 6,726 mercury-vapor fixtures.[61]

Figure 8 Asheville City Worker Installing LED Light Source: City of Asheville, NC

The City of Los Angeles is leading the country and the world in LED technology installation as it embarks on a massive, multi-year project to replace 140,000 street lights in the city to LED fixtures.[62] The project is expected to last five years and cost an estimated $57 million dollars.[63] Annual energy and maintenance savings are estimated at $10 million dollars, and it is expected that emissions will be reduced by over 40,000 tons of CO_2 per year.[64] The new streetlight network in Los Angeles will be controlled by a remote monitoring system that will send data

[55] Hartley, Douglass, Cassie Jurgens, and Eric Zatcoff, Mascaro Center for Sustainable Innovation, University of Pittsburgh, *Life Cycle Assessment of Streetlight Technologies*, (Pittsburgh: University of Pittsburgh), July 30, 2009, 28, 35-36.
[56] Asheville, North Carolina, City of, *City of Asheville Street-light LED Upgrades Begin This Week*, (Asheville: City of Asheville, May 9, 2011), http://coablog.ashevillenc.gov/2011/05/city-of-asheville-streetlight-led-upgrades-begin-this-week.
[57] Ibid.
[58] Ibid.
[59] Ibid.
[60] Ibid.
[61] New Streetlights, *Asheville, North Carolina, to install over 9,000 LED Streetlights*, (New Streetlights Staff, October 4, 2010), www.newstreetlights.com/index_files/LED_street_light_news_Asheville_North_Carolina_to_install_over_9000_LED_streetlights_243.htm.
[62] Clinton Climate Initiative, *City of Los Angeles LED Street-lighting Case Study*, (Los Angeles: Clinton Climate Initiative, February 2009).
[63] Ibid.
[64] Ibid.

back to street-lighting officials in real time so that more efficient and timely action can be taken when outages or malfunctions occur.[65] The remote monitoring system will also collect performance data so that energy usage can be tracked, allowing city officials to track LED performance over time.[66]

It is easiest to summarize the information about the four lamp technologies in a table where the data performance can be compared side by side. As with any technology, it is certain that some of the statistical numbers will change as the products evolve over time. This is particularly true with LED lamps, since they are a new technology that is still developing quickly. It should be expected that LED prices will drop as production is standardized and manufacturers move toward this promising technology. Similarly, LED performance should improve as research continues and competition separates the best manufacturers from imitators hoping to get in on the latest, greatest technology. Again, the numbers for the table below come from the University of Pittsburgh's Mascaro Center report, a life-cycle assessment completed in 2009.

Table 3 Comparing Current Street-Light Technologies

	High Pressure Sodium (HPS)	Metal-halide (MH)	Induction	Light-Emitting Diode (LED)
Bulb Cost (USD Estimate)	12	27	280	9-322*
Wattage	150	162.9	109	105
Bulb Longevity (Est. Hours)	23981	12077	100000	58823
Color Temperature (Est.)	2000	3000-4000	5000	5000
Color Rendering Index (Est.)	20-30	60-80	70-90	70-80

*Estimate based on multiple Life Cycle Assessment models; actual prices vary and are fluctuating
Source: University of Pittsburgh, *Life Cycle Assessment of Street-light Technologies*

The exact numbers for environmental impacts are not included on this chart because they vary significantly, depending on means of electricity production and the primary phase in which environmental concerns were focused. Using clean energy results in less particulate matter (i.e., cleaner air), less CO_2 (i.e., less global warming), and less ecotoxicity for a cleaner earth. Using an electricity mix based more heavily on fossil fuels results in just the opposite. The impacts of manufacturing, using, and disposing of the bulbs and fixtures are minimal in comparison to that of the production process used to gain the electricity needed to run the lamp. The technologies that use the most electricity, generally MH and HPS have, accordingly, the heaviest impacts. Again, these impacts are all minimized by using clean sources of energy like solar and wind energy.

[65] Ibid.
[66] Ibid.

In a study titled *Economic Feasibility of Solar-Powered LED Roadway Lighting,* M.S. Wu and others contend that considering monetary investment, overall savings, payback time, and lighting lifetime, "lighting using high-power LED either by grid power or solar power is economically feasible."[67] They contend that solar-powered LED roadway-lighting systems can save 75 percent on energy use as compared to the mercury lamp.[68] The payback period for the excess investment used for the hypothetical lighting system was 2.2 years for LED using grid power and 3.3 years for LED using solar power.[69] The figure below shows the cost-estimate comparison for a hypothetical 10km (roughly 6.2 mi) roadway-lighting project.

Figure 9 Cost Effectiveness Comparison of 10km Roadway Lighting:

Roadway distance (km)	10		
Number of lamps installed	667, 30 m apart in tow staggered rows		
Type of lighting design	Grid-powered LED	Mercury lamp	Solar-powered LED
Lighting power per lamp, W	100	400	100
Total power consumption, kW	77	267	67
Total installation cost, USD	2,248,335	1,881,622	3,090,982
Maintenance and lamp replacement saving			
Maintenance cost per year, $/yr	3% 47,450	3% 55,249	3% 72,735
Lamp replacement time, yr	10	2	10
Lamp replacement cost, $/yr	0	36,667	0
Net maintenance saving, $/yr	44,465	–	19,181
Overall cost/effectiveness			
Power saving, kW	190	–	267
Lighting hours, h/day	12		
Electricity price, $/kWh	0.3 (fixed price) (in remote island)		
Yearly total energy saving, kWh/yr	832,368	–	1,168,000
Yearly total energy saving, $/yr	249,710	–	350,400
Net maintenance saving, $/yr	44,465	–	19,181
Additional investment for LED, $	366,713	Base	1,209,360
Payback time (LED additional investment/ total yearly saving), yr	1.2	–	3.3
Side benefit of LED lighting			
CO_2 emission reduction, kg/yr	549,363	–	770,880

Source: M.S. Wu and others, *Economic Feasibility of Solar-Powered LED Roadway Lighting*

[67] M.S. Wu and others, *Economic Feasibility of Solar-Powered LED Roadway Lighting*, (Taipei: National Taiwan University, January 13, 2009), 1938.
[68] Ibid.
[69] Ibid.

Solar street-lighting bollards have been installed in European countries like Denmark and the U.K. DelDOT has piloted use of solar lighting to study performance and cost-savings potential.

2-2. Shielding

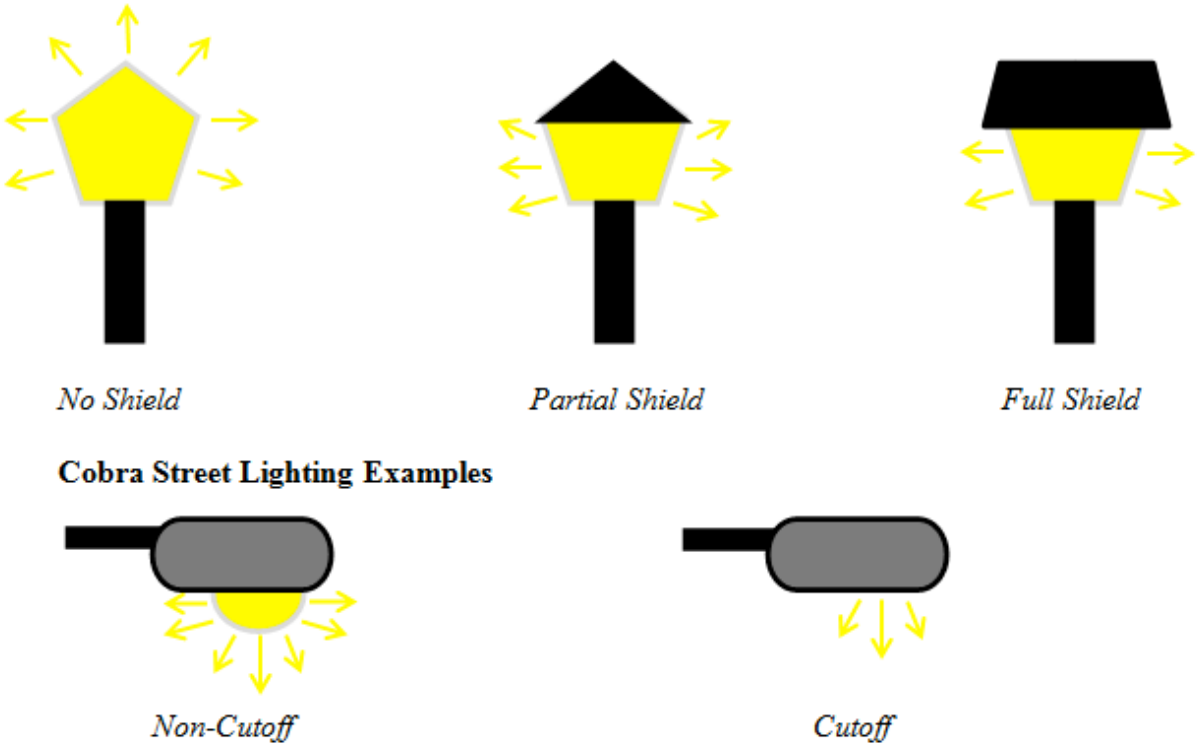
Outside of what type of lamp to use, another primary issue when installing pedestrian or street lighting is how much shielding the fixtures should provide. This is a particular concern for organizations concerned with light pollution, such as the International Dark-Sky Association (IDA) and others. Many local stargazing groups share the opinion that lights should be shielded to the maximum extent practical, so as to keep the night sky dark for their purposes. Many ordinances throughout the country require a certain level of shielding for certain lights, and local and state laws should be reviewed in the process to ensure that whatever shielding chosen is appropriate.

Perhaps of greatest concern to policymakers, the energy we use to unnecessarily light up the night sky is essentially wasted. The electricity used to create the unneeded light does cost money, and the production of that electricity has already negatively impacted the environment. Proper shielding ensures less wasted light and, thus, less waste of electricity and money. Since proper shielding saves money, protects the habitats of nocturnal animals, and allows all to better enjoy the beautiful resource that is the night sky, the overall argument for shielding lights is a strong one.

Assuming that a community has chosen shielded lighting for one or more of the reasons above, the next question is the amount of shielding. There are several options and a wide variety of fixtures. The IDA provides a particularly useful resource that lists all the fixtures from the available various manufacturers that they feel meet their requirements for minimizing light-pollution. This primarily means that they recognize the fixture to be fully shielded but some lights also carry an IDA-approved Dark Sky Friendly designation, which indicates the fixture has actually been provided to, tested by, and approved for use by the IDA. The lists of approved fixtures for multiple purposes, including separate lists for pedestrian and street-lighting, can be found on the IDA website (darksky.org). A substantial collection of fully shielded fixtures can be found there along with some basic specifications and comments, some of which should be helpful to communities considering new lighting.

Proper shielding varies by situation and fixture type. Below are several diagrams depicting the levels of shielding that are typically available and how the shielding helps direct light away from the sky. The specific requirements for designating a fixture as non-cutoff, semi-cutoff, cutoff, or full-cutoff are based primarily on the amount of light that escapes above the 90-degree level. These specific details for individual fixtures can be found through the IDA website or individual manufacturers, but the basic design differences among the shielding levels are illustrated here. Most pedestrian lighting is provided with post-top fixtures or, in situations where pedestrians and motorists share lighting, cobra street-lights. The shielding diagrams highlight these two fixture-styles.

Figure 10 Light-Fixture Shielding



Source: International Dark Sky Association

Figure 10 shows a graphic from the International Dark-Sky Association showing the true meaning of "full-cutoff" light fixtures.

Refractors and reflectors are also used to minimize light shining in unwanted areas and, more specifically, to redirect it to necessary areas. Whereas shielding is designed primarily to keep light from venturing upward, various types of reflectors are used to point light in specific directions. The light that does go upwards into a shielded fixture may be diminished and essentially wasted (which is still better than becoming pollution) or, in the case of a light with a reflector, redirected toward the desired area. The concept is not unlike a mirror, although the exact shape of the reflector is highly technical and depends on the desired direction and shape of the light. For street and pedestrian lights, this provides more useful light to citizens. Refractors often work along with reflectors to properly shape lighting. As opposed to redirecting light shining upward, a refractor fits over the lamp and redirects all the light shining downwards into the needed shape. For example, on a long, straight path a large circular pattern of light shining down may not be desirable because light is wasted. A light with an oval pattern, on the other hand, that is just tall enough to cover the path but wide enough to extend down the path would be much more useful. The proper use of reflectors and refractors allows lighting engineers to design appropriate lighting schemes for specific situations. It also encourages the use of light that might otherwise be wasted, helping to ensure maximum utility for existing lighting while minimizing wasted electricity.

Figure 11 Cobra-Head Fixture with Refractor

Source: Solar Electric Power Company, www.sepco-solarlighting.com

The picture above shows a typical cobra-head street-lighting fixture with a refractor attached. Reflectors are more difficult to picture but are essentially larger versions of the shiny metal or plastic surrounding the bulb in most flashlights. Refractors and reflectors come in a wide variety of shapes and sizes to match the similarly wide variety of fixture-styles. Refractors may also have multiple models for certain fixtures in order to allow for various patterns of light. Models are also, offered without any refractor at all when the light output and coverage is appropriate without adjustments.

2-3. Energy Efficiency

This section includes a discussion of new innovations in energy efficiency related to pedestrian lighting. David S. Liebl, a researcher with the Solid & Hazardous Waste Education Center at the University of Wisconsin, estimates that poorly designed lighting fixtures can waste 30 percent to 40 percent of electricity by over-lighting areas.[70] Liebl estimates that billions of dollars per year in possible energy savings are wasted as a result.[71] Having discussed specific types of lamp technology and how advances in this area relate to energy efficiency, there are a variety of other innovations aimed at this goal. Beyond the individual lights themselves, there is other technology available to increase energy efficiency. One consideration already being used in some areas is a dimmer system. The use of technological advancements like this should continue to result in better energy efficiency going forward.

Dimming switches for street-light networks are being seen throughout the world, as governments search for ways to decrease electricity costs. In Victoria, British Columbia, Canada, a local company called Streetlight Intelligence had developed a dimming system it claims "can slash the power bills of provincial cities by 40 percent" and "save municipalities $6.5 million a year in electricity costs."[72] Those are the kinds of numbers that get the attention of government managers and finance officers everywhere. After a test project confirmed the potential to save 40 percent in energy, British Columbia decided to use incentives to get cities in the region on

[70] Liebl, David S., *Writing an Exterior Lighting Ordinance*, (Madison: Solid & Hazardous Waste Education Center, March 2003), 1.
[71] Ibid.
[72] Times Colonist, *City firm's street-light dimmer saves energy: A Victoria company says it can slash the power bills of British Columbia cities by 40 per cent and show sharp reductions in greenhouse gas emissions with a wireless Internet device that remotely dims street-lights*, (Victoria: Times Colonist, October 8, 2008), http://www.canada.com/victoriatimescolonist/news/business/story.html?id=45329a7a-e58f-4975-8ddb-af7de62330c9.

board with such an energy-saving idea.[73] The result was a grant program designed to cover the costs of studies to determine what the benefit would be in area cities, allowing them to essentially research the benefits and concerns for free.[74] Ironically, this specific situation led to significant interest in streetlight intelligence and dimming in general but also pulled competitors into the market. Several Canadian cities in the area had either installed or voted to install dimming systems from the company, and other firms will likely pick up the growing business.

Exactly how does a system that just dims a light cut energy use by 40 percent? The largest key is something often said by lighting experts and reiterated by Streetlight Intelligence prior to its bankruptcy: "Field tests in conjunction with B.C. Hydro show that dimming lights by up to 50 percent is 'imperceptible to the human eye.'"[75] A video that was shown during the working group explaining how this technology has been used in a United Kingdom town reiterated this sentiment, with a field reporter claiming, "It's very difficult to spot the difference with the naked eye."[76] This means 30-40 percent lower levels of light may be acceptable, especially for areas that aren't often used late at night. The entire system is controlled remotely, generally with a hand-held device and a central monitoring system or something similar.[77] This allows individuals in both the field and in an office to monitor the system by adjusting lighting levels as necessary, providing further flexibility and even more potential for energy savings.

This is a relatively new technology and has only been implemented in a few areas. However, the potential energy savings are substantial, and it is likely that more communities will utilize it. The initial cost to add dimming technology may be high, but cutting a large chunk of electricity costs out of the budget may make the investment worth it. Although business models and costs certainly vary, it may be beneficial for some areas to wait until a replacement of street lights is needed to do all the changes at once. Nonetheless, this is a promising option for governments and communities eager to save both money and the environment.

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[73] Ibid.
[74] Ibid.
[75] Ibid.
[76] British Broadcast Corporation, *BBC Breakfast*, (Surrey, UK: British Broadcast Corporation, March 5, 2010), http://www.youtube.com/watch?v=NRVcFTUINBQ.
[77] Times Colonist, *City firm's street-light dimmer saves energy: A Victoria company says it can slash the power bills of British Columbia cities by 40 per cent and show sharp reductions in greenhouse gas emissions with a wireless Internet device that remotely dims street-lights*, (Victoria: Times Colonist, October 8, 2008), http://www.canada.com/victoriatimescolonist/news/business/story.html?id=45329a7a-e58f-4975-8ddb-af7de62330c9.

2-4. Aesthetics

This section discusses the aesthetic value of lighting fixture design. Many communities desire lighting that enhances the historic character of long-standing downtown settings. In coordination with local governments and consumers, utility companies are continuing to develop and offer new aesthetically pleasing lighting options for use. The appearance of pedestrian lighting varies widely and often has a substantial impact on how the lighting is received by a community. There are many fixture options to choose from, differentiated primarily by technology, design, post style, and shielding type. Therefore, a community must ask itself both what aesthetic look they prefer and the purpose of the lighting before choosing a fixture style. Both of these considerations will be discussed here in more detail, followed by brief descriptions of several common fixture styles.

There are more variables than one might expect when deciding what type of fixture-style to use for a project. Among the first steps is determining what type of lamp is desired. Lamp technology provides various types of light, as has been discussed in the technology section. For a lighted area, this makes a significant aesthetic difference. Whiter light is often used to create a brighter look, which can be seen in many business districts. The yellow or orange light from older technologies provides quite a different atmosphere, often more relaxed. Choosing one or the other will directly influence the feel of the lighting and help to narrow the available fixture options.

> *"Creative deployment of decorative luminous elements can make pathway lighting more magical. For example, fiber-optic strands can be built into pavement materials, creating tiny sparkling lights on a path, or used in Victorian-style post-top fixtures in a historic part of town."*
>
> –Lighting Design Lab
> University of Washington

A second consideration when determining lighting styles is how decorative the community prefers the lighting. Some subdivisions prefer very basic lighting that blends in with the surroundings. Not surprisingly, these basic fixtures are generally cheaper as well. Other neighborhoods choose highly ornamental lighting that adds more than just light to the community, giving decorative value as well. The more elaborate the fixture, the higher the price climb. Residents may often disagree on details, but getting an idea for the level of ornamentation that may be desired is important and further narrows the many fixture options.

A final aesthetic consideration is the type of pole on which to mount the fixture. Variations include everything from brick, which is extremely expensive, to basic integrated poles where the lighting is mounted on existing poles (see below). A wide variety of finishes, colors, shapes, and other decorative features are available. While the pole may not make a huge aesthetic difference for most citizens, it's worth noting the wide variety on the market and that the decision does need to be made.

Figure 12 Integrated Pole with Acorn-Style Lighting

Source: U.S. Department of Transportation, Federal Highway Administration

Shielding should also be considered when discussing aesthetics. Although it doesn't necessarily impact aesthetics a great deal, it directly impacts what type of fixture is appropriate. Not all fixture types are available with several levels of shielding, meaning a decision on shielding should be made before choosing a fixture based simply on aesthetics. This will further inform the decision and narrow the options. Once installed, shielded lights do have the aesthetic difference of directing light downwards instead of all around. For those concerned with light pollution or who end up with a light outside their bedroom, the level of shielding may be the only aesthetic detail about which they care.

With these basic guidelines in mind, the following are examples of fixtures on the market right now. Most are similar or identical to options currently available to unincorporated parts of the state.

Figure 13 Arlington Design

Source: New Castle County Government

This style of fixture is common throughout the country and is one of several current options for those installing lighting in New Castle County. Note that it is similar to the acorn fixtures below but is well shielded in comparison.

Figure 14 Acorn Fixture

Source: New Castle County Government

The above fixture is a more traditional acorn style fixture that many people associate with pedestrian lighting. It is not shielded and does cause light pollution. The light fixture below is also currently available in New Castle County.

Figure 15 Lantern Design

Source: New Castle County Government

Perhaps least aesthetically pleasing are basic pedestrian lights like the above lantern-style fixture. However, the fixture is very well shielded and likely less expensive than other options.

Figure 16 Ornamental Design

Source: New Castle County Government

Lastly, Figure 14 is an example of a more ornamental design. It is essentially identical to the acorn fixture, but more aesthetic detail has been added in the form of ribs going up the sides. This adds cost to the fixture but may also add to the charming or luxurious image a community wishes to maintain. This is also another option offered in New Castle County.

Chapter 3. Project Workshop

This chapter presents a vital component of this project: the stakeholder workshop. In coordination with DelDOT, on April 12, 2011, IPA hosted a stakeholder's workshop to discuss the issue of pedestrian lighting in Delaware. Community, private-sector, government, and nonprofit representatives were invited to this workshop to provide a wide range of perspectives and viewpoints on pedestrian-lighting to highlight where potential opportunities exist and where hurdles interfere with further enhancement of pedestrian-lighting in Delaware. The key discussion points were:

- Criteria for Determining Lighting Needs
- Financing Mechanisms for Installation / Maintenance
- Light Fixtures, Shielding, and Green Technology
- Possible Recommendations and Best Practices
- Moving Forward and Next Steps

The agenda for the workshop is provided in Appendix 2. The PowerPoint presentation given at the workshop is provided in Appendix 9. The below table provides a listing of all those who attended the project workshop:

Table 4 Workshop Attendees

Name	Organization
Vincent Damiani	Delaware Transit Corporation (DTC)
Donald Weber	Delaware Department of Transportation (DelDOT)
Ralph Reeb	DelDOT
Michael Kirkpatrick	DelDOT
Karen Brittingham	DelDOT
Mark Eastburn	DelDOT
James Wilson	Bike Delaware
Dave Koppeser	Wilmington Trail Club
Denzil Hardman	New Castle County
Hal Godwin	Sussex County
Patti Deptula	Sussex County
Heather Dunigan	Wilmington Area Planning Council
Peter J. Driscoll Jr.	American Council of Engineering Companies of Delaware
Ed O'Donnell	Institute for Public Administration
Marcia Scott	Institute for Public Administration
Ryan Gillespie	Institute for Public Administration
Ted Patterson	Institute for Public Administration
Martin Wollaston	Institute for Public Administration

The following are notes taken as the workshop group discussed criteria for determining lighting needs:

- Roadway-safety problems at key intersections should be among the top criteria for determining priorities for pedestrian lighting. It was noted that addressing roadway safety problems with good lighting does not eliminate the impact of poor judgment on the part of an individual pedestrian. It was noted that there has been an increase in night injuries involving bicyclists.

- Density should be taken into account. Various densities necessitate various forms and intensities of lighting, whereas some low-density communities are not appropriate for substantial lighting investment.

- While not clearly articulated in the Americans with Disabilities Act (ADA), if a public entity provides accommodations for walking, lighting may be required under the law where low-light conditions exist.

- Public desire for pedestrian lighting often occurs following criminal activity or perceived security issues emerging within a community. Perceived and/or actual security concerns factor in as criteria determining public support for enhanced lighting.

- Criteria should be based on what the purpose is for the lighting. Is it to light a walking/biking path, a road, a parking lot, a sidewalk? Another key concern is the need to address lighting interconnectivity gaps in unincorporated areas between residential neighborhoods and areas where people walk and take transit.

- Criteria should be based on what exactly *the pedestrian* wants out of this. For the person who walks or would walk if they could, what lighting do they most prefer if any? If so, how much lighting, from their viewpoint, is adequate and desired? Not everyone wants light—citizens mention that lighting is counter to community character in some cases, the costs of lighting is prohibitive, or the view of the night sky is more important than enhanced lighting. Various levels of lighting standards should be considered for various levels of density/overlay districts. While illumination of walkways is important, pedestrians balk at lighting glare that is blinding.

- A plan for lighting should be included in a pedestrian-circulation plan, which would be prepared *before* development takes place, so property owners know what is planned. In Sussex County, planners advise residential developers to plan for a minimum amount of lighting for security purposes and have it reviewed during the subdivision approval process. Once a development is built and populated, it is not as easy to gain consensus from residents.

- An issue that needs to be addressed is the disconnect between Delmarva Power's lighting design vs. pedestrian warrants required by DelDOT. The issue of aesthetic vs. functional pedestrian lighting should be further investigated–are there model lighting warrants from other states?

- Accessibility should be taken into account. Lighting may be available, but how accessible is it to the public (e.g., individuals with disabilities or lighting that illuminates areas without sidewalks)? How accessible will it be in the future, given possible changes in land uses or roadway conditions?

The following are notes were taken as the workshop group discussed financing mechanisms for installation and maintenance of pedestrian lighting:

- Establishing light-tax districts to pay for capital and maintenance costs for street lighting is the most common way nationally and statewide in Delaware to finance lighting in unincorporated communities.

    - In Sussex County, where light districts are established, individual homeowners pay for lighting costs as part of property tax bills. Costs are determined by the number of lights within a development and the number of residents served by the lights.

    - In New Castle County, lighting costs are determined by the style of light that is offered by Delmarva Power and selected by a homeowners association (HOA). Based on the cost of the lighting style selected, New Castle County applies a flat rate charge based on assessed value of a property and then pays Delmarva Power. It was noted that Delmarva Power will no longer deal directly with lighting requests from private HOAs—all requests must go through New Castle County.

- In Claymont, a lighting tax district or special assessment district may be a financing option to fund pedestrian lighting within a Hometown Overlay District. Transportation enhancement funds are also an option to fund pedestrian lighting for streetscaping along Philadelphia Pike.

- In Delaware, discretionary "street improvement or urban lighting funds" were historically obtained from state representatives to fund underground infrastructure to provide street lighting. However, these discretionary funding earmarks are limited due to state budget constraints.

The following are notes taken as the workshop group discussed light fixtures, shielding, and green technology:

- High-pressure sodium (HPS) lighting is currently one of the most cost-effective lighting options available.

- There is significant hesitation to switch to LED technology for following reasons:

    - Unproven track record and lack of history. As more pilot projects are completed that accurately address LED long-term viability questions, more buy-in will occur.

    - LED lighting capital costs are somewhat prohibitive because new fixtures must be purchased in addition to new bulbs.

    - Complaints regarding intense brightness of LED lighting.

    - Concern with LED technology degradation over time. LEDs must be replaced on a maintenance schedule, because they will fade over time.

    - Failure rate of LED needs to be considered.

- LED lighting allows one to better see what the actual color of an environment is, whereas HPS or other older forms of lighting have a lower Color Rendering Index (CRI) value, allowing for less accurate color recognition.

- One limitation is the electricity provider's hesitancy to try new technology and provide lighting-fixture options.

- Pedestrian lighting at crosswalk areas, which would be triggered by motion/movement, was discussed. It was noted that DelDOT piloted an in-road, illuminated crosswalk project, but it was not practical due to damage by snowplows.

- DelDOT is currently testing solar lighting technology for park-n-ride facilities.

- DTC has been using solar lighting at bus stops in Delaware for years. However, the company that manufactured the solar eyes is no longer in business. DTC shields lights at bus stops to eliminate glare affecting drivers. The intent is to light the bus stop such that pedestrians are seen by motorists and feel safe and secure at the bus stop location.

- The following limitations with solar lighting were cited:

    - Safety concerns exist related to solar lighting. Will the light dim at night? Will the solar light provide adequate illumination? DelDOT is currently piloting a small-scale solar lighting project that will be studied in the short term and long term to analyze brightness and overall light quality for potential further applications throughout Delaware.

    - Solar lighting is cost prohibitive in terms of both capital costs (acquisition and installation) and maintenance for widespread application in Delaware. Currently, the costs of replacing batteries every two to three years are at least $800 per fixture.

The following are notes taken as the workshop group discussed possible recommendations and best practices for enhancing pedestrian lighting moving forward:

- A need was identified to focus more on walking-level lighting color. What colors work best in various land uses? What light color preferences exist for various areas? Lighting glare needs to be addressed upon selection of lighting fixtures. DelDOT removed lighting from the SR 1 bridge as a result of complaints from the maritime industry using the C&D Canal. Glare from the lights inhibited navigation.

- Gaps in rules, standards, and maintenance need to be assessed to improve intergovernmental coordination and overall pedestrian-lighting system performance.

- DelDOT is currently serving on a national committee to review lighting guidelines and standards for DOTs. The results of this committee work should prove to be valuable for application in Delaware.

- Electricity providers do not always meet the DelDOT Lighting Guidelines. This problem can be rectified through coordination with electricity providers and possible revisions made to the

DelDOT Lighting Guidelines. DelDOT officials expressed a desire to revisit and update Lighting Guidelines in the future. It was also noted that the DelDOT Lighting Guidelines could benefit from more language focused on pedestrian-scale lighting.

- Electricity providers and public officials should work collaboratively to provide more fixture options and allowances for green technology for use in Delaware. The Public Service Commission (PSC) should be included in this process to identify obstacles to adding new lighting-fixture options in Delaware. Additionally, an aesthetic lighting option should be added to specific land use/transportation applications (e.g., parks, scenic byways, historic districts and areas).

- Lighting infrastructure (i.e., underground lines) should be installed at the initial construction phase of the development project, regardless of whether or not top-side lighting is installed, to ensure that the capacity for lighting in the future is available. Some older New Castle County unincorporated communities do not have underground electrical infrastructure and, therefore, cannot install pedestrian lighting, even if residents of the community desired to do so.

- More attention should be placed on providing lighting on roads connecting well-lit developments. An example was mentioned in New Castle County in the Fox Run area, located along SR. 72 south of Rt. 40. Several developments in this area have street lighting, yet portions of SR 72, Del Laws Rd., Porter Rd., and others do not.

- Vandalism as a barrier to enhanced pedestrian lighting was mentioned. Workshop participants noted that utility companies are willing to replace vandalized fixtures, but if the problem persists, lighting will not be re-established due to cost constraints resulting from repeated vandalism. Mitigation strategies should be explored on how to decrease vandalism.

- DelDOT officials noted that all new street lights installed in Delaware have enhanced shielding, as per change in Delaware Code (Title VII, Chapter 71A).

- Transportation Enhancement (TE) funding is one means of supplementing funding of pedestrian-lighting enhancements as part of a streetscaping project.

- Currently DelDOT administrative policy prohibits capital improvement money from being augmented by maintenance and operational money. In the event that the use of new technology saves long-term maintenance or operational costs, officials are unable to use such savings to apply to potentially higher capital costs. Possible changes in administrative policy could lead to more use of green technology in the future, since green technology often allows for long-term maintenance savings while costing substantially more than conventional lighting for initial installation.

- DelDOT has completed a street-lighting inventory statewide, allowing for better tracking of lighting coverage.

- Maintenance responsibilities should be outlined and clearly assigned at the front end of the planning process, before lights are installed, to avoid problems over the long term.

It was noted that ultimately maintenance responsibility falls on the government (i.e., DelDOT) when/if HOAs or individuals do not pay for maintenance and upkeep of lighting facilities.

- Concerning developer provision of certain types of public infrastructure improvements, it was noted that lighting indeed should be considered "part of doing business" in Delaware—alluding to the possibility that lighting in certain areas should be required of developers at the onset of the planning process. County governments already require lighting as a condition of approval for subdivision proposals, but actual ordinance requirements in zoning or subdivision regulations are lacking.

- The Illuminating Engineering Society was mentioned as an excellent resource for research on types of lighting and recommended practices for reference.

- Participants suggested review of ADA compliance requirements with regard to pedestrian lighting.

- Participants expressed interest in reviewing best practices from other national and international transportation agencies with regard to pedestrian lighting.

The following are notes taken as the workshop group discussed next steps moving forward with regard to this project:

- Distribute notes of working group meeting to participants for changes, additional suggestions, or comments.

- Follow up on additional needs for research as a result of working group meeting.

- Incorporate recommendations into working paper, which will be submitted to DelDOT and available online as a downloadable document.

Chapter 4. Best Practices and Recommendations

This chapter incorporates information from research, interviews, and workshop discussion that, in total, provide various best practices and recommendations for consideration and possible implementation by Delaware public officials. Some of the below solutions are "low hanging fruit" in that they require minor changes or reviews of current policies whereas some proposed solutions are larger policy questions that will require long-term consideration and the cooperation of officials at several levels of government to accomplish.

4-1. Roles and Responsibility

Among the challenges to facilitating effective pedestrian lighting in Delaware, perhaps the most pressing is clearly defining roles of responsibility within the process. Who is to install the lighting and who will maintain the lighting after installation? Who pays for initial installation and who pays for maintenance and operation? If one party fails to pay for maintenance and operation, whose responsibility does it become? The following section will attempt to address many of these issues surrounding pedestrian lighting.

Provide Clear Instructions and Guidelines for Developers

Responsibility for the installation and continuing maintenance of lighting in a community must be established at the front-end of the planning process. In March 2008, the Arlington County, Va., Department of Environmental Services established the *Street-light Policy and Planning Guide Instructions for Developers*. This document clearly defines the expectations of responsibility that developers are required to comply with in Arlington County. Under the Arlington regulations developers have two options with regard to the installation of lighting: 1) install the lighting on their own or 2) pay Arlington County to install the lighting systems.[78] If developers elect to install lighting on their own, strict requirements on every component of installation are specified to ensure proper installation and system performance standards are met.[79] Inspections of all developer-installed lighting infrastructure are required.[80] By inspecting the installation of lighting and requiring strict standards for approved installation, Arlington County can reduce maintenance costs and potential infrastructure problems in the future.

Consider Benefits of Leasing vs. Owning Lighting Infrastructure

Local governments must weigh the costs and benefits of leasing vs. owning lighting infrastructure. The Massachusetts Municipal Association (MMA) reported that Worcester, Mass., along with at least 14 other municipalities in Massachusetts since 2000, purchased

[78] Arlington County, Virginia, Department of Environmental Services, *Arlington County Street-light Policy and Planning Guide Instructions for Developers*, (Arlington County: Department of Environmental Services, March 2008), 3.
[79] Ibid.
[80] Ibid., 4.

lighting infrastructure from the provider instead of leasing lights.[81] Worcester expects to save more than $1.6 million annually as a result of the purchase.[82] During fiscal year 2010, the municipality spent roughly $2 million to lease the street lights; in 2001 the cost was roughly $7 million dollars.[83] An official from National Grid, the lighting provider, attributed the reduction in cost over time to standard amortization practices.[84] Worcester will pay $473,900 to purchase roughly 13,000 lights from National Grid.[85] Although Worcester will incur additional costs associated with owning and operating the lighting system, government officials expect the additional costs will still be far lower than what Worcester would pay to lease the lighting in the future.[86]

Codify O&M Requirements of Developers

In 2006 the city of Dallas, Tex., Department of Public Works & Transportation surveyed several cities in the United States to determine how they defined the roles of responsibility related to lighting, and the results are shown in the below table. The fourth column in the table denotes light-spacing requirements.

Table 5 Survey of Funding Responsibilities Related to Developments

City	Installation	Operation & Maintenance	Spacing
Dallas	Developer pays	Developer pays*	**75 ft.**
Fort	Developer pays	City pays	**75 ft.**
San	Developer pays	Developer pays	**No standard**
Austin	Developer pays	Developer pays	**80 ft.**
Miami	Developer pays	City pays	**30 ft.**
Phoenix	No program	No program	**No program**

Source: City of Dallas Department of Public Works & Transportation

Dallas officials required that developers pay for operation and maintenance costs for 20 years after the development was completed, yet this requirement was not codified. Localities should codify requirements governing roles of responsibility for installation, operation, and maintenance of pedestrian-lighting facilities. Additionally, consideration should be given to the long-term operation and maintenance cost liability incurred after, in the Dallas example, a 20-year agreement is fulfilled.

[81] Evich, Mitch, Massachusetts Municipal Association, *Streetlights purchase to lead to savings*, (Boston: MMA, 2010).
[82] Ibid.
[83] Ibid.
[84] Ibid.
[85] Ibid.
[86] Ibid.

4-2. Financing Mechanisms

Local governments are considering various strategies for financing lighting improvements. This section will explore financing mechanisms and serve as a reference guide for public discussion in Delaware. This section will present the following financing mechanisms for review: 1) local assessment districts, 2) transportation-impact fees and excise taxes, 3) adequate public facility ordinances, 4) tax-increment financing, 5) grant funding, 6) general-fund expenditures, and 7) sales tax.

It should be noted that DelDOT received $140.9 million in American Recovery and Reinvestment Act funding for use on transportation projects.[87] Many projects utilizing this funding included enhancements to or installation of pedestrian lighting. For example, decorative lighting was incorporated into the Hockessin Streetscape Project completed in September 2010 at Valley Road to Erickson Avenue along Old Lancaster Pike.[88] DelDOT has also funded streetscaping projects that included installation of pedestrian-scale lighting such as the Marshallton Village Streetscape Improvements Project through the DelDOT Transportation Enhancements (TE) Program.

Figure 17 Before and After at Marshallton Village

Photo Source: DelDOT; photo editing by IPA staff

Local Assessment Districts

Local Assessment Districts (LADs) are the most common financing mechanism for funding pedestrian lighting. LADs are specified areas created by local governments that are assigned a tax assessment to pay for infrastructure improvements occurring in the area defined. In Delaware, this method for financing lighting is most popular. All three counties have policies in place that allow for the creation of LADs for new and/or existing developments to install residential lighting. LADs are created through a public-petition process whereby residents in a potential LAD can petition the government to levy the assessment.

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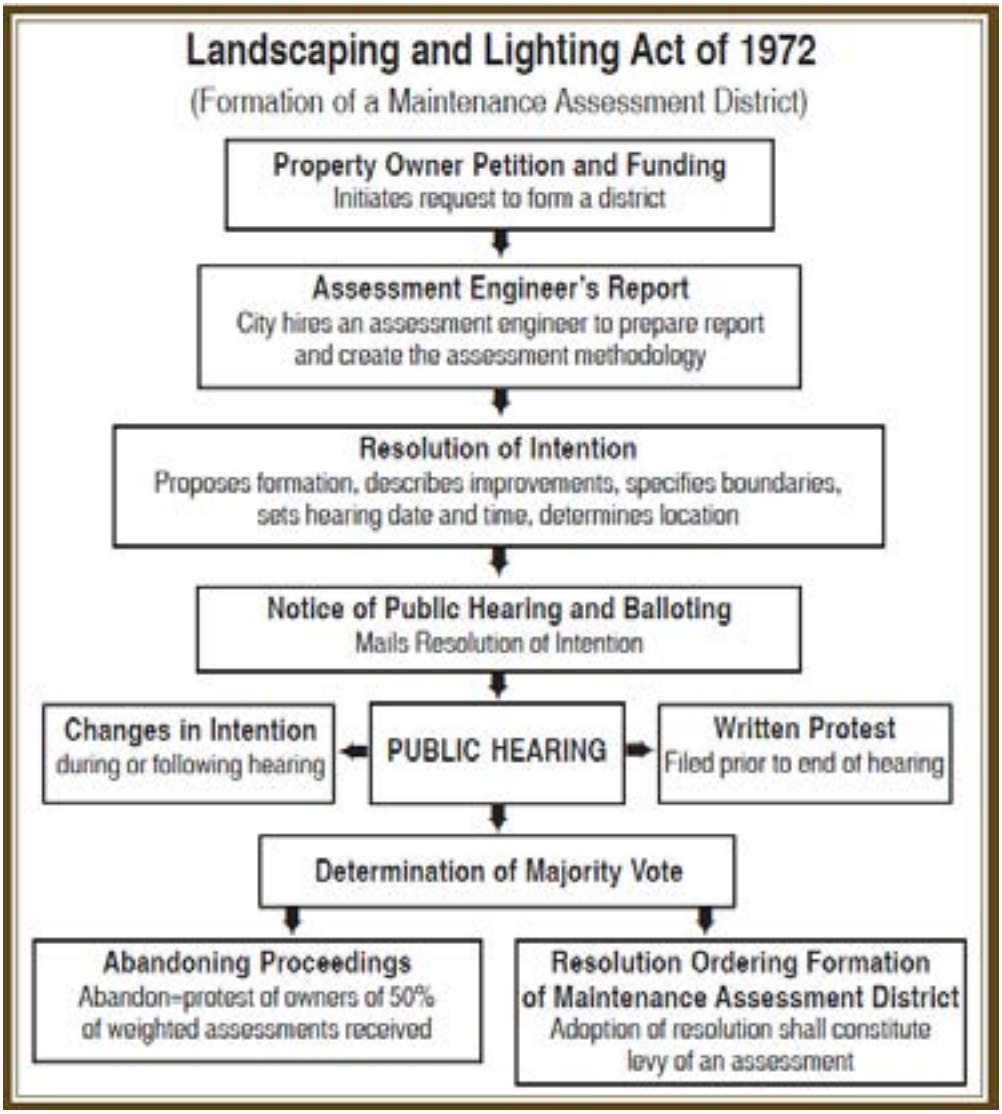
[87] Delaware Department of Transportation, *Recovery Act Updates: DelDOT's American Recovery and Reinvestment Act Projects*, (Dover: Delaware Department of Transportation, 2010), http://www.deldot.gov/information/projects/recovery/index.shtml.
[88] Ibid.

San Diego, Calif., allows for the creation of Maintenance Assessment Districts (MADs) for pedestrian lighting, which are essentially the same as LADs. The below figure shows the basic process by which MADs are created.

Figure 18 San Diego, Calif., Maintenance Assessment District (MAD) Formation Process



Source: Walk SanDiego

Seminole County, Fla., operates a Municipal Services Benefit Unit (MSBU) Program to install residential lighting in communities.[89] The Seminole County process is very similar to what is highlighted above- however, Seminole County requires a slightly higher than simple majority threshold of 55 percent of residents in a proposed MSBU area to vote in favor of establishing the

[89] Seminole County Government, *Municipal Services Benefit Unit Program: Street-lighting*, (Seminole County: Seminole County Government, 2010).

MSBU.[90] A process for the dissolution of an MSBU is also provided.[91] Detailed information about the Seminole County, Fla., MSBU Program can be found online:

http://www.seminolecountyfl.gov/fs/msbu/msbuprog.aspx

Transportation Impact Fees and Excise Taxes

The American Planning Association defines an impact fee as:

> Payments required by local governments of new development for the purpose of providing new or expanded public capital facilities required to serve that development. The fees typically require cash payments in advance of the completion of development, are based on a methodology and calculation derived from the cost of the facility and the nature and size of the development, and are used to finance improvements offsite, but to the benefit, of the development.[92]

Impact fees are normally authorized through state law or local ordinance. The legality of the impact fee stems from the emergence of the *rational nexus test* used in court cases across the country.[93] The rational nexus test encompasses the following components:

- The expansion of the facility and/or service must be necessary and must be caused by the development.
- The fees charged must be based on the costs of the new facility/service apportioned to the new development.
- The fees must benefit those who pay; funds must be earmarked for a particular account and spent within a reasonable amount of time.
- Funds received from impact fees must be segregated from the municipality's general fund and may be used only for the project or intent for which they were collected.[94]

Currently, Title 29, Chapter 91, Subchapter II of the Delaware State Code authorizes the development of impact fees in Delaware at the state and county level. Roads, streets, rights-of-way, transit facilities, and traffic signaling are all included as potential state public facilities to be funded through collection of impact fees. Although not explicitly stated, pedestrian-lighting and roadway lighting in general would seem an obvious piece of infrastructure to include with other transportation facilities for receiving funding from impact fees. Local impact fee ordinances can also be reviewed for mention of pedestrian-lighting facilities as authorized for funding from

[90] Ibid., 9.
[91] Ibid., 14.
[92] University of Delaware, *A Coastal Community Enhancement Initiative: Impact Fees*, (Newark: University of Delaware).
[93] Ibid.
[94] Ibid.

impact-fee revenue. The Idaho Development Impact Fee identifies street lighting as part of its "public facilities" definition.[95]

In *Impact Fees: Practical Guide for Calculation and Implementation* in 1991, Ross and Thorpe provide useful discussion on use of inductive versus deductive calculation for impact fees.[96]

> Inductive Calculation: This method employs calculation of the impact cost by determining the cost and the capacity of a particular facility and identifying it as the model for all future facilities.
>
> Deductive Calculation: This method of calculation involves calculating the impact cost by determining the additional demand on a facility or infrastructure from additional population and commercial and industrial square footage.[97]

The authors favor use of deductive calculations for lighting infrastructure.[98] Also noted are several other states that have dealt with creating development impact fees-California, Florida, Illinois, New Jersey, and Texas.[99]

Portland, Ore., assessed a Transit "System Development Charge" (SDC) starting in 1997, which is used for, among other improvements, lighting installation.[100] The SDC is transit-focused to equip the City of Portland with needed revenue to invest in system improvements related to bus stops, shelters, and pull-offs.[101]

In *TCRP Project J-5 Legal Aspects of Transit and Intermodal Transportation Programs: Legal Research Digest 28, Uses of Fees or Alternatives to Fund Transit*[102], Johnson and McDaniel identify crucial factors related to the legal framework behind transit-focused impact fees. Their research covers the statutory limits, structural considerations, and calculation methodologies that all contribute to the development of an effective transit-impact fee.[103] As transportation officials in Delaware consider how best to fund lighting-infrastructure improvements that serve the DART and SEPTA transit systems—the Johnson/McDaniel report will serve as an excellent reference for review.

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[95] Idaho State Code, Title 67 State Government and State Affairs, Chapter 82 Development Impact Fee.
[96] Ross, Dennis H. and Scott Ian Thorpe, "Impact Fees: Practical Guide for Calculation and Implementation," *Journal of Urban Planning and Development* (September 1992).
[97] Ibid.
[98] Ibid.
[99] Ibid.
[100] Johnson, Jaye Pershing and James B. McDaniel, *TCRP Project J-5 "Legal Aspects of Transit and Intermodal Transportation Programs: Legal Research Digest 28, Uses of Fees or Alternatives to Fund Transit*, (Washington DC: Transit Cooperative Research Program, Federal Transit Administration, December 2008), 28.
[101] Ibid.
[102] Ibid.
[103] Ibid.

In March 2009, the Pennsylvania Department of Transportation (PennDOT) published *Transportation Impact Fees: A Handbook for Pennsylvania's Municipalities*.[104] This document provides a model transportation-impact fee ordinance, fee-level comparisons among municipalities across Pennsylvania, and a checklist for establishing a transportation-impact fee. The checklist outlines a sample process for creating a transportation-impact fee that includes public input and proper review periods prior to ordinance review and possible adoption. This PennDOT handbook could be useful not only for DelDOT officials but also for Delaware counties interested in exploring new funding mechanisms for transportation improvements that would include lighting infrastructure.

In 2006, Yavapai County, Ariz. enacted a Roadway Development Fee Ordinance that was authorized by Arizona state law.[105] The ordinance requires developers to pay for necessary transportation facility infrastructure as a result of new trip generation.[106] The impact fee, however, cannot be used for maintenance, only for capital projects as per state law.[107]

Gila County, Ariz., implemented a transportation excise tax, authorized by Arizona state law, to fund roadway construction costs in 1994.[108] Revenues collected within the county are deposited into a state controlled regional area road fund; funds are dispersed on a monthly basis by the Arizona State Treasurer.[109] In fiscal year 2009, the Gila County Regional Area Road Fund totaled roughly $8.7 million dollars.[110]

Adequate Public Facilities Ordinances (APFOs)

APFOs specifically identify requirements that must be met for a development of any size to be approved for construction in a jurisdiction. APFOs define, on the front end, the infrastructure investment necessary to offset the demand incurred on government services and resources as a result of new development. APFOs have historically focused on school infrastructure investment and residential school-impact calculations, but transportation components can and have been incorporated into APFOs. Through the use of a transportation component, pedestrian-lighting infrastructure could be integrated into the overall transportation infrastructure installed on the front end of a development-review process.

Tax-Increment Financing (TIF)

The City of Amarillo, Texas, has a TIF policy that is used to fund pedestrian lighting. The Amarillo TIF policy consists of the following key components: 1) a Final Project and Financing Plan, 2) a TIF Policies and Procedures manual, and 3) Ordinance # 7012 authorizing the creation

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[104] Pennsylvania Department of Transportation, *Transportation Impact Fees: A Handbook for Pennsylvania's Municipalities*, (Pennsylvania Department of Transportation, March 2009).
[105] URS Corporation, *Northwest Cochise County Long- Range Transportation Plan: Funding Assessment and Impact Fee Planning Working Paper*, (Cochise County: Arizona Department of Transportation, May 2010), 4.
[106] Ibid.
[107] Ibid.
[108] Ibid., 6.
[109] Ibid.
[110] Ibid.

of a Tax-Increment Reinvestment Zone (TIRZ). The Final Project and Financing Plan identifies what specific geographic areas will qualify for TIF status, goals to achieve with regard to the target area defined, TIF revenue projections, and the actual project plan with estimated costs for identified project components. The Amarillo TIF Policies and Procedures document provides definitions for key terms associated with TIF, TIF authority as defined by Texas state code and the City of Amarillo, the purpose of the Amarillo TIF program, guiding principles for consideration of TIF, and description of the TIF project process. Ordinance #7012 authorizes the creation of TIRZ #1 and serves as a reference point for Delaware policymakers interested in sample ordinances governing TIF policy. The Final Project and Financing Plan and the TIF Policies and Procedures documents are provided in the bibliography of this paper for readers interested in learning more about the Amarillo TIF program.

In November 2007, the city created TIRZ #1.[111] TIRZ #1 covered an approximately 12-block by 12-block section of center city Amarillo[112] and serves as the only area in the city to utilize tax-increment financing. A streetscape-planning effort was initiated and completed using TIF funding. Currently, streetscape projects that include installation of pedestrian-lighting are underway throughout the city of Amarillo.

Grant Funding

The federal Safe Routes to School (SRTS) program offers limited potential for light funding. For Delaware, $125,000 is the funding limit for infrastructure projects.[113] It was noted by SRTS Coordinator, Sarah Coakley, that "in most cases lighting would exceed this [limit]."[114] Thomas Edison Charter School and Claymont Elementary School have considered pedestrian-lighting enhancements as part of SRTS funding.[115] Thomas Edison Charter School considered pedestrian lighting around the perimeter of the school, and Claymont Elementary School considered pedestrian-lighting at the approaches to a pedestrian bridge.[116]

Two key challenges emerged from consideration: 1) demonstrating that facilities would be used at night and 2) finding an entity to own and maintain the lighting systems.[117] Assuming lighting costs did fall within the funding limit set for infrastructure projects at $125,000, SRTS funding can only be used for installation and not for maintenance or operational costs.[118] Another key challenge is that, at least in the case of Thomas Edison Charter School, the land on which the school is located on is privately owned. Therefore pedestrian-lighting improvements would not likely be installed due to the role of ultimate responsibility being left to the private owner. SRTS

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[111] Downtown Amarillo, Inc., *Downtown Amarillo Development*, (Amarillo: Downtown Amarillo, Inc., 2011), http://www.downtownamarillo.com/development.
[112] Amarillo, Texas, *Final Project and Financing Plan: Tax Increment Reinvestment Zone #1 – City of Amarillo, Texas*, (Amarillo: City of Amarillo, July 2007), http://www.downtownamarillo.com/Websites/downtownamarillo/Images/PDF/Final%20Financing%20Plan%20v4%2011x17.pdf, 1.
[113] Sarah Coakley, e-mail message to author, April 4, 2011.
[114] Ibid.
[115] Ibid.
[116] Ibid.
[117] Ibid.
[118] Ibid.

Coordinator Coakley summarized use of SRTS funds in Delaware for pedestrian lighting by saying that "there could possibly be a situation where pedestrian-lighting is warranted, affordable, and someone else agrees to own and maintain it, but it hasn't happened yet."[119]

In coordination with the U.S. Department of Housing and Urban Development, the Delaware State Housing Authority offers Community Development Block Grants (CDBGs) to Kent and Sussex Counties. CDBGs are intended for infrastructure enhancements, which can include street-light installation in low and moderate-income housing developments. Communities around the country have utilized CDBGs for pedestrian lighting. For example, the City of Norman, Oklahoma used CDBG funding to install "pedestrian-scale, period lighting in the city's oldest neighborhoods."[120] This presents an excellent opportunity for citizens in Kent and Sussex Counties to seek funding for street-light enhancements in unincorporated areas. For more information on this program or for information on how to apply, contact Albert Biddle, Kent County Housing and Community Development Coordinator, at 302-744-2480 or Bill Lacates, Sussex County Community Development and Housing Director at 302-855-7777. You can also visit the Delaware State Housing Authority Community Development Block Grant webpage:

(www.destatehousing.com/Landlords/dv_cdbg.html).

In December 2010, the city of Lewes, Del. was awarded $500,000 in funding for installation of LED streetlights in town.[121] Twelve lights were to be installed with funding used from the U.S. Department of Energy's Energy Efficiency and Conservation Block Grant (EECBG) program.[122] This program was funded under American Recovery and Reinvestment Act (ARRA) of 2009, which was a short-term competitive-grant program. Since the City of Lewes already owns and operates approximately 350 low-pressure sodium, high-pressure sodium, and metal-halide streetlights, the success of the pilot LED program could lead to future investments by the city. Although this grant funding was not awarded for use in an unincorporated area, this example is provided to show that money is available for innovative lighting programs and is being used currently in Delaware.

Dover, Del., was also awarded grant money from the U.S. Department of Energy to install LED lights.[123] The City of Dover will install 118 LED street-lights that over the next 20 years are anticipated to save the city over $350,000.[124]

DelDOT is the "pass through" agency that administers the federal Transportation Enhancements (TE) program under the previous 2005 federal authorization of SAFETEA-LU. Projects that are related to surface transportation, dedicated to public use, and meet certain eligibility criteria are

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[119] Ibid.
[120] Norman, Oklahoma, City of, *First Courthouse Neighborhood Planning for Community Preservation Plan Draft*, (Norman: City of Norman, March 2011), 15.
[121] New Streetlights, *Lewes, Delaware, awarded EECBG funds for LED streetlights*, http://newstreetlights.com/index_files/LED_street_light_news_Lewes_Delaware_awarded_EECBG_funds_for_LED_streetlights_274.htm.
[122] Ibid.
[123] Wright, Maury, *Outdoor-lighting: Dover installs LEDs, others question technology costs*, January, 13, 2011, http://www.ledsmagazine.com/news/8/1/9.
[124] Ibid.

funded through a mix of federal and state funds; local matching funds are required. Pedestrian facilities, streetscaping projects, and other projects that strengthen the value of the cultural, aesthetic, or environmental value of transportation infrastructure have been funded in the past. More information on the TE program guidelines and protocol can be found here:

http://deldot.gov/information/community_programs_and_services/te

General-Fund Expenditures

Although seldom used by local governments to fund additional transportation projects, general-fund revenue can be made available for pedestrian-lighting infrastructure if local government officials decide to take such action. However, use of funds for such infrastructure would put in jeopardy funding for other general-fund programs requiring legislators and administrators at the local level to strategically prioritize all expenditures, especially during a time of economic hardship and declining revenue to government entities at all levels.

Sales Tax

Yavapai County, Ariz., approved a $0.50 sales tax for regional transportation projects.[125] The sales tax has no sunset provision.[126] Revenue generated from the sales tax was estimated at $12.9 million for fiscal year 2009.[127] The Delaware Code Title 30: State Taxes does not provide for the collection of sales taxes. A specific tax would require legislative action by the Delaware General Assembly.

4-3. Light Planning

Historically, light planning has largely been facilitated by developers and utility companies. As pedestrian-oriented outdoor lighting becomes more prevalent in the United States and as pedestrian focus increases in the national transportation discussion, light planning will receive greater interest. Local governments, transportation agencies, and neighborhood organizations are increasingly interested in concepts such as “streetscaping” and “complete streets” as the definition of a roadway is slowly changing from an automobile-centric to a more multimodal, choice-based design.

In the below series of recommendations, lighting planning strategies will be outlined and enacted examples from around the country will be referenced to provide templates and potential case studies for consideration, which transportation agencies, county governments, and elected officials can review when examining street-lighting policies in Delaware.

The following presents common standards and best practices for lighting pedestrian areas. The Green Valley Institute outlines the following standards for lighting of pedestrian areas:

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[125] URS Corporation, *Northwest Cochise County Long- Range Transportation Plan: Funding Assessment and Impact Fee Planning Working Paper*, (Cochise County: Arizona Department of Transportation, May 2010), 4.
[126] Ibid.
[127] Ibid.

- Consider a pedestrian's needs and safety in developing the lighting plan.

- Provide adequate, but not excessive, illumination for the space occupied by people and the elements within those spaces, such as stairs, walls, benches, curbs, and landscaping. Eliminate dark spots by the coordination of the lighting with other site elements.

- Illuminate walkways with enough peripheral distribution to illuminate the immediate surroundings within five percent of the levels defined by IESNA recommendations for pedestrian spaces.

- Design the placement and spacing of fixtures to follow a regular pattern that is in coordination with the pedestrian ways and other site elements. Highlight significant design elements such as gateways, plazas, major building entrances, and the like.

- Select light fixtures for pedestrian spaces that are appropriate for the project and that relate to the human scale with a maximum height of 15 feet.[128]

The Arlington County, Va., Street-light Policy and Planning Guide establishes classification factors for lighting needs, which provides a good framework for evaluating lighting needs for a given area:

[128] Green Valley Institute, *Community Planning Fact Sheet #14: Commercial Development Lighting Standards*, Green Valley Institute, http://www.greenvalleyinstitute.org.

Figure 19 Arlington County, Va., Lighting Need Classification Factors

CLASSIFICATION FACTOR	WHY LIGHTING IS NEEDED
Number of Lanes and lane widths.	The more lanes, the wider the road, the more light needed.
Median Openings and Driveways	The more openings, the greater the visibility need in those areas.
Curves and Grades	Sharper curves and steeper grades require more lighting.
Parking	Parking on one side, both sides or loading zones only will affect the need for the lighting in those areas where parked vehicles are present.
Percent of Development	The greater the development of the area, the greater the need for additional lighting.
Type of Use	Single family developments require less lighting than commercial areas.
Crime Rate	The higher the crime rate, the greater the need for lighting.
Night/Day Accidents	As night traffic accidents approaches 2 times that of daytime accidents, there is an increased need for more lighting.
Traffic signals	If traffic signals are present on the street, streetlights are most important.
Left Turns	If the street has left turn lanes in both directions, it has a greater visibility requirement than others.
Median Widths	The greater the median width the less the need for lighting because of the separation of opposing traffic.
Operating Speed	The greater the speed, the greater the need for lighting.
Pedestrians	The more pedestrian traffic that is present, the greater the need for improved lighting.
Street Classification	An arterial street needs more lighting than a neighborhood minor street by virtue of the amount of traffic it carries.

Source: Arlington County, Va. Lighting Policy and Planning Guide

Arlington officials weight classification factors according to FHWA guidelines and engineering judgment.[129] After classification factors are correctly weighted, numerical ratings are assigned to each factor on a one-through-five scale (five being most influential and one being least

[129] Arlington County, Virginia, Department of Environmental Services, *Arlington County Street-light Policy and Planning Guide*, (Arlington County: Department of Environmental Services, January 2008), 14.

influential).[130] Assuming lighting need is established based on the above classification factors, a field survey will be completed to collect more detailed information on the proposed site for use in developing an actual lighting plan and design.[131]

Enhance Current Planning Strategies

Enhance comprehensive plans, hometown overlays, redevelopment plans, circulate on plans and studies, and design guidelines to incorporate more enumerated pedestrian-lighting policies. Metropolitan planning agency plans such as regional transportation plans should consistently build pedestrian lighting facilities into overall transportation network-development priorities.

Jurisdictions are adding lighting components to comprehensive plans around the country. The below is a breakdown provided by the American Planning Association of plan components from many jurisdictions:

- Annapolis (Maryland), City of. 2009. *Annapolis Comprehensive Plan*. Chapter 7, Environment.
  - See Policy 5, "Minimize Noise and Light-pollution."

- Coconino (Arizona), County of. 2003. *Comprehensive Plan*. Community Character Element: Dark Skies.
  - Dark skies are an important aspect of Coconino County's community character and vital to the continued use of nearby astronomy facilities.

- Fairfax (Virginia), County of, Environmental Quality Advisory Council. 2009. *Annual Report on the Environment.* Chapter IX. Noise, Light-pollution and Visual Blight. Section IX-2. Light-pollution.
  - Report details the main issues and problems of exterior lighting and examines county efforts to address these issues.

- Laramie (Wyoming), City of. 2007. *Laramie Comprehensive Plan*. Chapter 11, Conservation.
  - See "Noise/Light-pollution" on p. 9 of chapter, and "Noise/Light-pollution Goals and Action Statements" on p. 12.

- Loudoun (Virginia), County of. 2001. *Revised General Plan*. Chapter 5. The Green Infrastructure: Group Four: Complementary Elements. B. Lighting and the Night Sky.
  - Calls for appropriate regulations and performance standards to promote quality lighting that also protects the night skies by reducing light-pollution.

- Lynwood (Washington), City of. 2009. *Comprehensive Plan Amendments*. Environmental Resources Element. Subgoal ER-9. View Protection and Light-pollution.
  - Policies ER-9.3 through ER-9.5 address glare prevention.

[130] Ibid.
[131] Ibid.

- New Lisbon (New York), Town of. 2008. *Comprehensive Plan*. Chapter 5, Section 5.6. Night Sky. Chapter 12. Plan Implementation.
  - Natural Resource Protection Recommendation 10 addresses light-pollution.[132]

The *Delaware Statewide Pedestrian Action Plan,* published in 2007, could include more emphasis on lighting-facility infrastructure as a crucial component to nighttime walkability. Properly lit pedestrian areas can become nighttime activity centers and sources of economic development for struggling small communities or commercial corridors.

The City of Norman, Okla., produced a neighborhood-redevelopment plan for the First Courthouse neighborhood. The *First Courthouse Neighborhood Plan*[133] incorporates pedestrian-lighting components by defining where pedestrian-lighting deficiencies currently exist, what lighting enhancements pedestrians in the community want, and what light intensity pedestrians prefer in various areas. Special attention is given to supporting lighting that matches the historic character of the First Courthouse community.

New Castle County government currently assists unincorporated communities in the county with creating development plans and Hometown Overlay districts. New Castle County government in the Hometown Overlays document references the "opportunity to create development and redevelopment guidelines that preserve those qualities which define their community. The Hometown Overlay designation provides a framework for active local involvement in community development and design."[134] Four unincorporated communities (Claymont, North St. Georges, Hockessin, and Centreville) have so far completed the Hometown Overlay process by developing a Redevelopment Plan and Design Guidelines in coordination with the New Castle County Department of Land Use.[135]

Often the design guidelines enumerated address the topic of outdoor-lighting. The Claymont Redevelopment Plan, for instance, outlines six key requirements for outdoor-lighting installation in Claymont that include:

- All site lighting shall be required to meet Division 40.22.700 of the New Castle County Unified Development Code to reduce glare and light trespass.

- Decorative bases, posts, luminaries, and bollards shall be used in lieu of standard poles within Claymont Center and along the Philadelphia Pike.

- All lighting shall provide for the illumination of sidewalks and other multiuse pathways via low-intensity fixtures that provide an even distribution of light while avoiding areas of intense shadows.

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[132] American Planning Association, *PAS Essential Info Packet: Outdoor-lighting*, (American Planning Association, October 2010).
[133] Norman, Oklahoma, City of, *First Courthouse Neighborhood Planning for Community Preservation Plan Draft*, (Norman: City of Norman, March 2011).
[134] New Castle County Government, *Hometown Overlays* (New Castle: New Castle County Department of Land Use, 2011), http://www2.nccde.org/landuse/Planning/HometownOverlays/default.aspx.
[135] Ibid.

- Street lights shall not be greater than 18 feet in height in Claymont Center and shall be spaced to provide an even distribution of light.

- Pedestrian lighting shall be provided from storefronts using either indirect illumination from within the building or direct illumination under canopies or awnings.[136]

Other Redevelopment Plans and Design Guidelines offer similar language; however, such policy documents could be enhanced.

A possible reference model for developing better pedestrian-lighting language in redevelopment plans and design guidelines would be the *White Rock Lake Park Lighting Master Plan & Design Guidelines, Dallas, TX*.[137] This document 1) properly assesses existing lighting conditions within an area, 2) identifies lighting-enhancement possibilities, and 3) identifies implementation strategies for pedestrian-lighting installation with clear prioritization and timelines.

To properly assess existing conditions, over 70 pictures were taken at various locations throughout the White Rock Lake Park during the day and the evening.[138] The pictures show pedestrian pathways, rest areas, intersections, bridges, and existing light fixtures. The pictures helped to identify potential strengths and weaknesses in pedestrian-lighting infrastructure throughout the park. A map was also created using aerial images of the park to show where current lighting infrastructure existed along multimodal pathways and intersections.[139] Roadways, pathways, buildings, pavilions, parking lots, and trail bridges were all accounted for to show how the lighting infrastructure fit into the overall layout and design of the park. Foot-candle levels of existing lights in the park were measured to show the actual light area illuminated during the night.[140]

To identify lighting enhancement possibilities, additional mapping was completed to plot out where new lights could be installed throughout the park to enhance lighting infrastructure.[141] Lighting criteria were defined to match various lighting styles with various locations. For instance, fully shielded luminaires were suggested for mounting on trees in certain park locations, while full cut-off luminaires with historic styling were preferred for open-air, circulation-corridor applications.[142] Various styles of lighting were determined to be most compatible with various kinds of use zones.[143] Use zones defined include Circulation Corridor, Nautical, General Park, Multi-Use, Environmental Reserve, and Special.[144] From this

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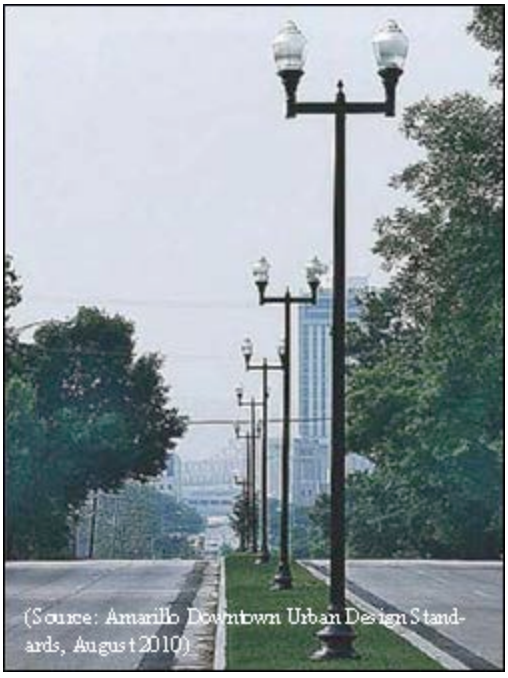
[136] New Castle County Government, *Claymont Community Redevelopment Plan*, (New Castle: New Castle County Department of Land Use, October 2004), 18-19, http://www2.nccde.org/landuse/documents/HometownOverlayClaymontDocuments/Claymont%20Design%20Guidelines.pdf.
[137] Dallas, TX, City of, *White Rock Lake Park Lighting Master Plan and Design Guidelines, Dallas TX*, (Dallas: City of Dallas Park & Recreation Department, June 18 2009).
[138] Ibid., 33-38.
[139] Ibid., 10.
[140] Ibid.
[141] Ibid., 11.
[142] Ibid., 24.
[143] Ibid., 29.
[144] Ibid.

categorization, varying lighting needs were determined for various park use zones, thereby prioritizing which areas in the park needed more light than others. Illumination criteria for lighting of docks, piers, walkways, parking lots, and signage were also included.[145]

Figure 20: LED Light



To identify implementation strategies for pedestrian-lighting installation with clear prioritization and timelines, mapping of a phasing program was completed. The White Rock Lake Park plan defined eight key regions in the park that were each assigned to be completed in phases based on time and monetary constraints.[146]

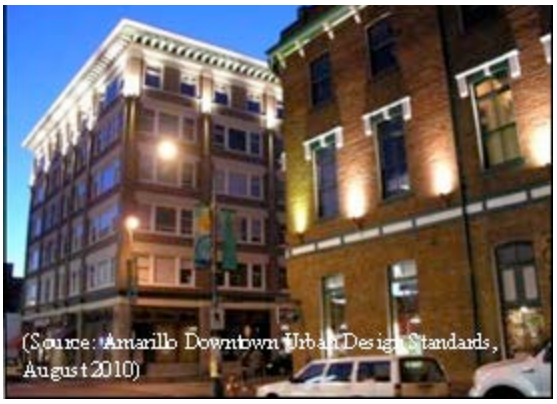
Another reference model for better pedestrian-lighting language in design guidelines is the *Amarillo Downtown Urban Design Standards*. In August 2010, the City Commission adopted these standards as part of the city zoning ordinance applying to downtown development projects.[147] The design standards require that pedestrian-lighting components be included in all new construction projects and redeveloped properties that were vacant for at least one year.[148] The design standards dictate that pedestrian lights located in the public right-of-way cannot be modified or removed without City of Amarillo approval.[149] Developers are required to use LED lighting resembling the design and style of the fixtures shown in Figure 15.[150] Pedestrian-lighting in downtown areas are Amarillo are required to be placed roughly at the midpoint along the street between street trees.[151] Maximum spacing for pedestrian lighting is 50 feet.[152] Space requirements for pedestrian lighting can only be changed to accommodate

- Mature existing trees
- Curb cuts
- Fire hydrants
- Fixed infrastructure elements
- Steps
- Existing buildings[153]

[145] Ibid., 24-28.
[146] Ibid., 32.
[147] Downtown Amarillo, Inc., *Downtown Amarillo Development*, (Amarillo: Downtown Amarillo, Inc., 2011), http://www.downtownamarillo.com/development.
[148] Amarillo, Texas, *Downtown Amarillo Urban Design Standards*, (Amarillo: City of Amarillo, Texas, 2010), http://www.downtownamarillo.com/Websites/downtownamarillo/Images/FinalDesignStandards.pdf, 8.
[149] Ibid.
[150] Ibid., 12.
[151] Ibid., 13.
[152] Ibid.
[153] Ibid.

The design standards also require pedestrian lighting to be white light.[154]

Figure 21 Building-Mounted Lighting



Exterior lighting standards are defined in the *Amarillo Downtown Urban Design Standards* as well. Building-mounted lighting as part of building facades is encouraged.[155] Building lighting is to be complementary to the architecture of the building.[156] Lighting design must avoid light-pollution that causes disturbances to adjacent properties, such as excessive glare. The design standards also make specific note of encouraging white-light installation in street trees.[157] Lighting in parking structures is required to be pointed inward to eliminate possible light-pollution.[158]

DelDOT should consider possible revisions to Traffic Impact Study (TIS) methodology to better incorporate pedestrian-facilities into the overall development-review and permitting process. By further incorporating pedestrian facilities planning into the early stages of development review and approval, issues such as pedestrian-lighting can be adequately planned for and implemented from the start. Currently, TISs focus largely on trip generation and Level of Service (LOS) impacts caused by developments.

Inventory Lighting Infrastructure

Delaware officials at various levels are mapping transportation facilities statewide. Mapping projects for inventorying sidewalks, bike paths, roadway, and transit stops have all occurred and are improving the ability of public officials to focus transportation investment and target new areas for consideration. The same should be done with street and pedestrian lighting to provide visual displays of lighting infrastructure. This inventory can complement the overall pedestrian- and bicycle-planning effort underway in Delaware. DelDOT, county governments, and utility companies can work cooperatively to combine and consolidate data for integration into GIS and Google Earth mapping applications. Easily accessible, interactive maps will provide residents and businesses in unincorporated areas with improved access to lighting information that could lead to more public education and government transparency related to lighting.

Statewide and countywide pedestrian and bicycle plans exist to help direct public investment. Lighting enhancements can be easily added to this planning framework. With a comprehensive lighting inventory, lighting components can be further incorporated into regional transportation plans (RTPs) and transportation improvement programs (TIPs). The RTPs published by the three metropolitan planning organizations in Delaware provide extensive information on transportation-investment prioritization, especially on expanding focus from roadway

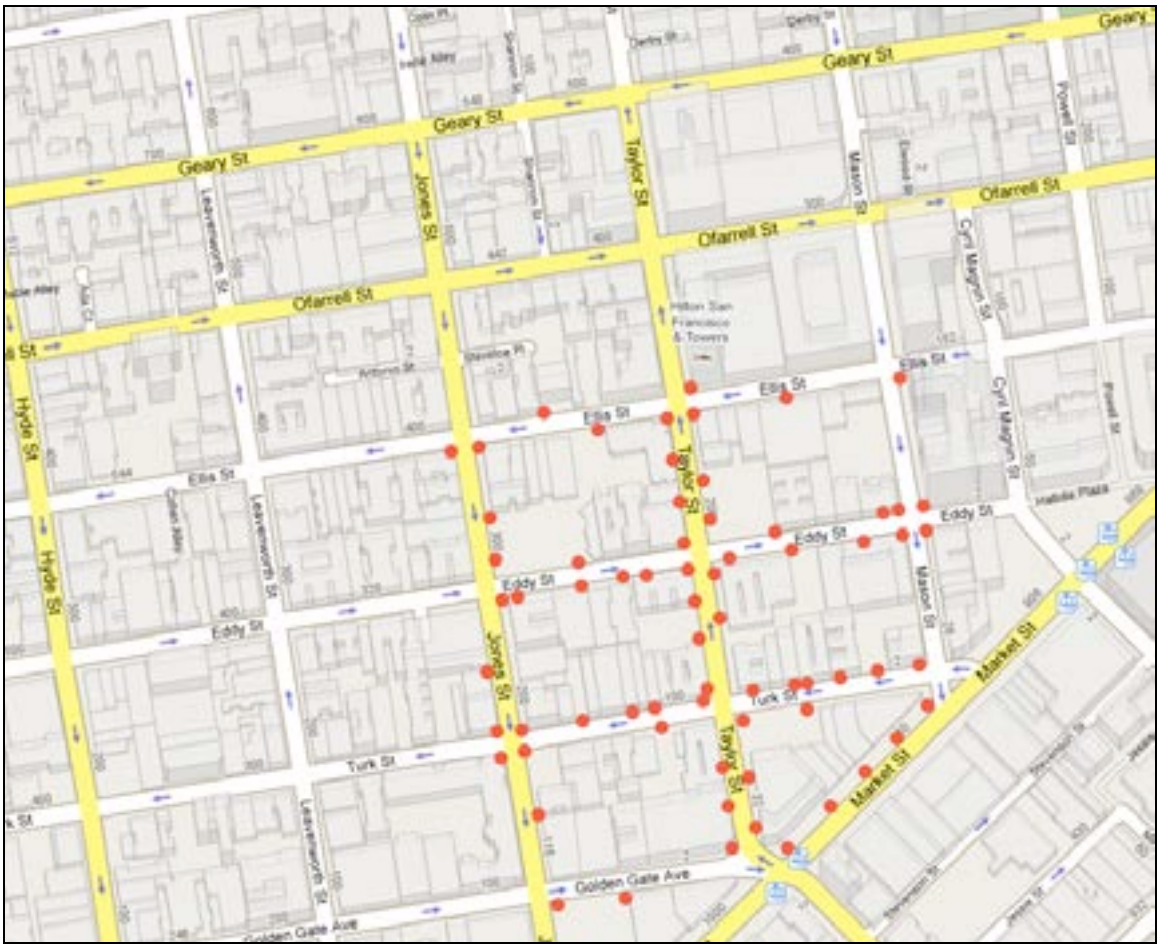
[154] Ibid.
[155] Ibid., 16.
[156] Ibid.
[157] Ibid.
[158] Ibid., 22.

infrastructure to pedestrian and bicycle infrastructure. Several RTPs identify where pedestrian sidewalk facilities are located for their respective focus areas as well as other types of transportation infrastructure, such as bus routes, train stations, bicycle paths, and major roadways.

Streetscaping and lighting projects can be included in TIPs as well. For example, the WILMAPCO 2012-2015 TIP includes mention of bus stop—lighting improvements for the Bear-Glasgow corridor of U.S. Rt. 40. In light of DelDOT's Complete Streets Policy, lighting enhancements should be considered during the project-development stage of a roadway paving, rehabilitation, and/or reconstruction project.

In 2009 Doug Lybeck utilized Google Maps to inventory lighting facilities in San Francisco's Tenderloin District.[159] First, Lybeck mapped city street-light facilities.

Figure 22 City Street-light Inventory

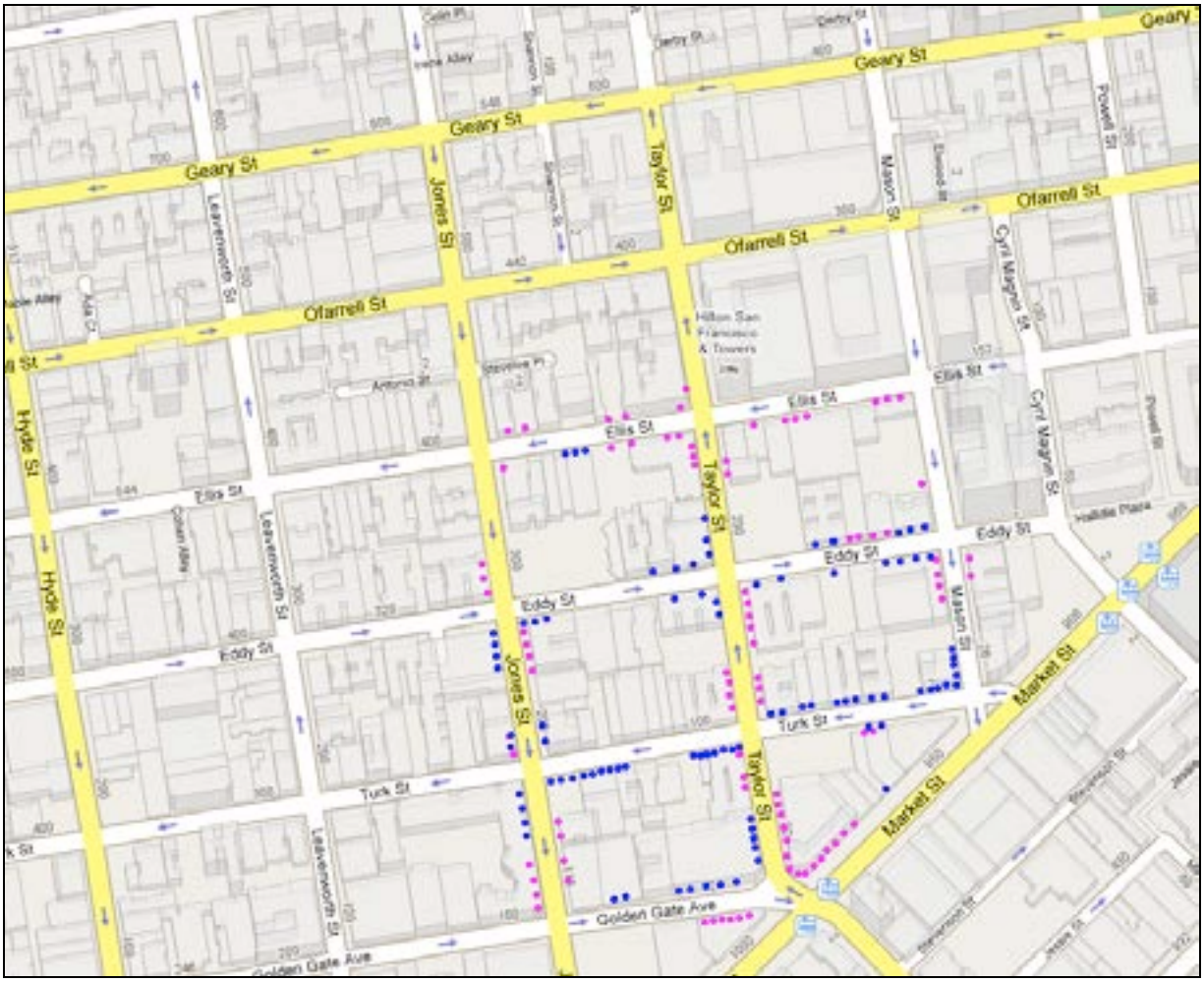


Source: Doug Lybeck, 2009

[159] Lybeck, Doug, *Pedestrian Oriented Lighting Analysis of the Tenderloin Neighborhood*, (SanFrancisco: Lybeck, 2009).

Notice that the existing city streetlight stock (red dots) is irregularly placed and does not provide complete lighting coverage in the area of concern. Second, Lybeck mapped what he noted as "informal lighting stock."[160] Lybeck defined "informal lighting stock" as any and all privately owned lighting.[161] This largely comprised storefront lighting.

Figure 23 Informal-Lighting Stock

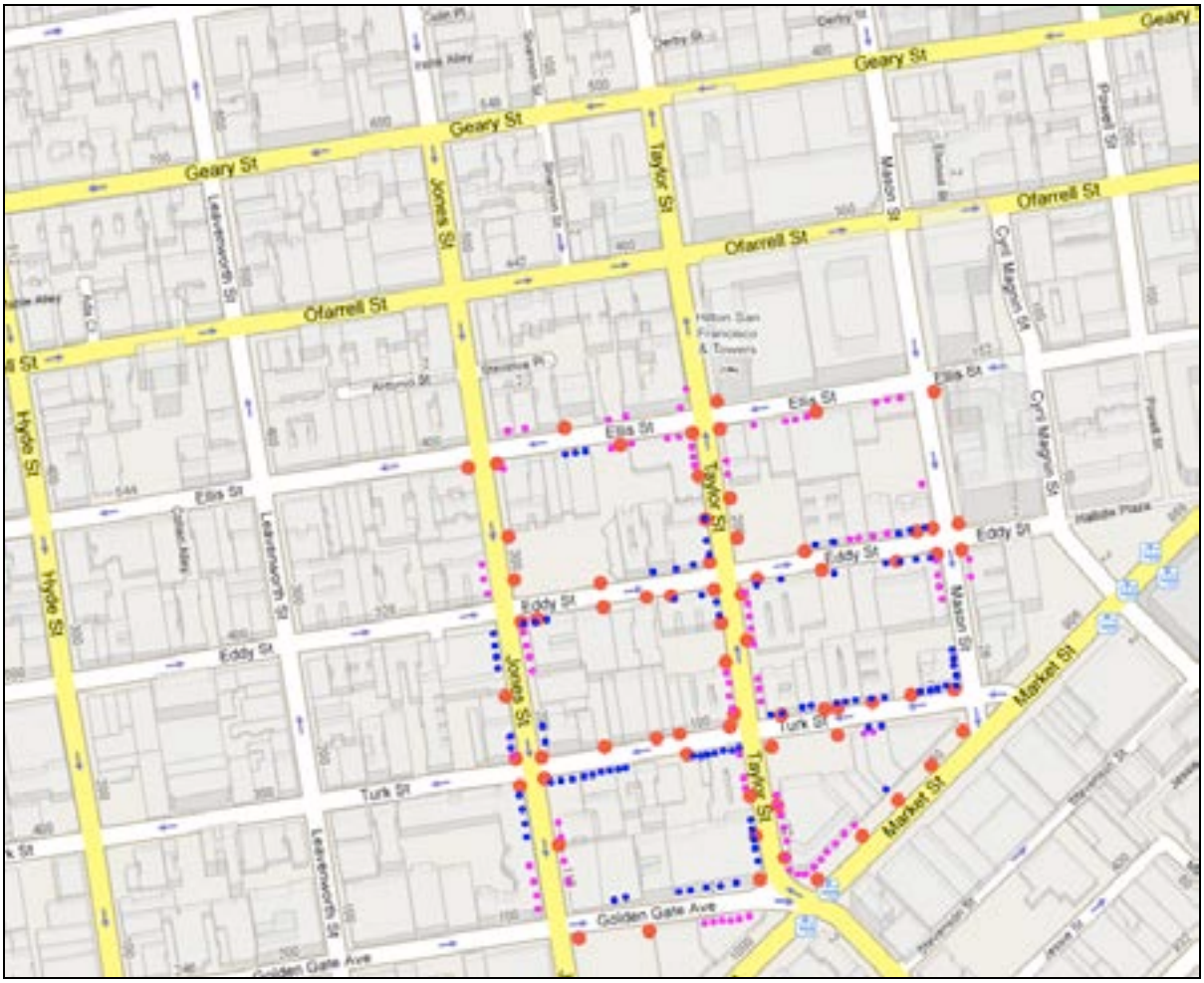


Source: Doug Lybeck, 2009

Just as the city streetlights are irregularly placed, it is no surprise that the private "informal-lighting stock" (blue and pink dots) is irregularly placed as well. Lybeck then maps the combined lighting stock of both public and private lighting assets in the Tenderloin District.

[160] Ibid.
[161] Ibid.

Figure 24 Combined Lighting Stock



Source: Doug Lybeck, 2009

By mapping the combined lighting stock, one can easily see areas lacking adequate lighting. To further illustrate deficiencies, crime statistics for the prior 90 days in the Tenderloin District were mapped to illustrate any correlation between lack of lighting facilities and crime intensity.

Figure 25 90 Days of Crime vs. Lighting Infrastructure Location

Source: Doug Lybeck, 2009

Although crimes still occurred in lit areas, crime clusters were evident in areas with no or little lighting infrastructure in place. The purple, green, teal, and blue dots denote different types of crimes. The bright white areas show approximations of lit areas. From the light mapping Lybeck formulated targeted lighting recommendations for use in the Tenderloin District.

Figure 26 Partial-Build Lighting Scenario

Source: Doug Lybeck, 2009

Lybeck's partial-build scenario assumes fiscal constraints that would not allow complete replacement of public lighting infrastructure in the area. He proposes a targeted approach to better illuminate deficient areas of the neighborhood. Using this approach, Lybeck was able to harness the strengths of the existing lighting system in the neighborhood while also advocating for cost-effective lighting enhancements that would provide for balanced lighting facilities throughout.

Add Lighting Components to Multimodal LOS Calculation

Pedestrian-lighting components should be added to emerging multimodal LOS calculations. Transportation investment is tied to transportation-system assessment and is perhaps the most common way for evaluating roadway-system performance. Integration of pedestrian and bicycle LOS calculations into overall roadway-LOS calculations would support multimodal policy objectives in the future. To date, most multimodal-LOS models lack pedestrian-lighting elements.

Dixon identifies pedestrian-lighting components as pedestrian-LOS performance measures in *Bicycle and Pedestrian Level-of-Service Performance Measures and Standards for Congestion Management Systems*. Use of benches and pedestrian lighting especially in "activity centers"[162] is identified as a measure of pedestrian-LOS performance that is rolled into a scoring formula explained in the paper. The scoring framework for the bicycle and pedestrian-LOS calculation is provided below:

Figure 27 Bicycle and Pedestrian LOS—Scoring Framework

BICYCLE			PEDESTRIAN		
CATEGORY	CRITERION	POINTS	CATEGORY	CRITERION	POINTS
BICYCLE FACILITY PROVIDED (Max Value = 10)	Outside Lane 3.66m (12')	0	PEDESTRIAN FACILITY PROVIDED (Max Value = 10)	Not Continuous or Non-existent	0
	Outside Lane >3.66m-4.27m (>12'-14')	5		Continuous on One Side	4
	Outside Lane >4.27m (>14')	6		Continuous on Both Sides	6
	Off-Street / Parallel Alternative Facility	4		Min. 1.53m (5') Wide & Barrier Free	2
				Sidewalk Width >1.53m (5')	1
				Off-Street / Parallel Alternative Facility	1
CONFLICTS (Max Value = 4)	Driveways & Sidestreets	1	CONFLICTS (Max Value = 4)	Driveways & Sidestreets	1
	Barrier Free	0.5		Ped Signal Delay 40 Sec. or Less	0.5
	No On-Street Parking	1		Reduced Turn Conflict Implementation	0.5
	Medians Present	0.5		Crossing Width 18.3m (60') or Less	0.5
	Unrestricted Sight Distance	0.5		Posted Speed	0.5
	Intersection Implementation	0.5		Medians Present	1
SPEED DIFFERENTIAL (Max Value = 2)	>48 KPH (>30 MPH)	0	AMENITIES (Max Value = 2)	Buffer Not Less Than 1m (3.5')	1
	40-48 KPH (25-30 MPH)	1		Benches or Pedestrian Scale Lighting	0.5
	24-32 KPH (15-20 MPH)	2		Shade Trees	0.5
MOTOR VEHICLE LOS (Max Value = 2)	LOS = E, F, OR 6 or More Travel Lanes	0	MOTOR VEHICLE LOS (Max Value = 2)	LOS = E, F, OR 6 or More Travel Lanes	0
	LOS = D and < 6 Travel Lanes	1		LOS = D and < 6 Travel Lanes	1
	LOS = A, B, C, and < 6 Travel Lanes	2		LOS = A, B, C, and < 6 Travel Lanes	2
MAINTENANCE (Max Value = 2)	Major or Frequent Problems	-1	MAINTENANCE (Max Value = 2)	Major or Frequent Problems	-1
	Minor or Infrequent Problems	0		Minor or Infrequent Problems	0
	No Problems	2		No Problems	2
TDM / MULTI-MODAL (Max Value = 1)	No Support	0	TDM / MULTI-MODAL (Max Value = 1)	No Support	0
	Support Exists	1		Support Exists	1
CALCULATIONS	Segment Score [1]	21	CALCULATIONS	Segment Score [1]	21
	Segment Weight [2]	1		Segment Weight [2]	1
	Adjusted Segment Score [3]	21		Adjusted Segment Score [3]	21
	Corridor Score [4]	21 = LOS A		Corridor Score [4]	21 = LOS A

[1] Segment Score = sum of points in the six categories
[2] Segment Weight = segment length / corridor length
[3] Adjusted Segment Score = Segment Score x Segment Weight
[4] Corridor Score = sum of the Adjusted Segment Scores in the corridor

Source: Linda B. Dixon, *Bicycle and Pedestrian Level-of-Service Performance Measures and Standards for Congestion Management Systems*

[162] Dixon, Linda B., *Bicycle and Pedestrian Level-of-Service Performance Measures and Standards for Congestion Management Systems*, (Washington DC: Transportation Research Board), 7.

Nicole Gallin in *Quantifying Pedestrian Friendliness – Guidelines for Assessing Pedestrian Level of Service* integrates lighting into a scored user factor labeled "Personal Security."[163] The "Personal Security" user factor is defined as

> qualitative measurement of the degree to which the path is safe for users. Characteristics of this factor include the provision of adequate lighting (from both direct and indirect sources), path visibility from the surrounding environment, sight distance etc.[164]

The figure below identifies the scoring framework used in Gallin's pedestrian LOS methodology. Highlighted in yellow is the pedestrian-lighting component.

[163] Gallin, Nicole, *Quantifying Pedestrian Friendliness – Guidelines for Assessing Pedestrian Level of Service*, (Western Australia: BSD Consultants, 2001), 122.
[164] Ibid.

Figure 28 Gallin Pedestrian LOS—Scoring Framework

Category	Factor	Weight	0 points	1 point	2 points	3 points	4 points
Design Factors (Physical Characteristics)	Path Width	4	No pedestrian path	0-1m	1.1 - 1.5m	1.6 - 2.0m	more than 2m wide
	Surface Quality	5	unsealed and/or many cracks/bumps, is very poor quality	poor quality	moderate quality, i.e. some cracks/bumps etc.	reasonable quality, ie acceptable standard	excellent quality (continuous surface with very few bumps/cracks etc)
	Obstructions	3	more that 21 obstructions per km	between 11 and 20 obstructions per km	between 5 and 10 obstructions per km	between 1 and 4 obstructions per km	no obstructions
	Crossing Opportunities	4	none provided, difficult to cross	some provided but poorly located	some provided and are reasonably well located but more are needed	adequate crossing facilities are provided and are reasonably well located OR none are provided as they are unnecessary	dedicated pedestrian crossing facilities are provided at adequate frequency
	Support Facilities	2	non existent	few provided and poorly located	few provided and reasonably well located	several provided and well located OR absent but unnecessary	many provided and well located
Location Factors	Connectivity	4	non existent	poor	reasonable	good	excellent
	Path Environment	2	unpleasant environment, close to vehicular traffic	poor environment, may be within 1m of kerb	acceptable environment, between 1 and 2m of kerb	reasonable environment, between 2 and 3m from kerb	pleasant environment, pedestrians more than 3m from kerb
	Potential for Vehicle Conflict	3	severe, more than 25 conflict points per kilometre	poor situation, between 16 and 25 conflict points per km	moderate, ie 10 to 15 potential vehicle conflict points per km	reasonable, 1 to 10 or less conflict points per km	no vehicle conflict opportunities
User Factors	Pedestrian Volume	3	More than 350 per day	226 to 350 per day	151 to 225 per day	81 to 150 per day	Less than 80 per day
	Mix of Path Users	4	majority of path users are non-pedestrians	approx 51% to 70% of path users are non-pedestrians	between 21% and 50% non-pedestrian path users	less than 20% non-pedestrians	pedestrians only
	Personal Security	4	unsafe	poor	reasonable	good	excellent security provided

Explore Application of Ecoluminance Design in Delaware

Ecoluminance design refers to the use of illuminated plants, trees, shrubs, and other landscaping to better light a roadway segment and save on electricity costs. The New York Department of Transportation partnered in 2009 with the Rensselaer Polytechnic Institute to study[165] how illumination of vegetation can improve transportation-network safety. By using illuminated vegetation at critical points in the transportation network, transportation planners can harness reflected light from vegetation as well as more conducive backdrops for driver visibility at night.

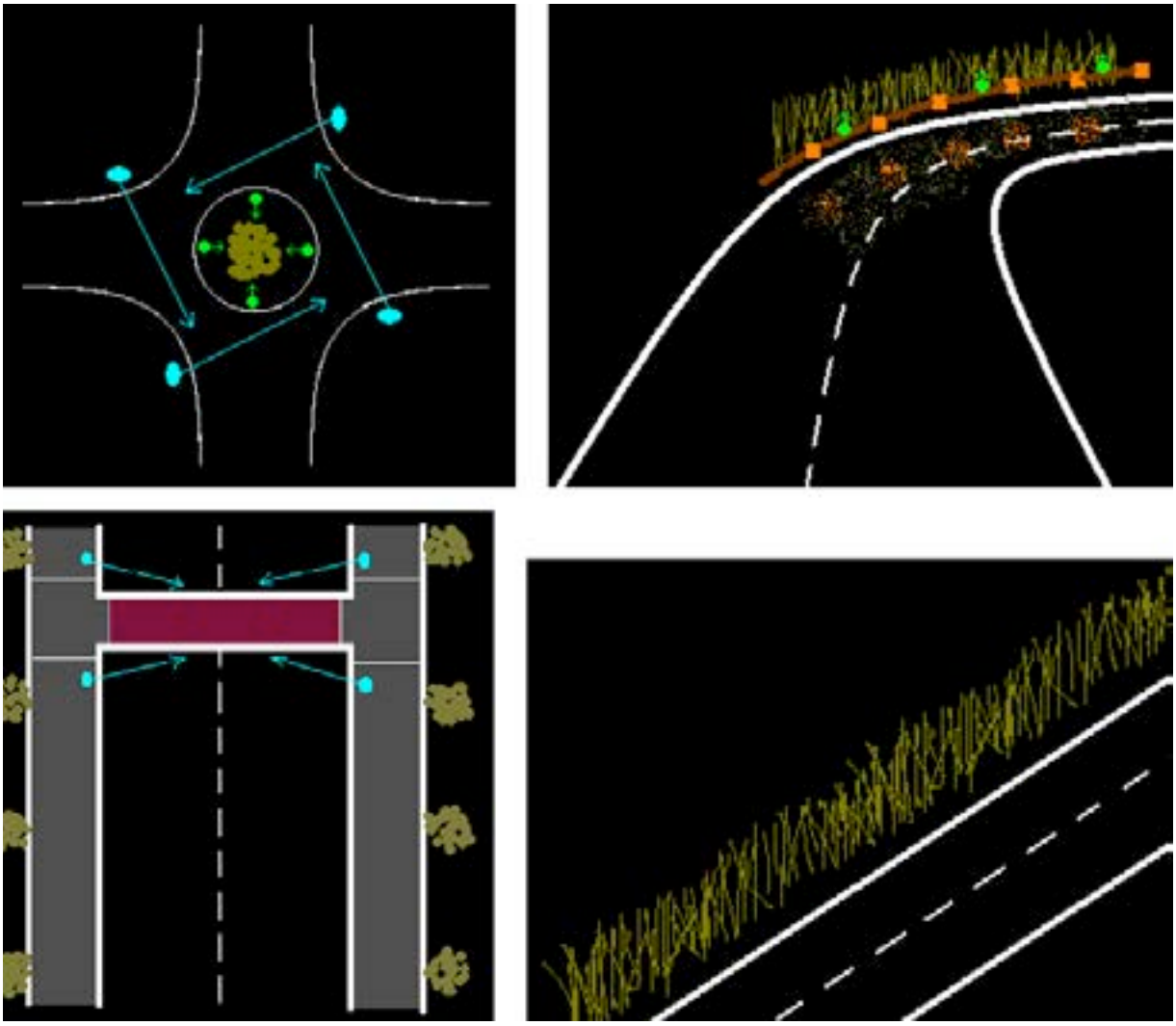
Figure 29 Simulated Ecoluminance

Source: Lighting Research Center, Rensselaer Polytechnic Institute & New York Department of Transportation

The below figure from the Rensselaer Polytechnic Institute study shows four ecoluminance applications. The top left is a roundabout application.[166] The top right shows a curve/exit ramp application.[167] The lower left shows an urban boulevard application.[168] The lower right shows a highway right-of-way application.[169] Vegetation is shown colored dark green.[170] Retroreflective delineators are colored orange.[171] Luminance-producing lighting is shown in light green.[172] Illuminance-producing lighting is shown in teal.[173]

[165] Bullough, J. D., M. S. Rea, J. D. Snyder, L. C. Radetsky, Z. Xhang, and N. P. Skinner, *Lighting and Vegetation for Energy-Efficient and Safe Roadway Travel*, (Troy: Lighting Research Center, Rensselaer Polytechnic Institute, May 2009).
[166] Ibid., 3-4.
[167] Ibid.
[168] Ibid.
[169] Ibid.
[170] Ibid.
[171] Ibid.
[172] Ibid.
[173] Ibid.

Figure 30 Ecoluminance Applications



Source: Lighting Research Center, Rensselaer Polytechnic Institute & New York Department of Transportation

Researchers found certain roadway applications to be particularly useful noting that

> the roundabout application and the urban boulevard had the greatest estimated impact on safety, as characterized by the drivers' visual performance when detecting pedestrians and other potential hazards along the road. The roundabout application also had the greatest energy savings in terms of electricity use, and as a result, had the greatest reduction in operating costs.
>
> Based on the results of the analyses, the project team recommends that NYSERDA and NYSDOT consider implementing a demonstration project to integrate lighting and vegetation approaches to providing visual information at roundabouts.[174]

[174] Ibid., iv.

The ecoluminance report, *Lighting and Vegetation for Energy-Efficient and Safe Roadway Travel,* includes a sample work plan and estimated schedule for implementing an ecoluminance-demonstration project in New York,[175] which could serve as an informative resource for Delaware.

The backdrops created in the night by ecluminance design take on specific importance in addressing nighttime visibility for older drivers. In spring 2011 Khan and Kline noted that a paramount 21st century challenge for transportation planners will be designing roadways, specifically lighting systems, that address the needs of older drivers through improving contrast in the night environment.[176] Kline and Khan assert that "highway lighting—system designs based on illuminance and luminance methods do not formally incorporate the important variable of contrast. Since contrast has a higher influence on visibility of small targets rather than pavement luminance, it is desirable to design lighting systems according to the visibility criteria."[177] The visibility criteria includes eight key factors listed and described in the authors' paper titled "Addressing Older Driver Visibility Needs in Roadway Lighting Design" listed in the bibliography of this working paper.[178]

Enhance Midblock Crosswalk Lighting

The Federal Highway Administration published an *Informational Report on Lighting Design for Midblock Crosswalks*[179] in 2008 that offers applicable guidelines to Delaware transportation planners. The report analyzes the appearance of pedestrians on the roadway under various conditions to establish what optimal lighting conditions are needed to ensure maximum visibility at crossings for pedestrians and drivers. State officials and county transportation planners can use this report as a guide for addressing potential lighting and visibility problems at midblock crosswalks in Delaware. The report is based on a series of nighttime pedestrian-visibility experiments completed at the Virginia Tech Transportation Institute. The major report findings are listed below:

- A vertical illuminance level of 20 lx measured at 1.5 m (5 ft.) from the road surface allowed drivers to detect pedestrians in midblock crosswalks at adequate distances under rural conditions.

- A higher level of vertical illuminance may be required for crosswalks when

    - There is a possibility of continuous glare from opposing vehicles.
    - The crosswalk is located in an area with high-ambient-light levels.
    - The crosswalk is located at a lighted intersection.

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[175] Ibid.
[176] Khan, Ata M. and Donald Kline, *Addressing Older Driver Visibility Needs in Roadway Lighting Design*, (Washington DC: Institute of Traffic Engineers, March 2011).
[177] Ibid., 29.
[178] Ibid., 24.
[179] Gibbons, Ronald B., Chris Edwards, Brian Williams, and Carl K. Andersen, *Informational Report on Lighting Design for Midblock Crosswalks*, (McLean: Federal Highway Administration, April 2008).

- The luminaire selected will influence the best mounting location and height of the luminaire with respect to the crosswalk.

- The vertical illuminance level that allowed drivers to detect pedestrians at adequate distances was the same for HPS and MH sources; however, MH or other white-light sources may provide better facial recognition and comfort for pedestrians.[180]

Improve Transit Lighting

At present, not all bus-shelters or bus stops in Delaware are adequately lit. The Delaware Transit Corporation is in the process of enhancing lighting at these facilities, in some cases utilizing solar lighting as a cost-effective option for bus-shelter lighting. Pedestrian facilities in the general vicinity of transit stops and shelters are also obvious target areas for lighting enhancement, as Delaware officials work to establish transit-oriented development in targeted areas throughout the state.

Park-n-ride facilities are often located at transit stops and serve as key components to the transportation network. Enhanced lighting at these facilities can encourage more citizens to carpool in Delaware. Appendix 3 shows park-n-ride locations throughout Delaware and current facility-use measures in number of cars counted as part of IPA's annual park-n-ride survey. Appendix 3 shows survey figures from 2010 and 2011. The park-n-ride survey is conducted twice a year. By tracking facility usage, transportation planning officials can affectively prioritize where possible lighting enhancements are needed.

Review and Enhance DelDOT Lighting-Design Guidelines

The DelDOT Lighting Design Guidelines (LDG) must convey that the purpose for lighting infrastructure is to improve *transportation network—user* visibility at night, not simply driver visibility. The LDG is logically driver-oriented since the transportation network serves primarily automobile traffic. Indeed, according to DelDOT SRTS Coordinator Sarah Coakley, the need for lighting "is typically evaluated based on crash data."[181] However, to truly create a multimodal network in Delaware, DelDOT protocol and design guidelines must reflect a multimodal consideration and approach.

It would be beneficial to characterize lighting infrastructure not as "roadway lighting," but as transportation-network lighting. This would reflect the fact that lighting infrastructure is not only intended for roadway applications, but for transit stops, pedestrian facilities, bike paths, or other transportation facilities maintained by DelDOT. Section 1.2 could be modified to include a more comprehensive purpose for lighting. A re-worded purpose statement for Section 1.2 might read as:

> The principal purpose of transportation-network lighting is to provide improved user visibility and safety at night.

---

[180] Ibid., 19.
[181] Sarah Coakley, e-mail message to author, April 4, 2011.

Language throughout the document should be converted from auto-centric characterizations to complete-network characterizations. For example, in Section 1.3, Part F, the word "road" could be substituted with "network." Mention of cyclists could be added to Section 1.3, Part H. Consideration characteristics for lighting defined in Section 2.2 should include mention of non-automobile-oriented network changes such as installation of a transit stop or bicycle facility. "Shall," "should," and "may," decision criteria included in Section 2.3 could incorporate bicycle- and pedestrian-facility language. Section 4.4.7, instead of considering how roadway lighting will be impacted by pedestrian lighting, could consider how pedestrian facilities and lighting can be impacted by varying quality of roadway lighting. In Section 4.3.2 nighttime crash rates are mentioned as a factor in determining intersection classification. In addition to nighttime-crash rates, pedestrian fatalities at intersections could be factored into the Section 4.3.2 intersection-classification criterion.

Preference in Section 4.2 is given to cut-off versus fully cut-off lighting fixtures based on maintenance issues. If possible, DelDOT should consider prioritizing fully cut-off lighting fixtures as the optimal choice for installation, since fully cut-off fixtures prevent upward-light pollution, glare, and light spill. Standard luminaire-mounting heights identified in Section 4.2.6 could be reviewed as well to determine whether mounting heights could be set higher or lower, considering cost implications and impacts on light pollution.

The LDG could also incorporate the use of alternative lighting technologies. Section 4.2 defines the standard DelDOT lamp to be HPS. Other lamp types such as LED or solar lamps could be incorporated into the LDG as possible options for installation in Delaware. At a minimum, the current LDG could be improved to address the need to use the most environmentally friendly and energy-efficient lighting, given cost and feasibility constraints.

Continue and Expand on Creation of Plans that Address Lighting Needs Within Targeted Unincorporated Areas

This section outlines key components for creating and implementing a lighting plan. Various strategies and formats are used in light planning. Some localities have explicitly created lighting plans and light master plans for parks, road segments, or neighborhoods. Others have incorporated lighting components into redevelopment plans, streetscaping projects, design guidelines, master plans, and other governing planning documents. The following will highlight exemplary plans for local officials to consider replicating in Delaware.

The Public Works Agency in Alameda County, Calif., published a *Pedestrian Master Plan for Unincorporated Areas* in July 2006.[182] The plan outlines several strategies for enhancing the pedestrian environment that include pedestrian-lighting enhancements. The plan specifically identifies cost estimates for lighting enhancements such as in-pavement, midblock crosswalk lighting, and individual light posts.[183] The plan then outlines a weighting and prioritization

[182] Dowling Associates, Inc., *Alameda County Pedestrian Master Plan for Unincorporated Areas*, (Alameda County: Alameda County Public Works Agency, July 2006).
[183] Ibid., 38.

framework for selecting pedestrian-enhancement projects for funding.[184] The plan's formula is defined by five criteria: "proximity to trip generators, safety and access, transportation connections, project readiness and feasibility, and equity."[185] Points were awarded in each category to determine which projects, not already fully funded, would receive additional funding. Lighting components were integrated into several top-rated projects.[186]

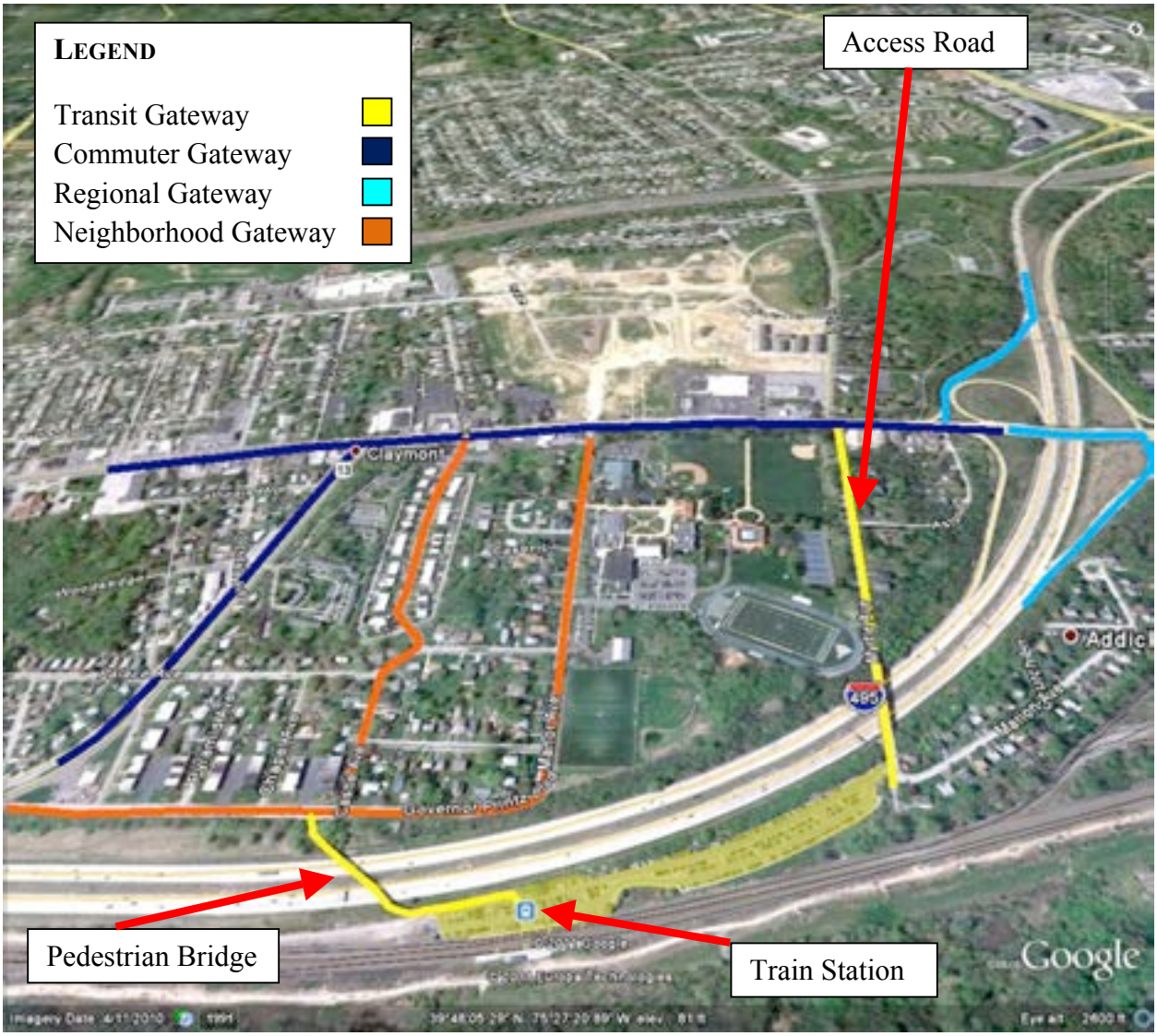
The *University City District Gateway Study* (UCDGS) provides an effective template for what a lighting plan should look like for a small neighborhood or community. Although this study was completed for a section of University City in busy downtown Philadelphia, Pa., the study illustrates several key aspects of an effective lighting plan that can be applied to unincorporated areas in Delaware. Those key aspects are 1) defining the areas of focus, 2) defining cost, and 3) designing and visualizing the change.

To define areas of focus, the UCDGS, as its name indicates, focused on enhancing six gateways to the University City area in downtown Philadelphia.[187] More than 20 gateways were identified, but ultimately six were chosen based on perceived need. The gateway concept may well be applicable to Delaware, as it can be categorized to apply to various types of community attributes. Gateways were categorized in the UCDGS under four types: 1) regional gateways, 2) commuter gateways, 3) neighborhood gateways, and 4) transit gateways.[188] Regional gateways were entrances to the entire University City area, such as major bridges or highway off-ramps. Commuter gateways were road segments that extended through the district that commuters would often use, for instance, on their way to work. Commuter gateways show passersby a glimpse of the community. Neighborhood gateways were similar to commuter gateways, but neighborhood gateways normally extended along roadways that could be characterized mostly as residential streets, not as major commuter arteries. Whereas commuter gateways feature cross-sections of the University City district, neighborhood gateways feature a glimpse of micro-areas within the district. Transit gateways marked crucial points within the district where travelers would enter the district from a bus stop or train station.

The gateway concept and categorization featured in the UCDGS may be useful for application in Delaware because it prioritizes lighting facilities to crucial transportation focal points in communities. An applicable example is the unincorporated community of Claymont, Del. A critical transit gateway in Claymont is located at the SEPTA Claymont train station.

[184] Ibid., 39.
[185] Ibid.
[186] Ibid., 53.
[187] Kise, Straw, & Kolodner Inc., *University City District Gateway Study: Welcome to University City*, (Philadelphia: University City District, 2007), 3.
[188] Ibid.

Figure 31 Transit Gateway - Claymont Train Station



Source: Created by IPA Staff using Google Earth

The two access points to the transit gateway are a pedestrian bridge connecting the station to the Claymont community and Myrtle Avenue, which provides the only automobile access road to the train station. The yellow shaded areas show the train station and parking area. Neighborhood gateways are highlighted in red, extending along Manor Avenue and Castle Avenue. Regional gateways exist at each exit point to Claymont off of Interstate 495. Commuter gateways extend along U.S. Rt. 13, known locally as Philadelphia Pike and Governor Printz Boulevard. The access points and neighborhood gateways connecting to the transit station identify potential lighting-enhancement areas in Claymont. Castle Avenue, Manor Avenue, and Myrtle Avenue currently have limited lighting infrastructure, yet they are critical connections between the greater Claymont community and the SEPTA train station. The below picture shows, from left to right, Manor Avenue, Myrtle Avenue, and Castle Avenue. All three streets have cobra-head street lights mounted on powerline poles (Figure 32) that are primarily located at intersections. Additionally, pedestrian facilities, such as sidewalks along portions of these roads, are not currently installed.

Figure 32 Transit and Neighborhood Gateways (Manor Avenue, Myrtle Avenue, and Castle Avenue)

Source: Google Maps Streetview

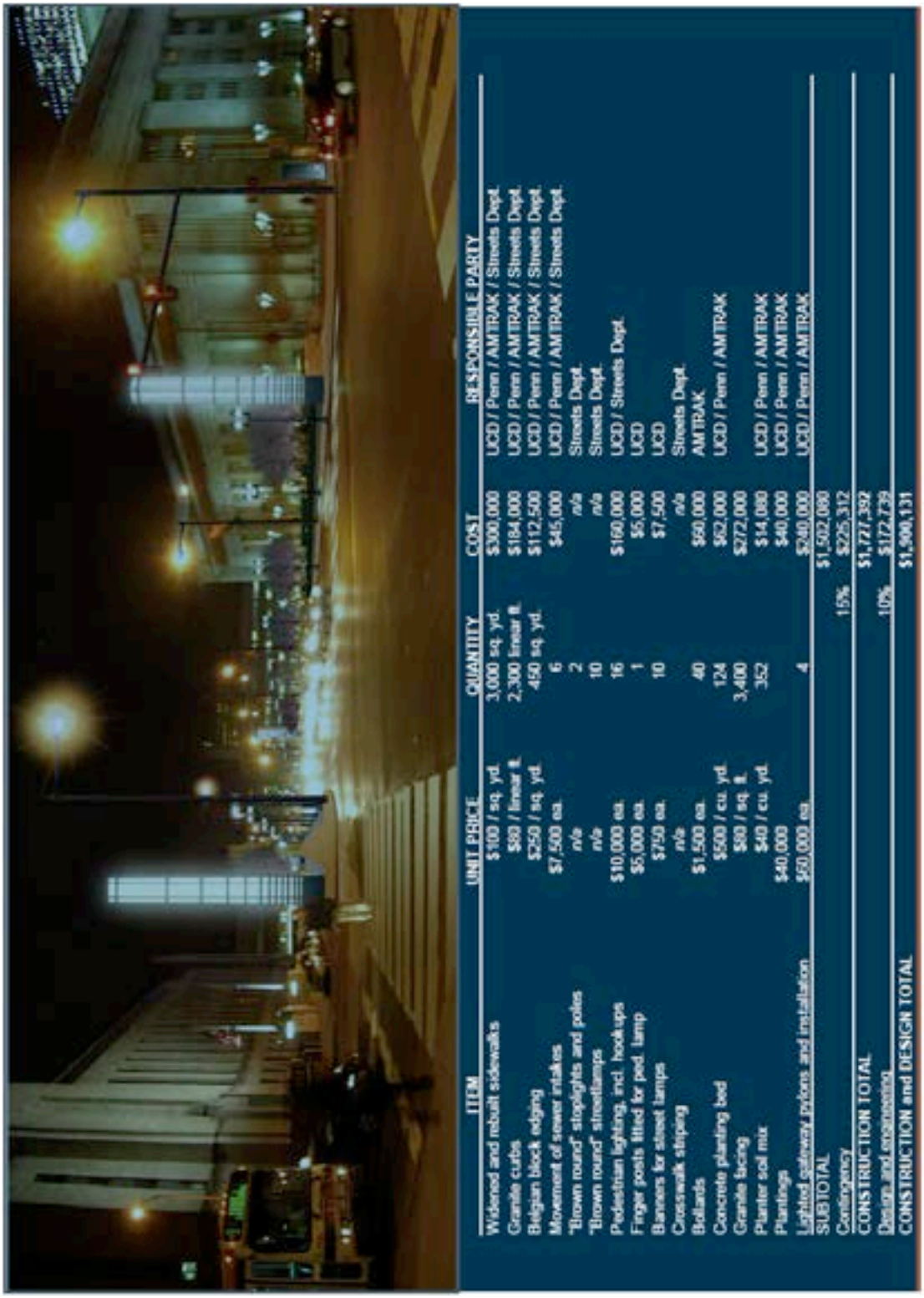
Figure 33 Cobra-Head Street-Light Fixture on Manor Ave.

Source: Google Maps Streetview

The UCDGS defined specific cost and visualized change by systematically assessing each gateway for improvements and estimating total costs associated with each enhancement proposed. For University City's 30th Street Station area, pedestrian-lighting enhancements were proposed for a small section of Market Street, located in front of the 30th Street Station. This "civic room"[189] was seen as a crucial component of the station area that, if enhanced, could become a more interconnected place with adjoining land uses in the station area. Figure 29 below shows a picture of a rendering produced in the UCDGS, showing what the new streetscape would look like with new lights throughout the Market Street segment adjacent to the station building.

[189] Ibid., 6.

Figure 34 UCDGS Cost Estimate for Lighting Improvements



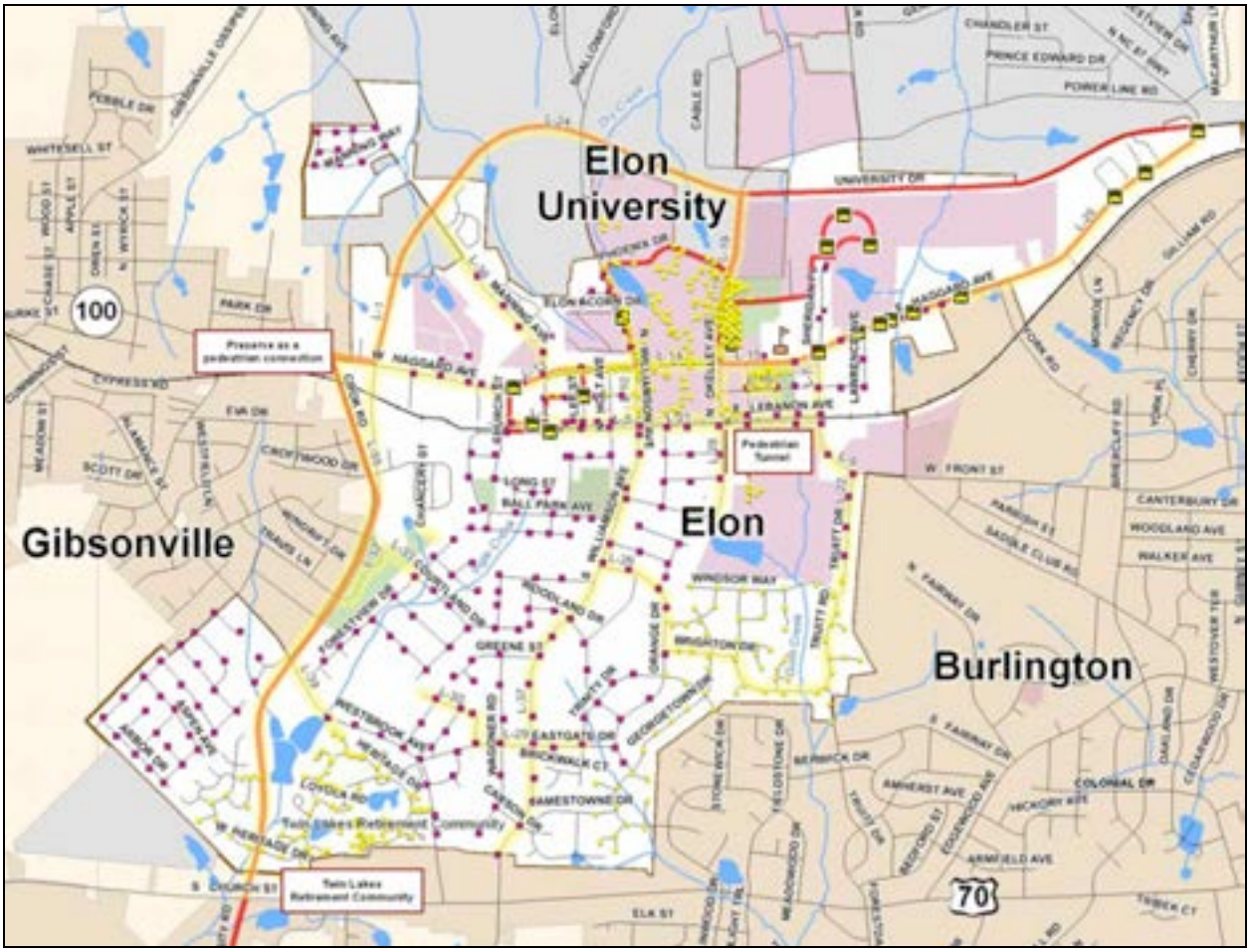
ITEM	UNIT PRICE	QUANTITY	COST	RESPONSIBLE PARTY
Widened and rebuilt sidewalks	$100 / sq. yd.	3,000 sq. yd.	$300,000	UCD / Penn / AMTRAK / Streets Dept.
Granite curbs	$80 / linear ft.	2,300 linear ft.	$184,000	UCD / Penn / AMTRAK / Streets Dept.
Belgian block edging	$250 / sq. yd.	450 sq. yd.	$112,500	UCD / Penn / AMTRAK / Streets Dept.
Movement of sewer intakes	$7,500 ea.	6	$45,000	UCD / Penn / AMTRAK / Streets Dept.
"Brown round" stoplights and poles	n/a	2	n/a	Streets Dept.
"Brown round" streetlamps	n/a	10	n/a	Streets Dept.
Pedestrian lighting, incl. hookups	$10,000 ea.	16	$160,000	UCD / Streets Dept.
Finger posts fitted for ped. lamp	$5,000 ea.	1	$5,000	UCD
Banners for street lamps	$750 ea.	10	$7,500	UCD
Crosswalk striping	n/a		n/a	Streets Dept.
Bollards	$1,500 ea.	40	$60,000	AMTRAK
Concrete planting bed	$500 / cu. yd.	124	$62,000	UCD / Penn / AMTRAK
Granite facing	$80 / sq. ft.	3,400	$272,000	
Planter soil mix	$40 / cu. yd.	352	$14,080	UCD / Penn / AMTRAK
Plantings	$40,000		$40,000	UCD / Penn / AMTRAK
Lighted gateway pylons and installation	$60,000 ea.	4	$240,000	UCD / Penn / AMTRAK
SUBTOTAL			$1,502,080	
Contingency		15%	$225,312	
CONSTRUCTION TOTAL			$1,727,392	
Design and engineering		10%	$172,739	
CONSTRUCTION and DESIGN TOTAL			$1,900,131	

Source: University City District Gateway Study

In 2008 the town of Elon, N.C., completed a *Pedestrian, Bicycle, & Lighting Plan* that serves as an excellent example of how to identify lighting infrastructure, select target areas for improvement, and set forth an action plan for implementation. The format used in the Elon plan could easily be applied to a county or small area plan in Delaware.

GIS mapping (Figure 35) was utilized to inventory current lighting infrastructure, which included both decorative lighting and street lighting, since both lighting types contribute to the illumination of pedestrian facilities.[190] The purple points on the map show where street lights exist; the yellow points show where decorative lighting exists. Roadways that are highlighted yellow represent where proposed lighting is planned for installation. Special mention was also made in the Elon plan to improve lighting at transit stops, which are also shown on the map below.[191]

Figure 35 Town of Elon Light Map



Source: Town of Elon, *Pedestrian, Bicycle, & Lighting Plan*, August 2008

[190] Elon, Town of, Pedestrian, Bicycle, & Lighting Plan: An Alternative Transportation Strategy, (Elon: Town of Elon, August 2008), http://www.elon.edu/docs/e-web/bft/sustainability/Elon%20Bike,%20Ped,%20and%20Lighting%20Plan%20-%20Final%20Exec%20Sum.pdf, 12.

[191] Ibid., 11.

Pedestrian and bicycle-crash locations were mapped and included in the Elon plan for reference.[192] It identified 15 proposed corridors for lighting improvements.[193] The Elon plan incorporates several lighting-specific recommendations for planning policy changes that are listed below:

Table 6 Lighting Recommendations from Elon Pedestrian, Bicycle, & Lighting Plan

Issue: Sustainable and energy-efficient lighting Current Policy: Requirement to place streetlights in new subdivisions and on new streets 160 to 200 feet apart. No requirement on the type of lighting or energy use. Recommended Policy: Require closer light spacing in high pedestrian activity centers and on major corridors. Explore lower wattage lights that also provide enough lumens for needed safety in Elon. Produce list of sustainable lighting vendors to share with developers and seek input yearly to update list and keep current.
Issue: Scenic Corridor Overlay District Current Policy: No current overlay district Recommended Policy: Work with the Appearance Commission to create this new overlay district to help beautify and preserve major and minor thoroughfares. The features would include lighting specifications, landscape requirements, signage requirements and other features to improve and preserve scenic beauty.
Issue: Decorative Lighting Overlay District Current Policy: No current overlay district Recommended Policy: Create this new overlay district to include detail on aesthetic and energy-efficient design, spacing requirements, foot-candle and lumens. Create the first district in the downtown area.

Source: Town of Elon, *Pedestrian, Bicycle, & Lighting Plan*, August 2008

The Elon plan also includes an implementation plan that identifies costs, task ownership, and overall timeline for execution of the plan.

[192] Ibid., 10.
[193] Ibid., 11.

Incorporate Light Planning into Economic Development & Market Analysis

The connections between economic development and transportation infrastructure can sometimes be overlooked, but the connection is very strong, especially when discussing pedestrian lighting. In August 2006, IPA, in coordination with Greater Brandywine Village Revitalization Inc., produced the *Greater Brandywine Village Market Analysis*. This work identified perceived safety and security concerns hindering to the economic vitality of the trade area studied in Wilmington. This work effectively shows the relationship between enhanced pedestrian lighting in a community and economic development. Surveys conducted with customers and business owners both identified perceived safety and security as crucial factors impacting whether or not an individual will do business and spend money in an area.

Key recommendations from the IPA study highlighted crime prevention through environmental design (CPTED).[194] CPTED is a discipline within planning focused on marrying land-use design and transportation design with crime prevention. Principal, among many components of CPTED, are "efforts to increase pedestrian usage of sidewalks at all hours."[195] Roughly 18 percent of IPA survey respondents were "very unhappy" with safety and security associated with problems of drinking and drug use in the Brandywine Village area.[196] Key recommendations coming out of this market analysis were to work with local business owners to decorate and light storefronts as well as vacant buildings to attract new tenants.[197] Exterior aesthetic lighting such as antique lamp posts, tree lighting, and a lighted water fountain were suggested to enhance the ambience of the business district and improve pedestrian safety.[198] Appendix 1 provides an example of a CPTED audit from the Houston Local Initiatives Support Corporation (LISC). The CPTED audit includes a section on lighting and incorporates way-finding and clear-line-of-sight questions for pedestrians into the entire survey.

> *"The proper design and effective use of the built environment can lead to a reduction in the fear and incidence of crime and an improvement of the quality of life."*
>
> *-National Crime Prevention Institute*

The Houston LISC CPTED audit could serve as a useful instrument for county government light-planning exercises in crime-ridden areas or target areas for economic development. The audit lends itself well to use in public-engagement exercises to better identify lighting needs in small neighborhoods.

[194] Institute for Public Administration, University of Delaware, *Greater Brandywine Village Market Analysis*, (Newark: University of Delaware, 2006), 5.
[195] Ibid.
[196] Ibid.
[197] Ibid.
[198] Ibid.

Similarly, the Office of Economic Development for Seattle, Wash., viewed pedestrian lighting as a downtown business—enhancement tool. Department officials view pedestrian lighting as a vital component to creating a friendly business environment saying:

> Good outdoor-lighting can create and encourage a pedestrian-friendly environment, which is especially beneficial to neighborhood business districts. Pedestrian-scale lights improve walkway illumination for pedestrian traffic and enhance community safety and business exposure.[199]

Officials in Seattle have identified pedestrian lighting as a crucial component to the city's Enhancement Projects program, which is designed to improve the downtown environment and create thriving business districts. The Seattle Department of Neighborhoods and Seattle City Light, a publicly owned utility in Seattle, work together to install pedestrian lighting in business districts throughout the city.[200] Neighborhood-planning processes are facilitated, and, at the conclusion of these processes, certain business districts request pedestrian-lighting improvements for their commercial area.[201] Normally, pedestrian-lighting improvements are included in neighborhood plans. Even if such provisions are not included in the planning process, business district representatives can still work with city government and the local utility to install pedestrian lighting.[202] Seattle City Light has a specific pedestrian-scale lighting program with fixture options included for application along main business arterials.[203]

The Delaware Economic Development Office (DEDO), county economic-development offices, and the Office of State Planning Coordination (OSPC) should consider, as part of the overall planning process and economic-development effort, coordinating enhanced pedestrian-lighting policies with utility companies and local business districts in Delaware. Business districts along major roadways in unincorporated areas of Delaware present excellent opportunities for business-friendly transportation enhancements. DEDO and OSPC can play a part in translating largely commuter, auto-centric transportation corridors into walkable destinations for Delaware residents. Creating places where people want to spend more time means more potential shopping and spending for Delaware businesses. Pedestrian lighting is a vital component to providing that incentive for people to shop and do business in certain business districts rather than others. Utility companies could follow the Seattle City Light model by developing specific pedestrian-scale lighting-fixture options to market to interested business district representatives.

Pedestrian-lighting and streetscaping programs could fit well with DEDO's Downtown Delaware initiative aimed at enhancing Delaware downtown centers. Although the initiative is largely geared toward towns, Downtown Delaware is an obvious area to link unincorporated business districts and corridors to training and business assistance that could include streetscaping and lighting enhancements.

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[199] Office of Economic Development, City of Seattle, Wash, *Creating a Thriving Business District: Pedestrian-lighting*, (Seattle: City of Seattle, Wash., 2010), http://www.seattle.gov/economicDevelopment/biz_district_guide/Pedestrian_Lighting.htm.
[200] Ibid.
[201] Ibid.
[202] Ibid.
[203] Ibid.

Consult with Law Enforcement Officials on Light-Planning Efforts

Municipal, county, and state police should be included and consulted on lighting installation. Installation of community lighting in crime-ridden neighborhoods under the right conditions can improve a blighted area and reduce crime.[204] Public safety personnel and transportation officials can solve multiple problems in the same community by communicating during the project-prioritization process. Figure 21 notes a public safety lighting project initiated in the UK. The project reduced automobile thefts in the targeted area where enhanced lighting infrastructure was installed. An excellent resource for better understanding the linkages between community-oriented policing and lighting investments is Ronald V. Clarke's *Improving Street-lighting to Reduce Crime in Residential Areas*.[205] Aside from providing the backdrop and overall context for the link between lighting infrastructure and public safety, Clarke provides a checklist for transportation officials, planners, and administrators to use from the initial planning to the installation of community lighting infrastructure.

Figure 36 Gray Street Lights Project, UK

This project was undertaken in Workington, West Cumbria, UK, and again was mounted to deal with nighttime thefts from parked cars. Analysis showed that Gray Street was the primary hot spot for thefts from cars in West Cumbria. The street is approximately 300 yards in length, with 90 small row houses on either side of the road and several small businesses at one end. During 2002, 27 thefts from vehicles parked in the street were reported with an estimated total loss of £5,000 (a little under $9,000). Most of these thefts occurred on weekend nights. Analysis of the problem identified poor street-lighting as an important contributory cause of the 19 thefts. Other presumed causes were the lack of private garages and off-street parking and the fact that the street was a busy pedestrian route after pub closing time.

The police established that a significant upgrading of the lights in the street would cost £14,000 (about $24,500) and coordinated a successful bid for government funds to pay for the lights. These were installed in December 2003; in 2004, only six thefts from cars were reported in the street, at an estimated cost of £833 (about $1,500). Clearly, this was a significant improvement from the situation in 2002, before the lights were upgraded. A survey established that residents believed the new lights had reduced crime and that they felt safer in the street.

(*Source: Ronald V. Clarke, U.S. Department of Justice, Office of Community Oriented Policing Services*)

Create a Partnership with Electricity Providers to Review Delaware Electric Tariffs

Electric tariffs serve as the governing documents determining the lighting-fixture offerings of electricity providers in Delaware. Such tariffs are approved by the Delaware Public Service

[204] Farrington, David P. and Brandon C. Welsh, "Improved Street-lighting and Crime Prevention," *Justice Quarterly*, 19:2 (2002): 313-342.
[205] Clarke, Ronald V, *Improving Street-lighting to Reduce Crime in Residential Areas*, (Washington DC: U.S. Department of Justice, Office of Community Oriented Policing Services, December 2008).

Commission. DelDOT and other governmental agencies should partner with electric providers and the Delaware Public Service Commission to review current electric tariffs to consider inclusion of pedestrian-lighting provisions or alternative fixture styles. Although electric providers operate under certain constraints related to the diversity of options they can provide to customers, there is a willingness to try new fixture styles and technologies in the future. For example, Delmarva Power recently reported that an LED pilot project was conducted in 2010 and that results from the pilot are under review for future application.[206]

4-4. Public Engagement

Public-engagement strategies are vital to the success or failure of a lighting-enhancement project, as public approval and support for lighting infrastructure is absolutely necessary during the early phases of a project.

The City of Norman, Okla., facilitated a participant discussion of community assets, liabilities, and opportunities at a public meeting held as part of a neighborhood planning exercise in 2007.[207] Participants utilized this exercise to define where strengths and weaknesses existed in pedestrian lighting. Specific areas in the neighborhood that were poorly lit emerged in the discussion and were noted and included as a part of the *First Courthouse Neighborhood Plan*.[208] As a result of the assets, liabilities, and opportunities discussion, specific deficiencies were discussed that helped prioritize community needs for lighting enhancement. For example, a pedestrian-activated crosswalk-lighting system was discussed at length because of a signal deemed confusing and therefore unacceptable to both pedestrians and drivers.[209]

Make information about lighting options more available and accessible to the public. County websites can serve as excellent tools for both educating the public and providing users with easier methods for reporting deficiencies or problems with pedestrian lighting. In some cases, pedestrian-lighting contact phone numbers or lighting-request information is buried within a government website. Using innovative website design and better internal organization, pedestrian-lighting information can be more accessible to citizens.

4-5. Lighting Ordinances

Current codes regulating outdoor-lighting among the three Delaware counties largely address light-pollution mitigation through shielding requirements, glare reduction, and light-positioning requirements designed to protect property owners. Additionally, regulatory elements define the public process for requesting and installing street lights in communities. Each county incorporates requirements and language about lighting into various sections of code. The following will provide Delaware planners and public administrators with key recommendations

[206] Picucci, Mike and Vince Jacono, Delmarva Power, e-mail message to author, April 20, 2011.
[207] Norman, Oklahoma, City of, *First Courthouse Neighborhood Planning for Community Preservation Plan Draft*, (Norman: City of Norman, March 2011), 19.
[208] Ibid.
[209] Ibid., 26.

and nationwide examples of lighting-ordinance components to compare and contrast with local regulations in Delaware.

Appendix 10, titled *Simple Guidelines for Lighting Regulations for Small Communities, Urban Neighborhoods, and Subdivisions,*[210] serves as preliminary guide to creating effective regulations for street lighting at the local level.

Appendix 5 shows a sample outdoor-lighting ordinance produced by the Hancock County Planning Commission in Ellsworth, Maine. The Hancock County sample ordinance provides a template for what a basic local lighting ordinance might look like. The sample ordinance includes provisions for review that regulate

- Building facade lighting
- Color Rendering Index (CRI) levels for parking areas and pedestrian ways in various zoning districts
- Maximum average foot-candles for various land uses
- Light-curfew requirements restricting light levels at certain non-business hours of the night
- Illumination levels at property lines measured in foot-candles

Fort Bend County, Tex., currently has a regulatory framework that addresses shielding and aiming requirements, illumination-level requirements, and enforcement requirements. The *Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County, Texas*[211] provides an excellent example of a modern day comprehensive outdoor-lighting ordinance. Fort Bend County is particularly useful in that its approximate population is very similar to the population of New Castle County. Both counties are also located southwest of larger metropolitan regions as Houston, Tex. and the Wilmington, Del./Philadelphia, Pa., areas.

Several components enumerated within the Fort Bend regulations are important to note. First, the Fort Bend orders regulate shielding based on total luminous flux. Total luminous flux is the "radiant flux in the visible-wavelength range usually expressed in lumens instead of watts."[212] Luminous flux generally measures how our eyes respond to various types of light.

The total-luminous-flux benchmark defined in the Fort Bend case is 1,800 lumens.[213] If a lamp emits a luminous flux less than or equal to 1,800 lumens, virtually no shielding is required for the lighting; however, if the lamp luminous flux exceeds 1,800 lumens, virtually all fixtures are

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[210] International Dark Sky Association, *Simple Guidelines for Lighting Regulations for Small Communities, Urban Neighborhoods, and Subdivisions*, http://www.darksky.org/index.php?option=com_content&view=article&id=745.
[211] Fort Bend County, Tex, *Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County*, (Fort Bend County: Fort Bend County Government, August 29, 2006), http://www.iessanjacinto.org/Ordinances/Fort%20Bend%20County%208-29-06.pdf.
[212] *Merriam-Webster*, s.v. "Luminous Flux."
[213] Fort Bend County, Tex, *Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County*, (Fort Bend County: Fort Bend County Government, August 29, 2006), http://www.iessanjacinto.org/Ordinances/Fort%20Bend%20County%208-29-06.pdf, 7.

required to be shielded. Table 7 from the Fort Bend County regulations[214] shows the fixture-shielding requirements for lamps exceeding 1,800 lumens:

Table 7 Fort Bend Shielding Regulations for Lamp Luminous Flux Greater than 1,800 Lumens

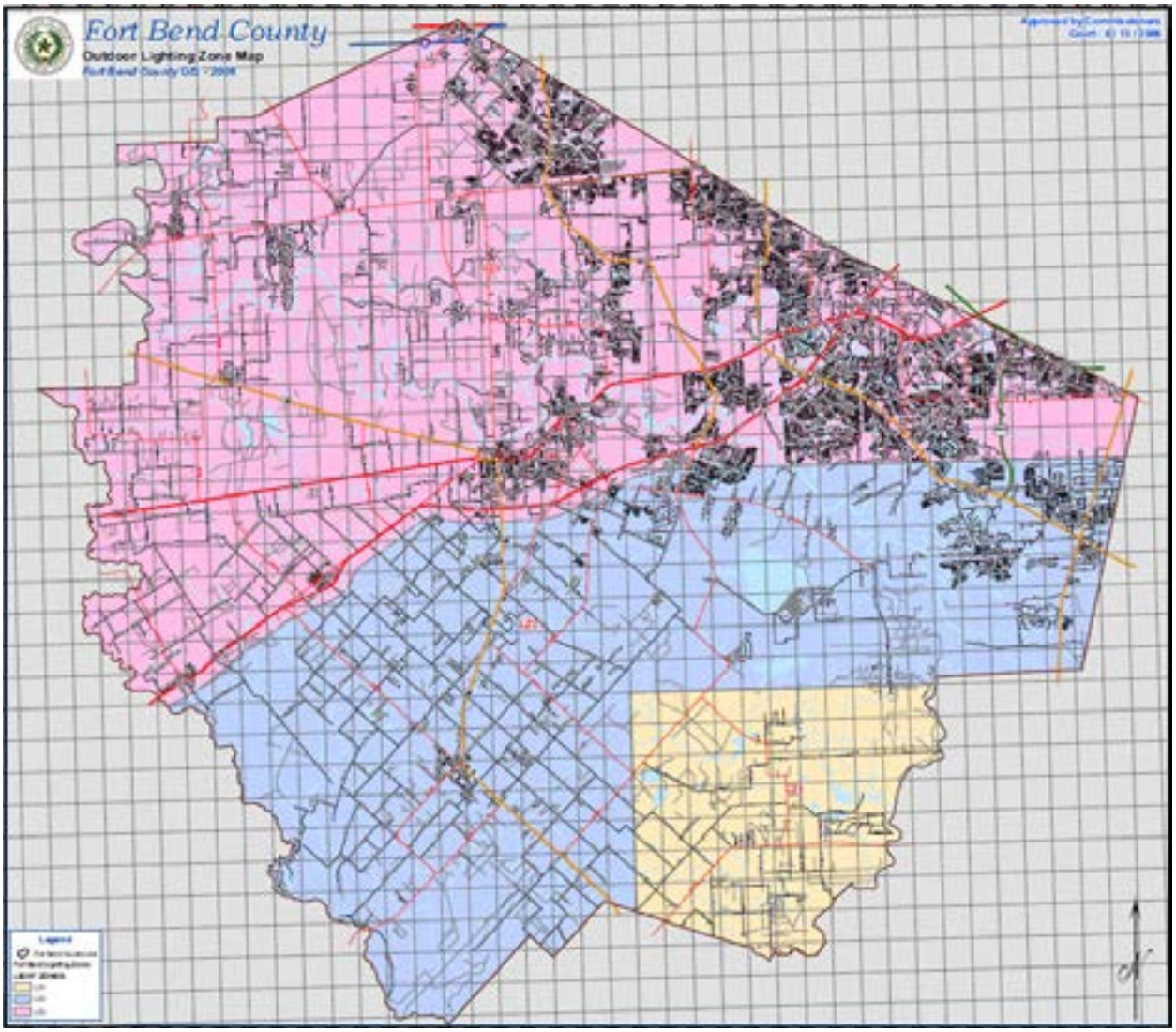
Lamp Type	Shielding
Low Pressure Sodium	Fully
Mercury Vapor	Fully
High Pressure Sodium	Fully
Fluorescent	Fully
Metal-halide	Fully
Halogen (Quartz)	Fully
Induction	Fully
Xenon	Fully
Incandescent	Fully
Fossil Fuel	Partially
Glass Tubes (With Neon, Argon, or Krypton)	Partially
Other Sources	Approved by Authority Assigned by Commissioners Court

Source: Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County, Tex.

Second, the Fort Bend ordinance categorizes all county communities and land into three lighting zones. Each lighting zone carries with it various illumination requirements. The three zones are shown in Figure 37 below. Lighting zones from north to south show less and less development, necessitating less and less light. Accordingly, the pink light zone has the highest light allowances, whereas the tan light zone has the lowest. The tan light zone includes Brazos Bend State Park, an area of obvious importance for light-pollution mitigation. Fort Bend County residents can easily find out which lighting zone they live in, as the light-zone map is online and instructions on how to find the map online are provided within the Fort Bend County regulations as part of the appendices.

[214] Ibid., 8.

Figure 37 Fort Bend County Light-Zoning Map



Source: Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County, Tex.

Third, although local street lighting is not required in Fort Bend County, it is regulated in terms of luminance permitted for road and property types in various light zones. Cement roads require lower average maintained luminance than do asphalt roads.[215] Commercial lighting is also regulated for various types of storefront or property lighting. Table 8 from the Fort Bend County regulations[216] shows the differences in average maintained foot-candle required for commercial properties located in the three light zones.

[215] Ibid., 10.
[216] Ibid., 11.

Table 8 Commercial Property Lighting vs. Light Zones

	Lighting Zone: LZ1		Lighting Zone: LZ2		Lighting Zone: LZ3	
Sales and Storage Lot Component	Average Maintained Illumination Level	Maximum/Minimum Ratio	Average Maintained Illumination Level	Maximum/Minimum Ratio	Average Maintained Illumination Level	Maximum/Minimum Ratio
Front Merchandise (display only public right-of-ways)	3 fc	5 to 1	5 fc	5 to 1	10 fc	5 to 1
Other display areas and entrances	2 fc	10 to 1	2.5 fc	10 to 1	5 fc	10 to 1
Entrance drives	0.5 fc	10 to 1	1 fc	10 to 1	1.5 fc	10 to 1

Source: Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County, Tex.

Finally, the Fort Bend ordinance delineates enforcement and penalties for violation. Under these provisions fines can be assessed, construction projects and development proposals can be delayed until compliance, and permits can be withheld for installed lighting that is not in compliance.[217]

To read and review the entire Fort Bend County *Orders for Regulation of Outdoor-lighting in the Unincorporated Areas of Fort Bend County,* please reference the bibliography of this document for a link to the online PDF file of this document.

The Arlington County, Va., *Street-light Policy and Planning Guide* sets forth the below standards for commercial and residential lighting:

Table 9 Pole and Lamp Properties vs. Land Use

Roadway Lighting Criteria	Residential	Commercial
Pole Spacing (ft.)	100 – 120	60 - 90
Lamp Lumens	5000	14000
Horizontal Luminance Average (fc)	0.5	1.5
Wattage	70	150

Source: Arlington County, Va., Street-light Policy and Planning Guide

4-6. Light-Pollution Mitigation

This section recommends light-pollution-mitigation strategies to use when addressing issues such as glare, light spill, view of the dark sky, and light impacts on wildlife.

[217] Ibid., 13-14.

Support the "Lights Out Wilmington" Initiative (http://lightsoutwilm.com)

The Lights Out Wilmington initiative is a collaborative light-pollution-mitigation effort sponsored and endorsed by several organizations—Delaware Ornithological Society, Delaware Department of Natural Resources and Environmental Control, Green Delaware, Energize Delaware, Delaware Museum of Natural History, Delaware Audubon, Delaware Nature Society, The Nature Conservancy, and Tri-State Bird Rescue. As recorded in March 2011 in *The News Journal*, a locally based effort to curb the impact of light-pollution on migratory birds in Delaware,[218] the Delmarva Ornithological Society launched Lights Out Wilmington, a project designed to encourage building owners and occupants to reduce light-pollution during fall and spring migration periods.[219] Specifically, individuals are being asked to turn off exterior lighting and interior lighting near windows between 10:00 p.m. and dawn.[220] Peak migration periods in Delaware occur in the spring between March 17th and June 7th and in the fall between August 20th and October 25th.[221]

Explore Use of Bird-Friendly Light Design Using Various Spectrum Color Types

Van de Laar in 2007 proposed that red or white lights be replaced with green lights, which greatly reduce "the negative effects of artificial lights on oil platforms on birds."[222] Poot and others in *Green Light for Nocturnally Migrating Birds* note the following:

> Laboratory experiments have shown the magnetic compass [of birds] to be wavelength dependent: migratory birds require light from the blue-green part of the spectrum for magnetic compass orientation, whereas red light (visible long-wavelength) disrupts magnetic orientation. We designed a field study to test if and how changing light color influenced migrating birds under field conditions. We found that nocturnally migrating birds were disoriented and attracted by red and white light (containing visible long-wavelength radiation), whereas they were clearly less disoriented by blue and green light (containing less or no visible long-wavelength radiation). This was especially the case on overcast nights. Our results clearly open perspective for the development of bird-friendly artificial lighting by manipulating wavelength characteristics. Preliminary results with an experimentally developed bird-friendly light source on an offshore platform are promising.[223]

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[218] Murray, Molly and Esteban Parra, *Delaware Wildlife: Birds blinded by the Light*, (Wilmington: Delaware News Journal, March 17, 2011), http://www.courierpostonline.com/article/BL/20110317/NEWS02/103170356/Delaware-wildlife-Birds-blinded-by-light.
[219] Ibid.
[220] Ibid.
[221] Ibid.
[222] Kociolek, A.V. and others, *Effects of Road Networks on Bird Populations*, (Bozeman: Montana State University, 2011), 245.
[223] Poot, Hanneke, and others, "Green Light for Nocturnally Migrating Birds," *Ecology and Society* 13, no. 2 (2008): 1.

Consider Adopting Relevant Components from the Joint IDA-IESNA Model Lighting Ordinance

The International Dark Sky Association (IDA) and the Illuminating Engineering Society of North America (IESNA), two of the primary lighting-policy organizations in the United States, jointly released a model lighting ordinance for application at the local level in June 2011. This ordinance could be used and reviewed by Delaware county governments to re-consider the light-pollution protocol currently in place in unincorporated areas of Delaware. The model light ordinance in its entirety, with a user's guide, can be found online (http://docs.darksky.org/MLO/MLO_FINAL_June2011.pdf).

The user's guide provides contextual information about the actual text of the sample ordinance. The model ordinance features the use of lighting zones to define and prioritize lighting need in various areas. The use of lighting zones will allow localities to tailor the ordinance applications to distinct areas, specific to each community's unique needs. The model ordinance also included use of the Backlight-Uplight Glare (BUG) rating system to better control unwanted light.

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Appendices

Appendix 1: Delaware State Code on Street Lighting

TITLE 9: Counties, New Castle County

CHAPTER 21. STREET AND HIGHWAY LIGHTING

§ 2101. Lighting streets and highways in unincorporated communities and villages; petition.

(a) Upon the petition of a majority of the property owners of any unincorporated community or village in New Castle County, the County Council may enter into a contract with any electric, gas or other lighting companies to light and illuminate the streets or highways running through, bounding and within the community or village, with electric light, gas light, or other illuminant. The petition of the property owners shall set forth the boundary lines of the community to be lighted. Street-lights shall be of such candle power, electric or its equivalent in other illuminating mediums, as shall be determined by the County Council. The County Council may enter into contracts for additional lights or may change the location of any lights theretofore located and may levy and collect additional tax for the payment of the same.

(b) For purposes of this chapter, the term "property owner" shall mean a person or entity who owns a fee simple interest in land situated in any unincorporated community or village in New Castle County entitling the owner to sign a petition filed pursuant to subsection (a) of this section and cast 1 vote in favor of or against illuminating streets or highways covered by such petition. In the event that a property is owned by more than 1 person or entity, either as joint tenants with right of survivorship, tenants in common or tenants by the entirety, each such party shall be entitled to cast a proportional vote equal to such party's proportional interest in and to the jointly-held property, as set forth in the deed of conveyance or other evidence of ownership. If the deed or other evidence of ownership does not set forth each owner's proportionate interest, each owner's interest shall be presumed to be equal for purposes hereof. It is the intent of this section that each property shall have no more than 1 vote, and each property owner shall have a vote equal to such property owner's proportional interest in such property.

38 Del. Laws, c. 81, § 1; Code 1935, § 1180; 48 Del. Laws, c. 77, § 1; 9 Del. C. 1953, § 2101; 55 Del. Laws, c. 85, § 13A; 68 Del. Laws, c. 238, § 1; 68 Del. Laws, c. 435, § 1; 71 Del. Laws, c. 401, § 15.;

§ 2102. Levy and collection of light-tax; penalty for late payment.

(a) The County Council, for the purpose of providing street and highway lighting pursuant to § 2101 of this title, shall levy for the installation and maintenance of such lights an annual tax based on the full annual cost of such lighting, plus up to but not exceeding 10% thereof to cover the actual direct and indirect costs of administration and billing. Such tax shall be levied against all properties within the boundary lines of the communities that have submitted petitions under § 2101 of this title. The County Council shall establish the method by which such tax shall be computed and shall adopt and levy annual light-tax rates that will yield sufficient revenue to

cover the full annual cost of all lighting services, plus up to but not exceeding 10% for the actual cost of administration and billing. No such taxes shall be levied against farm land.

(b) Such taxes shall be collected by the same collector, at the same time and in the same manner as other county taxes. If such taxes are not paid by the date set for the payment of other taxes, penalty shall accrue thereon in the manner and at the rate specified in § 8604(a) of this title.

(c) If the County Council receives a petition for street-lighting from any community and the contract for such street-lighting is entered after the commencement of the county's fiscal year, the Department of Finance may, at the same times established for supplemental assessments in § 8339 of this title, levy and bill a supplemental light-tax to the property owners within such community, computed in the same manner as all other light-tax bills, reduced at the rates specified in § 8340 of this title.

(d) All taxes levied under this chapter shall be considered real property taxes and, as provided in § 2901(a) of Title 25, shall constitute and remain a statutory lien on such property, together with any penalties that may accrue thereon, until such taxes and penalties are paid in full. Such lien shall enjoy the priority established for governmental liens by § 2901 of Title 25.

38 Del. Laws, c. 81, § 2; Code 1935, § 1181; 48 Del. Laws, c. 77, § 2; 9 Del. C. 1953, § 2102; 55 Del. Laws, c. 85, § 13A; 68 Del. Laws, c. 435, §§ 2-6; 71 Del. Laws, c. 401, § 15.;

§ 2103. Light-tax; administration of fund; surplus.

The Department of Finance of New Castle County shall receive all light-taxes collected, shall keep them in a separate account, and shall pay them out only upon orders signed by the County Executive and approved by the Department. The Department shall receive or charge no compensation for the performance of any duty required of it or New Castle County under this chapter, beyond that expressly authorized by § 2102 of this title. If, after payment of all contracts entered into pursuant to this chapter, there remains a surplus in the light account, the surplus shall be applied to reduce the light-tax rate for the succeeding taxable year.

38 Del. Laws, c. 81, § 2; Code 1935, § 1181; 48 Del. Laws, c. 77, § 2; 9 Del. C. 1953, § 2103; 55 Del. Laws, c. 85, §§ 13A, 13B, 13C; 68 Del. Laws, c. 435, § 7.;

§ 2104. Removal of lights.

Lights installed under the provisions of this chapter shall be removed only by ordinance of County Council or upon its direction after receipt of a petition, signed by a majority of the property owners within the bounds of any lighted community or village, requesting such removal. No such ordinance or petition shall be considered by County Council at any time within 3 years after the date of the first light-tax billing issued after the installation of such lights. After the removal of such lights, no light-tax shall be levied against properties within the bounds of the community or village identified in the ordinance or petition. In the event that such lights are

removed, County Council shall not refund any light-tax that has been levied for the fiscal year during which the lights are removed.

38 Del. Laws, c. 81, § 4; Code 1935, § 1183; 55 Del. Laws, c. 85, § 13A; 68 Del. Laws, c. 435, § 8; 71 Del. Laws, c. 401, § 15.;

Appendix 2: Workshop Agenda

AGENDA

Pedestrian-Lighting Options and Roles of Responsibility Within Unincorporated Delaware Communities

Project Workshop

Tuesday, April 12, 2011
8:30 a.m. – 11:30 a.m.
Gallery Room, UD Perkins Student Center

8:30a.m. – 9:00a.m.	**Registration/Sign-In** Continental Breakfast Welcome	Edward O'Donnell, AICP
9:00a.m. – 9:15a.m.	**Introductions** Overview of Workshop Review Agenda	Edward O'Donnell, AICP
9:15a.m. – 9:45 a.m.	**Project Presentation** Overview of Project	Theodore Patterson/Ryan Gillespie
9:45a.m. – 10:00a.m.	**Break**	
10:00a.m. – 11:20a.m.	**Workshop** Discussion	Edward O'Donnell, AICP
11:20a.m. – 11:30a.m.	**Wrap-Up**	Edward O'Donnell, AICP

Appendix 3: Park-n-Ride Study

Fall 2010

Park and Ride Facility	Survey 1					Survey 2				
	DE	MD	PA	Other License Plates	Total Count	DE	MD	PA	Other License Plates	Total Count
Aldersgate Church, 2313 Concord Pike	15	0	4		19	13	1	2		16
Bethesda United Methodist, Middletown	6	0	0		6	10	0	0		10
Brandywine Town Center	3	0	1	GA-1	5	0	0	2		2
Christiana Mall, Newark, DE	170	4	2	NJ-1, ME-1	178	152	6	5	NJ-2	165
Claymont Train Station and Overflow Parking	453	5	19	NJ-5, IA-1, TX-1, CA-1, OH-1	486	398	2	18	OH-2, NJ-3, NY-2, MS-1, FL-2	428
Concord Presbyterian, 1800 Fairfax Boulevard	32	0	4	NJ-1, ME-1	37	34	0	2	NJ-1	37
Faith Baptist, 4210 Limestone Road	40	0	3		43	31	0	2	MA-1	34
Faith Presbyterian, 700 Marsh Road	17	0	1		18	34	0	6	NJ-1	41
Fairplay Station	199	2	18	NY-3, NC-4, NJ-1, TX-2, OH-2, FL-2	233	162	1	12	VA-2, NC-4, OH-1, FL-1, CA-1, TX-1	185
4th & Jackson Streets					Not Surveyed					Not Surveyed
Hockessin Memorial Hall, Rte 41 and Yorklyn Rd.	7	0	9		16	11	0	2		13
Lower Brandywine Presbyterian, Old Kennett Rd.	0	0	1		1	0	0	0		0
Lutheran Church of the Good Shepard, Foulk Rd.	15	0	0	VA-1, NJ-1	17	13	0	2	NJ-1	16
Maryland Ave. & Germay Dr./Industrial Park	1	0	0		1	1	0	0		1
Naamans & Carpenter Roads	0	0	0		0	2	0	0		2
Newark Train Station	160	30	42	MA-2, MI-1, NA-1, MS-1	237	148	32	31	NJ-1, VA-1, NV-1, NY-1	215
North Baptist, 3318 Silverside Road	1	0	0		1	0	0	2		2
People Plaza, Rt 896 & 40	39	8	2		49	30	13	0	NY-1, FL-1	45
Prices Corner, Centerville Road	59	0	2		61	32	0	2	MA-1	35
DE 1 and Pole Bridge Rd. (New Boyd's Corner)	42	2	0		44	53	3	0	NJ-1, CO-1, NC-1	59
Route 72 and Chestnut Hill Rd. Scottfield	0	0	0		0	0	0	0		0
Route 41/Wachovia Bank, Hockessin	8	0	8		16	10	0	3		13
Route 52 and Route 100	26	0	8		34	34	0	6		40
Route 896 and Route 4, Newark	81	28	3	MS-1	113	94	32	5	NJ-1, NY-3	135
Route 7 and Route 273	43	1	1	NJ-3	48	35	0	0		35
Skyline United Methodist, Newark	2	0	0		2	2	0	0		2
Smyrna Rest Stop US 13 & SR1	61	0	0		61	61	0	1	NJ-1	63
Trinity Presbyterian, 112 Darley Rd.	1	0	0		1	2	0	0		2
Tybouts Corner, Route 13 and Hamburg Road						22	0	2		24
Odessa Park and Ride (DE 1 and DE 299)	62	10	0	VA-2	74	86	4	0	NJ-2	92
I-95 and Naaman's Road - Tri State Mall	1	0	0		1	0	0	0		0
Brandywine Springs Park	3	0	1	GA-1	5	1	0	0		1
Delcastle Recreation Center	2	0	0		2	0	0	0		0
Greenbank Park, Route 41, Wilmington	0	0	0		0	0	0	0		0
I-95 Service Plaza, Newark					Not Surveyed					Not Surveyed
Lantana Square, SR 7 and Valley Road	0	0	0		0	0	0	0		0
Pine Tree Corner, Route 13, Townsend	12	0	1		13	13	0	0		13
Route 13 and Wallace Road, Odessa	0	0	0		0	0	0	0		0
US 13/DTC Mid County	13	0	2		15	11	1	1		13
Frawley Stadium	180	9	10	NJ-8, VI-1, NY-2, OH-1, MA-1	212	152	7	5	NY-2, NJ-5, IL-1, CT-1, VI-1	175

Spring 2011	Survey 1					Survey 2				
Park and Ride Facility	DE	MD	PA	Other License Plates	Total Count	DE	MD	PA	Other License Plates	Total Count
Aldersgate Church, 2313 Concord Pike	10	1	1		12	13	0	3		16
Bethesda United Methodist, Middletown	15	2	0		27	15	0	1		16
Brandywine Town Center	2	0	1		3	0	0	1		1
Christiana Mall, Newark, DE	119	10	13	NJ-6, VA-5	153	224	11	16	VA-13, NJ-5, Oth-12	281
Claymont Train Station and Overflow Parking	445	6	18	NJ-7, NY-3, Oth-4	483	450	4	23	NJ-5, DC-2, NY-2, Oth-3	489
Concord Presbyterian, 1800 Fairfax Boulevard	35	1	5		41	36	0	4		40
Faith Baptist, 4210 Limestone Road	27	1	2		30	40	0	2		42
Faith Prebyterian, 700 Marsh Road	12	0	4		16	11	0	1	NJ-1	13
Fairplay Station	182	0	12	NY-2, NJ-1, Oth-3	200	168	1	10	NJ-3, Oth-5	187
4th & Jackson Streets	0	0	0		0	0	0	0	0	0
Hockessin Memorial Hall, Rte 41 and Yorklyn Rd.	6	0	9		15	6	0	12		18
Lower Brandywine Presbyterian, Old Kennett Rd.	0	0	0		0	0	0	0		0
Lutheran Church of the Good Shepard, Foulk Rd.	12	0	4		16	10	0	2	NJ-1	13
Maryland Ave. & Germay Dr./Industrial Park	0	0	0		0	0	1	0		1
Naamans & Carpenter Roads	2	0	0		2	1	0	0		1
Newark Train Station	160	25	15	NJ-1, NY-1, Oth-3	205	175	26	33	VA-1, Oth-5	240
North Baptist, 3318 Silverside Road	1	0	0		1	1	0	0		1
People Plaza, Rt 896 & 40	44	6	0	VA-1	51	50	4	1		55
Prices Corner, Centerville Road	20	1	8		29	38	1	0	Conn-1	40
DE 1 and Pole Bridge Rd. (New Boyd's Corner)	62	2	0	NJ-1	65	44	2	0	NJ-1	47
Route 72 and Chestnut Hill Rd. Scottfield	2	0	0		2	1	0	0		1
Route 41/Wachovia Bank, Hockessin	14	0	6		20	9	0	10		19
Route 52 and Route 100	25	0	7		32	27	0	5		32
Route 896 and Route 4, Newark	88	25	1	NJ-2, Oth-1	117	71	26	5	NJ-4	162
Route 7 and Route 273	50	3	2	NJ-1	56	49	4	5		58
Skyline United Methodist, Newark	5	0	0		5	3	0	0		3
Smyrna Rest Stop US 13 & SR1	67	0	0	NJ-1	67	74	1	0	NJ-1	76
Trinity Presbyterian, 112 Darley Rd.	12	0	1		13	2	0	0		2
Tybouts Corner, Route 13 and Hamburg Road	28	1	0	NJ-1	30	26	1	0		27
Odessa Park and Ride (DE 1 and DE 299)	93	9	2	NJ-1, VA-1	106	92	8	0	FL-1	101
I-95 and Naaman's Road - Tri State Mall	0	0	0		0	1	0	0		0
Brandywine Springs Park	1	0	0		1	0	0	0		0
Delcastle Recreation Center	20	1	1		22	3	1	0		4
Greenbank Park, Route 41, Wilmington	0	0	0		1	0	0	0		0
I-95 Service Plaza, Newark	40	16	12	NJ-11, NY-4, Oth-3	86	33	11	9	NJ-11, VA-4, NY-8, Oth-11	87
Lantana Square, SR 7 and Valley Road	0	0	0		0	0	0	0		0
Pine Tree Corner, Route 13, Townsend	14	1	0		15	18	0	1		19
Route 13 and Wallace Road, Odessa	0	0	0		0	0	0	0		0
US 13/DTC Mid County	12	1	3	NJ-1	17	18	0	0		18
Frawley Stadium	138	3	11	NJ-6, VA-2, Oth-2	162	139	10	6	NJ-12, VA-2, Oth-4	173

Appendix 4: Houston LISC CPTED Audit

CPTED Safety Audit Checklist

Audit is (circle): Indoors Outdoors
General Area: _____

Specific Location: _____

Date: _____ Day: _____ Time: _____

Audited By: _____

Reason for Audit: _____

1. General Impressions

What is your first impression of the location? Your 'gut reaction' to it?

_____

_____

_____

Which 5 words best describe the place?

_____

_____

_____

_____

_____

2. Lighting

Circle: Very poor Poor Satisfactory Good
Very Good Too Dark Too Bright

Is the lighting consistent throughout the space? Yes No

Are there any lights out? If so, how many? What proportions of the lights are out?

_____

_____

_____

_____

Are you able to identify a face from 25 meters (75 feet) away? Yes No

Do you know where/whom to call when light are broken / not on? Yes No

Out of doors, is the lighting obscured by bushes or trees? Yes No

How well does the lighting illuminate walkways and sidewalks (circle one)?

Very Poor Poorly Satisfactory Well Very Well

3. Signage

Is there a sign (room no, building name) that identifies where you are? Yes No

If "No", are there directional signs or maps nearby that can help? Yes No

Are there signs to show where to get emergency assistance? Yes No

Are there signs to direct you to wheelchair access? Yes No

Are there signs posted showing the legitimate operating hours of area? Yes No

What is your overall impression of local signage (circle one)?
Very Poor Poor Satisfactory Good Very Good

What signs should be added, in your opinion?
_____
_____
_____

4. Sight Lines

Can you clearly see what is up ahead? Yes No

If not, why? Reasons could include:
Indoors: sharp corners, walls, pillars, _____
Outdoors: brush, fencing, hills, _____

Are there places someone could be hiding? Yes No

If "yes", where? _____
_____

What changes would make it easier to see and provide a better sight line (circle several)?

Transparent Angled corners Trimmed bushes Vehicles moved
Security mirrors Debris cleared
Other: _____

5. Isolation- Eye Distance

At the time of your audit, does the area feel isolated? Yes No

How many people are likely to be around?

In the morning?	None	Few	Several	Many
During the day?	None	Few	Several	Many
In the evening?	None	Few	Several	Many
Late at night (after 10pm)?	None	Few	Several	Many

Is it easy to predict when people are around? Yes No

Is there a monitor surveillance system? Yes No Don't Know

6. Isolation- Ear Distance

How far away is the nearest person to hear a call for help? _____

How far away is the nearest emergency service, such as an alarm, crisis phone or security patrol?

_____

_____

Is the area patrolled? How often?

_____

_____

Can you see a sign directing you to emergency help? Yes No

7. Movement Predictors

How easy is it to predict people's routes/ paths of direction when traveling?

Very Easy Somewhat Obvious No Way of Knowing

Is there an alternative, frequently traveled path available? Yes No

Can you tell what is at the end of the path, tunnel, or walk? Yes No

Are there corners, alcoves, or bushes someone could hide behind? Yes No

Other Comments:

_____

8. Possible Entrapment Areas

Indoors

Are there empty buildings that should be locked left open? Yes No

Are there small, defined areas available such as:

Recessed doorways	Yes	No
Stairwells	Yes	No

Unlocked Closets Yes No
Elevators Yes No
Other: _____

Outdoors

Are there small, confined areas where you could be hidden from view? Yes No
Alley
Recessed Doorway
Construction Site
Other _____

How easy would it be for an offender to disappear? Easy Very Easy Don't Know

How difficult would it be for you to escape if needed?
Difficult Very Difficult Easy Don't Know

9. Nearby Land Uses

What is the nearby land area mainly used for (circle what applies)?
Stores Restaurants Parking Lots Factories Woods Traffic
Residential Homes Offices Bodies of Water

Can you identify who owns nearby land? Yes No

What is your impression of the land use? Poor Satisfactory Good

10. Maintenance of the Area

Does the area seem cared for? Yes No

Does the area seem abandoned by people? Yes No

Is there any graffiti visible? Yes No

Are there any signs of vandalism? Yes No

Is there litter lying around (circle one)? Lots Some None

Is there need of major repair? Yes No

Do you know who to contact for repairs? Yes No

11. Overall Impressions of the Area

If you weren't familiar with the area, would it be easy to find your way around?
Yes No

Is the entry point visible and well defined?	Yes	No
Are public areas visually protected and well lit?	Yes	No
Is the area designed to be too spread out for safety?	Yes	No
Are there a confusing number of levels or paths in the area?	Yes	No

Appendix 5: Sample Outdoor-Lighting Ordinance

SAMPLE OUTDOOR
LIGHTING ORDINANCE

Adapted by:

Hancock County Planning Commission
395 State Street
Ellsworth, ME 04605
Voice: 207-667-7131
Facsimile: 207-667-2099

www.hcpcme.org

Financial assistance was provided by the Maine State Planning Office through the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, US Department of Commerce

SAMPLE LIGHTING ORDINANCE

No town should ever adopt standards directly from another town. Rather, it needs to review the standards carefully to see if they apply to their community. The example presented here is modified from Great Falls, Montana.

I. Authority

This Ordinance is adopted pursuant to Home Rule Powers as provided for in Article VII Part 2, Section 1 of the Maine Constitution and Title 30-A, MRSA, Section 3001 et seq.

I1. Short Title

This Ordinance shall be known and may be cited as the "Lighting Ordinance of the Town of _____Maine", and will be referred to as this "Ordinance".

III. Statement of Need and PURPOSE

The town/city of ____ recognizes the following:

1. Improperly located lighting can cause unsafe and unpleasant condition;.
2. Excessive lighting can cause unsafe, unhealthful and unpleasant conditions, waste electricity and threaten the natural environment;.
3. Obtrusive lighting can cause unsafe and unpleasant conditions;
4. Proper lighting can enhance safety and enjoyment of the built environment;
5. On balance, lighting with a higher color rendering index (CRI) provides more desirable lighting than lighting with a lower CR; and.
6. Illumination levels should be appropriate to the visual task.

This ordinance is established to promote the public health, safety, and welfare and is intended to accomplish the following purposes:

1. allow appropriate lighting levels to preserve safety, security, and the nighttime use and enjoyment of property;
2. reduce light-pollution, light trespass, glare, and offensive lighting;
3. promote energy conservation;
4. allow people in residential areas to view the stars against a dark sky;
5. enhance the aesthetics of the built environment; and
6. protect the character of the natural environment and preserve ecological values.

IV. Applicability

A. **New construction/uses**. The provisions of this ordinance shall apply to parking lots, buildings, structures, and land uses established after the effective date of this ordinance.

B. **Expansion and redevelopment**. The provisions of this ordinance shall apply to the entire building/structure, parking area, or use, as appropriate, under the following conditions:

1. when a building or structure is expanded in size by 25 percent or more;
2. when the area of a parking area is expanded by 25 percent or more;
3. when an outdoor use (e.g., outdoor storage, vehicle sales) is expanded by 25 percent or more; and
4. any other activity subject to site plan or subdivision review.

COMMENT: This provision needs to be modified to reflect the provisions your community has in its site plan and subdivision ordinances.

The stated thresholds apply to a single addition or cumulative additions occurring after the effective date of this ordinance.

C. **Exemptions**. The following are exempt:

1. lighting required by the Federal Aviation Administration (FAA) for aviation control/safety;

2. seasonal lighting displays using low-wattage lamps between November 15 through January 15 of the following year;
3. lights used by police, fire, and medical personnel during an emergency;
4. luminaires attached to a residential building which are less than 2,000 lumens and mounted below the eaves; and
5. lighting placed underwater to illuminate swimming pools or fountains, for lamp type and shield standards only.

V. Severability and conflicts with other ordinances

A. **Validity and Severability:** Should any section or provision of this Ordinance be declared by the courts to be invalid, such decision shall not invalidate any other section or provision of this Ordinance.
B. **Conflict with Other Ordinances:** Should any section or provision of this Ordinance be found to be in conflict with any other municipal ordinance or regulation, the more stringent section or provision shall prevail.

VI. Prohibited lighting

The following types of outdoor-lighting are specifically prohibited:

1. lighting that could be confused for a traffic control device;
2. lighting that is oriented upward, except as otherwise provided for in this ordinance
3. searchlights, beacons, and laser source light fixtures;
4. lights that blink, flash, move, revolve, flicker, change intensity, or change color;
5. any lamp or bulb when not within a luminaire and which is visible from the property boundary line of the parcel on which it is located, except for landscape ornamental lighting;
6. lighting inside of an awning when the awning material is translucent; and
7. a string of lights, suspended between 2 or more objects (e.g., between 2 poles).

VII. General standards

A. **Illumination level at property boundary line**. When a commercial or industrial use abuts a residential use, lighting shall be designed so that the illumination at the property boundary line that is attributable to the subject property does not exceed 0.3 foot-candles. When a commercial or industrial use abuts a public right-of-way, or another commercial or industrial use, lighting shall be designed so that the illumination at the property boundary line does not exceed 1.0 foot-candles;

COMMENT: Be sure to adjust this section to reflect the zoning districts in your community.

B. **Pole-mounted luminaires**. Luminaires shall not be taller than 15 feet in residential and downtown zoning districts or when placed within 50 feet of a residential zoning district. In all other zoning districts, luminaires shall not be taller than 30 feet;

C. **Building-mounted luminaires**. In non-residential zoning districts, building-mounted luminaires shall not be attached to a sloped roof and shall not be taller than 30 feet or the height of the principal building, whichever is less. The use of wall-pack luminaires is discouraged;

D. **Overhead electrical lines prohibited**. For new installations, electrical lines for luminaires mounted on freestanding poles shall be placed underground between poles. This requirement shall not apply to rural residential areas except as otherwise noted in the town of _____ subdivision ordinance;

E. **Material for light poles**. Light poles shall be anodized, painted or otherwise coated so as to minimize glare from the light source;

F. **Continued maintenance**. Lighting installations shall be maintained in good repair to meet the provisions of this ordinance on an on-going basis;

G. **Lighting curfew.** For parcels with non-residential uses, lighting in vehicle parking areas containing 20 parking spaces or more shall be reduced to 50 percent of permitted levels one hour after the business closing to one hour before the business opens. If lighting levels are already below 50 percent of permitted levels, no curfew adjustment is required;

H. **Luminaire types.** Full-cutoff luminaires shall be used in parking areas, along internal streets, and along pedestrian ways. The City/town may allow cutoff luminaires or semi-cutoff luminaires in these locations when the overall uplight would be less than for full-cutoff luminaries. To promote a unified development theme, post top luminaires (also referred to as period lighting) may be used as an alternate if they have built-in reflectors that effectively eliminate uplight. Except as provided in this ordinance, all other luminaires shall be directed downward and the light source shall be shielded so that it is not visible from any adjacent property;

I. **Maximum average lighting levels.** Average lighting levels shall not exceed the standards provided for in Exhibit 1. For those areas not specified, the planning board shall work with the applicant to set an appropriate level on a case-by-case basis in keeping with the intent of this ordinance;

J. **Maximum uniformity ratio.** In all parking areas and along sidewalks and other pedestrian walkways, an average to minimum uniformity ratio of 6:1 or better shall be maintained;

Exhibit 1. Maximum average light levels

Location	Foot-candles
At entries for residential, commercial, and industrial buildings	5.0
At loading areas (berths) associated with a commercial or industrial use	10.0
In parking areas for multi-family uses	3.0
In parking areas for non-residential uses	5.0
Along sidewalks and other pedestrian walkways	3.0
Under service station canopies	10.0

In general storage areas for commercial and industrial uses	8.0
In vehicular display areas	10.0

K. **Minimum color rendering index (CRI).** In all parking areas and along sidewalks and other pedestrian walkways, lighting shall meet or exceed the minimum color rendering index as provided for in Exhibit 2.

Exhibit 2: Minimum color rendering index (CRI) for parking areas and pedestrian ways	
District	**Minimum CRI**
Residential zoning districts	60
Downtown	60
Mixed-use zoning districts	60
Commercial zoning districts, except downtown	20
Industrial zoning districts	20

VIII. Special standards for specific applications

These standards are in addition to the foot-candle standards and CRI standards specified in Exhibits 1 and 2.

A. **Flag poles, statues and similar monuments**. A flag pole bearing a state flag, a flag of the United States or a flag of a foreign nation may be illuminated, provided the following standards are met:
1. The luminaires shall be fully shielded.
2. Upward aiming luminaires shall be placed as close to the base as possible.
3. The luminaires shall not collectively exceed 40,000 mean lumens.
Public statues, memorials or other similar monuments may also be lighted upon approval by the planning board, provided the above standards are met.

B. **Building façade lighting**. The exterior of a building may be lighted provided the following standards are met:

1. The lighting is done to accentuate an architectural or aesthetic element of the building, not the entire building.
2. The light shall only be directed onto the building façade and not spillover beyond the plane of the building.
3. Upward aimed lighting shall not exceed 4,000 mean lumens per accent feature, shall be fully shielded, and mounted as flush to the wall as possible.
4. Lighting exceeding 4,000 mean lumens per accent feature shall be aimed downward, fully shielded, and mounted as flush to the wall as possible.

COMMENT: if your community has a sign ordinance, be sure to check for any potential conflict between standards.

C. **Sign lighting**. Signs may be lighted consistent with the following standards:

1. Ground signs that are less than 6 feet in height may be internally lit, lighted from above provided the luminaire is no taller than the top of the sign, or lighted with ground-mounted lights provided the lights are fully shielded and mounted as close to the sign base as possible.
2. Ground signs 6 feet in height or taller may be internally lit or lighted from above provided the luminaire is no taller than the top of the sign.
3. Wall signs may be internally lit or lighted with ground-mounted lights provided the lights are fully shielded and mounted as close to the wall as possible.

D. **Canopy lighting**. Lighting associated with a canopy used for a vehicular shelter shall meet the following standards:

1. Luminaires beneath a canopy shall be either a full-cutoff luminaire or mounted so the luminaire or lens, whichever is lower, does not project below the bottom of the canopy surface.
2. The sides or top of the canopy shall not be illuminated, except as permitted by the sign lighting standards.
3. Lighting installed beneath a canopy shall be pointed downward and substantially confined to the ground surface directly beneath the perimeter of the canopy.
4. Lighting beyond the perimeter of the canopy shall be consistent with the lighting standards for parking areas.

E. **Telecommunication facilities**. Telecommunication facilities shall be unlit, except for the following:
1. A manually-operated or motion-detector controlled light above the equipment shed door which shall be kept off except when personnel are actually present at night.
2. The minimum tower lighting required by the Federal Aviation Administration or other state or federal requirement. Where tower lighting is required, it shall be shielded or directed to the greatest extent possible in such a manner as to minimize the amount of light that falls onto nearby properties, particularly residences.

F. **Recreational facilities**. Lighting for outdoor athletic fields, courts, or tracks shall meet the following standards:
1. Lighting installations shall be designed to achieve no greater than the minimal illuminance levels for the activity as recommended by the Illuminating Engineering Society of North America (IESNA).
2. Light trespass and glare shall be reduced to the greatest extent possible given the illumination constraints of the design. When an outdoor athletic field abuts a residential district, lighting as a goal should be designed so that the illumination at the property boundary line that is attributable to the subject property does not exceed 0.5 foot-candles.
3. Lighting used to illuminate the athletic surface shall be turned off within one hour after the last event of the night.
4. Lighting shall be designed by a registered engineer having experience with lighting installations.

IX. DEFINITIONS

A. CONSTRUCTION OF LANGUAGE

1. In this Ordinance, certain terms or words should be interpreted as follows:

a. The word "person" includes a firm, association, organization, partnership, trust, company, or corporation, as well as an individual;

b. The present tense includes the future tense, the singular number includes the plural and plural includes the singular;

c. The word "shall" is mandatory;

d. The word "may" is permissive;

e. The words "used" or "occupied" includes the words "intended", "designed", or "arranged to be used or occupied"; and

2. Terms not defined shall have the customary dictionary meaning.

B. DEFINITIONS OF WORDS

For the purpose of interpreting this Ordinance, the following terms, phrases, words and their derivations shall have the meaning given herein.

"Color rendering index (CRI)" means a measurement comparing the color of an object under a light source to a reference light source of comparable color temperature. CRI values generally range from 0 to 100. As the CRI approaches 100, the color of the lit object becomes truer or closer to the original color.

"Cutoff luminaire" means a luminaire where less than 2.5 percent of the lamp lumens occur at or above the horizontal plane and no more than 10 percent of the lamp lumens occur above 80 degrees.

"Foot-candle" means a measure of light falling on a given surface. One foot-candle is equal to one lumen per square foot.

"Full-cutoff luminaire" means a luminaire where no light occurs above the horizontal plane and no more than 10 percent of the lamp lumens occur above 80 degrees.

"Glare" means luminance in excess of what the human eye is accustomed to resulting in annoyance, discomfort, or loss of visual performance and visibility.

"Illuminance" means the amount of light falling on a surface. Illuminance may be measured in lux or in foot-candles.

"Illuminating Engineering Society of North America (IESNA)" means a professional organization that was created to advance knowledge and disseminate information for the improvement of the lighted environment to the benefit of society. Its membership includes engineers, architects, designers, manufacturers, contractors, distributors, utility personnel, educators, students, and scientists.

"Light meter" means a device that measures the amount of light energy falling on a given surface.

"Light trespass" means light emitted by a lighting installation that falls outside the boundaries of the property on which the installation is sited.

"Lighting fixture" See: luminaire.

"Lumen" means a measure of light energy generated by a light source. Manufacturers list ratings for all their lamps. Average lumen ratings are slightly lower than initial lumen ratings.

"Luminaire" means a complete lighting unit consisting of a light source and all necessary mechanical, electrical, and decorative parts.

"Nadir" means the angle pointing directly downward from the luminaire, or 0°.

"Non-cutoff luminaire" means a luminaire where a considerable amount of light occurs above the horizontal plane.

"Security lighting" means outdoor-lighting used for, but not limited to, illumination for walkways, roadways, equipment.

"Semi-cutoff luminaire" means a luminaire where less than 5 percent of the lamp lumens occur above the horizontal.

"Uniformity ratio" means the ratio of average illumination to minimum illumination within a given area.

"Uplight" means light emitted upward by a luminaire.

Appendix 6: Sussex County Streetlighting Sample Cost Estimate

SAMPLE**

SUSSEX COUNTY STREETLIGHTING DISTRICT
COST ESTIMATE

1. Electric Provider Charges:

Electric Provider (EP) Monthly Charges:		
10- Colonial style Streetlights @ $18.00 per streetlight per month		**$ 180.00**
01- Cobrahead style Streetlight at entrance @ $ 15.00 per month		**+ 15.00**
TOTAL EP MONTHLY CHARGES (for 11 streetlights)	=	**$ 195.00**
TOTAL EP ANNUAL CHARGES (for 11 streetlights)		**$2,340.00**
$ 195.00 monthly x 12 months = Annual Charges		

2. Sussex County Charges:

Sussex County Annual Administrative & Contingency Charge	**$ 351.00**
15% of EP Annual Charges of $2,340.00	

3. Total EP & County Charges:

GRAND TOTAL ANNUAL CHARGES	**$2,691.00**
$2,340.00 (EP) + 351.00 (Sussex County)	

Number of Improved Parcels in Proposed Streetlighting District	**100***
Estimated Annual Assessment per Improvement*	$ 26.91
$2,691.00 divided by 100 improvements	

** Only Improved Parcels billed*

*** This is a sample cost estimate only and the Electric Provider streetlight rates used within this estimate are examples only and may not reflect actual rates. The actual monthly rate is based on the type and wattage of streetlights provided.*

Appendix 7: Sussex County Streetlighting Districts (2010)

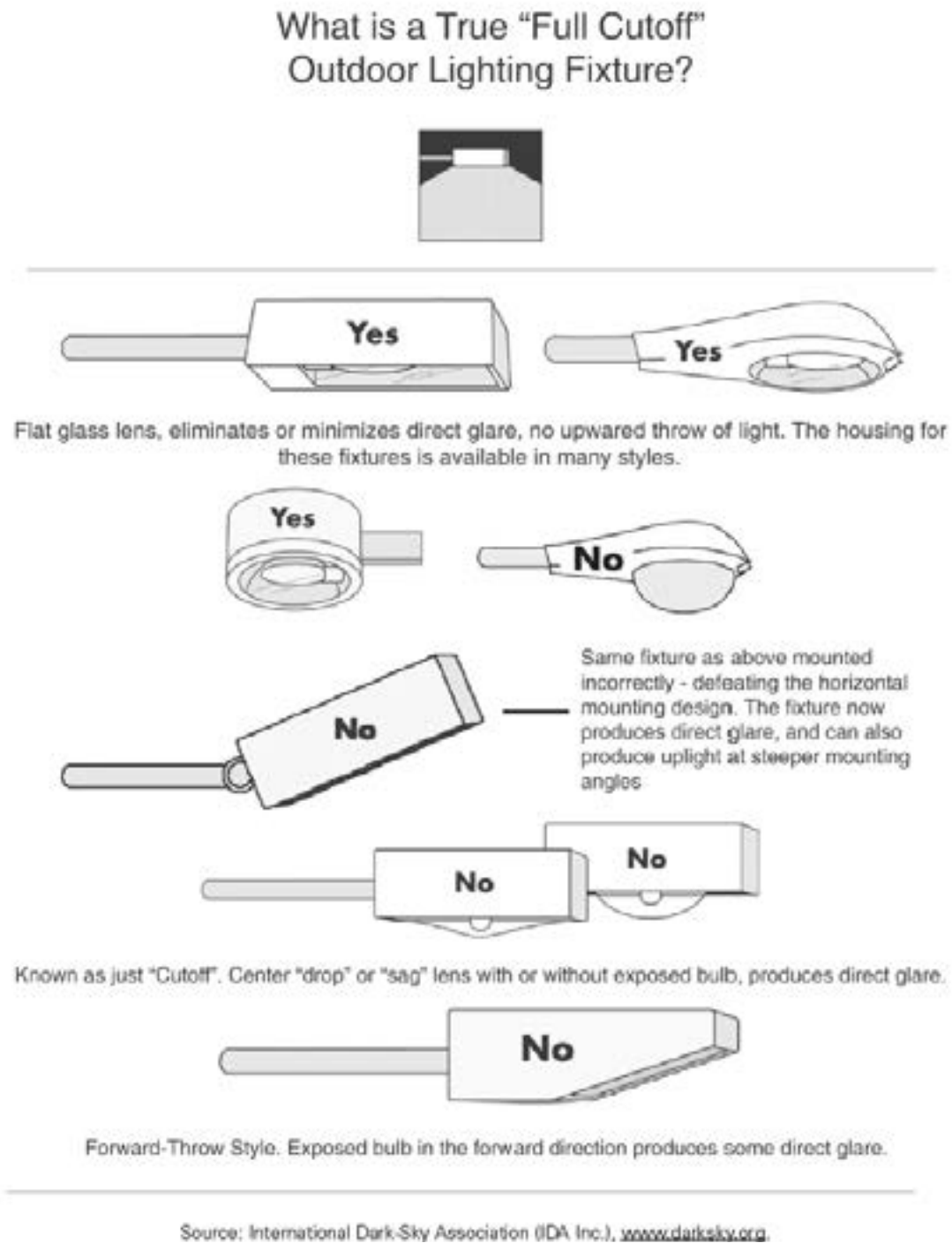
SUSSEX COUNTY STREETLIGHTING DISTRICTS

NAME OF DISTRICT	YEAR FORMED/ MODIFIED	#OF LIGHTS	TYPE OF LIGHTS	#OF UNITS	POWER PROVIDER	2010ANNUAL ASSESSMENT $PER UNIT
1- Harbeson	1976	19	Cobra 100W-HPS	71	Delmarva Power	$29.60
2 - Oak Meadows	1980 2003	25	Traditional 175W-MV	139	Delmarva Power	$33.70
3 - Covey Creek	1986	16	Cobra- 1 175W-MV Traditional- 14 175W-MV	87	Delmarva Power	$27.33
4 - Fieldwood	1990	17	Contemporary 175W-MV	108	Delmarva Power	$32.75
5 - Cedar Creek Estates	1994	20	Contemporary 100W-HPS	101	Delaware Electric Cooperative	$21.14
6 - Hudson Pond Estates	1994	8	Traditional 100W-HPS	34	Delaware Electric Cooperative	$25.08
7 - Orchard Manor I & II	1994	34	Contemporary 175W-MV	105	Delmarva Power	$56.38
8 - Beaver Dam Heights 1&11	1995	31	Cobra 100W MV	70	Delmarva Power	$49.13
9 - Nanticoke Estates	1997	9	Cobra- 2 100W-HPS Traditional - 7 100W-HPS	27	Delmarva Power	$58.30
10 - Keenwick West	1998	19	Traditional - 17 100W-HPS Security- 2 100W-HPS	122	Delaware Electric Cooperative	$16.48
11 - The Meadows at Cubbage Pond	1998 2004	22	Contemporary 100W-HPS	67	Delaware Electric Cooperative	$33.85
12 - Atlanta Estates	1998	17	Traditional- 16 100W-HPS Cobra –1 250W-HPS	76	Delaware Electric Cooperative	$24.89

13- Saraglen Acres	2002	18	Traditional- 17 100W-HPS Shoebox –1 400W-HPS	41	Delmarva Power	$87.51
14- Fox Hollow	2003	23	Traditional - 23 100W-HPS	67	Delaware Electric Cooperative	$36.59
15 - Heritage Village	2004	16	Traditional- 14 100W-HPS Shoebox-2 (One at each entrance)	61	Delaware Electric Cooperative	$27.31
16 - Lochwood*	2005	16	Traditional- 15 100W-HPS Security - 1 on Wooden Pole 100W-HPS	166	Delaware Electric Cooperative	$10.17
17 - Cedar Creek Landing	2010	45	Traditional 100W-HPS	111	Delmarva Power	$102.52

*** 20 new lights approved June 2010**
Table Revised 06/10

Appendix 8: International Dark Sky Association "Full Cutoff"



Source: International Dark-Sky Association (IDA Inc.), www.darksky.org.

Appendix 9: IPA PowerPoint Presentation

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Project Overview

- Good outdoor lighting can create and encourage a pedestrian friendly environment and promote walkability within a community.

- While pedestrian lighting is desirable, there are several issues regarding lighting responsibilities within unincorporated areas.

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Project Overview

- Criteria for determining lighting needs
- Determining options for fixture style(s)
- Financing capital costs of the purchase of poles and fixtures
- Installing and maintaining the fixtures and long-term maintenance
- Financing annual maintenance costs and improvements

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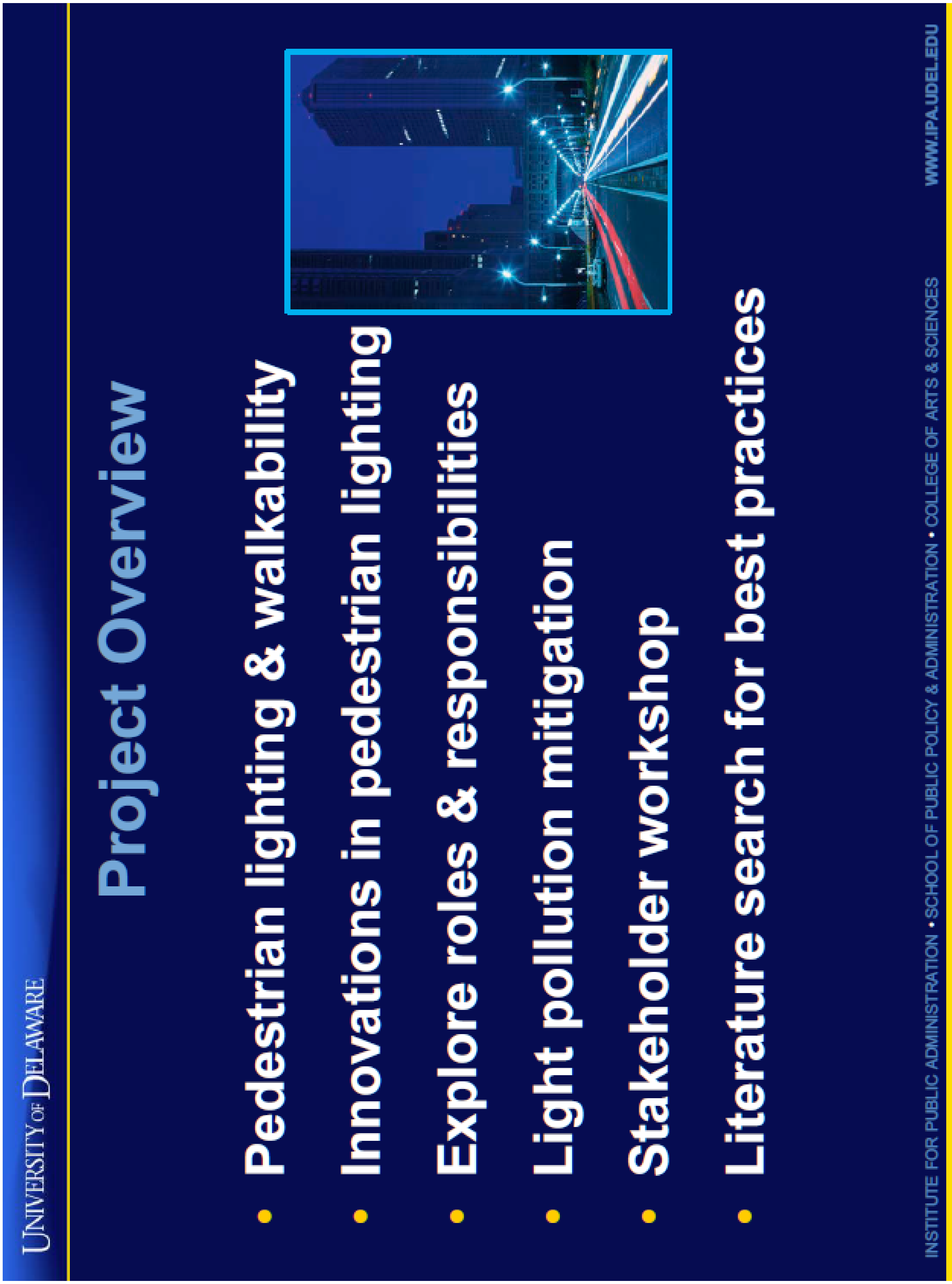
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Project Overview
Pedestrian lighting & walkability
Innovations in pedestrian lighting
Explore roles & responsibilities
Light pollution mitigation
Stakeholder workshop
Literature search for best practices
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Why Pedestrian Lighting?

- **Energy Efficiency & Environmental Conservation: Currently lighting consumes 18% of total power generated in the country. (CCI, Jan 2011)**
- **NHTSA: Approximately 70% of pedestrian fatalities occurred at night (2009)**
- **WHYY News (August 2010): "16 pedestrians had died in traffic-related crashes in Delaware. [Of these deaths] 75% occurred in *low light or dark conditions*."**

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Pedestrian Lighting and Walkability

- Improved security on paths/roads
- Longer operational hours for lit paths
- More exercise = healthier community
- Increased mobility and connectivity

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Delaware Law

- All three counties have policies on pedestrian lighting in unincorporated areas.
- Laws outline processes by which citizens can petition to have lighting installed.

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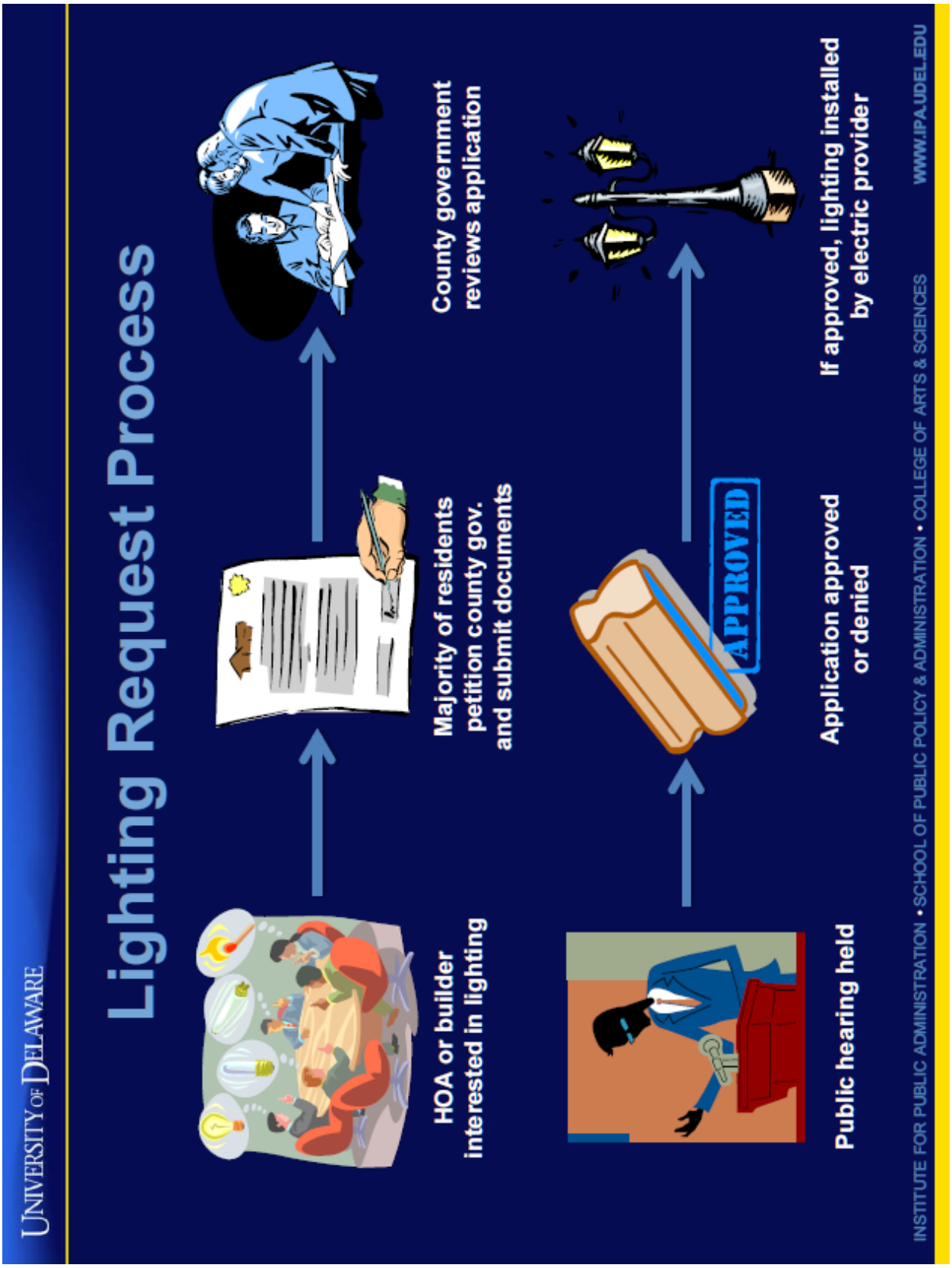
Lighting Request Process
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HOA or builder interested in lighting
Majority of residents petition county gov. and submit documents
County government reviews application
Public hearing held
Application approved or denied
APPROVED
If approved, lighting installed by electric provider
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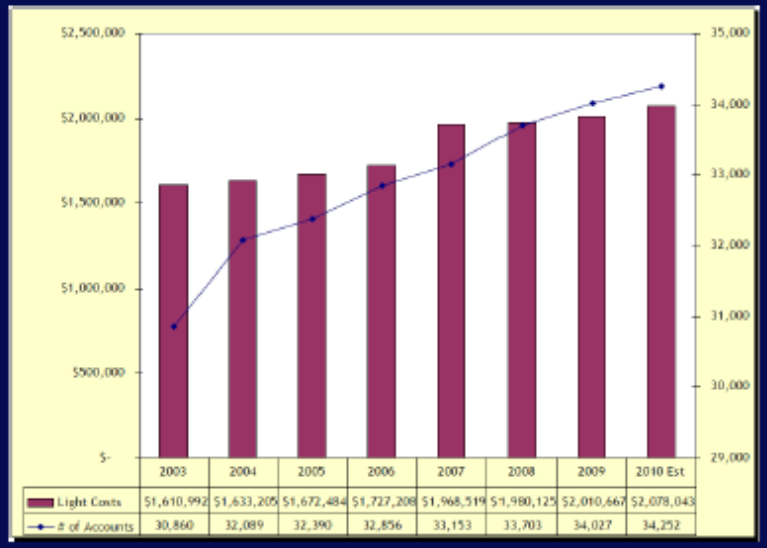
Lighting Costs for Residents



"Annual tax bills include County property taxes, as well as County sewer and water, tax ditch and street lighting fees, where applicable."

–Sussex County News Release, August 5, 2009

NCC Average Light Tax Bill	
Turn of the Century	$116.31
Ornamental Mercury	63.47
Wood Incandescent	4.86
Wood Mercury	25.71
Metal Mercury	45.20

New Castle County, Street Light Fund, Overview, January 2010

Lochwood Subdivision, Sussex County	
161 Lots; 225 Parcels	15 colonial lights
1 area streetlight at Dorman Rd. & Route 24	
Annual cost per unit was $11.57*	
*Subject to change based on # of assessable units & fuel costs	

Sussex County Council Meeting, April 12, 2005

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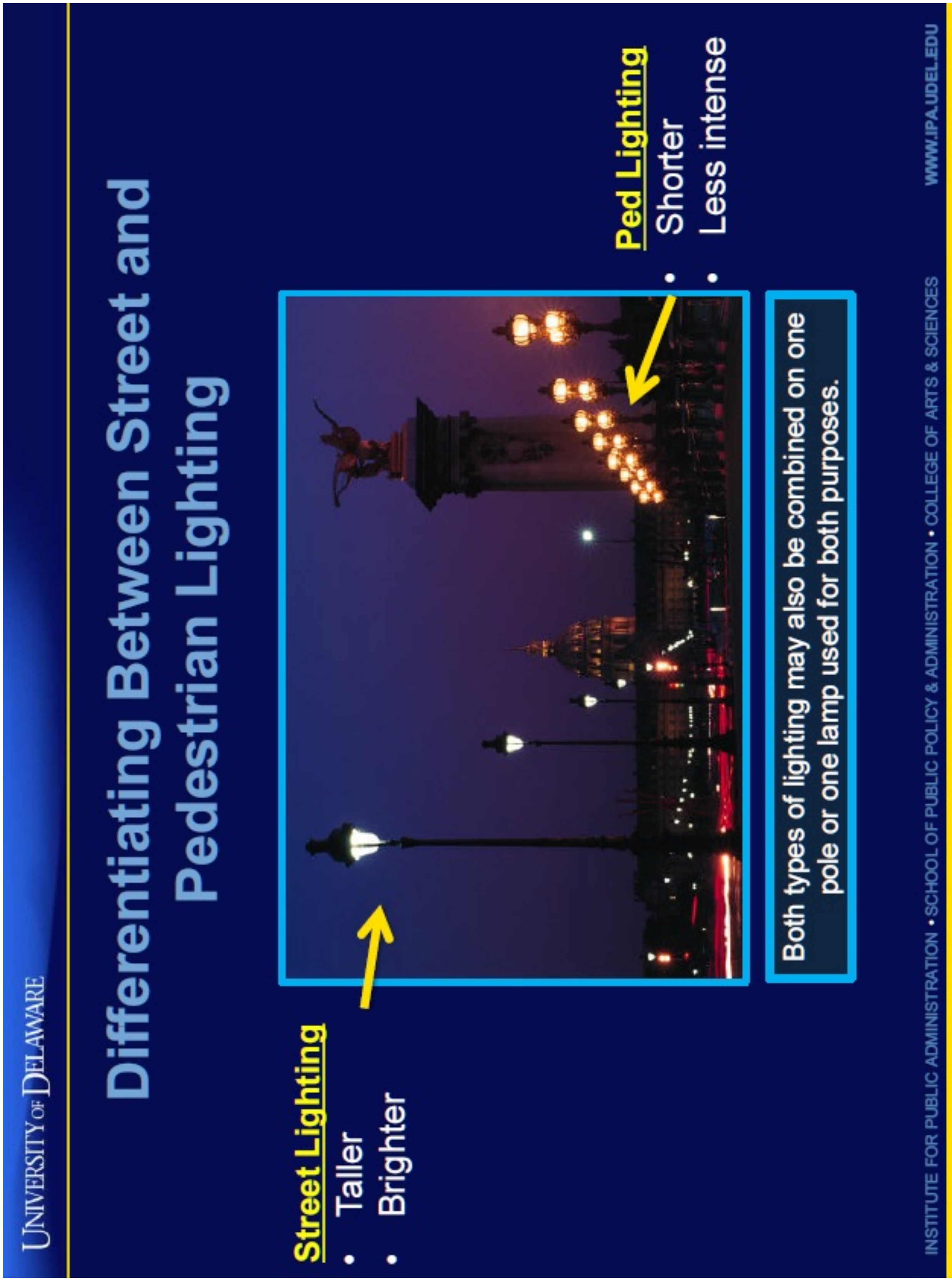
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Differentiating Between Street and Pedestrian Lighting
Street Lighting
• Taller
• Brighter
Ped Lighting
• Shorter
• Less intense
Both types of lighting may also be combined on one pole or one lamp used for both purposes.
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Changing Technology
www.ledlightmall.com
http://www.neptunlight.com
www.1000bulbs.com
Incandescent
High Pressure Sodium (HPS)/Metal Halide (MH)
LED and Induction
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Comparing Technology

Summary Table: Comparing Current Street Light Technologies

	High Pressure Sodium (HPS)	Metal Halide (MH)	Induction	Light-Emitting Diode (LED)
Bulb Cost (USD Estimate)	12	27	280	9-322
Est. Lumens Per Watt (Light Out Per Watt In)	100 www.1000bulbs.com	85 www.1000bulbs.com	92 www.getdeco.com	60 http://www.ledlight.com
Bulb Longevity (Est. Hours)	23,981	12,077	100,000	58,823
Color Temperature (Est.)	2000	3000-4000	5000	5000
Color Rendering Index (Est.)	20-30	60-80	70-90	70-80

Data from "Life Cycle Assessment of Streetlight Technologies," University of Pittsburgh 2009, Except Lumens per Watt Row

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Green Technology

Plasma Lighting

www.Luxim.com

Plasma Technology	
Bulb Cost	High
Bulb Longevity (Est. Hours)	30000
Color Temp (Est.)	5300-6000
CRI (Est.)	95

Wind/Solar Power

sunworth.en.made-in-china.com

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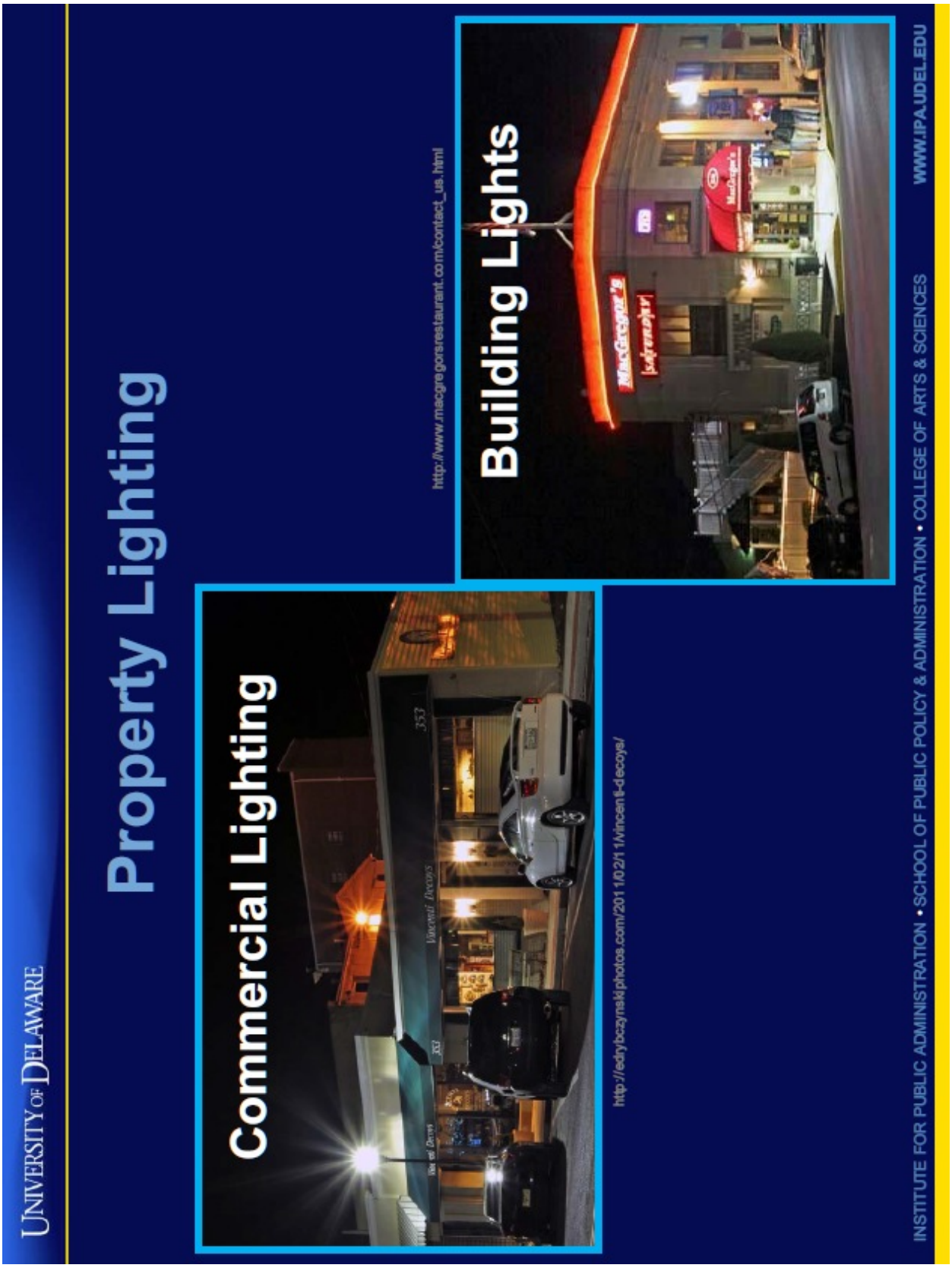
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Property Lighting
Commercial Lighting
http://edrybczynski.photos.com/2011/02/11/vincent-decoys/
Building Lights
http://www.macgregorsrestaurant.com/contact_us.html
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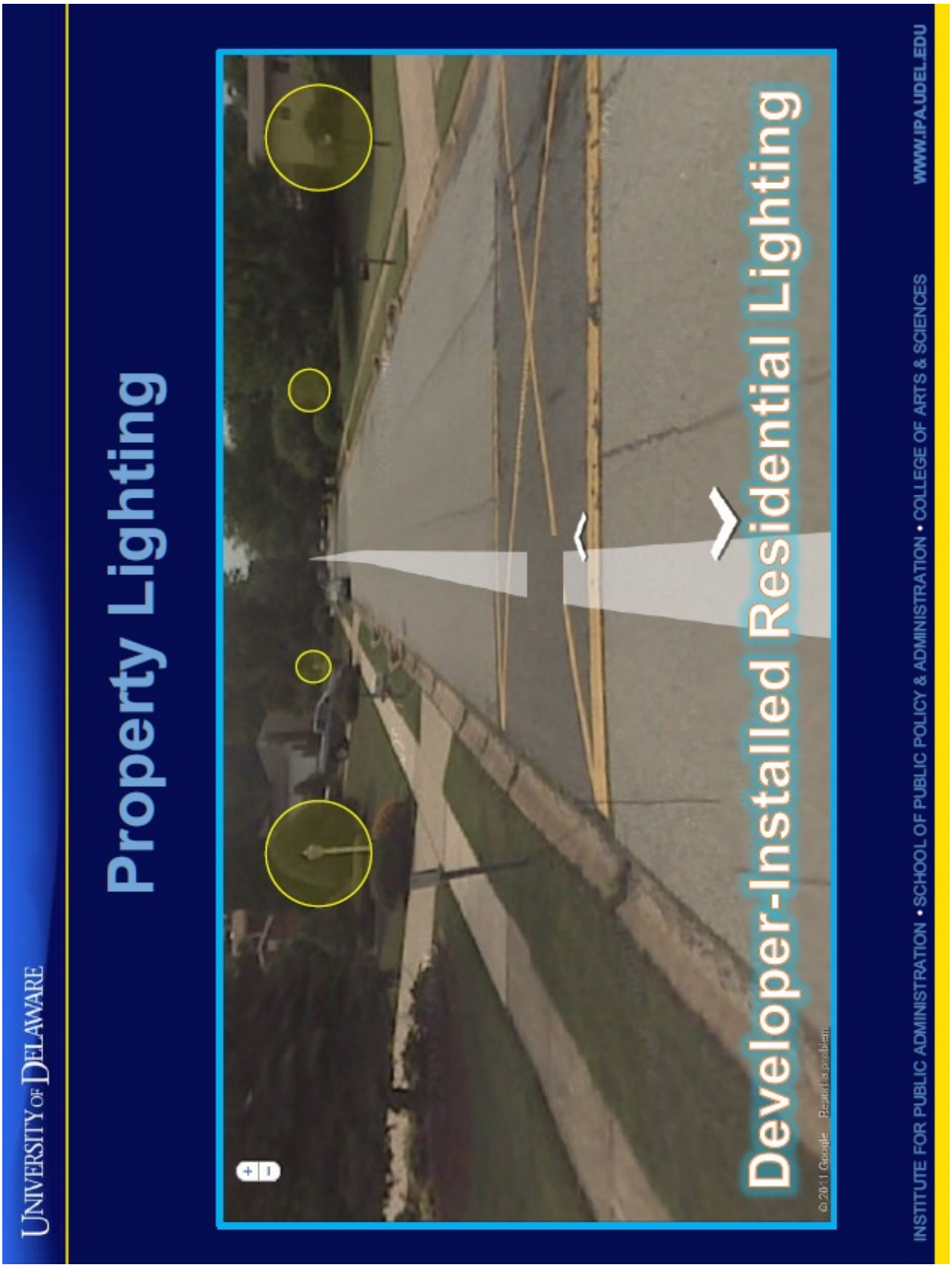
Property Lighting
Developer-Installed Residential Lighting
© 2011 Google
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Property Lighting
Dimensions
Light & Battery
Warranty
Included
Height: 25"
Width: 10.5"
(8) 10MM LED's
(1) Li-Ion 3.2V
1 Year MFG
- Light
- Battery
- Mounting Screws
Brightness = 55 Watt Equivalent
$200
The Flat Mount Base Measures
5.75 by 5.75 inches
Convert your lamp post to solar!
Pole Mount Fits Standard 3" Poles
Outdoor SolarStore.com
http://www.outdoorsolarstore.com/imperial-eagle-solar-lamp-post-light.aspx
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Mitigating Light Pollution

http://www.sdaa.org/images/cityLightsLg.jpg

"Scientists have known for decades that migratory birds -- from warblers to sparrows -- get disoriented after sundown by city lights, sometimes with deadly consequences."

-Delaware News Journal, "Delaware wildlife: Birds blinded by the light," March 17, 2011

Light Pollution - Any adverse effect of manmade light (Often used to denote urban sky glow)

(International Dark-Sky Association Definition)

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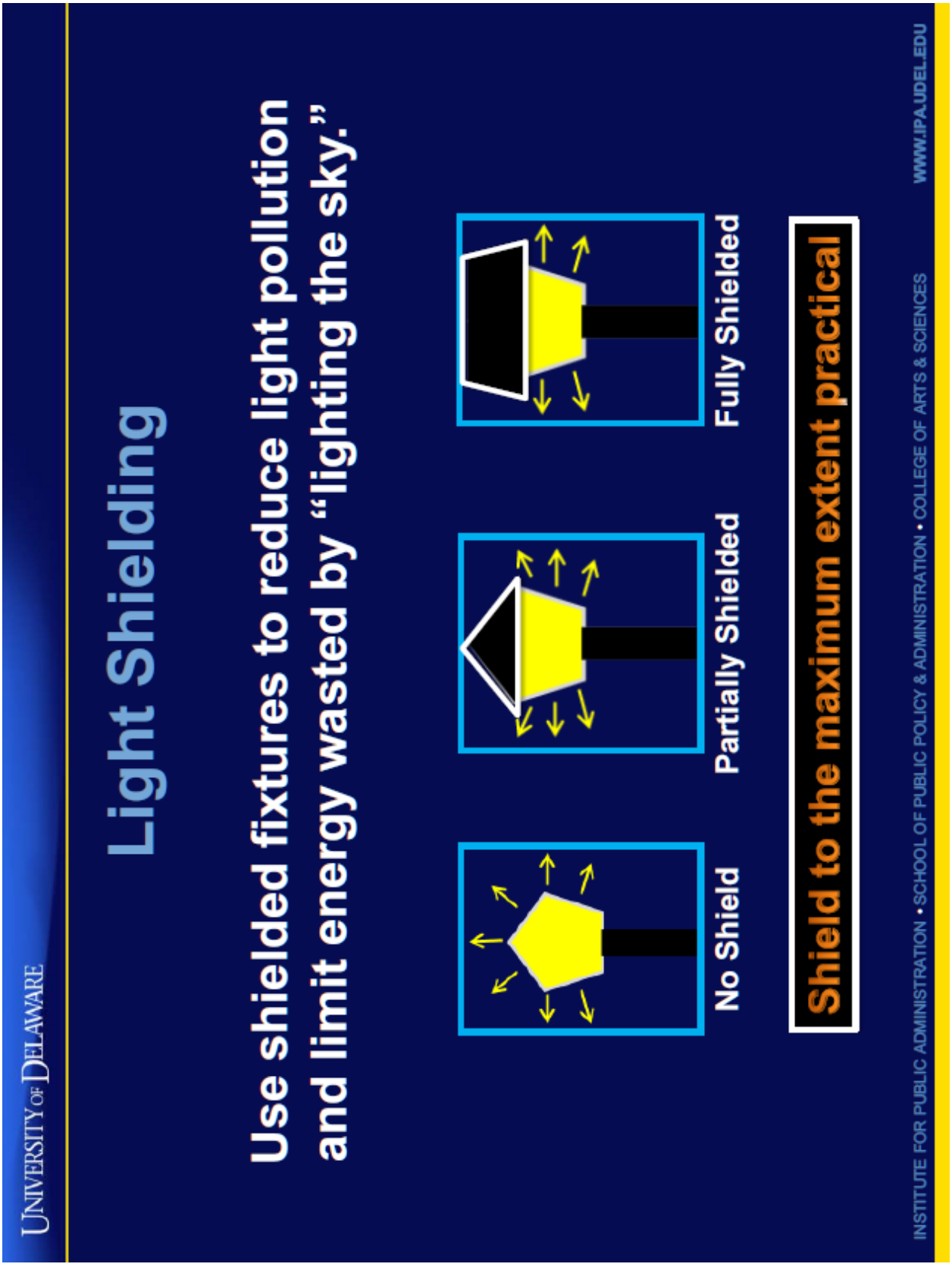
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Light Shielding
Use shielded fixtures to reduce light pollution and limit energy wasted by "lighting the sky."
No Shield
Partially Shielded
Fully Shielded
Shield to the maximum extent practical
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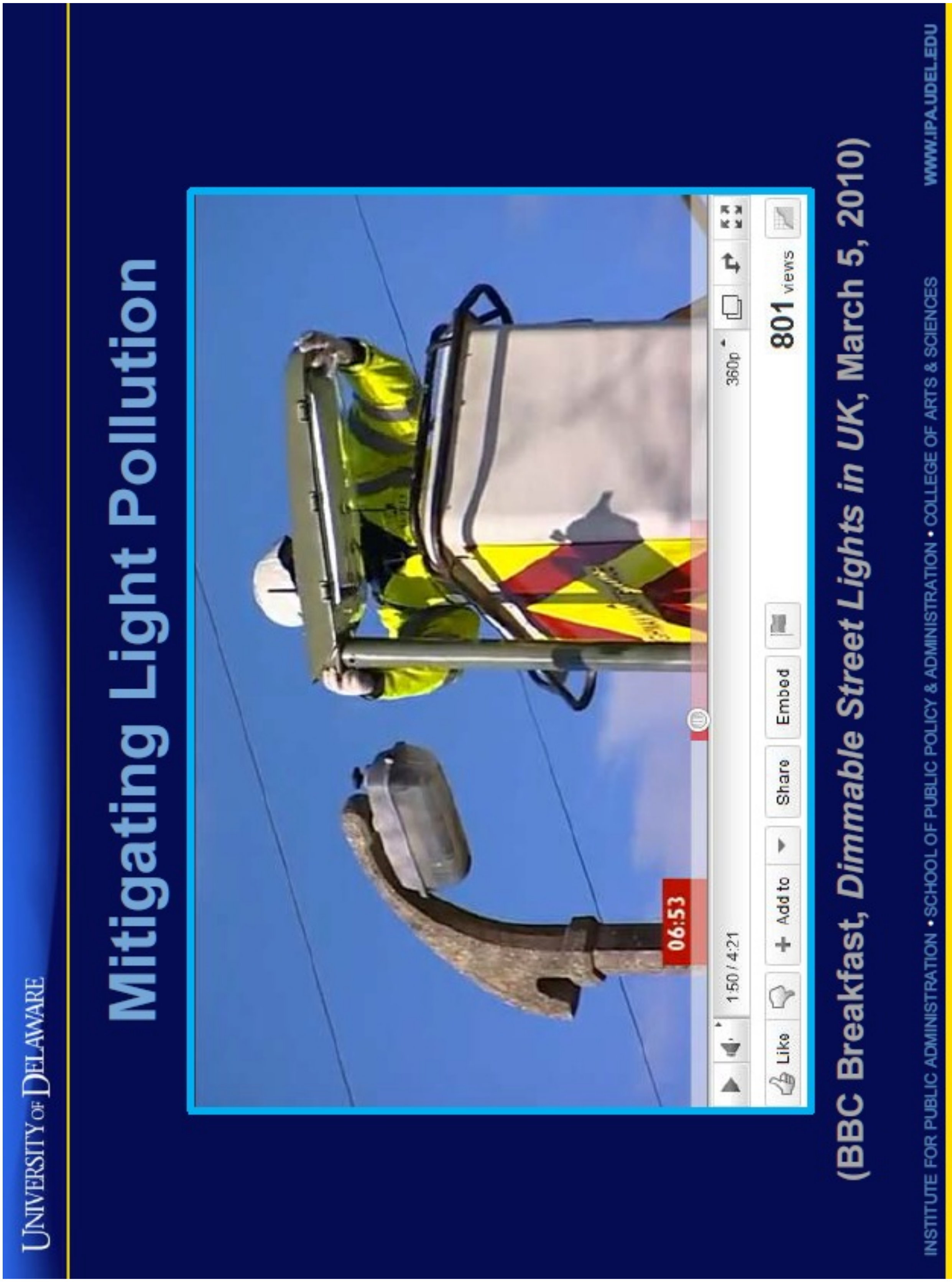
University of Delaware
Mitigating Light Pollution
06:53
1:50 / 4:21
360p
Like
Add to
Share
Embed
801 views
(BBC Breakfast, Dimmable Street Lights in UK, March 5, 2010)
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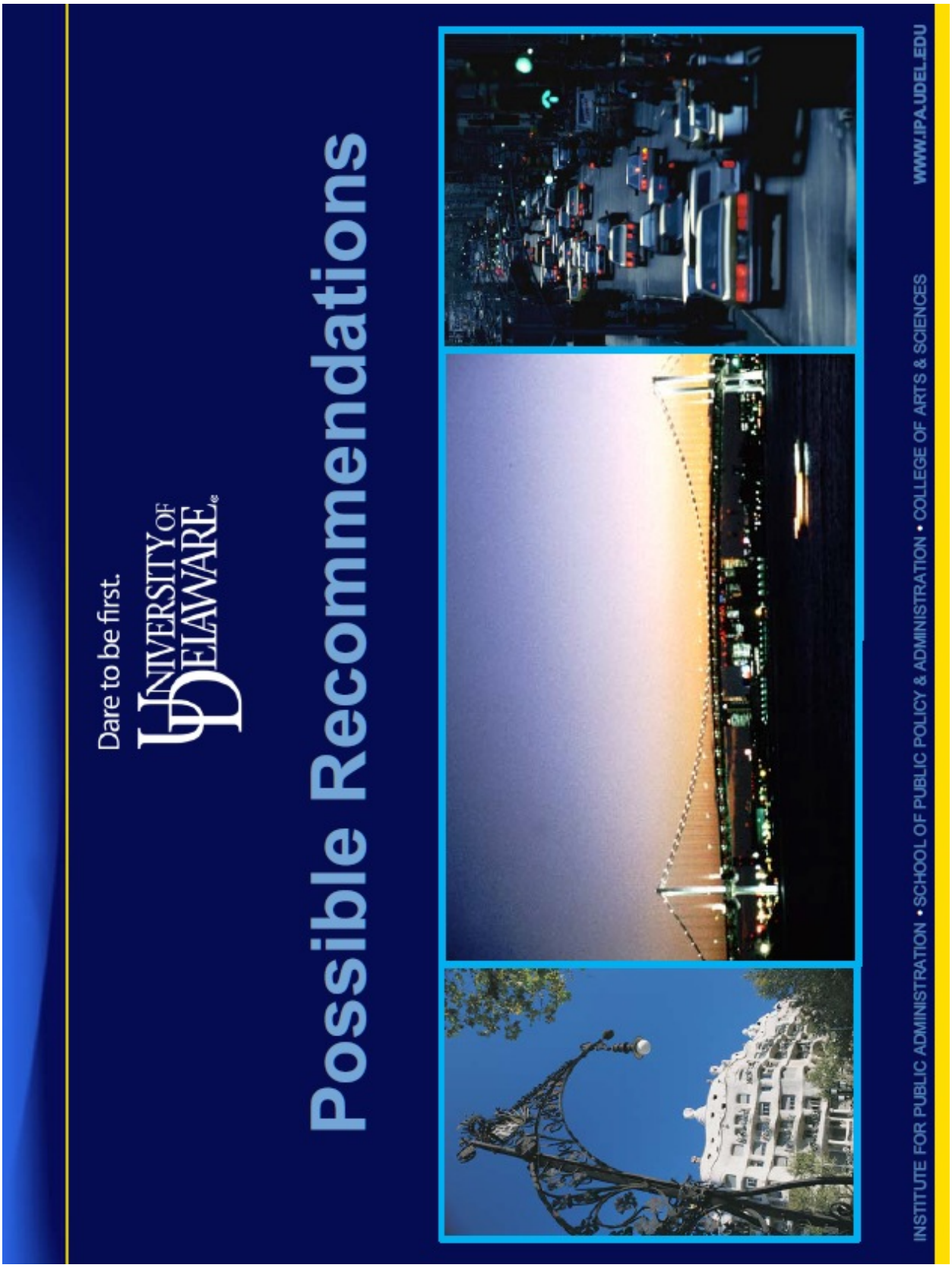
Possible Recommendations
Dare to be first.
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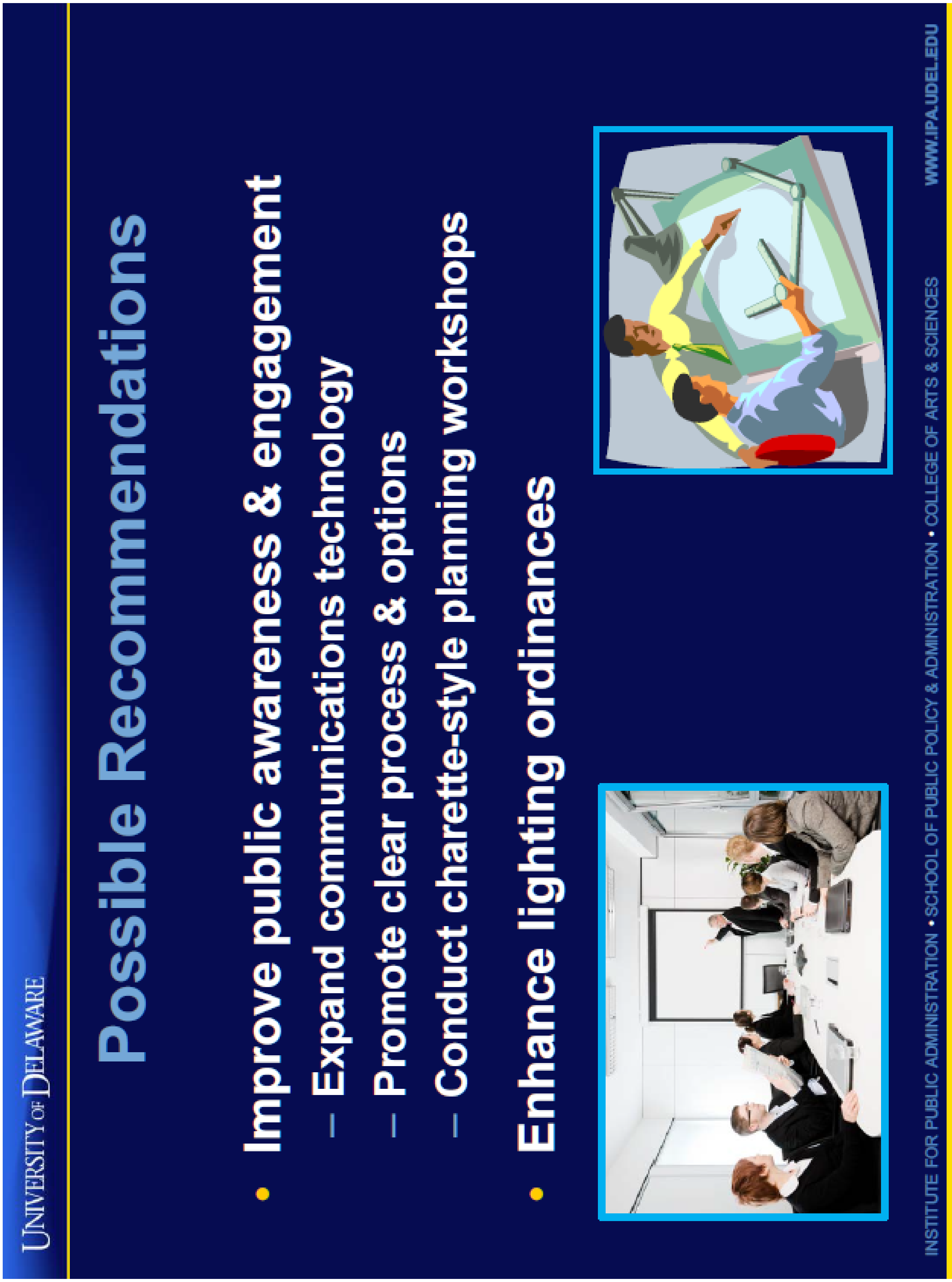
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Possible Recommendations
• Improve public awareness & engagement
– Expand communications technology
– Promote clear process & options
– Conduct charette-style planning workshops
• Enhance lighting ordinances
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Possible Recommendations

- Integrate language into comprehensive plans, hometown overlays, design guidelines
- Consider incentives for installation
- Develop lighting plans for targeted areas
  - Inventory lighting
  - Identify needs
  - Assess costs

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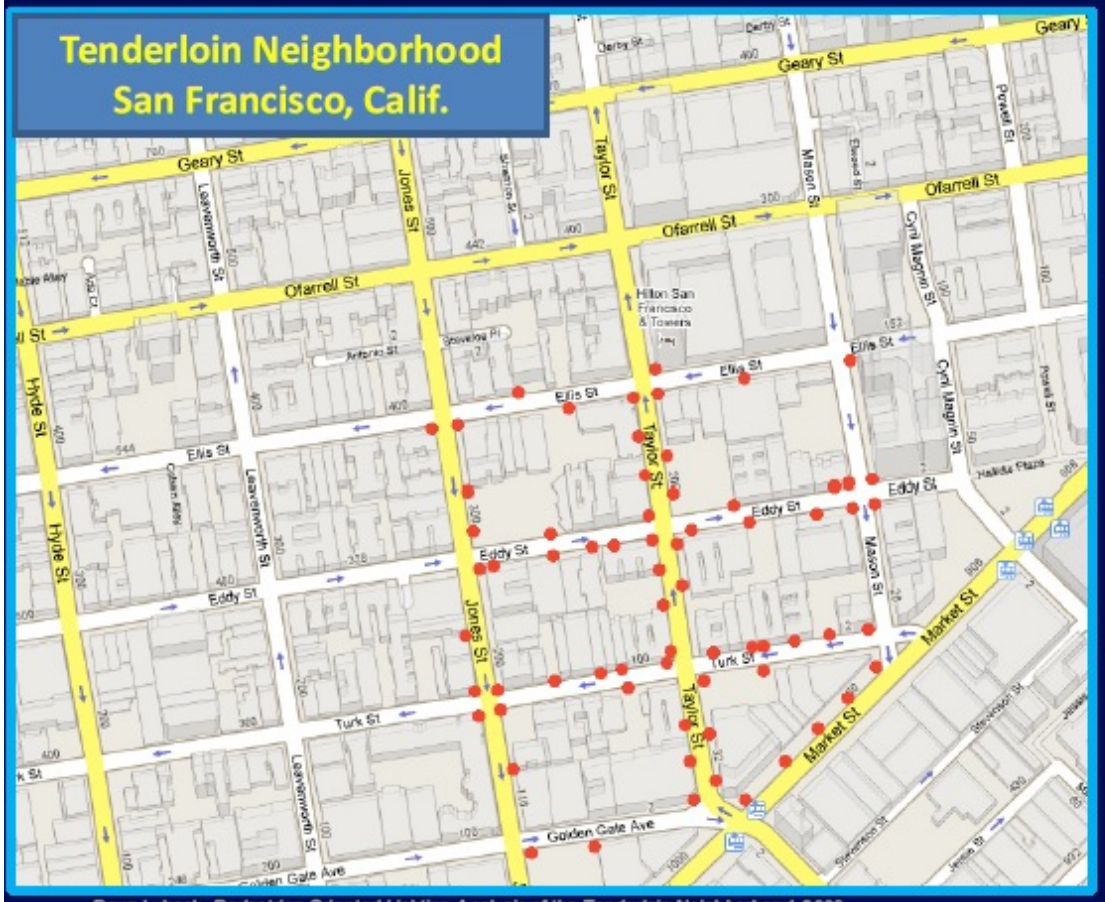
Criteria for Determining Lighting Needs



-City street lighting is automobile focused

-Lamps are irregularly spaced

-Approx 80% of existing stock is functioning

Doug Lybeck, *Pedestrian Oriented Lighting Analysis of the Tenderloin Neighborhood*, 2009

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Criteria for Determining Lighting Needs
Tenderloin Neighborhood
San Francisco, Calif.
-Informal stock is owned, operated and maintained by individual property owners.
-Designed to illuminate sidewalk and storefronts
-Extreme irregularity in quality, spacing, and functionality
- Approx 60% of existing stock is functional
Geary St
Ofarrell St
Ellis St
Eddy St
Turk St
Golden Gate Ave
Market St
Powell St
Cyril Magnin St
Mason St
Taylor St
Jones St
Leavenworth St
Hyde St
Doug Lybeck, Pedestrian Oriented Lighting Analysis of the Tenderloin Neighborhood, 2009
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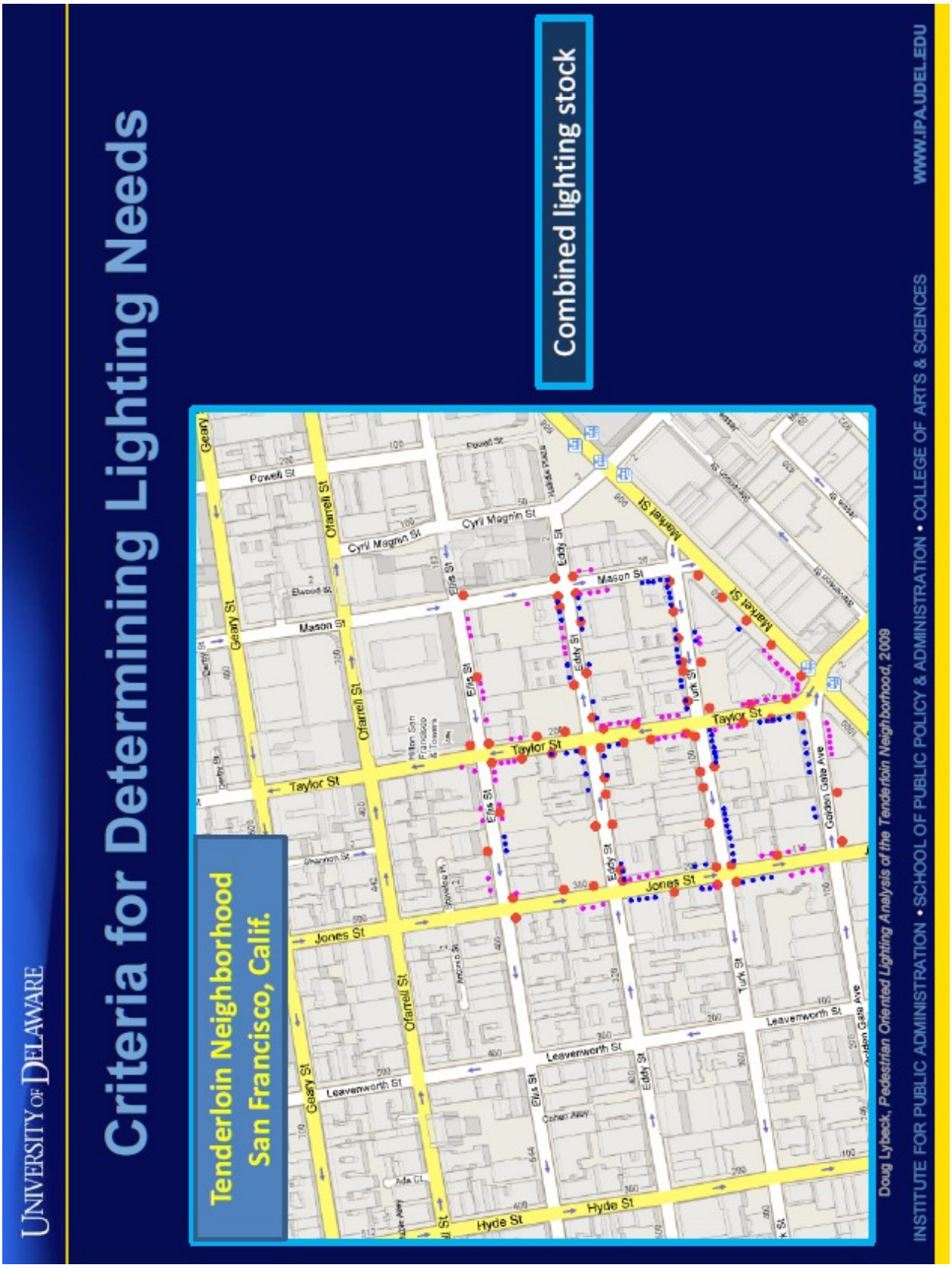
Criteria for Determining Lighting Needs
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Tenderloin Neighborhood
San Francisco, Calif.
Combined lighting stock
Geary
Powell St
Ofarrell St
Cyril Magnin St
Mason St
Taylor St
Jones St
Leavenworth St
Hyde St
Ellis St
Eddy St
Turk St
Golden Gate Ave
Market St
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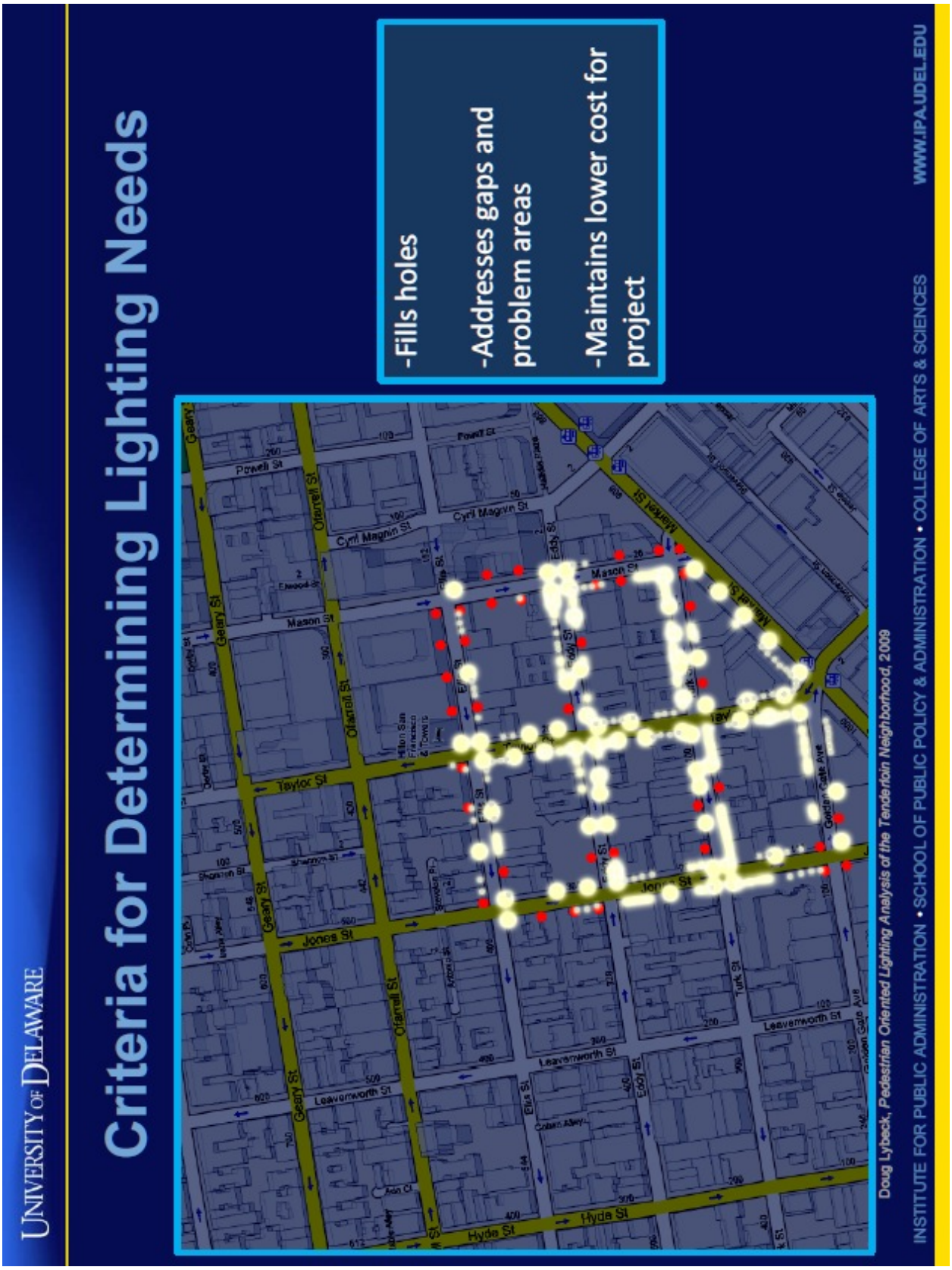
Criteria for Determining Lighting Needs
-Fills holes
-Addresses gaps and problem areas
-Maintains lower cost for project
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Doug Lybeck, Pedestrian Oriented Lighting Analysis of the Tenderloin Neighborhood, 2009
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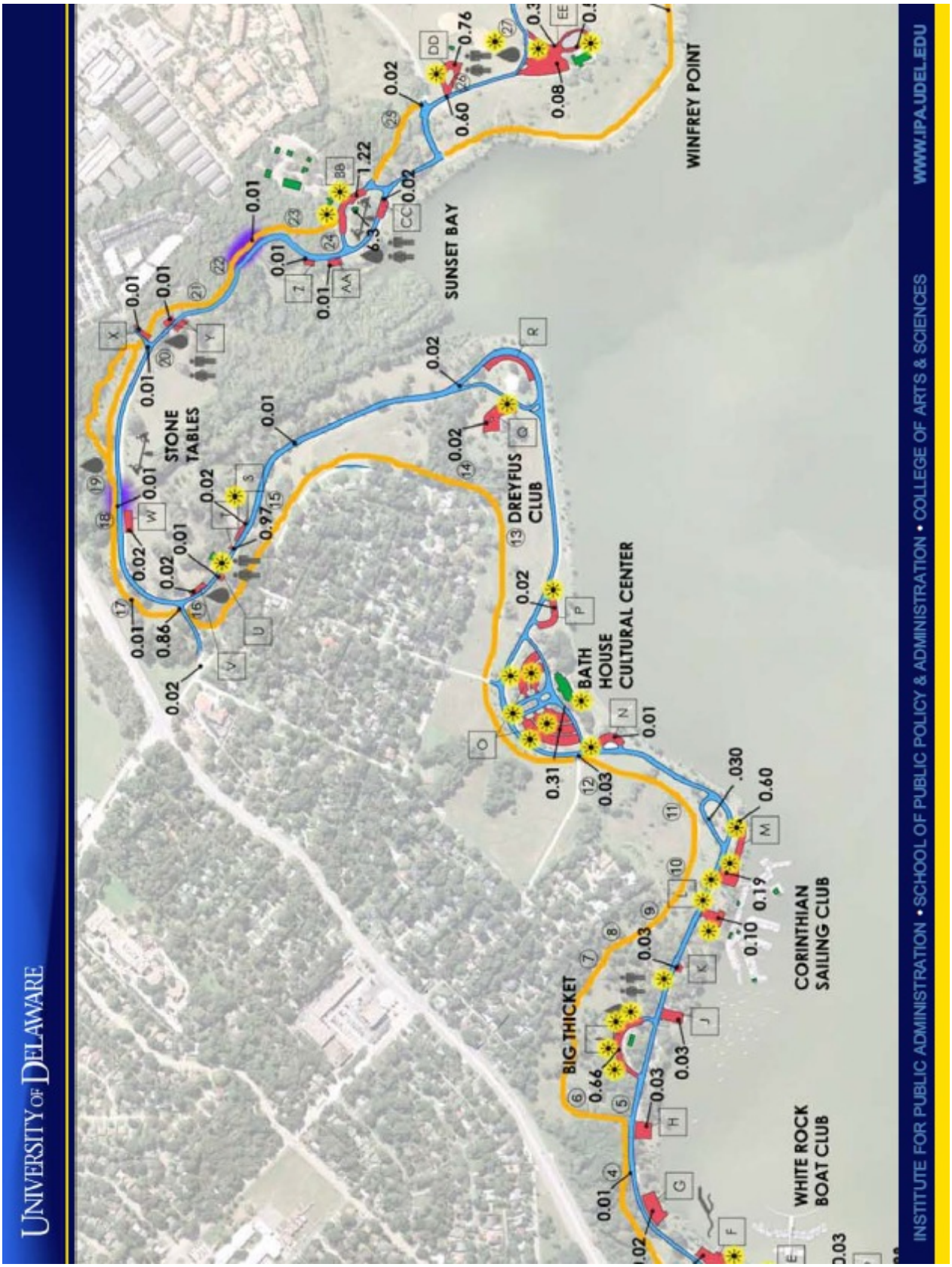
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WINFREY POINT
SUNSET BAY
STONE TABLES
DREYFUS CLUB
BATH HOUSE
CULTURAL CENTER
BIG THICKET
WHITE ROCK BOAT CLUB
CORINTHIAN SAILING CLUB
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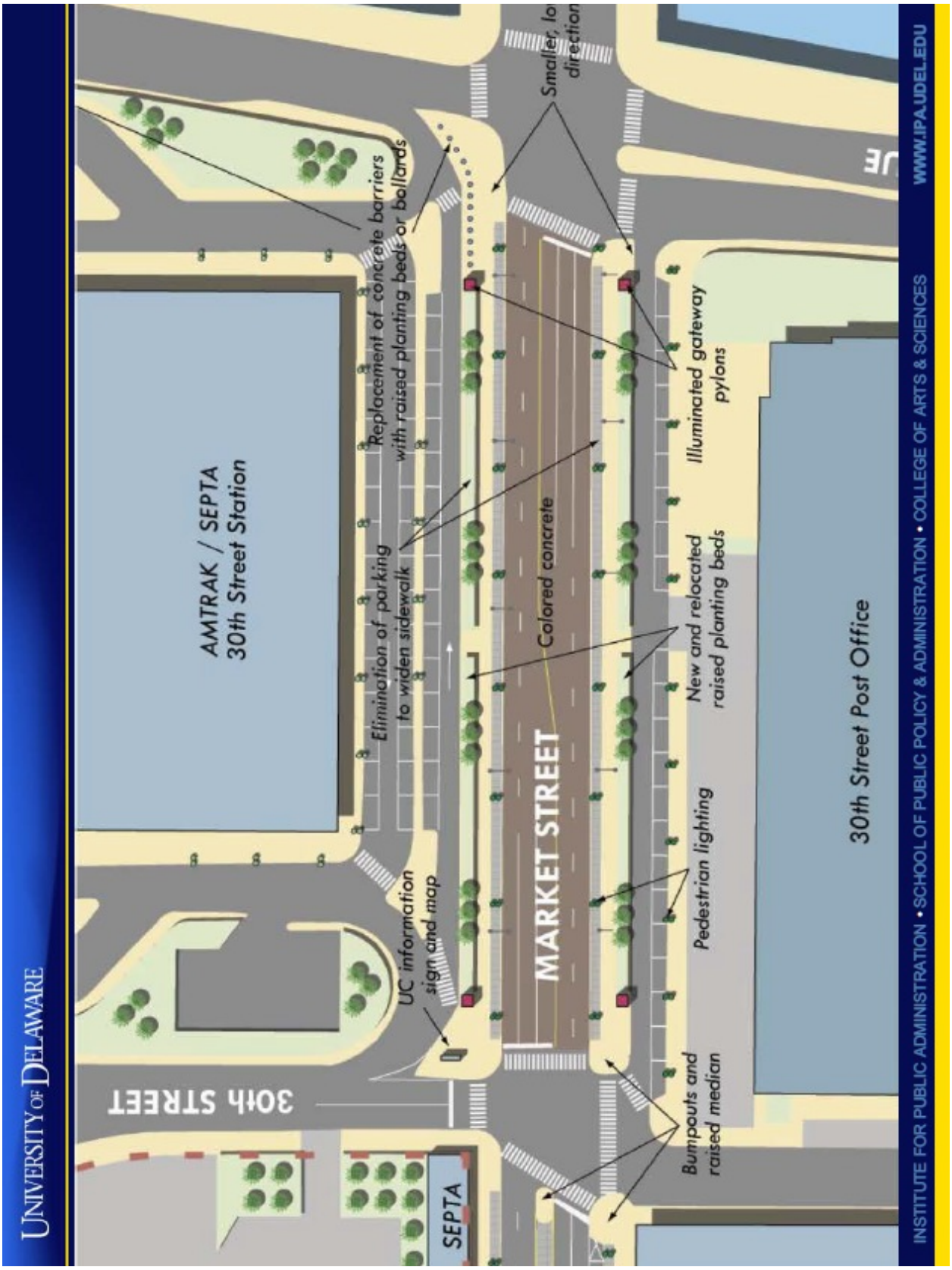
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AMTRAK / SEPTA
30th Street Station
Replacement of concrete barriers with raised planting beds or bollards
Smaller, lo
direction
Elimination of parking to widen sidewalk
Colored concrete
MARKET STREET
Illuminated gateway pylons
New and relocated raised planting beds
Pedestrian lighting
30th Street Post Office
UC information sign and map
30th STREET
SEPTA
Bumpouts and raised median
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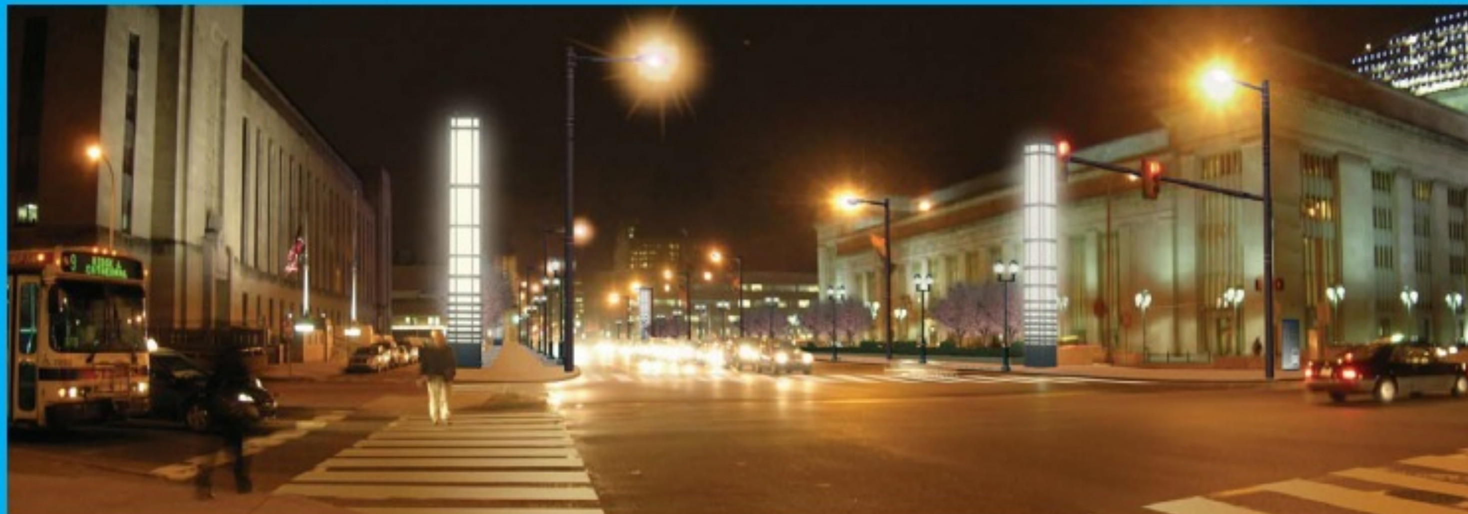

ITEM	UNIT PRICE	QUANTITY		COST	RESPONSIBLE PARTY
Widened and rebuilt sidewalks	$100 / sq. yd.	3,000 sq. yd.		$300,000	UCD / Penn / AMTRAK / Streets Dept.
Granite curbs	$80 / linear ft.	2,300 linear ft.		$184,000	UCD / Penn / AMTRAK / Streets Dept.
Belgian block edging	$250 / sq. yd.	450 sq. yd.		$112,500	UCD / Penn / AMTRAK / Streets Dept.
Movement of sewer intakes	$7,500 ea.	6		$45,000	UCD / Penn / AMTRAK / Streets Dept.
"Brown round" stoplights and poles	n/a	2		n/a	Streets Dept.
"Brown round" streetlamps	n/a	10		n/a	Streets Dept.
Pedestrian lighting, incl. hookups	$10,000 ea.	16		$160,000	UCD / Streets Dept.
Finger posts fitted for ped. lamp	$5,000 ea.	1		$5,000	UCD
Banners for street lamps	$750 ea.	10		$7,500	UCD
Crosswalk striping	n/a			n/a	Streets Dept.
Bollards	$1,500 ea.	40		$60,000	AMTRAK
Concrete planting bed	$500 / cu. yd.	124		$62,000	UCD / Penn / AMTRAK
Granite facing	$80 / sq. ft.	3,400		$272,000	
Planter soil mix	$40 / cu. yd.	352		$14,080	UCD / Penn / AMTRAK
Plantings	$40,000			$40,000	UCD / Penn / AMTRAK
Lighted gateway pylons and installation	$60,000 ea.	4		$240,000	UCD / Penn / AMTRAK
SUBTOTAL				$1,502,080	
Contingency			15%	$225,312	
CONSTRUCTION TOTAL				**$1,727,392**	
Design and engineering			10%	$172,739	
CONSTRUCTION and DESIGN TOTAL				**$1,900,131**	

Kise, Straw, & Kolodner Inc., *University City District Gateway Study: Welcome to University City*, (Philadelphia: University City District, 2007).

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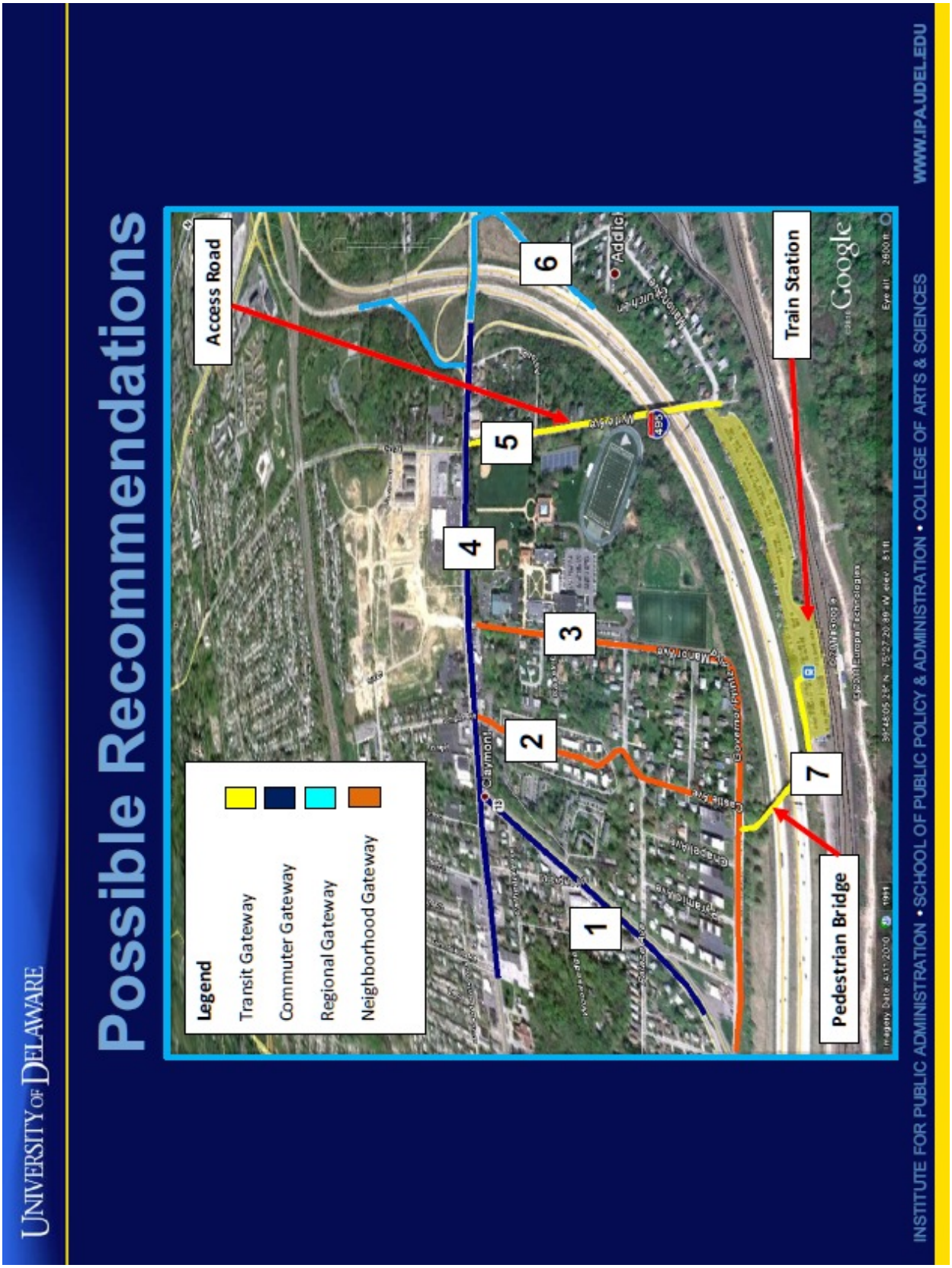
Possible Recommendations

Creating a Lighting Plan

- **Claymont Application**
  - Unincorporated Community
  - Potential TOD / Hub
  - Several gateways to Claymont community
  - Dominated by cobra head lighting


Possible Recommendations
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Legend
Transit Gateway
Commuter Gateway
Regional Gateway
Neighborhood Gateway
Access Road
Train Station
Pedestrian Bridge
1
2
3
4
5
6
7
Google
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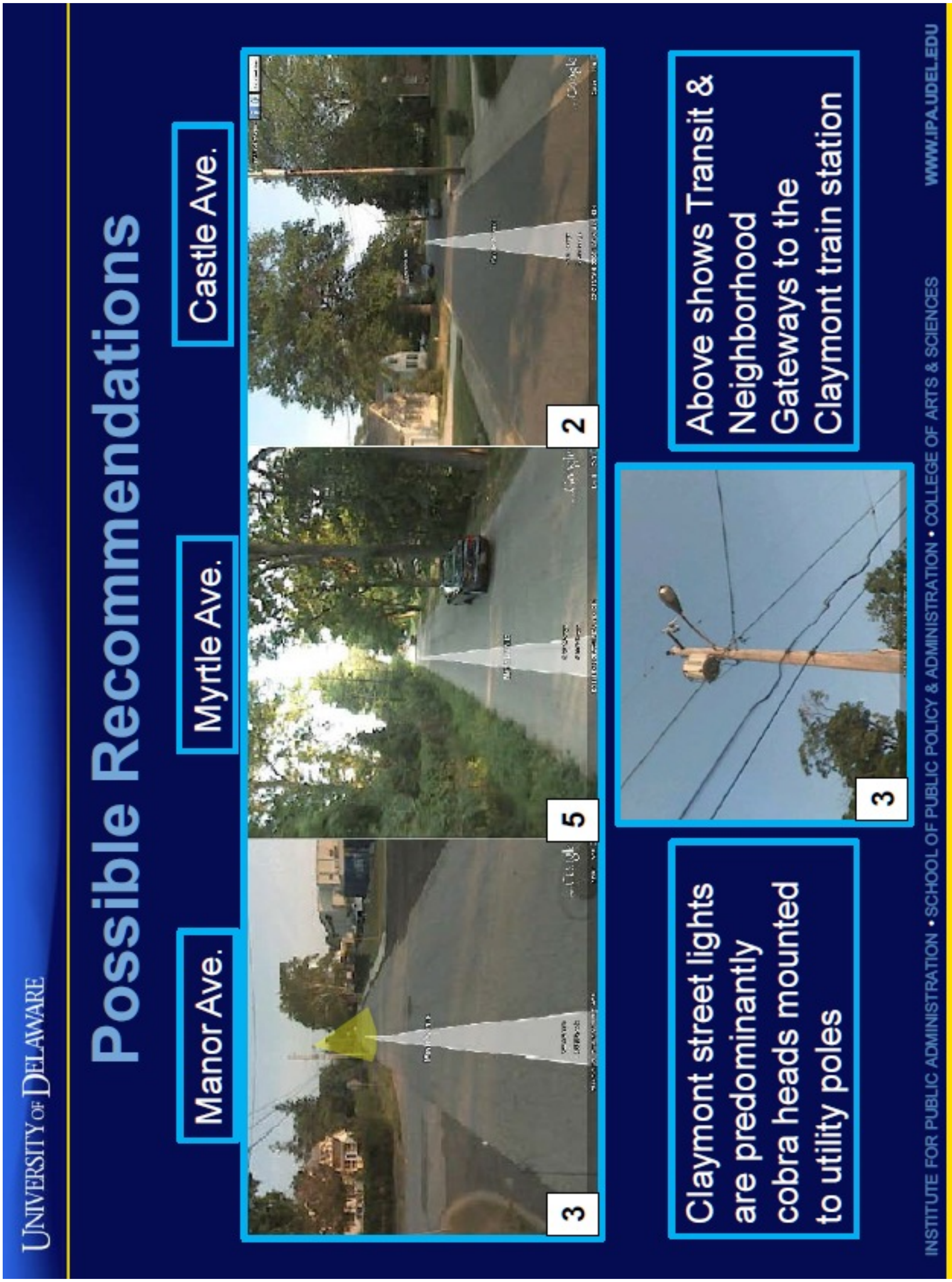
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Possible Recommendations
Manor Ave.
Myrtle Ave.
Castle Ave.
3
5
2
3
Claymont street lights are predominantly cobra heads mounted to utility poles
Above shows Transit & Neighborhood Gateways to the Claymont train station
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Possible Recommendations
Train Station
7
Conduct picture surveys to identify strengths & weaknesses
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Possible Recommendations
7
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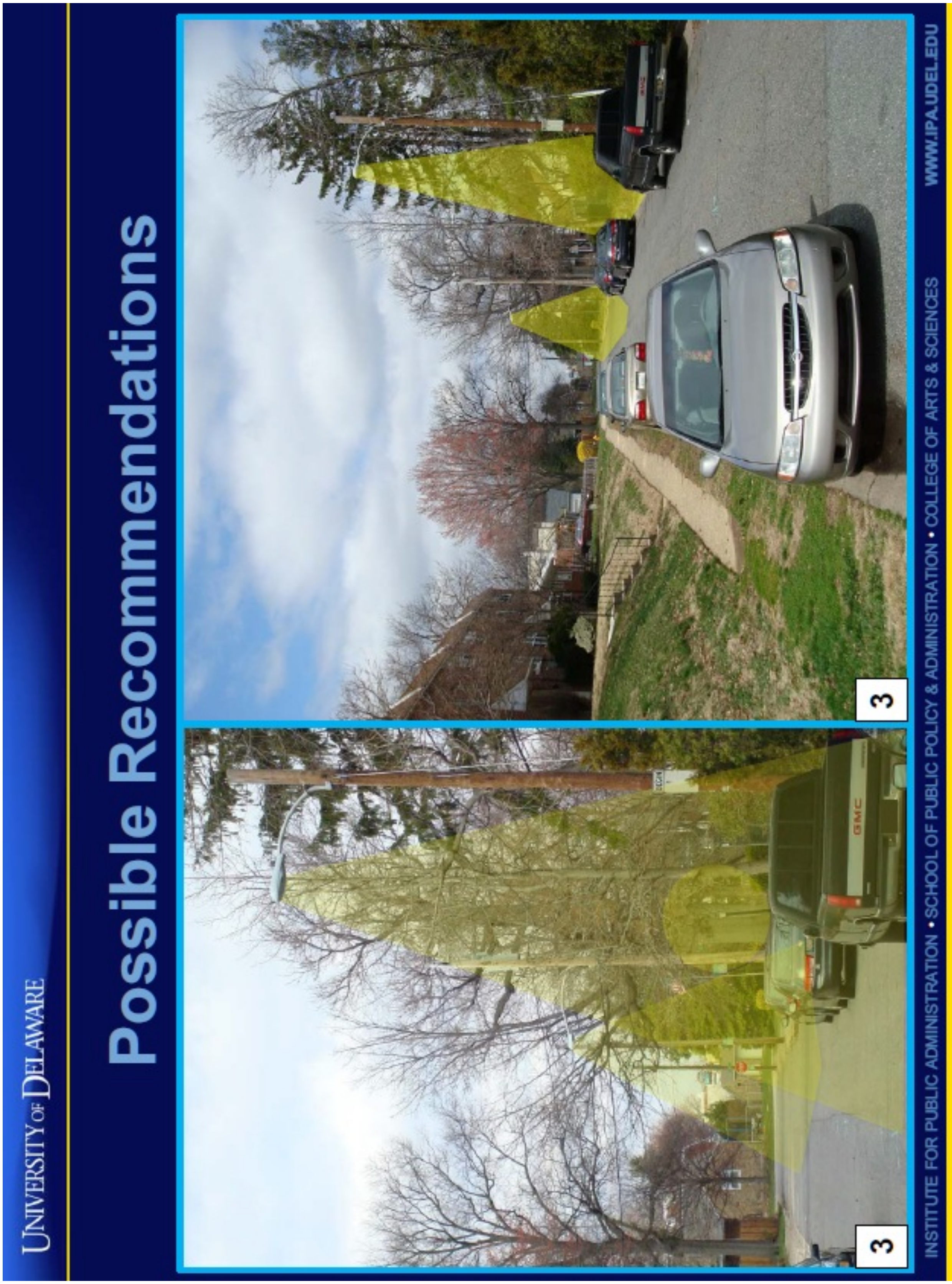
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Possible Recommendations
3
3
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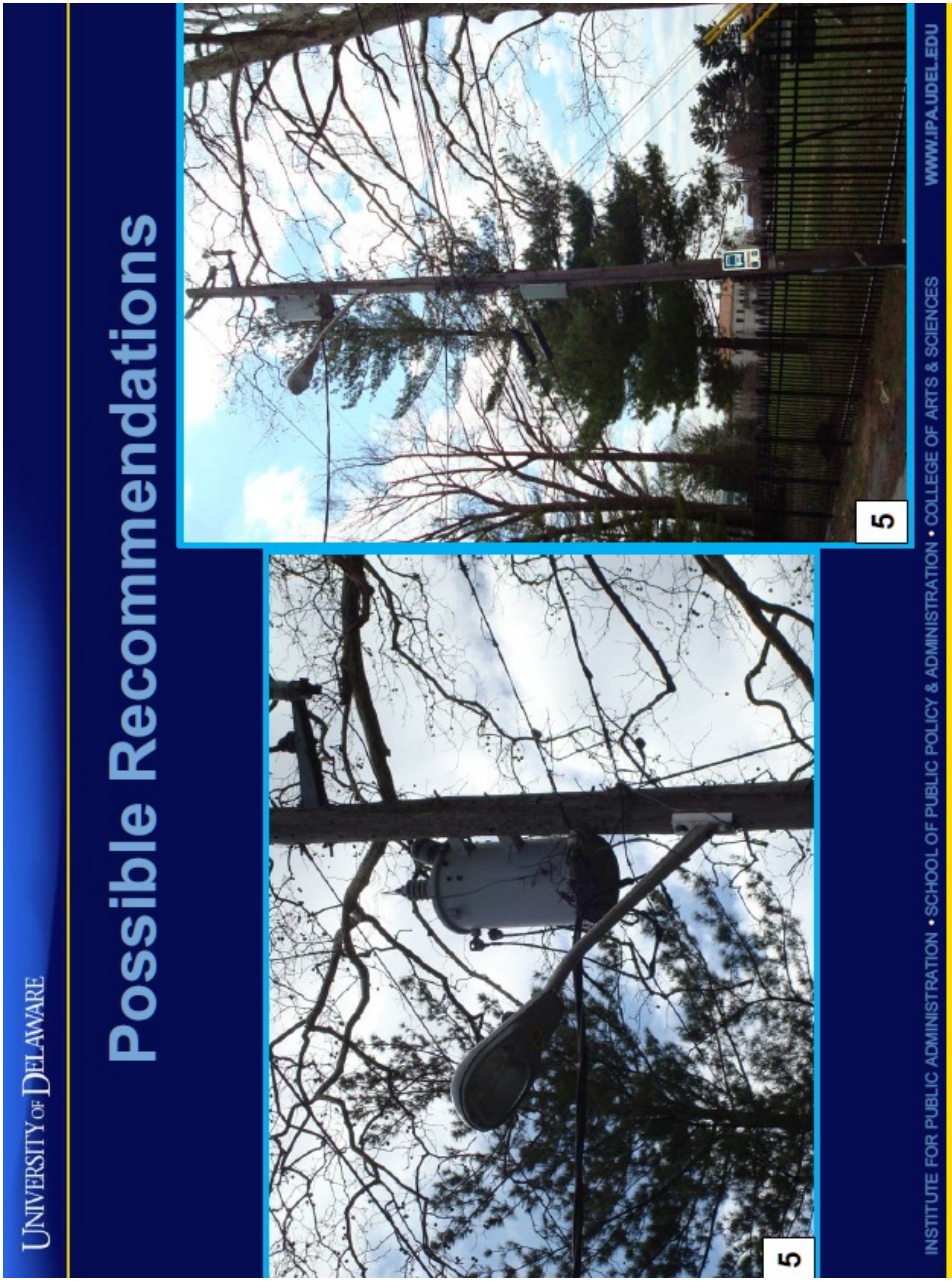
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Possible Recommendations
5
5
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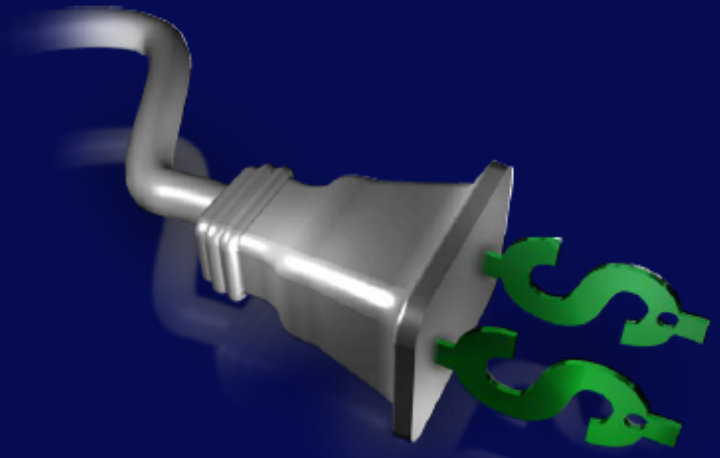
Financing Pedestrian Lighting

- Light tax districts & special taxing districts
- Transportation impact fees & excise taxes
- Adequate Public Facilities Ordinances (APFOs)
- Tax increment financing
- Grant Funding



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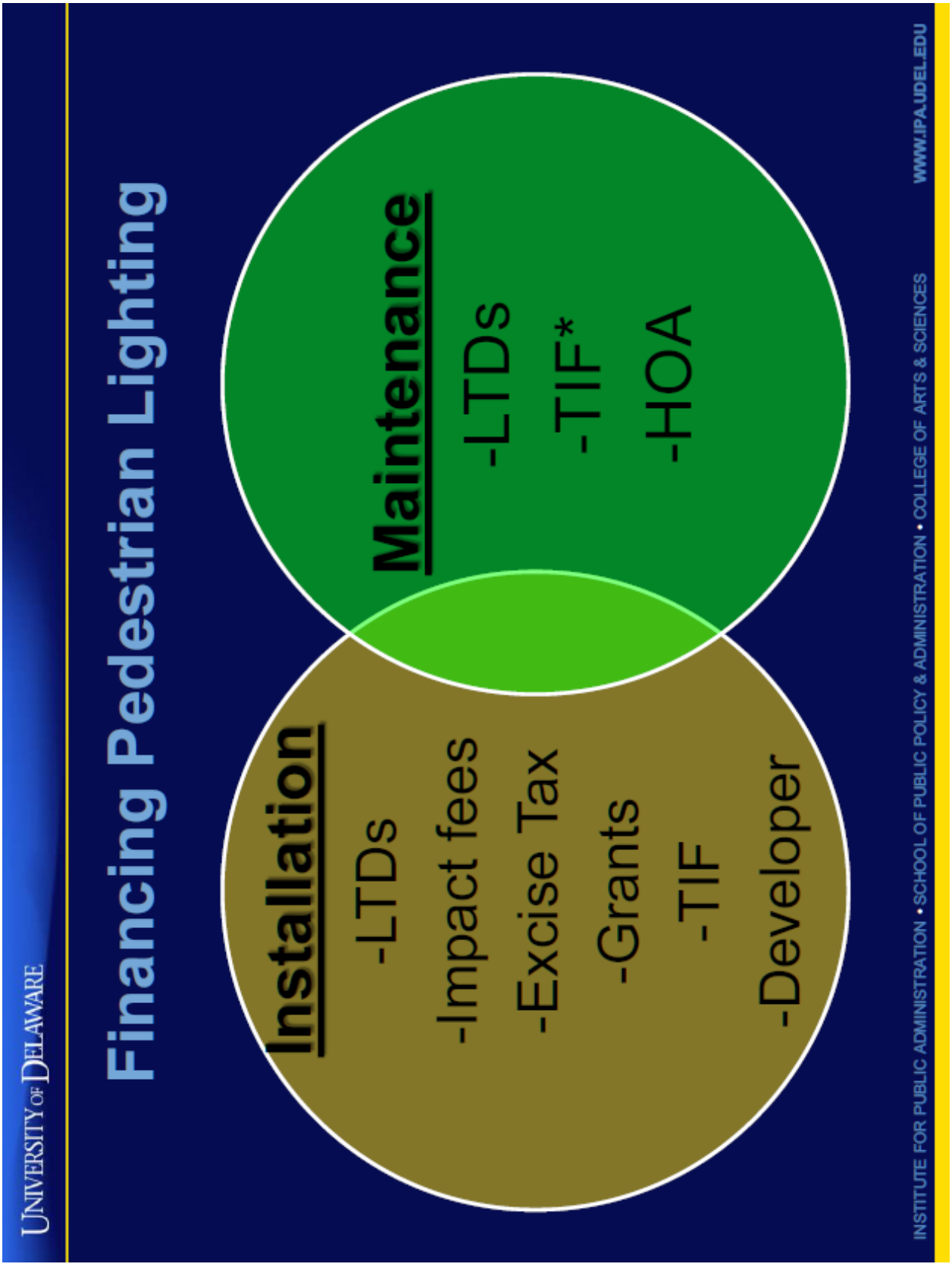
Financing Pedestrian Lighting
Installation
-LTDs
-Impact fees
-Excise Tax
-Grants
-TIF
-Developer
Maintenance
-LTDs
-TIF*
-HOA
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Possible Recommendations
WHAT ARE PEOPLE SAYING?
"County govt. could conduct night-time surveys"
"Remind folks that keeping front door lights lit-with day/night sensors--is cheaper than utility/government action"
"Electric companies and county govt. could assist with cost of initial installation"
"Encourage residents to install day/night sensors and compact fluorescent bulbs on front door lights"
"Should be handled by individual homeowners, not HOA"
"Provide incentives to HOAs"
"INSTALL SOLAR STREET LIGHTS– OFF THE GRID"
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Dare to be first.
University of Delaware
Workshop Discussion
Topics
1. Criteria for determining lighting needs
2. Financing Mechanisms for Installation / Maintenance
3. Light Fixtures, Shielding, & Green Technology
4. Possible Recommendations & Best Practices
5. Moving Forward & Next Steps
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Appendix 10: International Dark Sky Assocation Regulations for Small Communities

International Dark Sky Association: Simple Guidelines for Lighting Regulations for Small Communities, Urban Neighborhoods, and Subdivisions

The purpose of the regulation is to:

- ✓ Permit reasonable uses of outdoor-lighting for nighttime safety, utility, security, and enjoyment while preserving the ambiance of the night;
- ✓ Curtail and reverse any degradation of the nighttime visual environment and the night sky;
- ✓ Minimize glare and obtrusive light by limiting outdoor-lighting that is misdirected, excessive, or unnecessary;
- ✓ Conserve energy and resources to the greatest extent possible;
- ✓ Help protect the natural environment from the damaging effects of night lighting.

All outdoor-lighting fixtures (luminaires) shall be installed in conformance with this Regulation and with the provisions of the Building Code, the Electrical Code, and the Sign Code, as applicable and under permit and inspection, if such is required.

Comment: Practical Considerations

1. The idea that more light always results in better safety and security is a myth. One needs only the right amount of light, in the right place, at the right time. More light often means wasted light and energy.
2. Use the lowest wattage of lamp that is feasible. The maximum wattage for most commercial applications should be 250 watts of high intensity discharge lighting should be considered the maximum, but less is usually sufficient.
3. Whenever possible, turn off the lights or use motion sensor controlled lighting.
4. Incorporate curfews (i.e., turn lights off automatically after a certain hour when businesses close or traffic is minimal). This is an easy and fast way to initiate dark sky practices.

Maximum Lamp Wattage and Required Luminaire or Lamp Shielding:

All lighting installations shall be designed and installed to be fully shielded (full cutoff), except as in exceptions below, and shall have a maximum lamp wattage of 250 watts HID (or lumen equivalent) for commercial lighting, 100 watts incandescent, and 26 watts compact fluorescent for residential lighting (or approximately 1,600 lumens). In residential areas, light should be shielded such that the lamp itself or the lamp image is not directly visible outside the property perimeter.

Lighting that is exempt from these regulations:

1. Lighting in swimming pools and other water features governed by Article 680 of the National Electrical Code.

2. Exit signs and other illumination required by building codes.

3. Lighting for stairs and ramps, as required by the building code.

4. Signs are regulated by the sign code, but all sign lighting is recommended to be fully shielded.

5. Holiday and temporary lighting (less than thirty days use in any one year).

6. Football, baseball, and softball field lighting; only with permit from the authority recognizing that steps have been taken to minimize glare and light trespass, and utilize sensible curfews.

7. Low voltage landscape lighting, but such lighting should be shielded in such a way as to eliminate glare and light trespass.

Additional requirements:

1. Lighting attached to single-family home structures should not exceed the height of the eave.

2. Residential pole height restrictions can be considered to control light trespass on adjacent properties.

Notes:

1. The general belief that more light means better safety and security is just a myth. All that is needed is the right amount, in the right place, at the right time. More light just means wasted light and energy.

2. Use the lowest wattage of lamp as possible. For cost saving purposes, consider compact fluorescent lamps rather than incandescent, as they use much less energy and have a much longer lifetime.

3. Whenever possible, turn off the lights.

Defintions:

Glare: Intense and blinding light. Causes visual discomfort or disability.

Landscape lighting: Luminaries mounted in or at grade (but not more than 3 feet above grade) and used solely for landscape rather than any area lighting.

Obtrusive light: Spill light that causes glare, annoyance, discomfort, or loss of visual ability. Light-pollution.

Luminaire (light fixture): A complete lighting unit consisting of one or more electric lamps, the lamp holder, any reflector or lens, ballast (if any), and any other components and accessories.

Fully shielded (full cutoff) luminaire: A luminaire emitting no light above the horizontal plane.

Spill light: Light from a lighting installation that falls outside of the boundaries of the property on which it is located. Usually results in obtrusive light.

Other Resources for Establishing Outdoor-lighting Guidelines

Model Lighting Ordinance (MLO)
Recommended Outdoor-lighting Zones
IDA Lighting Code Handbook
Directory of Ordinances and Other Regulations
Glossary of Basic lighting Terms and Definitions

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