

City of Pittsburgh

LED Modernization Project

Special Considerations

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LED Modernization Project Special Considerations

Overview

Project Introduction



The LED Modernization Project made use of an extensive amount of existing data collected and maintained by the City of Pittsburgh and its partners.

Background

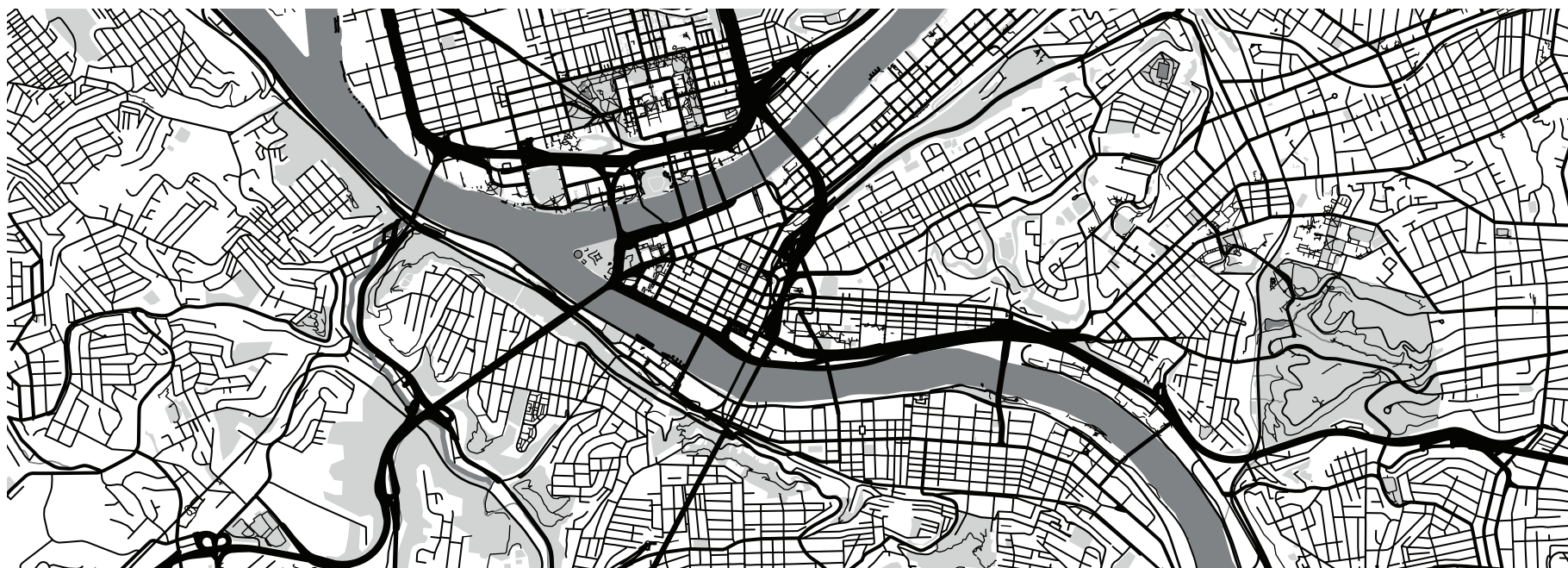
The City of Pittsburgh's LED Modernization Project represents the culmination of several years of planning, development, and design efforts intended to provide residents and visitors alike with a modern, energy efficient, and effective streetlight network that makes use of advances in lighting technology and analysis techniques to create better public spaces for all.

This document is intended to provide high-level insights into the relationship between streetlighting and the communities it serves. Through a series of conceptual analyses of existing data, the document presents a high-level summary of the community characteristics and concerns considered during the design process, with an eye towards providing an equitable approach to providing the benefits of an improved lighting network citywide.

By analyzing and reviewing these special considerations and incorporating them into the design and construction, the City and its residents will more fully enjoy the benefits of a lighting system that provides an appropriate level of illumination for the community and its needs, while lowering costs, protecting the city's investments, and achieving other City goals relating to public safety and energy efficiency.

Special Considerations

Construction projects such as this represent an opportunity to address historic inequities between the provision and quality of municipal services and populations considered marginalized. "Special considerations" refers to a way to identify, plan for, and improve the lives of these communities. Considerations were paid to gaps in the existing lighting, vulnerable populations, public safety, and other concerns. By prioritizing improvements in these areas, the City can ensure limited project resources are targeted to those locations and populations who stand to benefit the most from the timely and effective implementation of new and improved lighting infrastructure.



C

Collect

The City of Pittsburgh, along with its County and state governmental partners, maintains an extensive amount of data on its streetlight infrastructure. The first step in completing a comprehensive analysis is to bring all relevant data into a single environment for analysis.

M

Model

Using a custom modeling application, the horizontal illumination of an existing light fixture can be modeled and displayed alongside additional data to create a digital twin and comparison of old and new lights.

E

Enrich

The project team used a combination of field observations and desktop-based review of this data to append attributes of the City's streetlight data with roadway, parcel, and demographic information for use in modeling and analysis applications

A

Analyze

Once the modeling efforts are complete, a series of technical processes are conducted to examine relationships, if any, between the lighting environment and different community concerns. This is a great way to identify if new lights can help to address these concerns in a fair and context-appropriate way.

Lighting Network Overview



Older, more-established cities like Pittsburgh often feature lighting elements whose characteristics, conditions, and efficacy can vary significantly. This image represents a typical light scheduled for conversion to LED as part of this project.

Characteristics

The City maintains information on dozens of attributes for each of the 43,945 streetlight poles in its database citywide. However, the LED modernization project scope only involves the conversion of the City's existing 36,536 cobrahead-style high pressure sodium (HPS) lights. Decorative fixtures are excluded from the conversion at this time.

A key initial aspect of this project was to develop a single unified dataset from several generations and formats of utility and engineering data. This data was then standardized, geo-referenced to resolve location errors, and reviewed by technicians to ensure accuracy. Accurate data ensures a more effective conversion process, as it allows the City to order the correct amount of new lights, and assists contractors in completing the specific upgrades required at each location.

As with many older cities, the existing network is a mix of technologies, materials, and bulb types, owing to the dynamic and constantly-evolving ways cities provide illumination for their residents. Highlights of the network include:

Fixture Type - Streetlight fixtures fall into five main categories: Cobra (84%), No Light - Pole Only (6%), Acorn Post Top (6%), and Teardrop Pendant (3%), and Other (1%).

Lamp Type - Streetlight lamp/bulbs fall into two main categories: High Pressure Sodium (HPS - 82%) and Light Emitting Diode (LED - 10%). The remaining 8% of streetlights featured an Unknown bulb type.

Pole Type - Streetlight poles fall into five main categories: Light-only (81%), Non-Standard (9%), Signalized Intersection (6%), Trolley (2%), and Utility (1%), with the remaining 1% belonging to infrequent categories.

An illustration of the geographic distribution of these characteristics can be seen on page 7, and patterns of distribution emerge based on the land use and roadway characteristics of certain neighborhoods and streets, respectively.

Example Images



HPS Cobrahead on a wooden utility pole



HPS Cobrahead on an aluminum lightpole



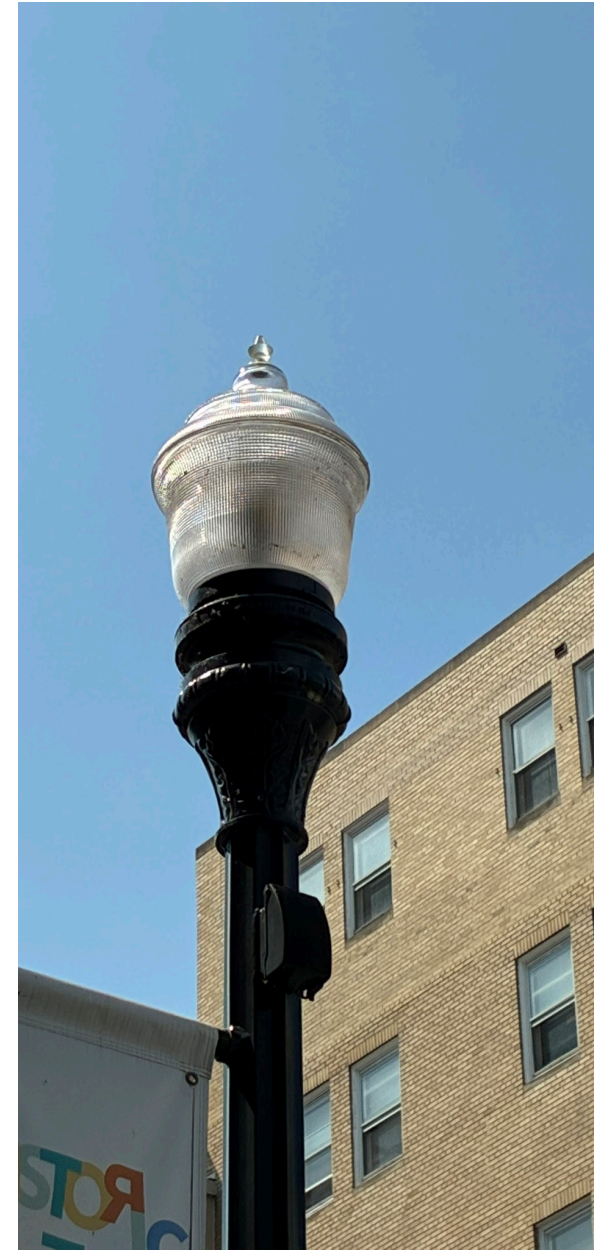
Typical trolley pole material and condition



LED Cobrahead on a wooden utility pole



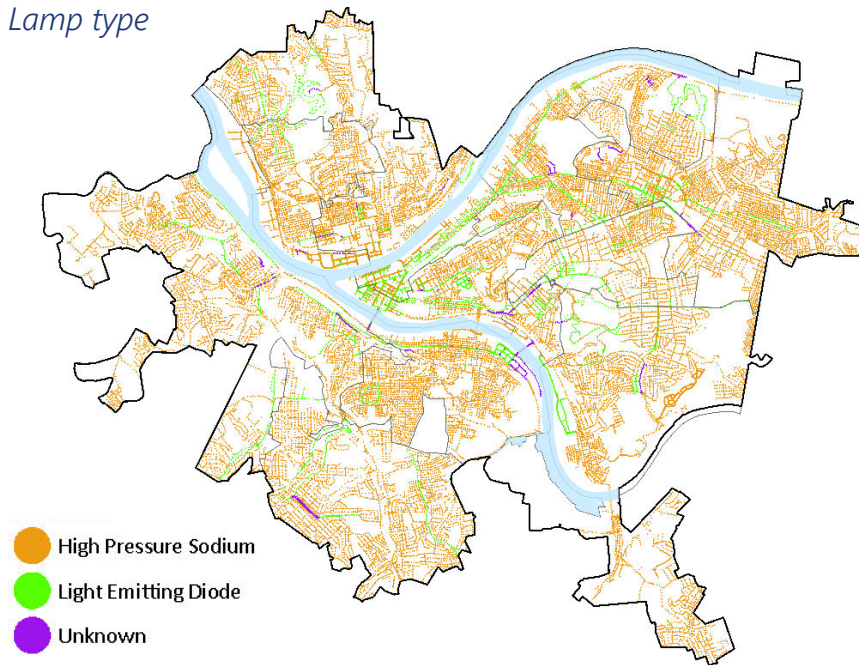
LED Pendant Teardrop on a metal traffic signal pole



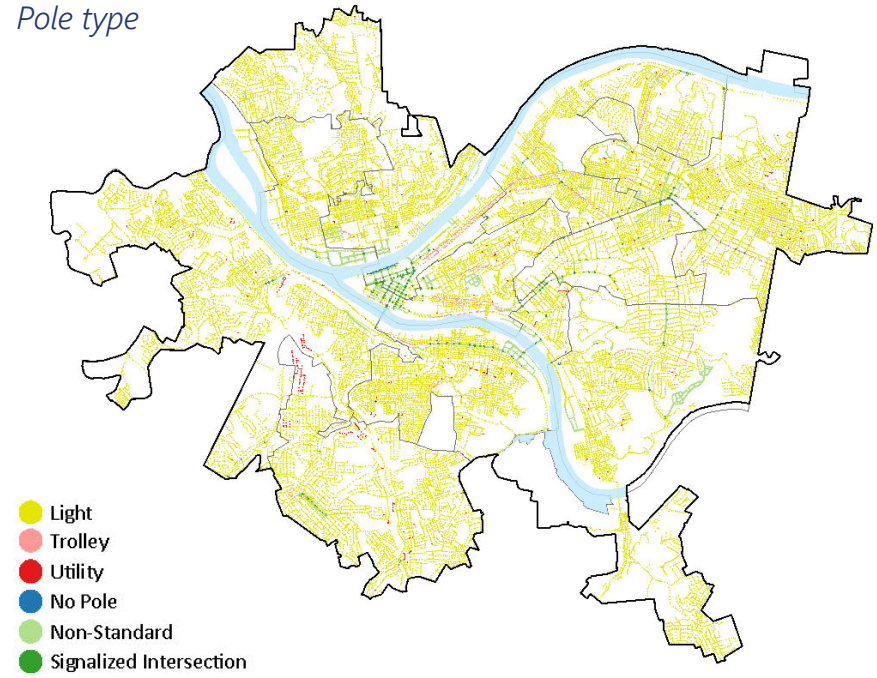
LED acorn on an aluminum lightpole

Lighting network by selected characteristics

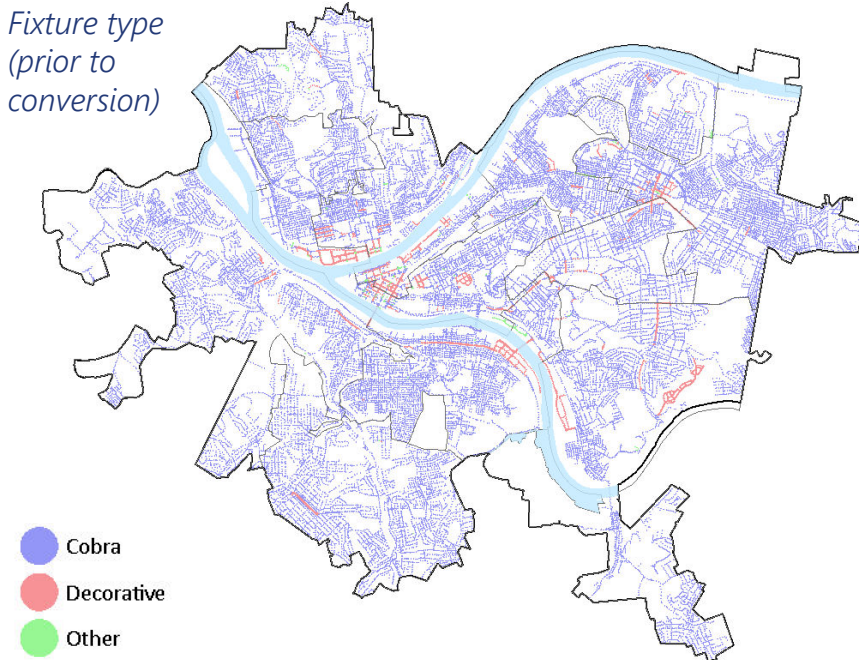
Lamp type



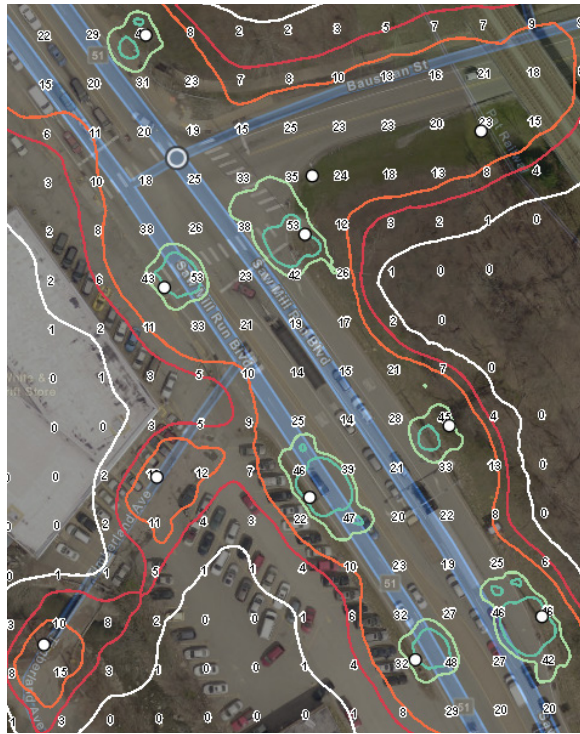
Pole type



*Fixture type
(prior to conversion)*



Network Gap Analysis



Citywide photometric analysis makes use of location and conditions information to model the horizontal illumination across the entire city, and provides readings in footcandles to ensure compliance with city ordinance.

Background

Residents have expressed concerns in the past about gaps in the City's lighting network. These gaps can be systemic (blocks or areas without adequate lighting), or individual (inoperable or dim lights).

In order to examine the nature and location of these gaps, particularly with an eye towards any spatial patterns of inequity between the amount of existing lighting in an area and the social and demographic residents of the area, a series of technical analyses were conducted.

Citywide Photometric Analysis

The easiest way to identify gaps in the lighting network, and to examine spatial patterns in the location of these gaps is to collect the location and physical characteristics on each light fixture, and model the illumination provided by each light.

This is achieved through a process known as photometric analysis, and provides lighting designers and engineers with not only the existing illumination levels (or lack thereof), but also the illumination provided by different design scenarios developed in consultation with lighting manufacturers.

The City of Pittsburgh used a first-of-its-kind citywide photometric analysis method which created illumination levels citywide, as opposed to traditional analysis, which can only model individual roadways, intersections, or other small-scale locations.

By conducting a citywide photometric analysis, gaps in lighting can be quantified and displayed alongside related datasets to explore spatial patterns and relationships between lighting, community characteristics, and concerns.

Results of this analysis for both existing conditions and the proposed design can be accessed at: <https://experience.arcgis.com/experience/d7fd7ba4c73d47658af4bbde2ecf2d77>

Lighting Gap Identification

Systemic lighting gaps are defined as lineal gaps in existing horizontal illumination (where the light from the fixture meets the ground) below a certain threshold. In locations where this gap is greater than 250 feet, a gap was noted, and documented for potential further analysis. These results are shown on the following page.

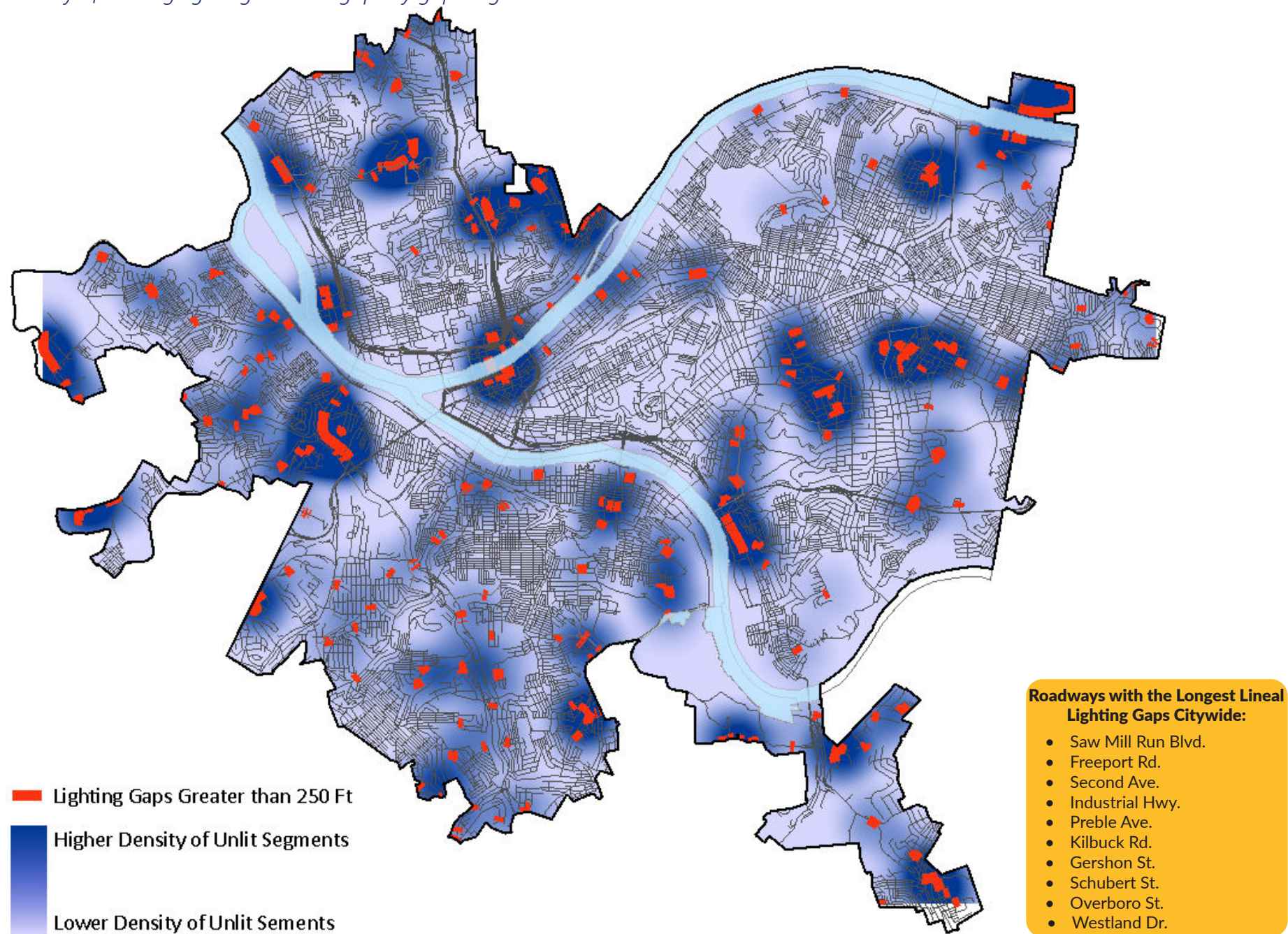
In addition to these lineal gaps, residents can help identify maintenance gaps (gaps created by malfunctioning streetlights or a reported lack of lighting) using the City's 311 system to request an analysis or repair. Taken together, City staff can begin to identify locations which may be prioritized for conversion to LED.

Findings

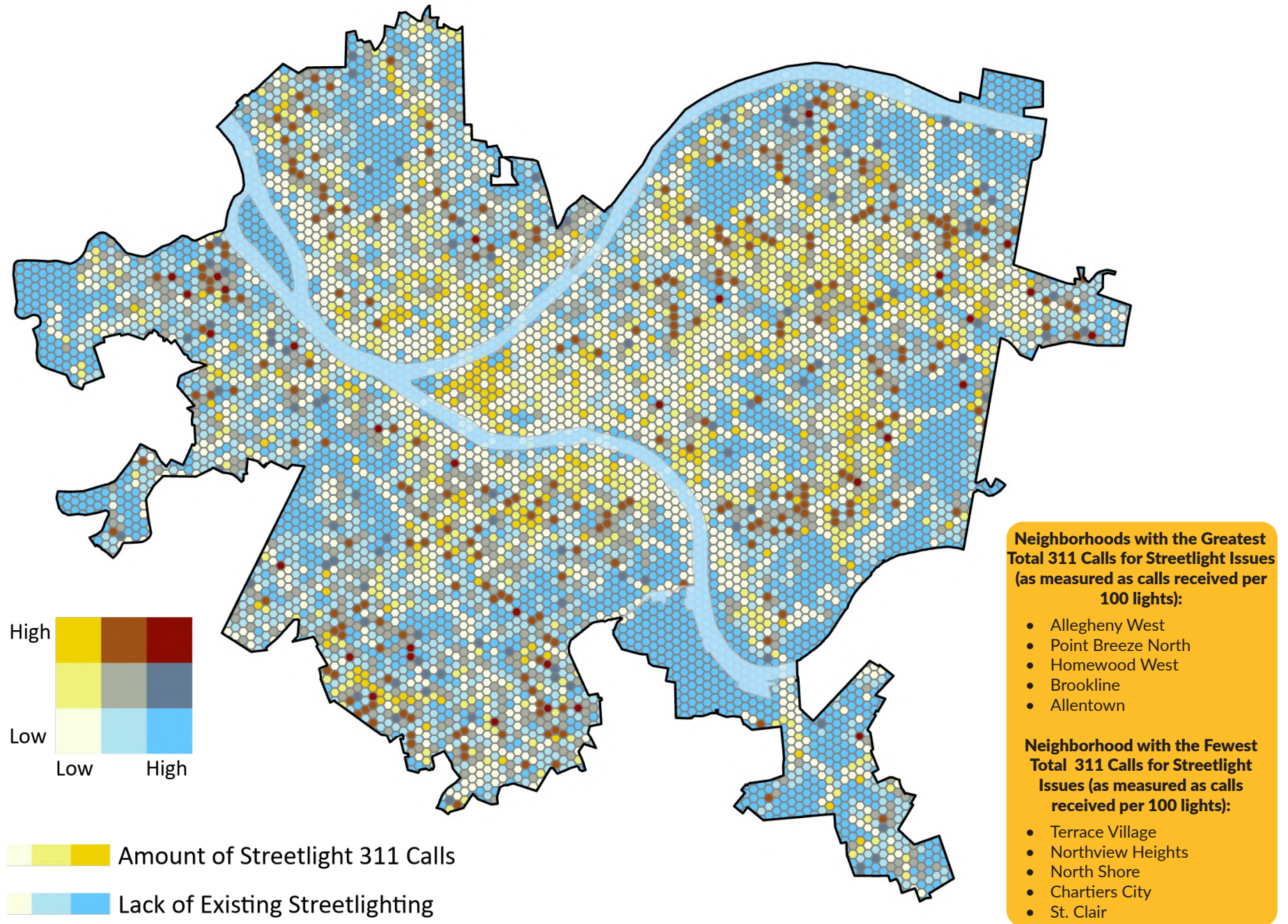
Using the location of the City's existing lighting, systemic gaps of 250' and greater between lighting elements were first plotted to look for patterns, with additional weight given to larger gaps. The results are shown in the illustration on page 10, and reveal a relatively even distribution of these gaps citywide. Following this initial exercise, the results of the citywide photometric analysis showing existing illumination on each block were aggregated and tiled into a series of cells of equal size intended to create what is known as a "bivariate choropleth," which is a cartographic representation of the hypothesis of the spatial relationship between two variables. For brevity and consistent symbology in the figure below and those that follow, the term "lack of existing streetlighting" is intended to refer to lower average levels of horizontal illumination per cell.

In the illustration on page 11, the amount of illumination in an area is analyzed alongside the location of nearly 5000 streetlight-related 311 calls placed by residents in the period from 2021-2024. These calls represent resident complaints of malfunctioning lights, outages, or general requests for more light. In essence, this figure is intended to identify high-priority locations where the photometric analysis identified lower light levels, and also where residents noticed and reported operations and maintenance issues with the streetlight network.

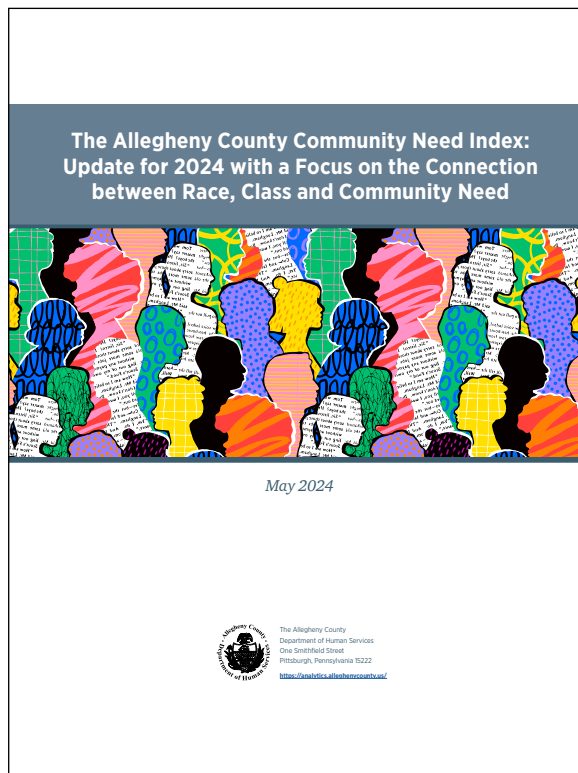
Density of existing lighting network gaps by gap length



Bivariate choropleth of amount of streetlight-related 311 call histories and average illumination levels



Vulnerable Populations



Allegheny County develops and maintains a detailed assessment of areas of need for the County's residents.

Background

Perhaps the most comprehensive and authoritative resource on identifying the City's residents with heightened levels of socioeconomic need and disproportionate exposure to measures of harm is provided by The Allegheny County Department of Human Services (DHS).

This organization regularly publishes a Community Needs Index (CNI), which can prove useful in establishing an adopted methodology and approach for residents in the City of Pittsburgh. Data from this report can be overlaid against lighting data from this project to help prioritize investments in these at-risk communities.

Regional CNI data provided by DHS was clipped to the City boundary, and is displayed using the level of need categories found in the report. The specific metrics presented in the report include:

- The percentage of families who live below the poverty line
- The percentage of unemployed or unattached males
- The percentage of those aged 25 and up without at least a Bachelor's degree
- The percentage of single parent households
- The percentage of households without internet access
- Rate of homicide per 100,000 residents
- Rate of fatal overdoses per 100,000 residents

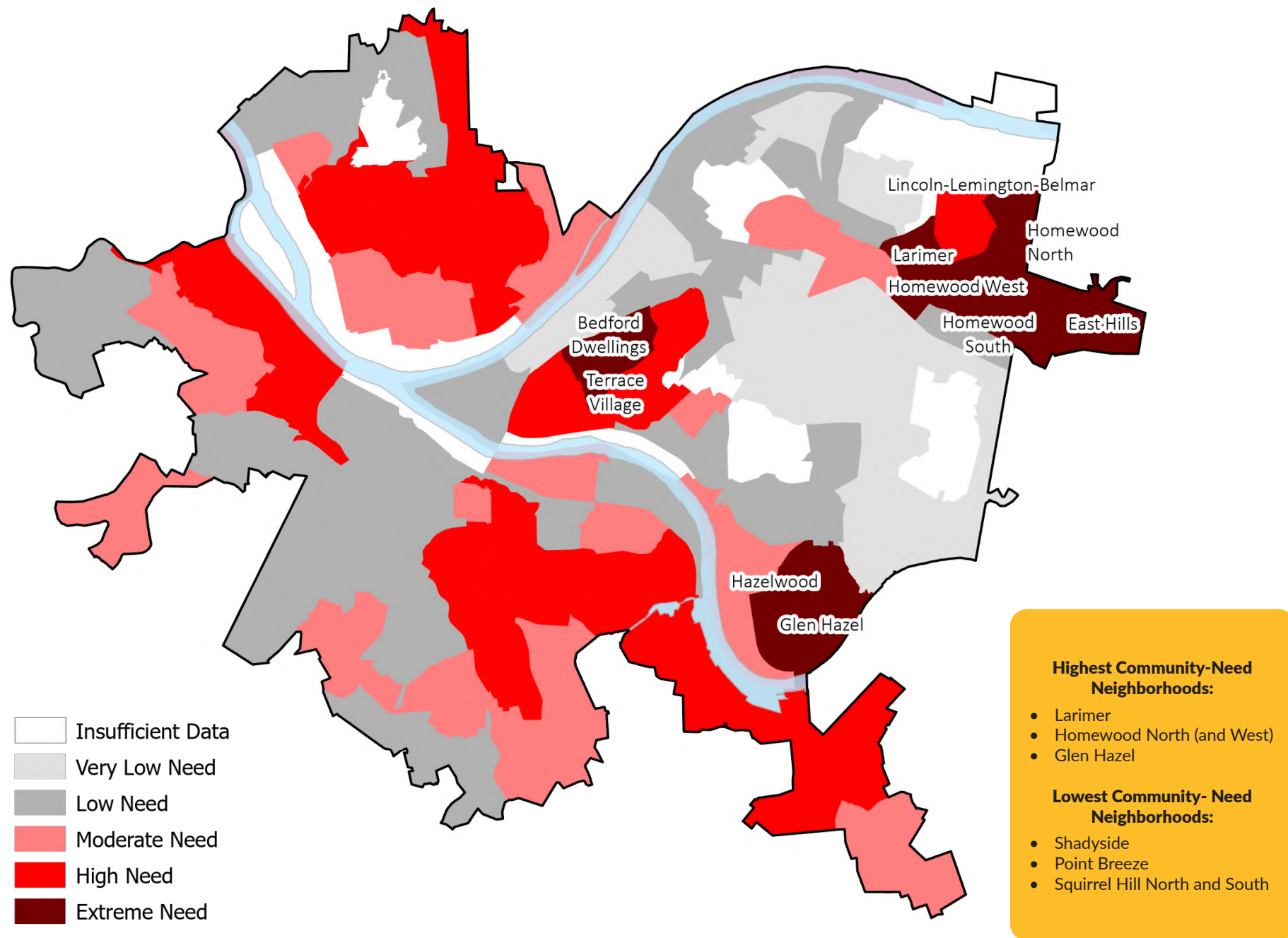
High-priority locations were considered for construction as part of the early phases of this project's LED installations, including, "... the highest levels of need in specific sections of the City of Pittsburgh (Hill District, South Hilltop, parts of the West End, Upper East End neighborhoods, Upper Northside)."

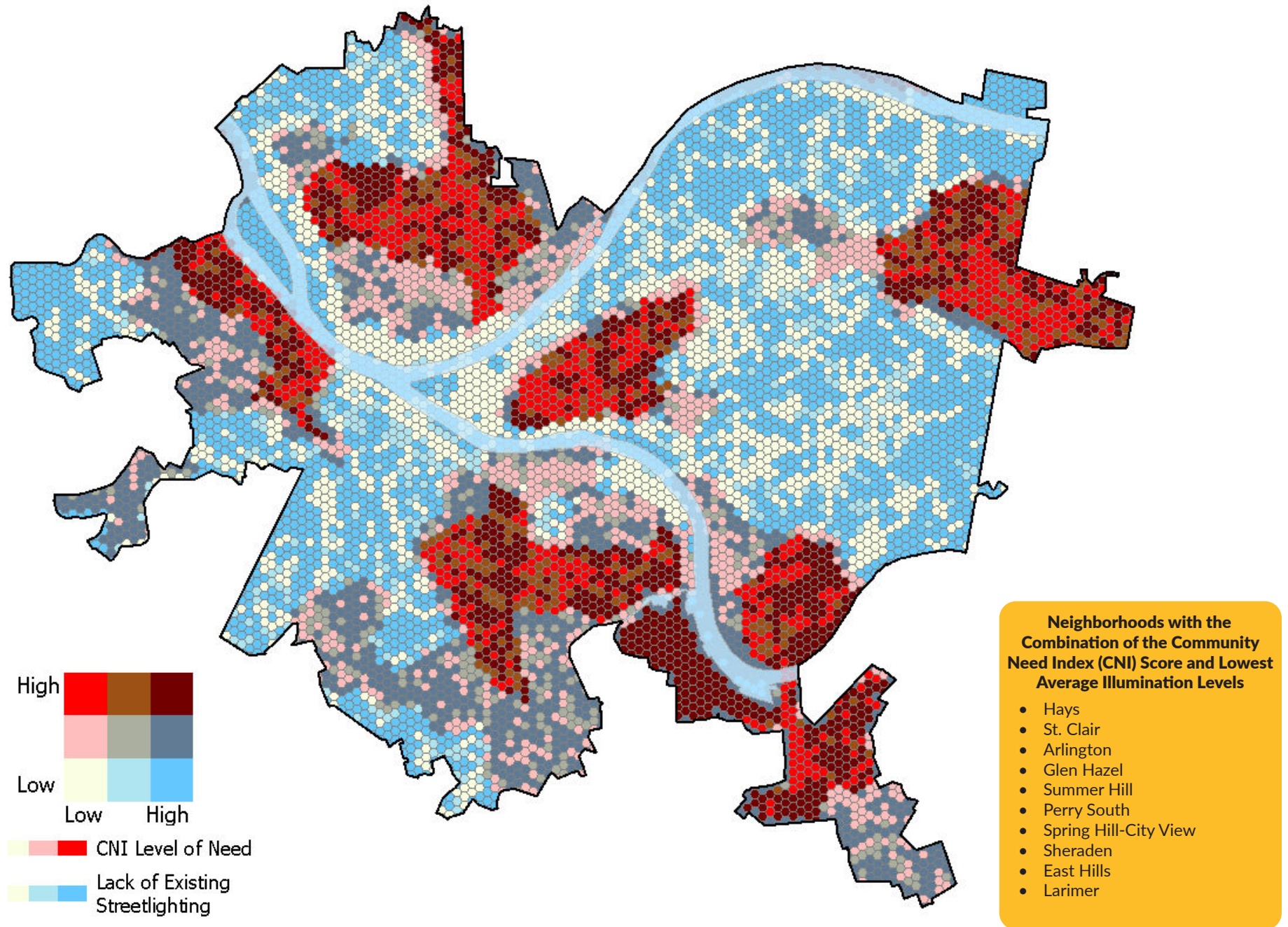
Findings

The figure on the left below represents the 2024 CNI findings aggregated by census tract and clipped to the political boundaries of the City of Pittsburgh. As noted in the CNI, *"there are vast discrepancies between the lowest need communities, which have an average poverty rate of 2%, and the highest need communities, where the average poverty rate is 38%, and with few exceptions, census tract-level community need is persistent over time."* Additional detail on the current CNI can be accessed at https://analytics.alleghenycounty.us/wp-content/uploads/2021/05/24-ACDHS-05-CNI-Report_v2.pdf

While historic investment in municipal infrastructure was not considered as part of this report, overlaying photometric results conducted on the city's streetlight network to assess the nature of the relationship between illumination levels, or lack thereof, and community need levels may be an effective proxy to identify potential patterns of systemic underinvestment of lighting resources.

The figure on the right below displays this relationship for the three categories of greatest community need, and may prove useful in helping city staff develop a construction phasing approach which aims to reinvest resources more quickly in areas of greatest need and prioritize LED installations.





Public Safety



Public safety at night is frequently cited by residents as a concern, particularly the perception of safety and lack of lighting.

Background

Public safety information considered in this analysis consists of a number of datasets developed and maintained by law enforcement from the City of Pittsburgh and the State of Pennsylvania. For this exercise, key location-based datasets included:

Collision History data includes all vehicular collisions on City-owned and maintained roadways in a similar five-year period (2018-2022), including vehicle-to-vehicle collisions as well as those involving people walking and biking. As with index crime data, collisions occurring at night were placed on a map for further investigation.

Index Crime data refers to one of eight categories of violent crimes as defined by the FBI. Location records of these crimes over a seven-year period (2015-2021) were reviewed, and crimes committed at night were placed on a map for further investigation.

As with other potential relationships between illumination levels and these variables, location data was tessellated and assessed using a series of bivariate choropleths. Results can be seen on pages 18-19.

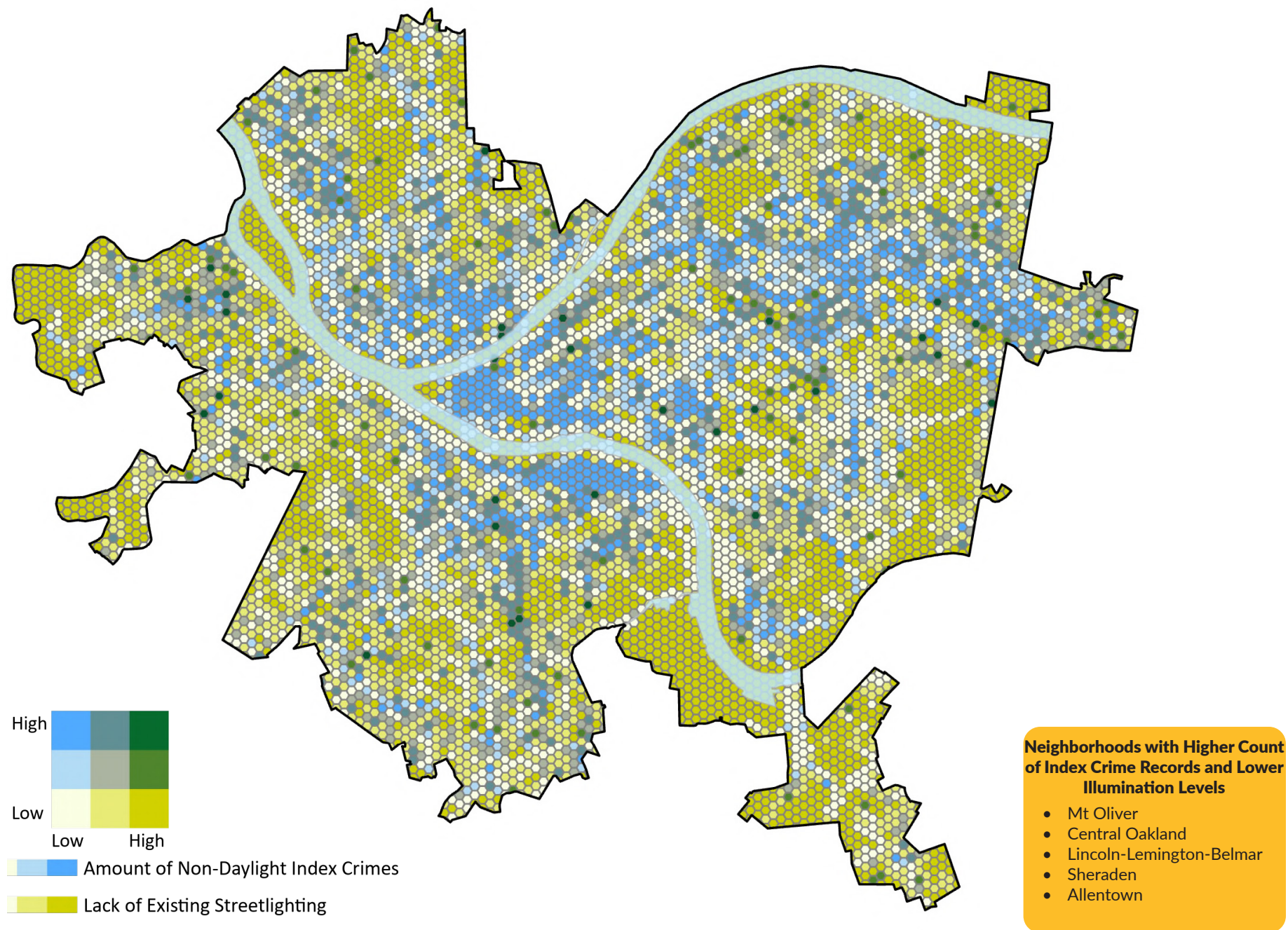
Additional investigation outside the scope of this effort may be warranted to explore the effectiveness of new LED lights in reducing the frequency of index crimes and collisions throughout the City.

Findings

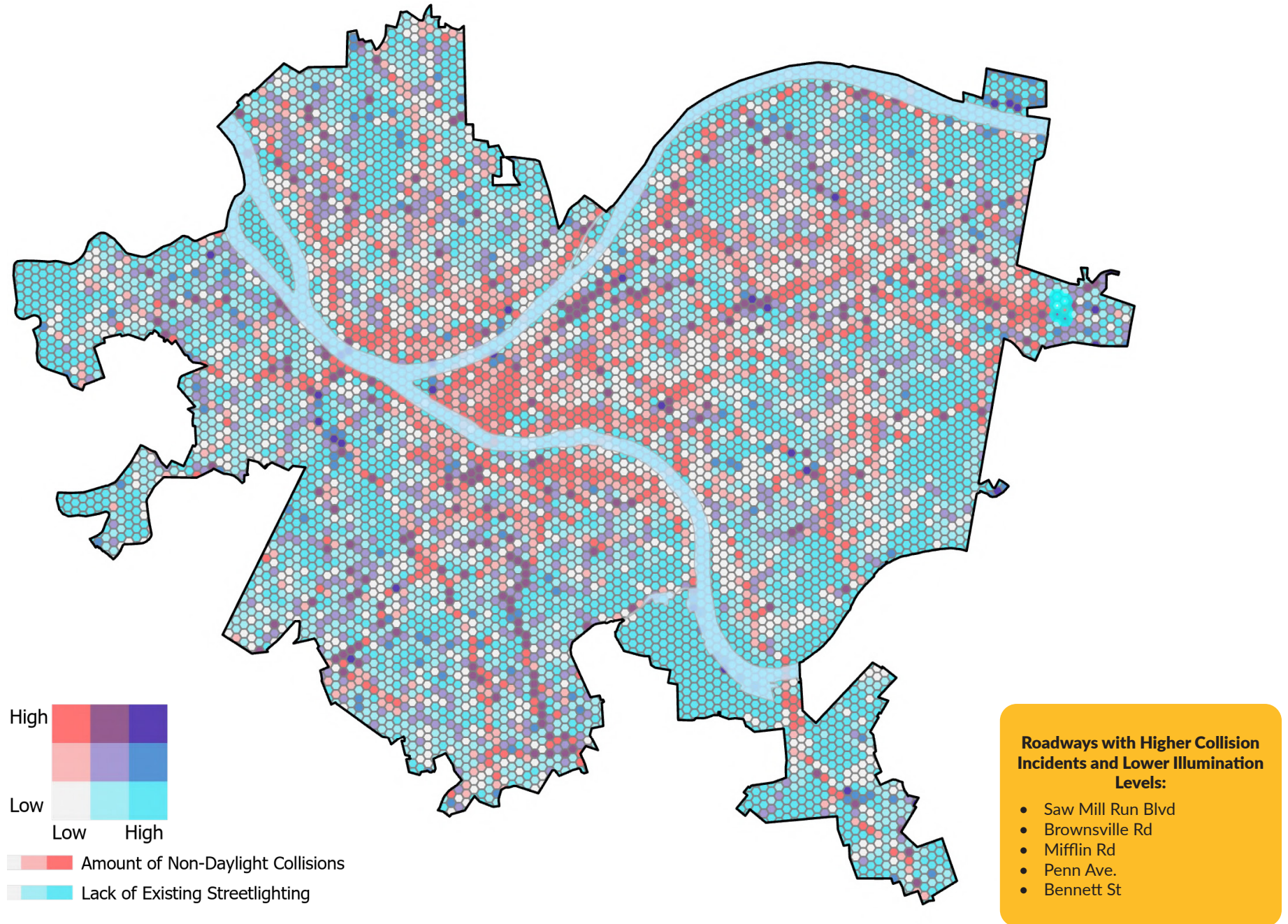
Perhaps no issue relating to lighting animates residents more than the role lighting may play in the perception of public safety. In recent years, several organizations and research efforts have devoted significant resources to understanding the role a lack of lighting may play in the perceived safety of a public space, but also the role too much lighting may play in reinforcing negative perceptions of excessive surveillance and other impacts among population groups. The organization Light Justice explains this concept as, "...under-resourced communities frequently endure inappropriate and even oppressive lighting, which in turn is detrimental to their well-being." An equitable approach to lighting should evaluate locations of overlighting and underlighting, while at the same time using data to help reinforce or rebut opinions about lighting and safety.

For this exercise, public safety is defined in two ways: roadway safety in the form of non-daylight collision locations compared to average illumination levels, and non-daylight index crimes compared to average illumination levels. As shown in the figures below, large-scale geographic patterns between these variables are difficult to identify at this scale, and may warrant additional analysis and the development of interdisciplinary strategies to systemically address any issues.

Bivariate choropleth of non-daylight collision locations on local roads and average illumination levels



Bivariate choropleth of non-daylight index crimes and average illumination levels



Additional Design Decisions



Modern LED lights allow for an unprecedented amount of customization to meet the lighting needs of the City's residents and visitors.

Overview

Alongside the construction phasing and equity considerations relating to community need, lighting gaps, and other criteria illustrated on the previous pages, the City of Pittsburgh considered several additional characteristics in the design of the LED Modernization Project, including the following:



Color Temperature - The City started installing LED streetlights over 10 years ago, and there are approximately 4,000 LED fixtures throughout the City. Existing LEDs have a correlated color temperature (CCT) of 4,000K, which means they are cooler, whiter, and glare more than the 2,700K lights installed under the modernization project. Recent industry research and community preference has indicated these "warmer" lights are preferred over cooler ones.



Dark Skies/Light Trespass - The City has consulted with the International Dark Sky Association (IDA) to ensure new LEDs can serve the needs of residents while remaining consistent with the principles of the IDA, whose mission is, "to preserve and protect the night time environment and our heritage of dark skies through quality outdoor lighting." Designs were evaluated to minimize uplight/skyglow, but also to limit light trespass onto private property and sensitive habitats which may be impacted by unnecessary lighting.



Network Lighting Management System - The City has partnered with Dimonoff and their Smart City Management System to enable the new LEDs to perform a number of networked functions, including monitoring, metering, dimming controls, report/alerting of outages, and interconnecting across the network. This functionality will ensure a more responsive and informed approach to any necessary refinements in illumination levels and maintenance concerns.

Next Steps

Once installed, LED lights provide residents and visitors with brighter light, a more realistic ability to see colors, and can be adjusted to respond to community concerns or other conditions as they occur. In addition, these lights cost taxpayers less to operate and maintain as well. Construction will continue through 2027.

Typical residential street with HPS fixtures



The same location following the installation of LED fixtures



Next Steps

Phased Construction Approach



Construction crews have begun installing new LED fixtures in high-priority locations. Work is anticipated to continue for several months.

The Role of Special Considerations in Construction Phasing

While not immediately apparent to the casual observer, a comprehensive understanding of cultural and historic contexts of a neighborhood is an important element in designing and building better public spaces for all people.

Through data-driven analysis, community feedback, and detailed engineering and construction approaches, a modern LED lighting network can be implemented in a way that maximizes public investment by prioritizing the allocation of limited capital and resources in areas where these investments can make the greatest impact.

For the purposes of this section, the preceding special considerations were a series of frameworks and metrics designed to identify areas with the greatest potential for near-term return on investments in the form of increased safety, better lighting, and improved quality of life for residents.

At the same time, by prioritizing implementation based not only on the needs of the built environment, but for those residents who face larger socioeconomic barriers relative to those faced by others, this project can help to remedy historic and systemic inequities in a way that aligns with similar local and regional priorities, social programs, and capital projects.

Construction Phasing

Using a combination of the equity metrics outlined above, staff input, and other constructibility considerations, a general construction phasing approach was developed for the LED Modernization Project based on City Council Districts as follows:

1. District 1
2. District 6
3. District 9
4. District 5
5. District 2
6. District 7
7. District 3
8. District 4
9. District 8

Following this high-level prioritization effort, each of the lights scheduled for conversion to LED was assigned a construction timeline and placed on a "look-ahead" map on the City website to help residents understand when their neighborhood can expect to receive new lights.

The information is updated regularly based on construction progress and can be accessed at <https://www.pghled.org/progress-tracker>.

Conceptual construction phasing by City Council District Number

