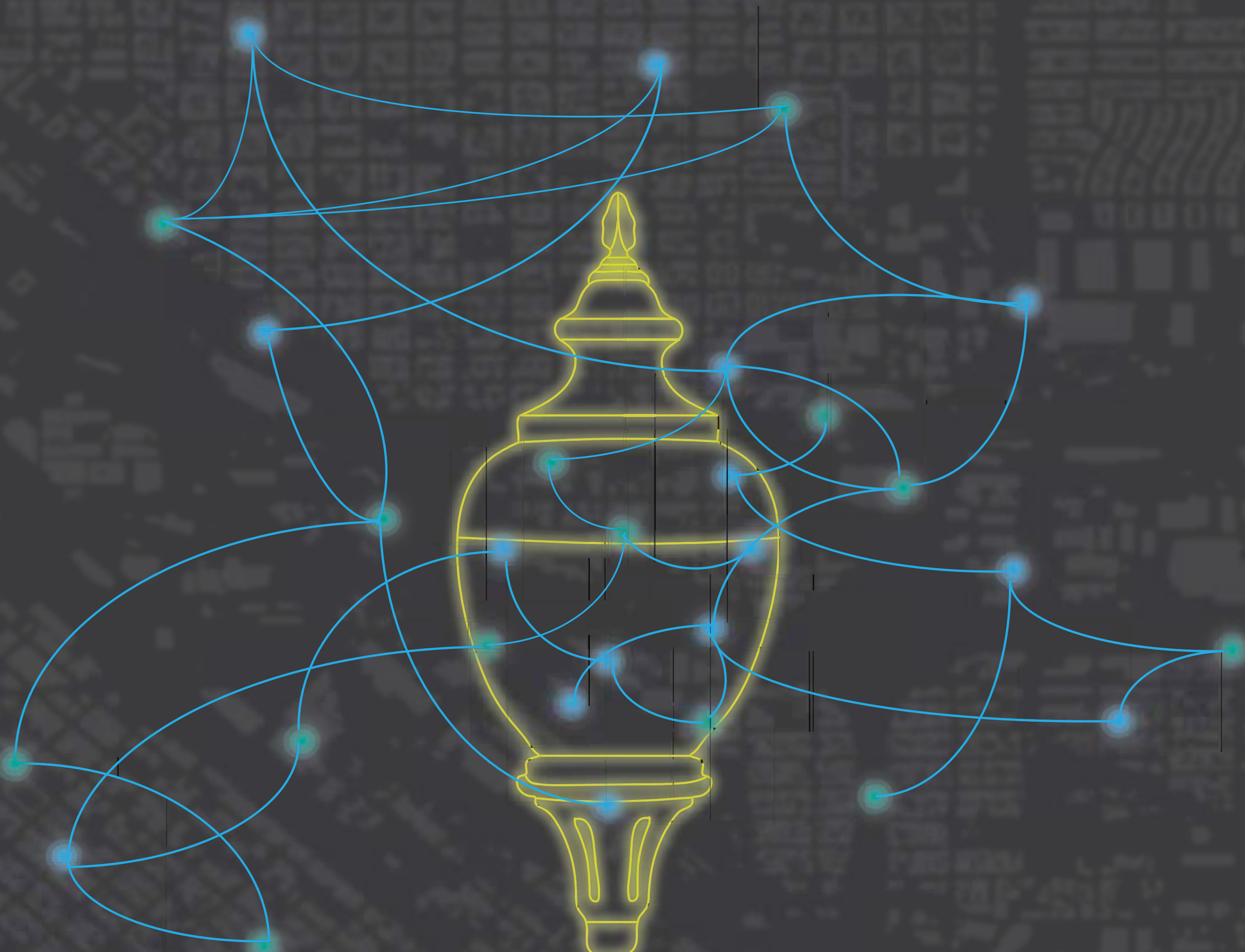
APPENDIX F

Municipal Smart Streetlight Conversion & Evolving Technology Guidebook

January 27, 2020



Municipal Smart City Street Light Conversion & Evolving Technology Guidebook

Submitted by: Planning4Places
In Association with: International Nighttime Design Initiative (NTD)

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CDTC

MUNICIPAL SMART CITY STREET LIGHT CONVERSION & EVOLVING TECHNOLOGY GUIDEBOOK

Prepared for the Capital District Transportation Committee and the City of Saratoga Springs, NY

By

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1 INTRODUCTION AND CONTEXT

Background

City street lighting debuted in in the United States in 1860 with a mixed reception. By the early 20th Century, however, it was established as a method to deter crime and support safety and security (Jakle, J.A., 2001).

Urban lighting technologies and methodologies have since undergone drastic changes due to advancements in both fields, and recommendations are constantly being updated to provide design and maintenance guidance (IES, 2018). Traditionally, the focus in urban street lighting research and development has been to improve both safety for the user and overall reduction of energy use to fulfill general sustainability requirements. In more recent years, community sustainability has been increasingly discussed and defined as an important qualification. Criteria to improve factors such as improved physical and mental health (walkability and social cohesion) as well as nighttime economy benefits, have entered public design guidelines (Lee, K.K., 2012). Today, cities have opportunities to implement adaptability and innovation, and so-called "smart" lighting is an important part of that strategy.

This guidebook, commissioned by the Capital District Transportation Committee, addresses street lighting and other categories of municipally and utility-owned public lighting systems. The guidebook's impetus is the initiative to convert conventional street light luminaires to LED and smart technology.

Currently, energy saving is generally perceived to be the primary benefit from upgraded street lighting technologies. This results from the conversion of older, less efficacious lighting technologies to light emitting diode (LED) sources. LED technology requires less power to achieve the same light levels as many traditional light sources.

LEDs when properly maintained, can have a long life. Significantly, LEDs can also be dimmed, reducing light output levels when appropriate. The lower (dimmed) light level provides opportunities for even lower energy consumption, along with associated reductions in cost. However, in many cases, such as in New York State, where the local utility does not pass along savings from actual reduced energy usage, even Operations & Maintenance ("O&M") savings alone can justify the capital outlay for street light conversions. Payback or Return on Investment ("ROI") periods are calculated, in that case, using cost savings through utility rebate programs and projected reductions in maintenance cost.

In addition to these benefits, lighting conversion provides opportunities to qualitatively improve legibility for open and public spaces at night. This can elevate city and community life and vitality, as well as provide enhancements for safety, economic development, financial and other strategic advantages. While in the past it was customary, in many municipalities, for energy providing utilities to own street lighting, thus limiting municipal options, choices and ultimately control of the infrastructure, in 2015, existing legislation was amended by the New York State Public Service Commission (PSC) to enable the transfer of ownership of street lighting systems from the utilities to the municipalities. Outside of New York City, the majority of street lights in the state are utility owned high-pressure sodium cobra head lights. This change now permits municipalities to take control of their street and pedestrian lighting. At the time of writing, PSC has approved the sale of over 54,500 street lights to 26 municipalities. For example, as of October 2019, the PSC approved

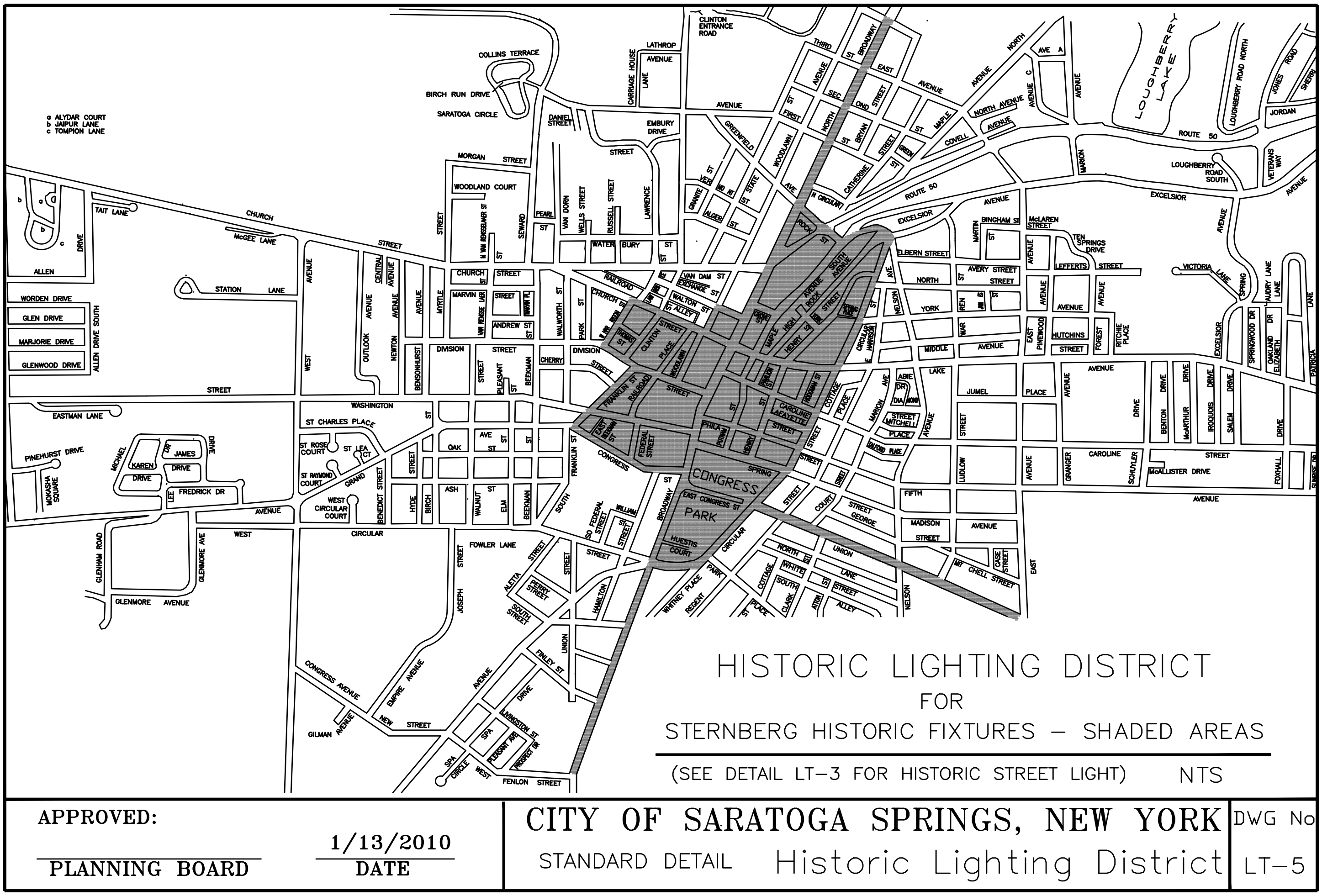


Fig-1: Historic Lighitng District

Source: City of Saratoga Springs

separate requests to sell utility-owned street lights to the City of Syracuse, Village of Nyack and the Town of Warwick. The goal of these efforts primarily focuses on faster adoption of energy efficient lighting with updated technologies. This guidebook was commissioned by the New York State Capital District Transportation Committee (CDTC) as a part of their Smart Communities Program. This program was established to explore strategies for becoming a “Smart Region,” or a region that uses data, applications and technology to help people and goods move more efficiently. The goal is to provide Capital District municipalities with tools to strategize their “smart” lighting needs and start identifying the appropriate “smart” street light infrastructure and technology, features and functionality for each community. The majority of New York State street lights are owned by utility companies. New York’s Smart Street Lighting Program Initiative facilitates street light purchase, often referred to as “buy-back,” and conversion to energy efficient and advanced technology (NYPA, 2019).The intent of this guidebook is to provide education to underlie initial dialogues between city stakeholders as steps are taken to assess existing conditions, needs and options. This guidebook builds on CDTC's New Visions' commitment to advancing technology to improve safety, operations, and environmental quality (CDTC, 2015). Starting in July 2019, Planning4Places, LLC and the International Nighttime Design Initiative, collaborated with a Study Advisory Committee (SAC) consisting of staff and officials from the City of Saratoga Springs, CDTC, Capital District Regional Planning Commission (CDRPC), National Grid, New York Power Authority (NYPA), Capital District Transportation Authority (CDTA) and other agencies to discuss and develop this guidebook.

This effort comes during a time when "Smart City" strategies and technologies are being added to one-to-one street light conversions. These advanced technologies are in a process of evolution.

This document cites currently available options (as of 2019), such as WiFi capabilities, sensors, speakers, electric vehicle charging options, pedestrian safety features, and applications such as wayfinding and real-time information displays.

The objective is to provide the City of Saratoga Springs, and other regional municipalities, support to strategize and start implementing safety and sustainability goals found in the City's Smart Cities Roadmap, the Comprehensive Plan, and the Complete Streets Plan.

Here, the City of Saratoga Springs serves as case study for other Capital Region municipalities looking to implement updated lighting solutions and smart technologies. This case study is structured to provide initial planning-level support for conversion efforts to energy efficient LED and related smart street light technologies, and to assist in the evaluation of the purchase of utility-owned street lights.

LightWalk: studying the corner

LightWalk: Observing public space

All photos this page from NightSeeing™ Downtown Saratoga Springs

The Guidebook development included community-engagement processes. On September 26, 2019, a NightSeeing™, Navigate Your Luminous City event – a walk and talk - was held for Saratoga Springs and regional stakeholders.

The objective of NightSeeing™ is to expand citizen awareness of nighttime ambiances and public lighting. Traditionally, outdoor lighting is most often practiced by engineers. Creative lighting design is a young profession expanding into environmental and site-based work. Simultaneously city design is increasingly important. Concern with nighttime economy, safety and culture is rising along with digital technologies. With the opportunity of responsive ("smart") lighting on the horizon, The NightSeeing™ methodology is an experiential, immersive, learning activity which enjoins communities to better understand their existing after-dark conditions. Within this informal setting, while walking together, the present environment is critiqued, with an eye to improvement, where needed.

The talk was held in the Saratoga Arts Center and then the group proceed to walk in and around downtown, for a knowledge exchange. Key discussions touched upon the atmospheres and ambiances created by publicly supplied illumination and private light sources, such as shop windows and building mounted luminaires (e.g., sconces, bracketed floods). Observations were wide ranging. Concerns were raised about the streetscape, such as safety at crosswalks and sufficient lighting (and overly bright lighting) of parking lots. Pros and cons of commercial signs and projected lighting effects provoked spirited discussion. Critical issues in regard to sky-glow and lighting's effect on nature along with the glare of private and public lighting were broached. These healthy debates are to be expected—pointing to the need for placemaking with light for Saratoga Springs and other communities' open space and streetscape usage after dark.

LightWalk: Thoughts on sidewalk projection

The Talk: Discussing urban lighting

Photos by Planning4Places, LLC

Saratoga Springs - Existing Conditions

The City of Saratoga Springs has a vibrant downtown filled with restaurants, shops and an active street scene. Tourism is a vital part of the city's economy. The summer season results in significant visitor and local engagement throughout the city. The city also has a growing residential population and special areas built around institutional uses which are generally pedestrian-friendly but also car-based. A significant element in the year-round streetscape is lighting – an element like many other utilities that is often taken for granted and overlooked by those using the infrastructure as part of their daily routine. In particular in Saratoga Springs, as well as other Upstate New York municipalities, lighting is vital not only for illuminating the street, but to illuminate the pedestrian realm for both mobility and safety. Heritage Sternberg-brand, post-top street and pedestrian lighting installed by the city, as well as private lighting, combine to create a unique sense of place within Saratoga Springs. Lighting adds to the ambiance, attractiveness and often the uniqueness of the streetscape; for example, the warm amber-white appearance of the historic lighting in downtown Saratoga Springs.

There are currently 3,255 street lights in the City. Of these 3,255 street lights, there are three street light types: historic luminaires (a single post top and a triple top), decorative street lights, and standard (cobra head) street lights which are owned by National Grid. Within the Historic Lighting District there are two types of lighting styles – green agave historic light poles with globe post tops in the inner Historic Lighting District and acorn-type luminaires with black poles along the outer Historic Lighting District.

The majority of these use high pressure sodium light sources and are not shielded to protect the night sky. High pressure sodium is considered an outdated light source technology as it has poor color rendering and is not dimmable. According to an inventory of lighting assets provided by the City Electrician, 1,307 of the lights are currently monitored by the City, with only approximately 17% of the lights (222 total) utilizing newer LED-type sources.

In addition, the City has some luminaires that are maintained and metered by others; these are located as follows: 7 lights at the Woodlawn Garage, 5 lights in Congress Park, 10 lights at the Putnam Garage, 9 lights on Vanderbilt Ave & Worth St (metered from the Recreation Center), 10 lights on Myrtle St (metered and paid for by the Hospital), 33 metered lights on Excelsior Ave/Gibson Ct/Whister Ct, 14 LED lights at the Woodlawn Parking Garage, 24 LED lights along Ballston Ave, and 4 LED lights at the Excelsior Convention Center. The parking garage lights are metered and dim when there is no movement for 15 minutes and brighten when movement is detected.

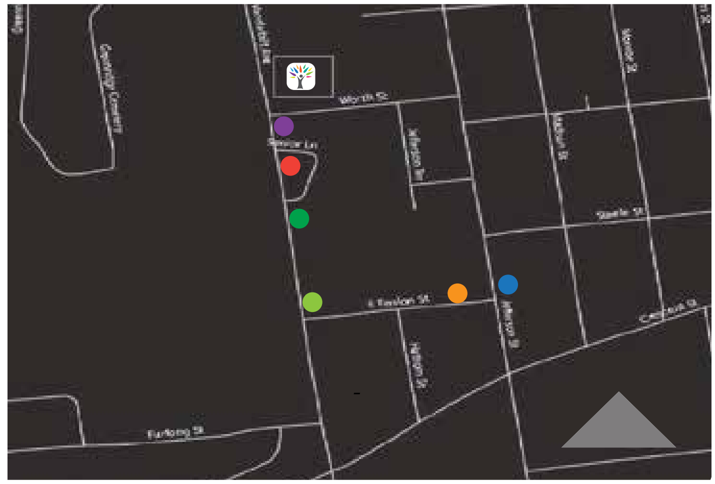
Three typological areas were selected to illustrate the varied lighting approaches for area-based nighttime needs. The focus areas and typologies help to differentiate unique elements of both the built environment and lighting needs/opportunities.

Three typological areas are:

1. Residential Area
2. Institutional Area
3. Downtown/Mixed Use/Central Business District

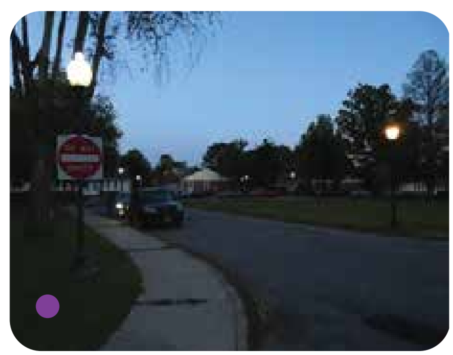
Typological Area: Residential

Residential areas within the City of Saratoga Springs are mostly lit by cobra head high pressure sodium lights (standard lights) with major corridors also having some decorative street lights (and in some cases, the decorative street lights are LEDs). In a field view analysis of residential areas, it was found the majority are dark at night, and those areas that have street lighting generally consist of a patchwork bright light and areas of shadows, making for inconsistent lighting. There are some variations in the post tops found within the residential areas, but they are primarily the acorn style.



Jefferson Street: Residential street with public decorative post top (unshielded, 360 degree light)

Vanderbilt Avenue: Residential street with public decorative post top (unshielded 360 degree light) pedestrian lighting and bracket mounted public cobrahead lighting for street illumination



Senior Way: Residential street with public decorative post top (shielded against upward light) and decorative post top (unshielded, 360 degree light)

Senior Way: Residential street with public decorative post top (shielded against upward light)

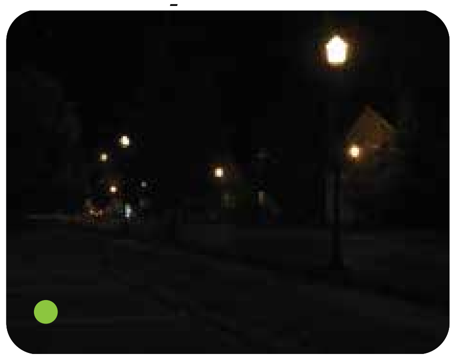
Public Post Top (shielded against upward light)

Fenlon Street: Residential street with public decorative post top (unshielded, 360 degree light)

Institutional Area

Institutional areas within the City of Saratoga Springs are mostly lit by cobra head high pressure sodium (standard lights) with major corridors also having some decorative street lights. In the hospital area, the brightest lights are found in the parking lots adjacent to the hospital. The remaining streetscape is largely dark, except along the major corridors where there are decorative LED street lights.

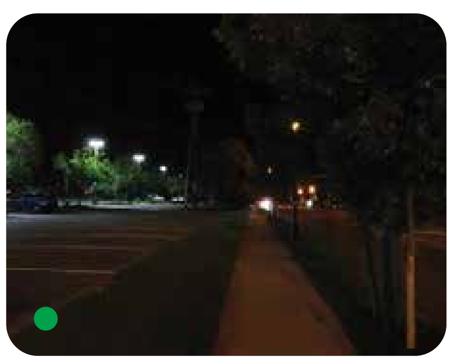
Myrtle Street: Street with bike path lighted by public decorative post top (unshielded, 360 degree light)



Church Street: Residential street with public decorative post top (unshielded, 360 degree light)

Church & Myrtle Streets: Signage lighting for way-finding from hospital and private businesses

Corner of Church & Myrtle Streets: Residential street with public decorative post top (possible outage of additional cobrahead

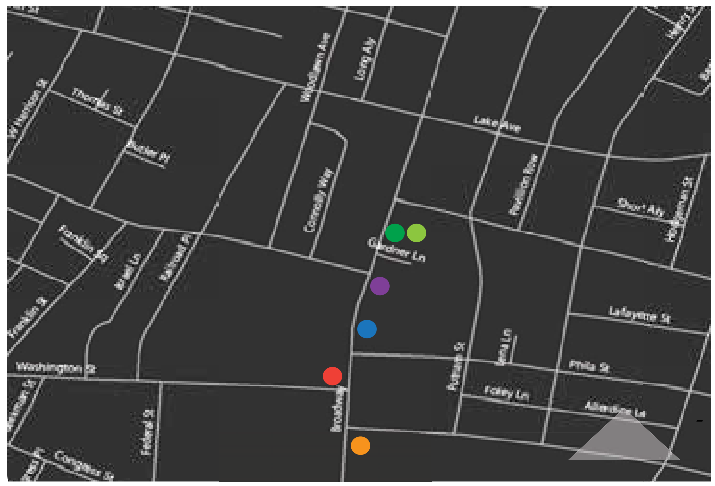


Church Street: residential street and walkway lighting with public decorative post top, and parking lot pole lighting (Note: warm/cool color)

Myrtle Street: Residential street with decorative post top (unshielded, 360 degree light) pedestrian lighting and bracket mounted cobra-head

Downtown/Mixed Use/Central Business District

Decorative, historic lights are the primary street light with accessory, “private”, lighting emitting from storefront shops and the occasional window sign. Signs projected on the sidewalk by businesses, internally illuminated clocks, uplit walls, and facades also provide unique and distinctive lighting throughout the Downtown area. Most of the light is colored in a warm to neutral shade of white with the occasional splashes of color, such as purple and greens either as a part of uplighting or a sign face and multi-colored from window signs. Twinkle lights are found on street trees and around the restaurants and bars.



Broadway near Washington Street: Sidewalks with public decorative post top (unshielded, 360 degree light) and spill-light from storefronts

Alley near Northshire Bookstore: Private, facade mounted pedestrian lighting

Broadway near Division Street: Signage lighting from private businesses

Broadway - Adelphi Hotel: Private decorative facade lighting

Broadway approaching Lake Avenue: Private lighting on sidewalk

Historic Pole-mounted Lighting: Public decorative tripple post top (unshielded, 360 degree light) marking downtown intersections

2 WHAT IS "SMART?" — AN OVERVIEW

Opportunities for connected, "smart" technologies range from public safety to asset management. When considering networked "smart" lighting, (fig-3) and the introduction of "smart" technologies, a wide variety of infrastructures and ownership/ maintenance practices must be reviewed in detail to develop a Smart Communities strategy.

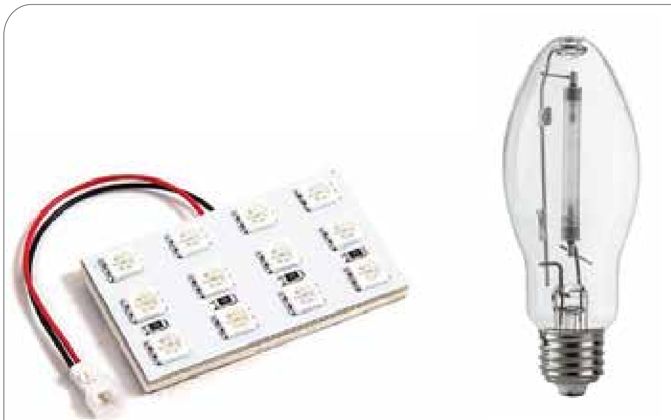
Here, the guide uses quotes around the word smart, because the adjective is employed with a varying degree of specificity. Smart can describe the electronically-based system which connects an assortment of devices that monitor, measure and surveil geographical areas. It also describes the devices, such as "Internet of Things" (IoT) devices and sensors, themselves.

There is no conclusive definition for a Smart City/Smart Community. The technologies being integrated and systemized are ever growing. A leading expert in sustainability and Smart Cities defines a city that is smart as one that "utilizes information and communications technology to meet the demands of its citizens, and that community involvement in the processes is a necessity for a smart city." (Deakin, M., 2012).

For the purposes of this Guidebook, the term Smart Community is used when discussing community governance and social benefits of neighborhoods in towns, villages and cities; the term Smart City is used when discussing the related technology and infrastructure aspects.

Cities are embracing connectivity and digital technologies to verify and improve service proficiency through the collection of data. This is done by sensors for environmental conditions and traffic flow, such as cameras, counters and triggers that are placed at key locations along streets and roads.

The information retrieved over time includes pedestrian counts, traffic circulation and city services. Once collated, the data can be used to either inform programs by analysis (trash collection, traffic flow, parking) or to trigger an action, for example, adaptive and predictive traffic signals or real-time information displays during events, rush hour, trash pickup, or in response to weather conditions or as an emergency alert. In addition, this can also include adaptive lighting to support civil behavior.



Sample of LED Module to replace conventional light source in a luminaire

Sample of conventional light source (lamp)

Fig-2: Comparison: LED and Traditional Lighting

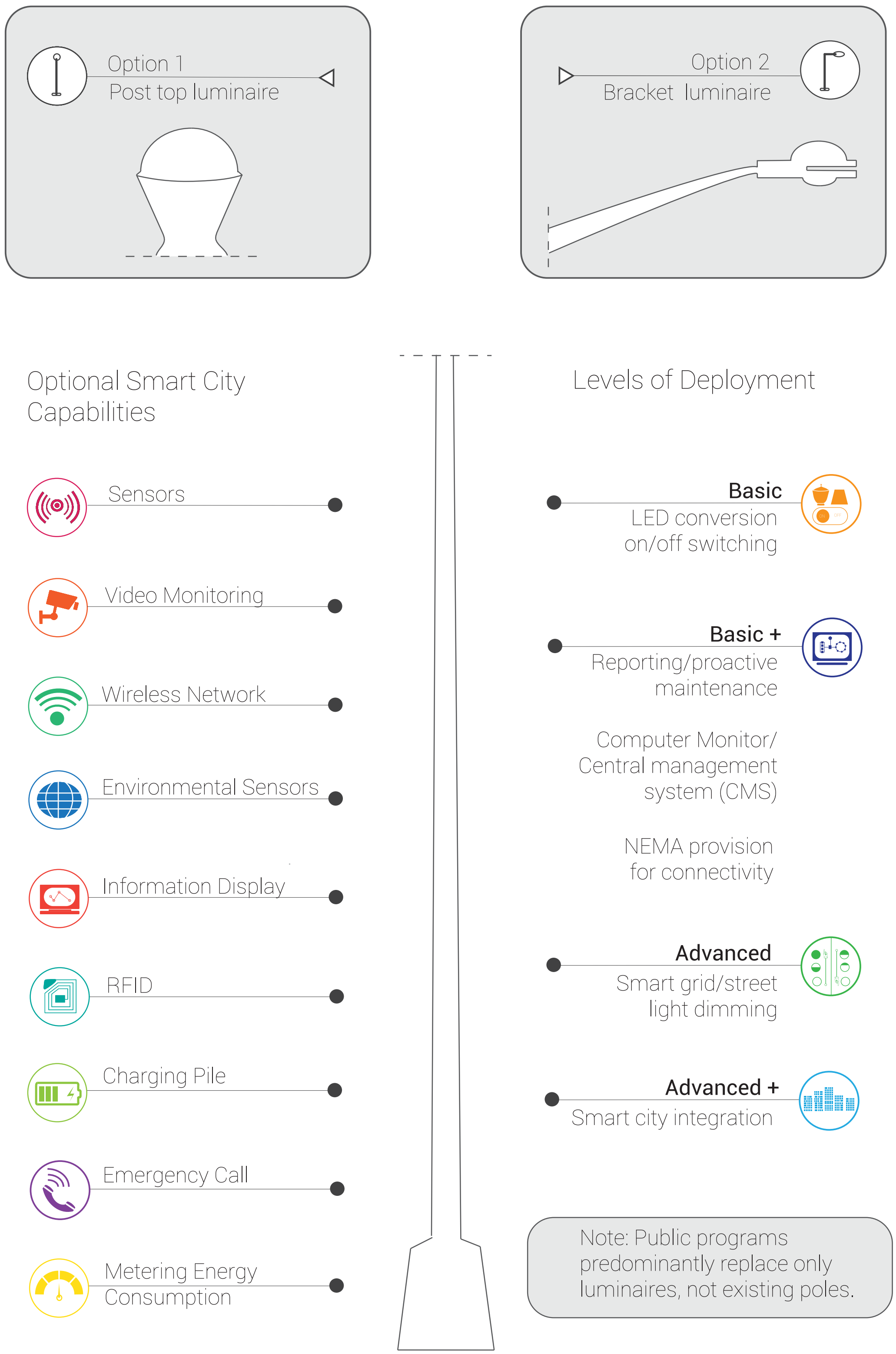


Fig-3: **Smart Lighting**

AN OVERVIEW — Smart Lighting Is Responsive A

Lighting is at the center of Smart technology roll outs because the sensors and devices indicated above are opportunistically mounted on street light poles. These poles are reliably and continuously spaced throughout cities, typically at around 100-150' on center. Therefore, the word smart in the Smart technology context can also include and refer to illumination, typically to poles, luminaires, and their controls. The end result is a lighting system which is only one layer of municipal infrastructure.
The term "Smart Cities" (also sometimes referred to as "Smart Communities") and "Smart Tech" covers a rapidly-changing, evolving set of functionalities. It is useful to think of "Smart Lighting" as the term that refers just to the lighting systems, and "Smart Poles" as a potential mounting point for the wide range of technologies available to create Smart Communities, which can include Smart Lighting, rather than conflating the two. One could argue that good quality lighting design is in itself Smart Lighting. However, opportunities have emerged, alongside a desire for advanced design considerations that require enabling, connected technologies, to make lighting responsive, adaptable, and, in short "smart."

Responsive lighting with integrated enabling technologies can be designed to brighten, dim or color the atmosphere in particular streets, neighborhoods and districts. Such design initiatives are often best undertaken through a process that directly includes stakeholders and members of the community. These technologies can be used to support public health objectives such as walkability, sociability, transit and last mile considerations.

Placemaking with light can be applied to mixed-use, entertainment and walking districts, housing and institutional or corporate campuses – most of the neighborhoods within the City of Saratoga Springs.

For advanced lighting to affect placemaking initiatives, first, the district's existing open space usage must be evaluated. This can be effectively conducted from a "shades of night" (fig-4) perspective, surveying street and space activities or lack thereof, from dusk to dawn. This process opens opportunities to evaluate gaps and put strategies in place to establish extended benefits such as economic development. Responsive, quality lighting can support community building and thriving nighttime environments. For downtown areas, this can result in nighttime economy improvements -- where new businesses associated with nighttime activity can potentially be developed or expanded.
On the technological side, Smart Lighting is a lighting industry-centric umbrella term for Smart City technologies, as the devices, methods, and communications associated with these technologies provide services over and above night illumination alone. These devices are integrated with luminaires that house light emitting diodes (LEDs) and can be remotely controllable, in terms of on/off, dimming and can report on their status, typically to a central control system.

The purview for this guidebook is limited to smart systems as they interconnect with lighting. Key Smart Lighting capabilities can be summarized as:
- Remote on/off and dimmability
- Self-reporting of status and trouble ("proactive maintenance")
- Dynamic spectral, dimming, and color changes for special application

In contrast, key smart poles capabilities can include all above Smart Lighting capabilities as well as:
- WiFi or Cellular antennas
- Data gathering sensors (temperature, barometric pressure, sound, vibration)

And Sustainable – Quality And Technology

- Visual annunciators (parking, wayfinding, transportation, commerce)
- Video surveillance

When developing the strategy for lighting infrastructure alone, there are broadly four categories, as shown in more detail in the illustration below. The "Basic" category is not yet "smart" per se but provides energy savings through LED conversion, and an opportunity to be "smart-ready" and implement provisions for later integration of smart-enabling technologies. Basic+ and Advanced define varying levels of lighting controls, and Advanced+ incorporates Smart City and Community integration. Public and private sector entities play a role in introducing Smart Lighting. They include government agencies such as public works, departments of transportation, law enforcement and information technology, among others.

Importantly, community citizens participate to inform the design of infrastructural systems. Quasi-public entities such as utilities also play a role, often with educational programs and incentives to drive localities to smart infrastructure. On the private side, manufacturers, consultants and contractors are employed to design, fulfill procurement and install systems.

This guidebook provides information to these entities to build capacity for improved nighttime environments, whether residential, institutional or downtown districts. In New York State, New York Power Authority and National Grid offer partnerships and incentives to municipalities in three areas for deployment, in Basic, Basic +, and Advanced (fig-5). For Advanced+, additional collaborations with private industry partners and turn-key, full service, providers are starting to be available.

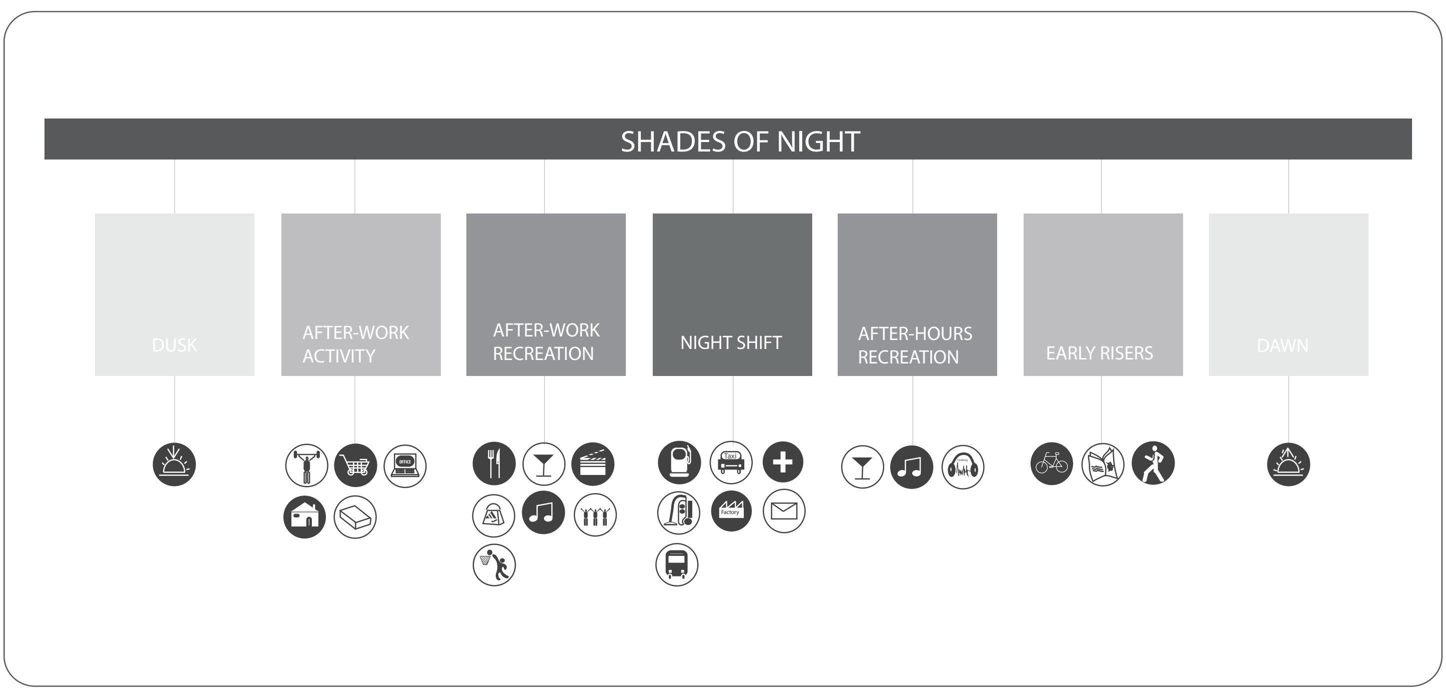


Fig-4: Shades of Night

Unique Benefits And Challenges For Communities Aspiring To "Smartness"

There are many potential benefits and challenges to implementing Smart City and Lighting technologies, some are summarized in the following table-1. It is suggested that a municipality undergo a careful analysis and strategic planning before deploying Smart City technologies. The following details some suggestions to jump start strategic planning.

There is tremendous dynamism in the industry – new manufacturers are regularly entering the market, while old ones are regularly exiting it. A city seeking to partner with a single, future-proof manufacturer faces a set of challenges. Authorities are faced with some choices and must anticipate rapid technological and commercial changes. This document proposes an approach to decision-making to support the City of Saratoga Springs and the NYS Capital Region.

Decision-making for technological upgrades can be daunting given the complex choices and ever-changing market. Manufacturers often silo their products as a one-stop market solution. Other manufacturers claim that their systems are "open" or that they "interoperate." So far, however, interoperability between different systems and products tends to be limited as systems often still require the use of manufacturer-specific coding at the functional level. In general, it is recommended that municipalities clearly identify their objectives for interaction of technologies (what responses are triggered by which devices) and then test in pilot installations, mock-ups and case study projects, either themselves or with support from an independent organization. Identifying whether the products and systems interoperate as needed is a vital element of the process.

Infrastructure Challenges

A municipality deploying Smart City technology or Smart Lighting technology has a number of infrastructure alternatives.

Examples include selecting power supply options, method of data communication between devices and preferred mounting method, if devices are to be mounted on existing armatures (e.g. lighting or telephone poles). The following sections describe some of these physical and digital equipment infrastructure choices, followed by infrastructure needs related to system management, ownership and human resources.

Street light with smart hardware attached
Photo by Planning4Places, LLC

Benefits of deploying "Smart" technology

Potential Benefits of LED Streetlights

- Energy savings
- Longer life
- Reduce maintenance cost

Potential Benefits of "Smart" LED Streetlights

- Energy savings
- Longer life
- Dynamically adjustable color
- Dimmability
- Self-reporting of light status/trouble

Potential Benefits of "Smart" LED Streetlight Poles

Mounting point for:

- Wi-Fi access points
- Cellular antennas (5G)
- Data gathering sensors (crowd,temperature, vibration and sound)
- Visual annunciators (parking, wayfinding transportation,commerce)
- Any technology that benefits from being mounted above and along streets.

Challenges of deploying "Smart" technology

- IT staff required that will deal with multiple computers on every light pole (security, updates, etc.)
- Multiple infrastructure and support staffs required, one for each application deployed (first responders, highway workers, commercial communications staff, etc.)
- Rate of innovation guarantees need for nearly constant swapping out of old technology for new.

Table -1

AN OVERVIEW — Considerations: Physical Equip

Digital Infrastructure

In general, Smart Lighting devices that are installed as replacements for earlier generations of street lighting technology will utilize the same source of power as had been used by the earlier systems.

The choice is more complex for Smart City devices ("smart devices"). In many cases, smart devices will be deployed near or on the support systems for street lights (e.g. suspended catenary wires, telephone poles, or street light poles); in those cases, the same systems that power the street lights may be usable for the smart technologies. As a point of information, there are also cases where the optimal mounting location for a Smart City system might not be near a street light (e.g. video cameras capturing non-street areas; sound-monitoring systems in unlit parkland). Then, power-supply choices must be made based upon the power consumption needs of the smart device and the power sources available at or near the mounting location. This element of the guidebook focuses on smart technologies connected to lighting where power is typically available, either from the grid, or in some cases solar or battery backup.

Data Communication

A fundamental requirement for Smart Lighting and other Smart City technology is data communication. Devices must communicate among themselves and with a central control management system (CMS). Devices will have different bandwidth needs, communication interruption tolerances, and range requirements. These needs, in turn, will affect power requirements (some communication protocols require more power than others) and will impose restrictions on interoperability (a current implementation challenge), as a key component of interoperability is compatible communication infrastructure from one system (and manufacturer) to another. There is no inherent superiority of one data communication technology over another.

The proper technology is a context-specific choice. Among the factors that will need to be taken into account are: topography (e.g. is there a clear path for successful data transmission from one device to the next and are the distances between devices short enough to allow error-free communication?); capacity (e.g. bandwidth of the communication technology needs to be sufficient for the data requirements of the device); fault-tolerance (e.g. can the devices continue to operate, and for how long, when transmission errors occur).

Among the currently existing Smart City data communication technologies are:

- Wired
    - DALI
    - Ethernet
    - DMX (and its successor technologies)

- Wireless
    - LoRaWAN
    - Cellular
    - WiFi
    - ZigBee

To enable a decision-making process, cities first need to clearly identify their objectives and needs for the implementation and interaction of technologies (what services are needed and desired, what responses should be triggered by what input, what resources for maintenance and operation are available?). The resulting strategy is a crucial first step to launching system specifications planning,

ment, and Digital Infrastructure

including research into current products and protocols. As mentioned above, system interoperability should be tested before any larger-scale procurement decisions are put in place (see decision making matrix later in this document).

Physical Interfaces

The actual installation and mounting of technology to enable Smart Communities present an additional set of infrastructure and interoperability challenges. Municipalities should demand the most far-sighted, future-proof mounting systems for their Smart City technologies.

Most physical mounting systems, such as pole mounting, are inherently long-lasting and durable. However, integrated, Smart City products must be able to be updated at the speed of technological innovation. Additionally, it is essential that these poles (or other mounting infrastructure) provide the most flexible mounting opportunities, while also upholding an aesthetic standard. Design principles must be considered in regard to the appearance of digital device appurtenances. As of this writing, manufacturers are developing ways of hiding devices within luminaires and offering "smart pole" designs. If the systems are proprietary and siloed, they cannot be considered future-proof choices.

Art Installation: *Urban Light* by Chris Burden.
Image being used for Los Angeles Smart Light Pole design competition to integrate hardware into light pole
(https://www.lalightstheway.org/about)
Photo by Nick Ut, Associated Press

Example: Smart hardware visibly attached
Photo by Planning4Places, LLC

Example: Smart hardware integrated into luminaire
Photo courtesy Felicity Smart Technology

AN OVERVIEW — Human Infrastructure, Manage

As cities consider Smart Lighting and Smart City functionality for their communities, it is important to factor in governance requirements. Each department that consumes Smart City data or uses Smart City functionality will have different requirements for that data or functionality. New staff and departments may likely be required when implementing functions for Smart Communities using Smart City technologies. With the rise in Smart City technologies and the complexity of municipal services, U.S. cities such as New York and Boston have created new municipal departments to coordinate the Smart City related digital technologies and study their potential. For example, the Office of Urban Mechanics in Boston has focused on education, housing, public works and IT departments. In New York City, the Mayor's Office of the Chief Technology Officer is addressing broadband, smart city technologies and digital services. The need for upper level management for deployment of smart networks was emphasized on a panel for the Consumer Electronics Show in January 2020. Dr. Jennifer Harder, with the First Responder Network, U.S. Department of Commerce, commented, "To stay afloat in the sea of devices, cities should hire people who can be responsible for charting the course of emerging technology within government." (Johnston, R., 2020). " Small and mid-size municipalities may also need to implement additional resources to coordinate the opportunities and challenges of physical and digital Smart City technologies and the related infrastructures. Some examples are listed below.

Police, Fire, other First Responders

The deployment of Smart City technology that supports security functionality could include crowd size estimators; fire detectors; hazardous gas detectors; severe weather detectors; gunshot locators; and more.

The data collected by each of these require staff that is trained in the interpretation of that data and provided with the necessary tools to initiate a proper response when the data requires it. There is thus a clear need for the security departments that receive this data to have staff that is dedicated to conversion of this data to actionable information, and who have the capability to trigger responses to the information when necessary. These capabilities may not typically be present in the respective departments prior to the implementation of these new technologies.

Information Technology (IT)

The deployment of Smart City technology throughout an area is akin to deploying a network of computers throughout that same area – each smart device is itself a computer. The addition of so many computers to the information network of the city will place significant new demands on the IT department supporting those computers. Each device type will require its own upgrade and security policies, and maintenance techniques. Each individual device will require monitoring and regular servicing for status, compromise, and functionality updates.

Marketing

There is potential for annunciator boards, mounted on smart poles, to provide a creative opportunity for city self-promotion. Dynamic Smart City annunciator boards, however, require regular updating by dedicated staff with the skills required for creating compelling information delivery on electronic displays (skills akin to website content development). Additionally, signage applications may require a change in zoning regulations or in cases of state roads any applicable state signage regulations.

ement, and Governance Considerations

Transportation (ITS)

Similar to marketing information, Smart City annunciators can display constant status indicators about public and private transportation in a city. Information about arrival times, congested and alternate routes, parking availability, and more, can be alternated on annunciator boards with a city's marketing information.

For services to run smoothly and accurately, in addition to the technologies and staff that support automated reporting, staff must also be dedicated to maintaining the currency and accuracy of content and announcements.

Nighttime transit, bike, and pedestrian support

Technology provides ample opportunities to adjust to the needs of after-dark commuters and visitors of Saratoga Springs events travelling by bike or foot. During design phases a lighting inventory or audit is required for LED conversion. At that time, special attention will be paid to the needs of cycle lanes and priority pedestrian ways (or conversely, preferred future use of sidewalks), to match the community's targets for non-vehicular public-way usage.

Similarly, intersections, crosswalks, and night transit routes should be considered for augmented lighting and digital wayfinding, for example integrated with bus stops.

Specifically, new mobility-focused street design innovations can be explored; there are responsive signals for bike lanes and predictive signal technologies being tested as well as integration of street painting technologies with illumination

.

Narrow targeting by desired function

The first phase of technological planning is a narrowing of the desired functionality. The set of functions that are included under the broad term "Smart City" technology enabling the development of "Smart Communities" are vast. A city should evaluate which function or functions will benefit the city most and create a deployment plan accordingly (for only those functions).

Each of these functions will require their own analysis, infrastructure, and staffing plans. While in some cases, infrastructure and staffing might be able to be combined, this will have to be analyzed as the deployment is planned. Below is a selection of some of the available functions to consider for such strategy deliberations. Typically, they involve a combination of data input from an environmental sensor to trigger a change in lighting or information displays. (Some of the current technologies are summarized in the appendix in a technology matrix):

- Dimmable street lights (e.g. in response to natural light conditions, events, time, weather)
- Crowd-responsive lighting
- Emergency-responsive lighting
- Traffic and parking monitoring and maintenance
- Wayfinding
- Commercial advertising

Some functions focus on data collection and other background functions, such as, for example:

- Surveillance (cameras)
- Facial recognition
- Crowd size estimates
- Wireless hubs
- Public transportation information
- Energy Monitoring
- Maintenance alerts
- Environmental sensors (temperature, humidity, noise/sound, pressure, lighting, vibration)
- GPS locator

3 DECISION MAKING ROADMAP

Defining and prioritizing the civic challenges that might be solved or improved via smart technologies is key to creating Smart Communities with the implementation of Smart City technologies.

Connectivity and control are seductive possibilities that attract cities for reasons such as streamlining and efficiency of government services, signaling of emergencies and change, new processes and functionality. Innovation and creativity appeal to some, improving functionality is tempting to others. However, in a market-driven arena, the complexity of choices within these capabilities has been cloaked in a kind of magical realism, and cities are seeking clearer explanations about these services. For example, data security/ownership and privacy are also critical during the vendor selection process.

Nearly 40% of municipal respondents when queried about interest in Smart Lighting cited "More information about potential benefits and savings, and specific analysis of how my community/ organization might benefit" as the support they need. (Sensus/Smart Cities Dive, 2018). Northeastern cities foreground contrasting methods to develop smart, innovative tech in the years between 2010 and 2013. At that time, New York and Philadelphia focused on civic-minded software developers to help cities become more effective and efficient. Going further, in 2019, Boston issued requests for civic innovators to disrupt the norm by testing "brand new services altogether." As of January 2020, Philadelphia, has launched a "Pitch & Pilot program" for technology-enabled approaches, stemming from their Smart City Roadmap (City of Philadelphia, PA, 2019).

More information on other city approaches and case studies can be found later in this document. These are provided as examples. , in part to illustrate that community has taken a different path dependent on specific needs and objectives. The term of current usage is, "what is the problem we are trying to solve for" (with advanced technologies)? Each municipality will have a unique answer and therefore define a parallel technological solution (Johnston, R., 2019).

The Stepped Approach To Decision Making

Municipal departments must collaborate to identify the problems to be solved by networked and advanced technology, and how and when to deploy onto or into light poles. That is, smart tech and smart lighting are not purely operational decisions, but rather issues of governance, prioritization and staging. The following diagrams summarize and illustrate some of the necessary steps.

Decision Making Roadmap

Foundation | First Steps | Second Steps | Third Steps

Basic	Basic +	Advanced	Advanced +
LED conversion and Provision for future technologies	Central management System	Dimming and tuning enabled	Smart City technologies enabled and integrated
Energy savings = money saving	Proactive maintenance / asset management	Additional energy/ money saving and longer equipment life	Lighting in response to sensor and data analysis feedback systems, e.g. crowd-responsive lighting, emergency responsive lighting, traffic and parking assistance, active wayfinding and information systems
Leverage government and utility incentives and programs for LED conversion	Reporting of failure and performance	Systematic reduction or increase of lighting levels on a timed basis	
Coordinate for future smart upgrades	Interconnected luminaire control	Placemaking with light: design strategy to brighten and dim, tint or color based on area typology and community input	Integration of Smart Cities systems and coordination with governmental agencies
Utility initiatives and collaboration (e.g., National Grid)	State initiatives and collaboration (e.g., NYPA)	State initiatives and collaboration (e.g., NYPA)	Collaboration of governmental program, public engagement, and third party

* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Fig-5

Decision Making Roadmap

Foundation | **First Steps** | Second Steps | Third Steps

Outcome of First Steps

- Create prioritized list of challenges that might be addressed by smart technologies and managementstrategy
- Establish working party to manage smart initiative and departmental staff that will interface smart technology assets

Management:

- Identify city department services that might benefit from smart technologies.
- Develop working group to manage smart project
- Determine responsible party for budgets

→ Coordinate prospective departments to ainterpret and utilize data collection for management of services (eg. IT, Police, Fire, transit, transportation)

Citizen engagement:

Community outreach create awareness of smart tech aspirations

→ Ensure all stakeholders contribute to strategy development early in the process

Shades of Night Analysis:

Measure public and open space usage from dusk through dawn in area typologies

→ Identify time-based activities as a baseline for future smart technology application

Establish ownership:

Identify relevant infrastructure jurisdiction issues or conflicts

→ Plan for prospective Integration of smart city systems such as poles, luminaires, telecoms electric power/wiring and maintenance thereof

Lighting prioritization:

Identify civic lighting-related issues

→ Consider energy, safety, comfort, orientation and legibility, city branding, placemaking, etc

Leverage programs:

Identify incentives to finance, offset costs, and implement options

→ Government and utility buy-back programs, competitions, implementation management and financing scenarios may be available. Review and compare

* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Decision Making Roadmap

Foundation | First Steps | **Second Steps** | Third Steps

Outcome of Second Steps

• Formulate Smart Lighting/ City strategy: incorporating technology and financial research into an action plan

• Translate case study / pilot results into a recommendation for implementation for different use cases

Engage design services for Smart Lighting:

An urban lighting design firm plus related design consultants will ensure that procurement decisions take into account operations, placemaking, equity, and aesthetics

→ Working party and design team to define next stepsand grants available

Engage Smart City strategist:
Develop a phased "smart city" strategy based on 1st Steps analysis

→ Collate options, prioritize
develp draft RFQ

Develop financial strategy.

Verify and align with municipal

→ Include ROI and cost-benefit analyses based on priorities selected, and technologies, services, maintenance plan

Familiarize with technological options:

Prepare civil servants to converse on technological subject matter

→ Research and prioritize preliminary technological options, and suppliers, for local conditions

Implement case-study pilots and use cases:

→ Design pilots
• test concepts,
• communication technologies
• interoperability
• quality of light

* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Outcome of Third Steps

- Ready for procurement
- Ready for installation

Develop and refine design with design team:

Assemble contract documents: Specifications and layouts for bid package

Design wraps up priority community needs, such as:

- municipal services (traffic, transportation, wayfinding, etc)
- citizen engagement
- nighttime placemaking,
- lighting

Develop procurement and implementation plan

- Request and retain bids
- coordinate implementation

Establish interagency cooperation plan for resource allocation management of services

Coordination is needed to share and utilize, for example:

- data collection,
- data analysis
- data management (including privacy)
- infrastructure maintenance

Establish a monitoring strategy:

Long term quality control of assets

A strategy will include, for example

- monitoring,
- testing,
- debugging

In the short term:

- future-proving the chosen systems after installation

Identify and put in place agreements with third-party contractors as needed

Set the stage for support services after installation:

- maintenance
- functionality
- system content

* All Steps: Identify and retain third party collaborators and consultants as needed for analysis, strategy, implementation, maintenance and management

Why Pilots?

Pilots are critical. They are interconnected with the decision-making process. During the research for this report, it was found that many of the professed smart lighting deployments are not full-on permanent installations, but rather demonstrations, or pilots. To determine the type and scale of pilot, a community must work through Steps 1 and 2 tiers of the Decision Making Roadmap.

Each community will solve for its own needs as they are prioritized. As noted earlier, integration of luminaires, poles and Smart City technologies are likely to have compatibility challenges. Equipment needs to be vetted and tested, to preclude incompatibility. Replacement or modification of technology on a full roll-out is costly to replace. Better to adapt with a small sample.

NYPA states that they focus on with open networks to accommodate multiple vendors during the design phase.

NYPA provides samples and mock-ups as part of their offer. Some manufacturers provide free pilots depending on the scale of the future deployment order. Decision makers and working parties, can also visit existing pilots and installations communities located throughout the state
(see case studies).

A group should be designated for the life of the pilot. Critical personnel are municipal managers, lighting designer, electrical engineer, manufacturer (supplier), installer. Provision for community engagement and input are also essential for full benefit of a temporary pilot. A Monitoring and Evaluation (M&E) plan may also be required.

Pilots are important for several reasons:

1. Proof of operation/functionality

- Connectivity, devices, interoperability, compatibility
- Sensing
- Asset Management demonstration - Reporting and managing
- Proof of security plan, including protection from hacking/viruses; validation of software update capabilities.

2. Aesthetics

- Quality of lighting – focus, color temperature /rendering
- Lighting levels – brightness, contrast
- Form factor of equipment – profile and finishes of luminaire, pole, attachments

3. Placemaking with light – Dimming control required

- Community engagement
- Digital responsiveness
- Software program operation
- Unique applications

4 DEPLOYMENT STRATEGIES: Financing, Fin

Municipalities have the opportunity to own their lighting and related Smart City infrastructure or enter into contracts with state or utility agencies. With each choice, there are different potential revenue streams that a city may realize and tradeoffs that need to be considered. As owner, for example, attachment fees onto smart pole "real estate" could be charged from other departments or third parties that wish to deploy additional technology alongside the street light sensors and controls. In addition, collected data are an asset that is widely discussed as a potential stream for revenue. Ownership provides those opportunities, however, also the responsibility of implementing, managing and maintaining the systems and infrastructures.

As of the date of this report, the New York Power Authority (NYPA) has recently announced a Smart City Technology Grant Program ("Smart City Grant"), scheduled to run through December 31, 2025. The goal is to support the planning and installation of Smart City sensor hardware and software technology as part of LED street lighting conversions. In order to receive an award, the applicant city must enter into an agreement with NYPA for the full turnkey project implementation of an LED street lighting conversion. The Applicant must also execute a cost recovery agreement with NYPA. NYPA's stated objectives are to support public safety through surveillance (video analytics, noise and motion monitoring, gunshot detection), environmental monitoring (air quality, ice and snow detection, sewer and storm water monitoring, weather detection), transportation management (traffic optimization, traffic monitoring, parking management), and connectivity (digital kiosks, connected vehicles, smart phone applications). Cost – benefit and ROI analyses for such projects have to extend the customary calculations of cost savings due to energy and maintenance reductions of LED conversions; these depend on the city's proposed strategy and needs. In 2019, NYPA proposed a $5-million dollar project to convert all lighting to LED to enable energy and maintenance savings, and with that, the associated financial benefits. This suggests that the City of Saratoga Springs may be able to finance a conversion project through NYPA, with NYPA potentially providing construction and/or project repayment loans.NYPA also offers management and engineering services for all phases from conceptualization through closeout; from design and construction phases, to coordination of strategic sourcing, purchasing, cash flows, rebates and public outreach.

A model ROI calculation using a "Basic" LED conversion, which is the most economical up-front solution, estimates the payback from energy and maintenance savings to be about 14 years. However, this solution does not yet include any of the above-mentioned provisions for lighting controls, dimming, sensor driven data collection and responsiveness, so called smart technologies (Advanced and Advanced+). The ROI and cost analysis for LED street light controls, such as dimming, and/or a street light sensor networks and management systems, providing additional functionality, need to be calculated based on the concept desired and developed by each city. Savings calculators look at construction costs, interest during construction and energy and maintenance savings. NYPA estimates that customer conversion projects can expect simple paybacks between 7 to 10 years (not including financing). To reiterate, actual Street lighting "Return on Investment" calculations must be highly customized. Details that are municipality and project specific reflect the street light inventory and particular LED conversion project under

...ances, and Tariffs

consideration. Many factors impact the cost and savings, including the number of decorative lights, the age of the infrastructure, a community's interest in smart cities, and other political and community goals. For New York State, specifics can be arranged discussed by meeting with NYPA, CDRPC (in the Capital District), and many other organizations that provide assistance in streetlight conversions.

NYPA includes a line item for "maintenance savings" which reflects replacements, truck rolls and labor required to maintain street lights compared to traditional street lights. Also, NYPA Operations and Maintenance (O&M) program being launched in 2020. This service has historically been provided by the city itself or third-party contractors.

The Capital District Regional Planning Commission, funded by the NYSERDA Clean Energy Communities Program (CEC), provides technical assistance. Using the requisite formulas, a community's quantitative details are employed. CDRPC is able to conduct cost analyses for purchasing streetlights or upgrading through utility programs – using data from the tariffs – as well as help communities connect with their utility account manager to request pricing and other details for purchase and upgrades. The CDRPC has assisted 28 communities in the region with designation in the CEC program, and provided over 30 streetlight analyses to these communities. CDRPC is able to determine ROI once a community receives their prospective utility upgrade/purchase cost from National Grid and additional conversion costs from NYPA. This analysis is also available from other regional groups for other areas, such as ANCA in the North County, Mohawk Valley Economic Dev District in the Mohawk Valley REDC.

Current Model		
Annual Costs		
	Amount	**Savings**
Facility	$ 4,660.32	N/A
Electricity	$ 7,187.43	N/A
Total	$ 11,847.75	N/A
Environmental Benefit		
	Amount	**Savings**
Annual Electricity Use (kWh)	32,434	N/A
Annual GHG emissions (kg)	9,195	N/A

Utility Convert		
Annual Costs		
	Amount	**Savings**
Facility	$ 6,216.84	$ (1,556.52)
Electricity	$ 2,049.59	$ 5,137.84
Total	$ 8,266.43	$ 3,581.32
Environmental Benefit		
	Amount	**Savings**
Annual Electricity Use (kWh)	9,249	23,185
Annual GHG emissions (kg)	2,622	6,573

Municipal Ownership		
Annual Costs		
	Amount	**Savings**
Facility (Maintenance)	$ 1,620.60	$ 3,039.72
Electricity	$ 1,451.73	$ 5,735.70
Total	$ 3,072.33	$ 8,775.42
Environmental Benefit		
	Amount	**Savings**
Annual Electricity Use (kWh)	7,464	24,970
Annual GHG emissions (kg)	2,116	7,079

GHG Emission Savings	
NYS Avg kg CO2e/MWh	283.50

Energy Saving Calculator Table

Source: CDRPC/NYSERDA

Tariffs Explained

Light is ephemeral. As a medium, if implemented properly, it can create the sensation of beauty and magic. This special characteristic can be evoked by increasing and decreasing in brightness, as well as tuning between color spectra. Technically, this dynamic ability is called dimming for brightness and tuning for a change in color. Prior to the popularization of LED as a public lighting source, the most energy efficient sources could not dim. They could only switch on and off. The dimming characteristic is of yet underexplored for public, open spaces and streetscapes for after-dark placemaking. Dimming has an extra benefit: energy reduction. When controllers are installed and used, lower energy usage is a result.

A tariff is formalized document from the Public Service Commission. It is based on a rate of delivery, energy, supply, and facility charges (including under or over ground supply). Charges also depend on ownership. If a city owns the street lights, there is a small reduction of charges, however that cost is replaced by the cost of maintenance.

In New York State, the tariff portion for energy consumption is based on the light source wattage (HPS, MH, or LED). This is the assumed, fixed, energy charge which is multiplied by quantity. In this case, a luminaire at full brightness/wattage or reduced (dimmed) is charged the same amount. In other words, energy is not metered, and charges are not based on actual usage.

Some communities would like to have the choice to save on money and energy with the dimming option. NYPA is testing the feasibility of a "dimming tariff" with Orange and Rockland Utilities company. There are precedents in the US and Rhode Island has installed a similar pilot.

A new rate incorporating dimming will, again, be an assumed rate, with a city commitment a set timed dimming schedule, for example, x hours - watt hours = kilowatt hours calculated. For the O&R pilot, each of 25 streetlights will have a controller and meter. Once installed, the test period will take place for 6 months. NYPA anticipates a 15% reduction (Money or energy or both?).

There are also hidden benefits to dimming. When first installed, LED is brighter than necessary, as the technology, as currently implemented, inevitably reduces light output over time. With the combination of dimming and asset controls, luminaires can be dimmed upon installation, with a gradual reduction in dimming over the 10-15-year lifetime. Additionally, there is a savings in O&M as the life of the LED is extended and does not need to be replaced as often.

Outdoor Lighting Quality And Ecological Balance

Many communities are especially concerned about preserving a view of the star filled night sky, and since wildlife is more preponderant in non-metro areas than in metropolitan areas, they have a responsibility to conserve darkness as well for nocturnal animals and other creatures. There is a concern to retain a balance of nature and urban life cycles, which can be interrupted by an unconsidered, badly designed lighting implementation.

Recommendations and policies guiding reduced light pollution are emerging. These recommendations, in some cases, are written into regulations such as city ordinances, where compliance is expected. In other cases, the recommendations are guidelines for best practice. Examples are materials by the Dark Skies Association, and the Illuminating Engineering Society (Dark Sky Organization, 2019).

Color Rendering Index (CRI)

Image Credit: Don Slater

Using light with high color rendering properties enables the visibility of different object and surface colors (e.g. under most white LED lighting reds, greens, and blues are visible)

Image Credit: Despacio

Using light with low color rendering properties limits the visibility of different object and surface colors (e.g. under low pressure sodium lighting reds, greens, and blues are not visible, all colors look brown-black)

Outdoor Lighting Quality And Ecological Balance

Four categories comprise "light pollution:" 1. Glare, 2. Sky Glow, and 3. Light Trespass. (IES, 2017 and 2018). Education and awareness campaigns can help to address the issue and target the practitioners responsible, such as lighting specifiers lacking appropriate design training, construction operators, and private owners of buildings.

Glare is outward facing lighting that, simply described, can hurt eyes, both human and wild. It also can momentarily or continuously blind the viewer, leading to safety problems and interrupted eco-cycles.

Sky Glow is the effect of lighting upwards causing clouds and particles in the atmosphere to glow and therefore obscure the night stars and planets, and also reflect back down, causing a "blanket" of light. Also true, however, is that ground-facing illumination does reflect back up to the sky, adding to sky glow. So, in this case illumination for both a darker sky and social benefit is a balancing challenge.

Light Trespass occurs when a luminaire casts light onto an area that is not intended to be illuminated, per intent. Two examples are, when a garage light pops on when unneeded, or when streetlight illumination strays into residential windows. Mechanical and optical solutions are available to reduce light trespass.

Additionally, poor lighting design can result in "over-lighting" and on the other hand "under-lighting." These two issues are complex, encompassing a range of factors. For example, a lack of understanding about contrast, visual adaptation and lighting needed for visual performance to support safety and desired social realities. Due diligence is needed during the design process (e.g. photometric calculations and mock-ups to review the lighting distribution, appearance and overall spatial effects). In the US, "Model Lighting Ordinances" have been developed to ensure that the natural environment is considered. Classification systems are available to evaluate a fixture according to its light distribution. Mechanical and optical means to shield stray light are available, and in most cases perhaps, are incorporated into streetlighting. In addition, the quality of the light itself can help mitigate undesired ecological impacts. Generally good color rendering properties are recommended to improve visibility of colors and details, and the use of warm to neutral correlated color temperatures as research suggests that light spectra with less short wavelength (blue) content might be less invasive (Lugingbuhl, C.B., et al. 2014).

Correlated Color Temperature (CCT)

Color of light

- Cool white light with typical CCT of 4000 – 6000K
- Warm white light with typical CCT of 2200 - 3000K

Image Credits: Nantes by night (© Didier Robcis photography)
https://www.lec-expert.com/topics/the-colour-rendering-index-at-the-led-test-bench

5 CASE STUDIES

Syracuse, New York's 'Flagship Smart City'

Many communities have commenced, and some have completed Smart Lighting/City projects since the Governor enacted the Smart Street Lighting NY Program, and enlarged its funding in 2019. There are also use cases, and lessons learned, throughout the United States and around the globe. We have selected two exemplary cases, Syracuse and Boston, that have gone above and beyond "Basic" with efforts to achieve community engagement to expand their smart roadmaps. Additionally, in this section, the progress of our upstate towns is summarized for comparison.

As must be reiterated, each town, city and community have its own civic priorities based loosely on safety, health and economics.

"Syracuse Surge," a long-term strategy to fund economic growth and workforce development in the Syracuse downtown south corridor, was announced in January 2019. As a part of the overall Surge initiative, NYPA approved a $500,000 grant for Syracuse to plan for procurement and replacement of the city's street lights with LED luminaires. It is anticipated that through the transfer of ownership the city will save an estimated 3-million dollars per year and reduce greenhouse emissions by 6,100 tons. The replacement of conventional lighting will provide the basis to design and install an interconnected smart grid with access points for data collection throughout the city, later in the process. The City of Syracuse has established an Office of Accountability, Performance, and Innovation and working with the Planning Division, a "sandbox," or experimental pilot, is being staged.

Syracuse plans to evaluate equipment that can expand Wi-Fi, and 4G and 5G internet connection capabilities on its streetlights, and to install other digital enhancements to city-wide services, with $500,000 of support from NYPA, the first award from the $7.5 million statewide program (NYPA, 2019).


Smarter Streetlights Are Just the Beginning in Syracuse, N.Y.

https://www.govtech.com/smart-cities/Smarter-Streetlights-Are-Just-the-Beginning-in-Syracuse-NY.html (Photo by Debra Millet, Shutterstock)

LED lighting, background (white), High-pressure sodium lighting, foreground (amber) (Photo by Dominic McGraw, Philadelphia Office of Sustainability)

Boston, A Holistic Approach To Smart City Planning

In 2010, Boston launched an experimental smart initiative. The Boston Seaport Innovation District was the first such US city district among 80 world-wide.

In 2018, Beta Blocks, another Boston initiative, was introduced to leverage smart/IoT capabilities. Today, Boston's tagline is "Sensors are not smart. Digital kiosks do not save the world. Efficiency is not democracy." This provocative program is based on "a truly Smart City is one that creates equal opportunities for people to connect with each other and with the world. It allows its residents to decide what their definition of "smart" should be, and what creates real civic value. It provides ample pathways for its people not just to optimize it, but to live in it. (City of Boston, MA, 2019)"

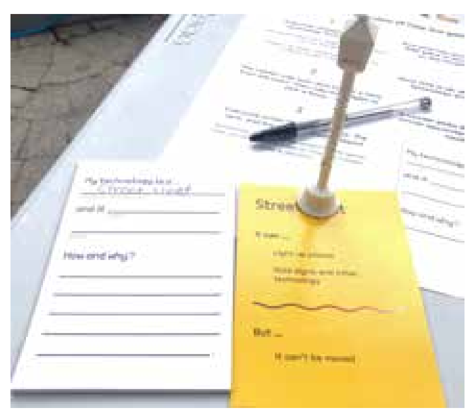
The Emerson Engagement Lab is delivering an authentic community outreach program. Entitled "Beta Blocks," the applied research lab provides a "civic experimentation process" for communities with problems that might be solved with Smart City technologies. The methodology includes government, private companies, researchers, designers and artists.

The Beta Blocks Action Research project responds to local challenges and is not "some expansive deployment of sensors or gadgets." The City of Boston's Urban Mechanics is responding to:

- o The lack of public dialogue around the civic values and privacy concerns of Smart City tools.
- o The lack of clear and dynamic processes and policies for civic experimentation.
- o The inability to easily "plug-and-play" new tools and designs in the public realm.

Question cards


The game


Street light icon

Boston "Beta-Blocks" community engagement exhibition in Chinatown, 2019 (All photos by Leni Schwendinger)

CASE STUDIES: Capital Region Examples

Overview

The following section provides summary information on projects underway in several Capital Region communities based upon municipal websites and newspaper publications. NYPA, National Grid, CDRPC, CDTC, and other agencies along with private-sector entities are collaborating with municipalities to assess and install LED lights and smart technology into existing systems.

According to NYPA, the majority of Capital Region streetlights are currently owned by utility companies, with the exception of the City of Albany which recently purchased their streetlights from National Grid. Many communities are exploring options in regard to the conversion and technologies elaborated in this guidebook, and NYPA noted in a press release for a City of Albany conversion project (discussed below) that they have installed, or are in the process of installing, more than 128,000 LED streetlights in municipalities across New York State.

City Of Schenectady: National Grid (Reforming The Energy Vision)

The City of Schenectady Smart City REV program is being undertaken to utilize technologies that are intended to enhance municipal services focused on public safety, mobility and sustainability. The project is also expected to bring lower energy costs and a reduced carbon footprint. Upgrades throughout the City are anticipated to provide the City with real-time data and lighting controls which are expected to provide more efficiency and management control of City assets (City of Schenectady, NY, 2019). Testing is underway by National Grid. The effort includes the rollout of smart technologies, including a wireless network, and replacement of 4,200 streetlights with LED lights. National Grid is comparing two systems: Cimcon NearSky in one section of the City and GE-AT&T City IQ in another. The entire project will take place over a three-phase, three-year period that began in 2019 (Schenectady, NY, 2019). Phase 1, was a test case in the historic Stockade neighborhood along Union Street between North College Street and Washington Avenue that included retrofitting 18 streetlights with intelligent controls and with a mixture of soft-white and daylight temperature LED lamps. This effort was undertaken to determine customer's preferences for 4,000K or 3,000K LED color temperature (National Grid, 2018).

The completion of Phase 1 included streetlight replacement in an area generally following the Mohawk Riverfront, including Downtown, the Vale Park area and areas of Mt. Pleasant and Hamilton Hill. Phase 2 includes the remainder of the City and is anticipated to be completed in 2020. Phase 3 focuses on evaluating the REV Demonstration Project through the year 2021. Some of the analytics anticipated to be undertaken include gunshot detection, multi-modal traffic volume analysis, and air quality measurement (City of Schenectady, NY, 2019).

Village Of Kinderhook

The Village of Kinderhook, in coordination with the CDRPC, is assessing how they can reduce costs and energy consumption while also reducing emissions. A focus of the effort is to determine how new LED lighting can positively impact the historic Village character while at the same time evaluating preferred color temperatures (Village of Kinderhook, NY, 2019).

Village And Town Of Colonie

The Village and Town of Colonie are working with NYSERDA, NYSDOT, the RPI Lighting Research Center (LRC), CDTC, National Grid, the University Transportation Research Center and an engineering consultant to evaluate the public sentiment of a recent LED lighting installation along an approximately 3.5-mile section of Central Avenue NYS Route 5) between Madison Avenue and Reber Street (Village of Colonie, 2019).

This initiative has divided the approximately 3.5 miles into five different sections for the purposes of the analysis. The online survey asked respondents to provide responses about their preferences and thoughts about the new white light LED luminaires, compared to traditional sodium streetlights (which produce yellow/orange light). The agencies intend to provide corresponding answers. Additionally survey questions covered visibility and safety in regard to perspectives as a both driver and pedestrian (Village of Colonie, 2019).

City Of Albany

The City of Albany is in the process of a wholesale change in streetlight ownership and how their lighting is managed. As part of the the Governor's Smart Street Lighting NY program that was announced in mid-2019, the City of Albany purchased its street lights from National Grid. Immediately thereafter, the City announced it was working with NYPA to install nearly 11,000 LED streetlights throughout the City (NYPA 2019).

This project will provide the City a new asset management system to monitor and control the street light system, provide the option for localized dimming, and automatically report outages. New poles will also provide a power source which can be used for future smart technology upgrades and additions. (NYPA, 2019 and City of Albany, NY, 2019).

Prior to a full conversion to LEDs, according to the Mayor's Office of Energy & Sustainability webpage, the City spent/spends 57% of its overall energy budget on street lights and traffic signals (City of Albany, NY, 2019). It is anticipated that the approximately $20M lighting upgrade project will save the City over $3.3M annually in energy costs and reduce greenhouse gas emissions by more than 2,850 metric tons per year. NYPA is financing and implementing the project and providing $850,000 toward project costs (NYPA, 2019).

Breathing Lights community art installation, Albany, Schenectady and Troy, 2016, Hyers + Mebane Install 34 https://breathinglights.com/installation/portfolio/

Artistic use of holiday lights in Albany's Washington Park 2019. https://www.iloveny.com/blog/post/holiday-lights-in-new-york/

CASE STUDIES: Capital Region Examples

City Of Glen Falls

The City of Glens Falls is actively working on a pilot program to install streetlights with smart technology in the City. The proposals include ideas to dim lights that get brighter when motion is detected, the addition of parking sensors, and air quality sensors.

In mid-2019, the City received a $50,000 NYSERDA grant and $34,000 in "savings and rebates" from National Grid earmarked toward the installation of 128 LED lights at East Field to replace the halogen lights. The energy cost, and resulting energy savings, to light East Field was anticipated to be reduced from $18,000 per year to $6,000 per year (Woodworth, G. 2018, April 25).

The City's sustainability consultant undertook detailed assessments of its infrastructure and found that the cost to upgrade street lights was more than originally anticipated. The City's street light inventory found that they owned more street lights than previously known – 1,569 instead of 1,378. Additionally, the City was going to need to pay a surcharge to National Grid for "hand holes" needed for technicians to maintain the new lights. This was going to increase the cost of LED upgrades from approximately $2M to nearly $2.75M. After utilizing a $75,000 NYPA Smart City grant and $93,000 in rebates and incentives from National Grid, the cost to the City was estimated at approximately $2.57M. This cost extended the length of the payback period from 11 to 14 years. This cost did not include smart technology upgrades that the City had been assessing. Three bids for the desired sensors ranged from approximately $182,000 to $231,00 0 (Woodworth, G. 2018, April 25).

Town Of Clifton Park

The Town of Clifton Park has been actively working on LED lighting upgrades for several years. In late 2017, the Town released an RFP seeking proposals to provide a performance-based energy contract to acquire existing street lighting from utility company owners and procure and install necessary upgrades to all LED lighting for streetlights under the Town's ownership In 2018, the Town awarded a contract to a private vendor to assist with the acquisition of street lights and conversion to LED. (Town of Clifton Park Board Resolution 246 of 2018).

The contract noted that the vendor guaranteed savings from energy efficiencies resulting from the use of LEDs, reduced maintenance costs and by eliminating service and maintenance charges that are assessed by utility owners. The private vendor was contracted to proceed with an Investment Grade Audit and related design work which compared the type, wattage, location and pole number for each street light facility and compared the data with that provided by National Grid and NYSEG. The vendor provided an energy efficiency contract which included specification of replacement luminaries, GIS mapping of all fixture locations and lighting controls proposed to be installed after acquisition of existing street lights from the utility companies, and a performance-based guaranteed energy savings. An audit of existing infrastructure found that the Town had been paying for lights and poles that did not actually exist at the time (Town of Clifton Park Board Resolution 246 of 2018).

The resolution included a proposal to purchase 600 street lights and lamps (not poles) from National Grid and NYSEG. The new lights will improve maintenance efficiencies, allow for dimming, provide smart lighting controls, and provide technology to monitor air quality, traffic and noise (Daily Gazette – December 3, 2019).

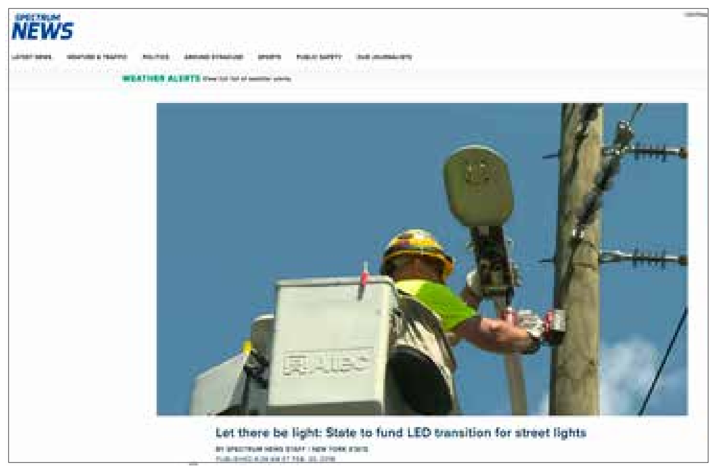
The anticipated savings on energy costs was expected to be approximately 60% by converting to LEDs ($4.5M over 20 years). The total implementation cost was anticipated to be $1.13M paid in cash with a 6-year payback period (Town of Clifton Park Board Resolution 246 of 2018).

The Town came to agreement with National Grid to purchase and convert just over 400 street lights and bulbs at a cost of just over $490,000. The anticipated payback is just over $5M over 20 years with the conversion paying for itself in 7 years. The anticipated energy savings is 60-65% (Parisi, K. 2019, December 3).

Regional Case Study Conclusion

There is significant interest in the Capital Region to assess and undertake street light conversions for LED and Smart City technology. Communities across the Upstate Region have undertaken varied conversion approaches, most doing so in phases, but all with at least a single common goal in common – to save energy and costs over the long-term. Additional common goals include better management of street light systems, improved maintenance operations, reduction of carbon footprint, increased safety, and provision of increased data and information (through Smart technology) for both government and citizen benefit.

Announcement Albany street light purchase from National Grid
Photo credit: Will Waldron/Times Union,12/5/2018



News article about Governor Cuomo's "Smart Street Lighting New York" program. Spectrum Local News article, published 8:26 AM ET Feb. 20, 2018 .Photo credit: Will Waldron/Times Union,12/5/2018

NYPA Smart City Technology Grant Program Website mast head.
Photo credit: Will Waldron/Times Union,12/5/2018

6 Appendix

Community Engagement and Website

A project website was developed to provide information about the project, share project documents, and highlight the NightSeeing™ event held in September 2019.

Project website

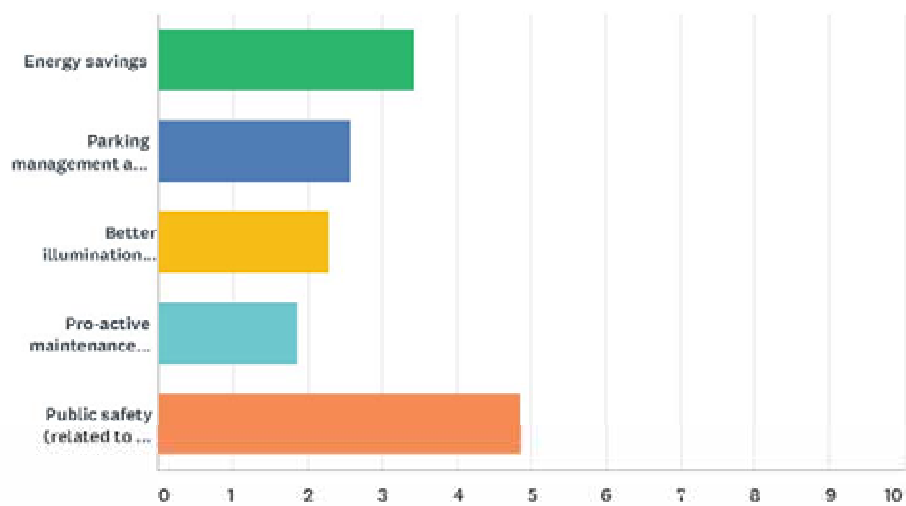
SAC Survey: City of Saratoga Springs Lighting Information and Smart Technology

A survey of key decision makers in the City of Saratoga Springs (elected officials and department staff) and members of the Stakeholder Advisory Committee (SAC) was created to help the Consultant Team understand the City's smart technology goals and to provide an overview for City Staff of cross-departmental ideas, concerns and priorities. Priorities for smart lighting based upon survey responses, in order of importance, include public safety, energy savings, parking management and wayfinding, better illumination for after-dark activation and safety, with pro-active maintenance needs being identified as the least important.

The survey included a question regarding the ability for smart lighting to dim, brighten, tint, and color lighting. Survey respondents stated a preference for dimming (viewing it as an important priority) and expressed interest in dimming in the institutional area as well as the Downtown and in the residential areas.

Q4 Please indicate your top priorities for Smart Lighting on a scale of 1 to 5 (with 1 being the highest priority and 5 being the lowest priority).

Answered: 7 Skipped: 0



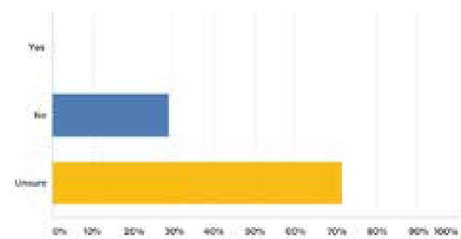
	1	2	3	4	5	TOTAL	SCORE
Energy savings	14.29% 1	42.86% 3	28.57% 2	0.00% 0	14.29% 1	7	3.43
Parking management and wayfinding	0.00% 0	28.57% 2	14.29% 1	42.86% 3	14.29% 1	7	2.57
Better illumination for after-dark activation and safety	0.00% 0	14.29% 1	28.57% 2	28.57% 2	28.57% 2	7	2.29
Pro-active maintenance (Inoperative or malfunctioning lights report back to base)	0.00% 0	0.00% 0	28.57% 2	28.57% 2	42.86% 3	7	1.86
Public safety (related to a feeling of personal security/sense of confidence and physical safety at night i.e. crosswalk lighting, lighting of sidewalks and bike lanes)	85.71% 6	14.29% 1	0.00% 0	0.00% 0	0.00% 0	7	4.86

Note: Public safety (related to a feeling of personal security/sense of confidence and physical safety at night (i.e. crosswalk lighting, lighting of sidewalks and bike lanes). Pro-active maintenance (inoperative or malfunctioning lights reporting back to base).

SAC Survey: City of Saratoga Springs Lighting Information and Smart Technology

Q8 Do you currently dim any of the street lights?

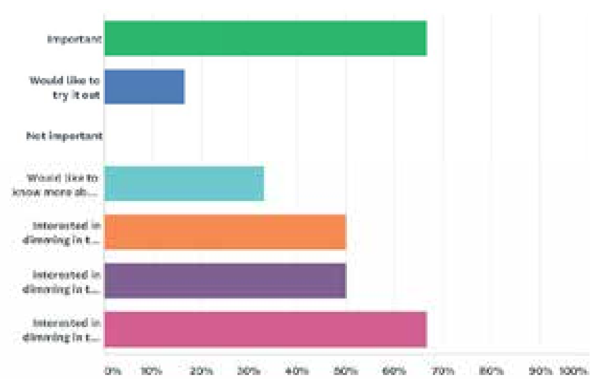
Answered: 7 Skipped: 0



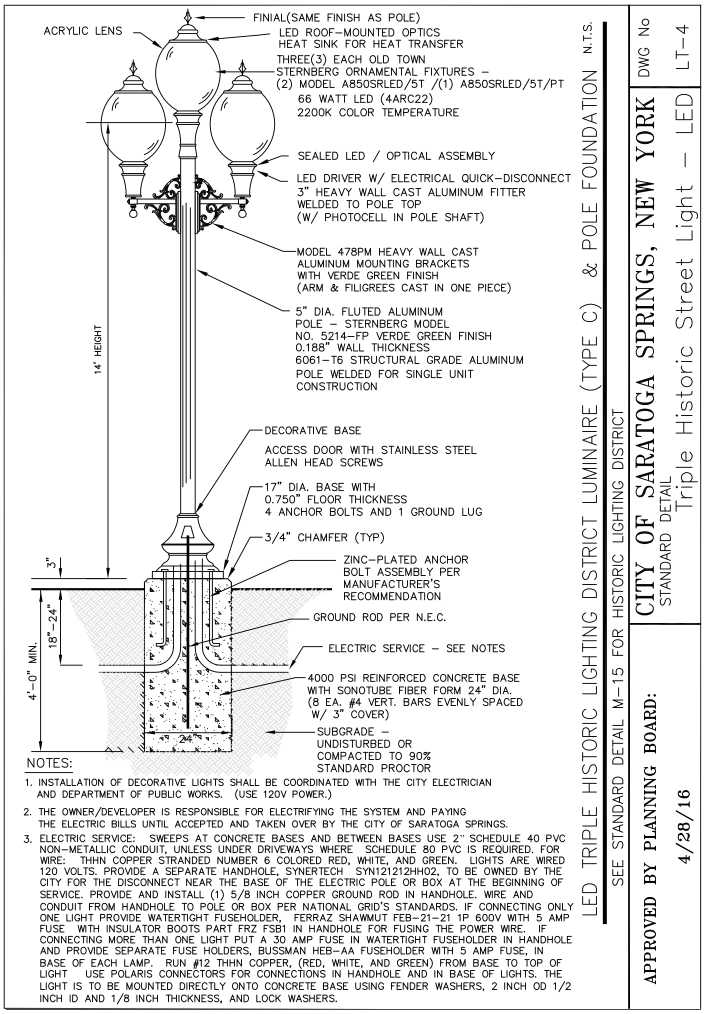
ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	28.57%	2
Unsure	71.43%	5
TOTAL		7

Q9 Smart lighting has the unique ability to dim, brighten, tint, and color lighting. Please indicate your interest/priority regarding these capability(ies) for Saratoga Springs and check all that may apply. For information on the focus areas described below (Downtown, residential, and institutional), please view them here.

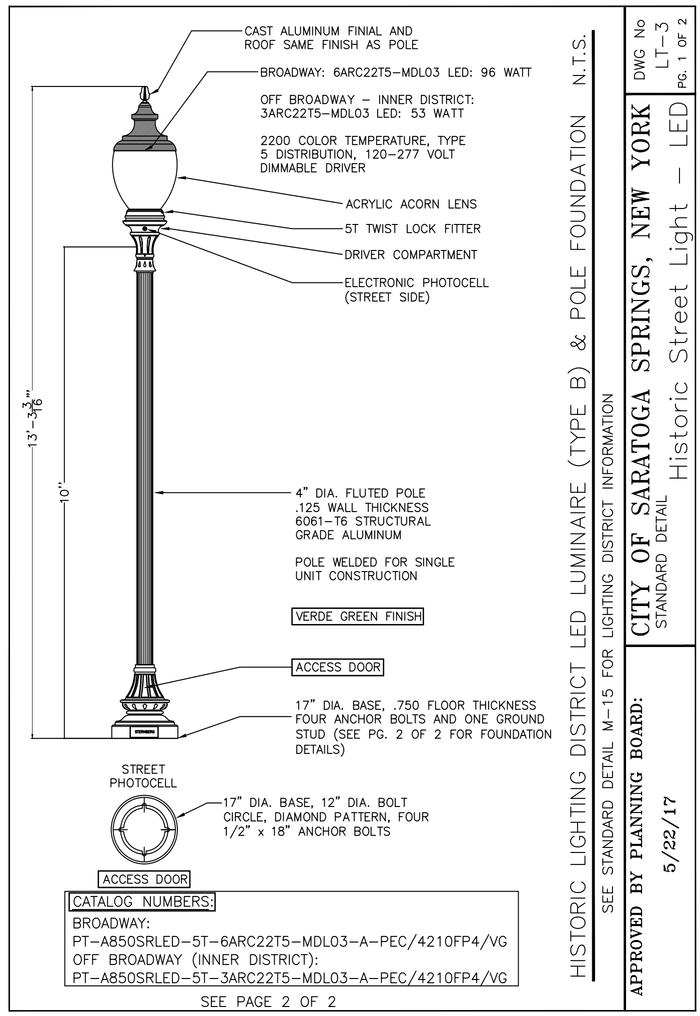
Answered: 6 Skipped: 1



ANSWER CHOICES	RESPONSES	
Important	66.67%	4
Would like to try it out	16.67%	1
Not important	0.00%	0
Would like to know more about it	33.33%	2
Interested in dimming in the Downtown	50.00%	3
Interested in dimming in the residential area	50.00%	3
Interested in dimming in the institutional area	66.67%	4
Total Respondents: 6		



Current Saratoga Springs Standard Detail:
Triple Historic Street Light, LED version



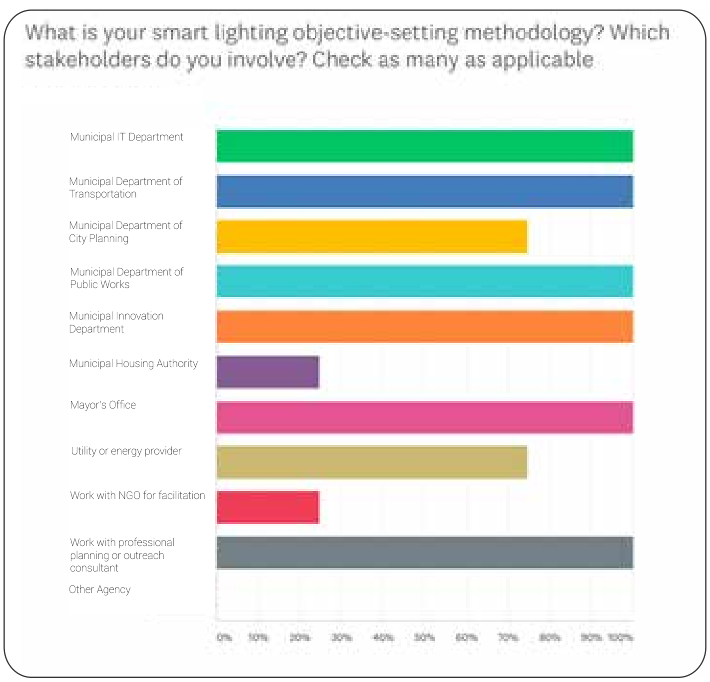
Current Saratoga Springs Standard Detail:
Historic Street Light, LED version

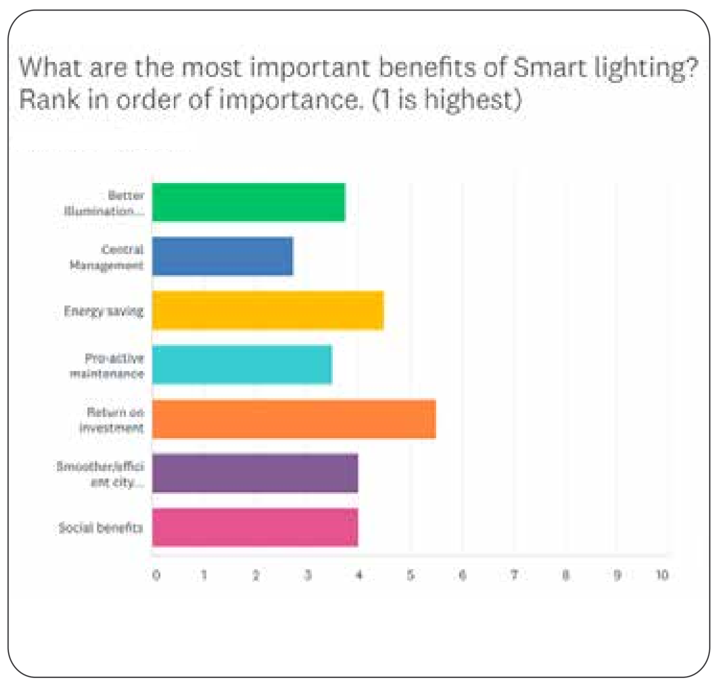
Smart City Street Light Technology Guidance Survey — Manufacturers

Summary:
We surveyed manufacturers who identify themselves as being in the smart lighting space, such as Signify, Cimcon, Citelum, Telensa, Felicity Smart Infrastructure, Verizon, GE Connect, and Tondo.

When asked about key competition, a consensus emerged which identified the main players in this space. Those manufacturers who responded saw GE Connect and Signify as being the main competitors in this commercial space.

Responding manufacturers identified Return on Investment as the most important benefit of smart lighting, with energy savings second, and smoother operations and social benefits coming in third (see graph below). When asked about their key differentiators – the factors that made them most different from their competitors – manufacturers identified their offering of turnkey services as the most significant. All manufacturers reported 100% interoperability, positive-dollar ROI, and reported on their permanent installations. However, please note, these categories have not been independently verified.





TECHNOLOGY OPTIONS

Reproduced from "The Benefits of LED and smart Street Lighting. A Performance Benchmark of US Cities."

http://northeast-group.com/reports/CityLab-Northeast%20Group%20-%20the-benefits-of-led-and-smart-street-lighting.pdf

COMMUNICATIONS OPTIONS (IN ALPHABETICAL ORDER)

COMMUNICATIONS TECHNOLOGY	HOW IT WORKS
CELLULAR (INCLUDING NB-IOT)	There are a number of licensed low power wide area network (LPWAN) communications options offered by cellular operators. These are public networks as opposed to many of the other options which are private networks. The emerging NB-IoT standard is perhaps the most well-known. NB-IoT is ideal for lower bitrate applications such as street lighting, with costs much lower than traditional cellular applications
LORA	LoRa is an open alliance of member companies and is another LPWAN communications option
POWERLINE COMMUNICATIONS (PLC)	PLC uses existing power cables to send data so it is a "wired" rather than a wireless communications option. PLC can be used for smart street lighting but has become much less common than the wireless options available and is more often found outside of the US
RADIO FREQUENCY (RF) •MESH •POINT-TO-MULTIPOINT •STAR	RF-Mesh networks have been used extensively by utilities and cities for smart metering and other IoT applications, including smart street lighting. The "mesh" configuration involves interconnectiveness between devices on the network to create a resilient, low cost network. The Wi-SUN Alliance is driving open standards and interoperability for RF-mesh devices and networks With RF Point-to-Multipoint, instead of the "mesh" configuration, each individual device communicates back to a central tower, without "hopping" to another device. Point-to-multipoint networks typically run over licensed frequency RF networks using Star topology use similar communications as mesh but with fewer connection points between the streetlights
ULTRA-NARROWBAND (UNB)	As its name suggests, UNB communications has a very narrow bandwidth. It is ideal for applications that generate small quantities of data, such as smart street lighting. There are a number of UNB offerings–including proprietary–such as Telensa and Sigfox

Matrix of Current Manufacturers and Technologies

Product	Website	Network Mode	Standards Compliance	Sensor capabilities for functions, such as environmental, parking, traffic	Control Interface
Acuity Brands, nLight Air	https://www.acuitybrands.com/brands/lighting-controls/nlight	Wireless	BlueTooth Low Energy BLE Proprietary IPv4 Proprietary IEEE 802.15.4 Proprietary WiFi IEEE 802.11	Yes	No standard interface reported
Autani, LLC, Energy Center	www.autani.com	Wireless	enOcean ISO/IEC 14543-3-10:2012 Proprietary IPv4 Proprietary – Other Zigbee HA Home Automation	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Eaton, LumaWatt Pro	Eaton.com/lumawattpro	Wireless	BlueTooth Low Energy BLE Proprietary IPv4	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Enlighted, Inc.	www.enlightedinc.com	Wired Wireless	BlueTooth Low Energy BLE	Yes	No standard interface reported
Hubbell Lighting, Inc., wiScape	https://www.hubbell.com/hubbellcontrolsolutions/en/Products/Lighting-Controls/Lighting-Controls-Sensors/wiSCAPE-Lighting-Controls/wiSCAPE-Wireless-Outdoor-Lighting-System/p/2135914#prod-resources-section	Wireless	BlueTooth Low Energy BLE Proprietary IPv4 Proprietary IEEE 802.15.4 XBEE PRO	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
LSI Industries Airlink	http://lsi-airlink.com/airlink-synapse/	Wireless	None	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
OmniSolu Technology Inc.,	http://meshsmart.com/	Wireless	Proprietary IEEE 802.15.4	No	NEMA ANSI C136.41 5 or 7-

MeshSmart			Zigbee 3.0		pin controller available
RAB Lighting, LightCloud	http://www.lightcloud.com	Wireless	3GPP Proprietary IPv4 Proprietary – Other Zigbee 2.0	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Telensa PLANet	http://www.telensa.com	Wireless	Proprietary	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Felicity Smart Infrastructure	www.felicitySI.com	Wireless	LoRaWAN	Yes	Proprietary
Signify BrightSites	https://www.signify.com/en-gb/our-company/news/press-releases/2019/20190618-brightsites-smart-pole-by-signify-turbocharges-smart-city-infrastructure	Wireless	4G/5G Cellular WiFi	Yes	Proprietary
Cimcon Lighting	https://www.cimconlighting.com/	Wired Wireless	Proprietary	Yes	NEMA ANSI C136.41 5 or 7-pin controller available
Verizon Smart Cities	https://enterprise.verizon.com/products/internet-of-things/smart-cities-and-communities/	Wireless	4G/5G Cellular	Yes	NEMA ANSI C136.41 5 or 7-pin controller available

Notes:

- All information listed reflects manufacturer's claims.
- Actual performance cannot be assumed; must be verified in the field.
- Interoperability claims, even when adherence to open standards and protocols is stated, must be verified in the field.
- There is no independent organization that verifies/validates these claims.
- This list is representative. The industry is undergoing rapid changes. Several of the companies listed below will likely no longer be in this industry within the next few years, and new companies will have entered the industry.
- The determination of the applicability of any of these product lines to the needs of a particular Smart Lighting project has as a prerequisite a municipality's production of detailed requirements, planning, and infrastructural support for that project.

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National Grid Technical Assistance
https://www.nationalgridus.com/pronet/technical-resources/technical-assistance

https://www.nationalgridus.com/ProNet/Services-Tools?r=10&page=1&locations=Upstate+New+York&interestedIn=Lighting+Solutions

NYPA Street Light Maintenance Program Overview
https://www.nypa.gov/services/customer-energy-solutions/smart-street-lighting-ny

NYSERDA
Clean Energy Community full page resource
https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Communities/Clean-Energy-Communities-Program-High-Impact-Action-Toolkits/LED-Street-Lights
https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Communities

Step-by-Step Guidance [PDF]
The slide presentation provides an overview of the Clean Energy Communities Program as well as a detailed description and step-by-step guidance for implementing the LED Street Lights action.
https://www.nyserda.ny.gov/ny/PutEnergyToWork/Energy-Program-and-Incentives/Lighting-and-Controls-Programs-and-Incentives

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CDRPC Technical Assistance
https://cdrpc.org/programs/sustainability/new-york-state-energy-research-development-authority-nyserda-clean-energy-communities-program

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The Benefits of LED & Smart Street Lighting, A Performance Benchmark of US Cities http://northeast-group.com/reports/citylab-northeast%20group%20-%20the-benefits-of-led-and-smart-street-lighting.pdf

Glossary

A selected glossary of definitions related to the subject of these guidelines follows.

Additional lighting-related terms can be found in:

• IES (Illuminating Engineering Society). (2018). ANSI/IES RP-8-18: American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting (https://www.ies.org/product/american-national-standard-practice-for-design-and-maintenance-of-roadway-and-parking-facility-lighting/)

• IES (Illuminating Engineering Society). (2017). ANSI/IES RP-16-17 Nomenclature and Definitions for Illuminating Engineering (https://www.ies.org/standards/definitions/)

Adaptive – "Smart Lighting" can be programmed to adapt to surrounding environmental and social settings (also see "Responsive").

Annunciator boards – An electronic display which can present messages intended to be viewed by large numbers of people.

Big data — Typically used to describe tools, technologies, analytics, and the results of using those tools, technologies, and analytics, related to very large datasets.

Broadband – a wireless transmission system and/or protocol that utilizes broad swaths of spectrum, typically to enhance security or increase data transmission volume.

Central control management system (CMS) – Software, hardware, and ancillary systems (including staff) that manage dispersed technological systems. Also related to "asset management."

Connectivity – the ability of devices to communicate, generally digitally, with one another. Also related to connecting people and places.

Devices – For use in this guidebook, sensors, cameras, switches, triggers – assets that measure and change actions are called devices.

eEnabling technologies – An electronic technology that creates an ability to perform a function.

"Internet of Things" (IoT) – an Internet of Things device is any device that communicates using the TCP/IP protocol, which is the data communications protocol of the internet.

Interoperability – the ability of multiple devices to work together as parts of a multi-device system. Typically, these devices would need to have a high degree of connectivity.

Governance —Used in this guidebook to point to the people and policies required to make Smart Cities technology work, to be useful, to run smoothly.

Intelligent Transportation System (ITS) – applies advanced technologies of electronics, communications, computers, control and sensing and detecting in all kinds of transportation system in order to improve safety, efficiency and service, and traffic situation through transmitting real-time information.

Machine learning – The technique by which a device analyzes inputs and produces results using artificial intelligence algorithms.

Metering – measuring energy useage by luminaires, devices, all electrical outputs.

NEMA 7 pin connector– a receptacle with seven connectors that allows for retrofitting of existing poles to use smart technologies.

Responsive – Smart Lighting and Smart City technology can be said to be responsive. Methods to

Shades of Night – A framework to categorize activity time bands and corresponding lighting levels and scenarios. A way of measuring nighttime activation (or lack thherof).

Smart – A marketing term used to describe a wide variety of technologies, generally which have computing technology within them.

"Smart-enabling" technology provisions to be "smart-ready" – Marketing concepts used to imply that the specific products being described will be compatible with future, yet-to-be-developed, "smart" devices (see "Smart").

Smart Cities devices – Marketing term used to describe "smart" devices intended to be deployed in urban environments.

TRC – "Total Resource Cost" a test for consumer and public sector measure in regard to costs and energy conservation.

Typological areas – For this guidebook, useful land use categories in any given city or community for the purpose of light planning, design and nighttime activation as relevant to the uses of the area.

Environmental Justice and Environmental Mitigation Analysis

Environmental Justice : Introduction

Per federal requirements, the Capital District Transportation Committee (CDTC) ensures that no person is excluded from participation in, or denied the benefits of, its metropolitan transportation planning process on the basis of race, color, national origin, sex, age, disability, or economic status. In our studies, we evaluate the impacts of transportation concepts and recommendations on these groups. Impacts may be defined as those that are positive, negative and neutral as described in CDTC's Environmental Justice/Title VI Analysis documents. The goal of these analyses is to ensure that both the positive and negative impacts of transportation planning conducted by CDTC and its member agencies are fairly distributed and that defined Environmental Justice populations do not bear disproportionately high and adverse effects.
This goal has been set to:

• Ensure CDTC's compliance with Title VI of the Civil Rights Act of 1964, which states that "no person in the United States shall, on the basis of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance,"

• Assist the United State Department of Transportation's agencies in complying with Executive Order 12898 stating, "Each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

• Address FTA C 4702.1B TITLE VI REQUIREMENTS AND GUIDELINES FOR FEDERAL TRANSIT ADMINISTRATION RECIPIENTS, which includes requirements for MPOs that are some form of a recipient of FTA, which CDTC is not.

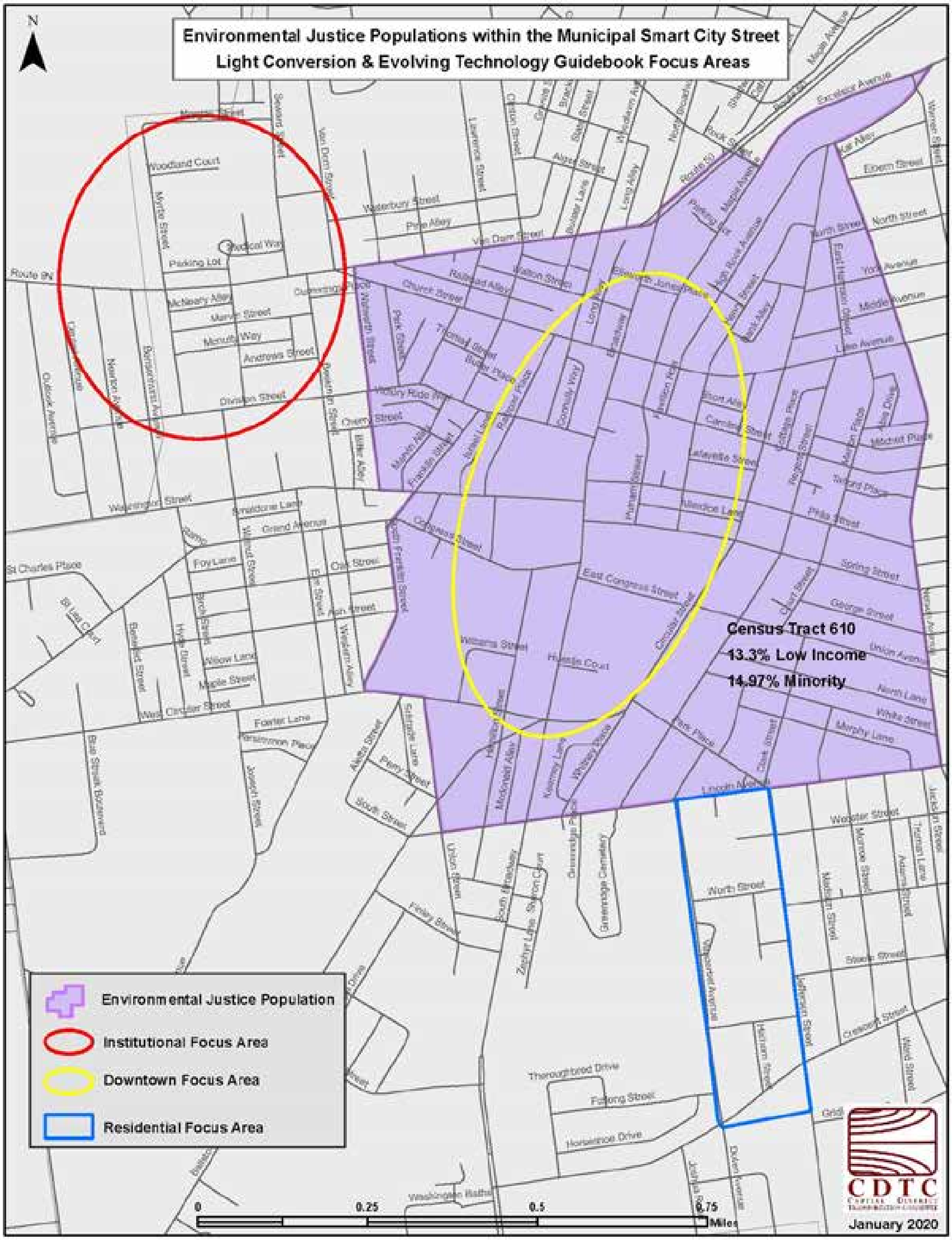
Data and Analysis

CDTC staff created demographic parameters using data from the 2010 United States Census as well as data from the 2010-2014 American Community Survey (ACS). Threshold values were assigned at the census tract level to identify geographic areas with significant populations of minority or low-income persons. Tracts with higher than the regional average percentage of low-income or minority residents are identified as Environmental Justice populations. Minority residents are defined as those who identify themselves as anything but white only, not Hispanic or Latino. Low-income residents are defined as those whose household income falls below the poverty line.

The transportation patterns of low-income and minority populations in CDTC's planning area are depicted in Table 1, using the commute to work as a proxy for all travel. The greatest absolute difference between the defined minority and non-minority population is in the Drive Alone and Transit categories: The non-minority population is 17.9% more likely to drive alone, slightly more likely to work at home, 9.8% less likely to take transit, and is also less likely to carpool, walk, or use some other method to commute. The greatest absolute difference between the defined low-income population and the non-low-income population follows the same trend, with the non-low-income population 19.9% more likely to drive alone and 10.6% less likely to commute via transit.

By Race/Ethnicity	Drive Alone	Carpool	Transit	Other	Walk	Work at Home
All Workers (16+)	80.5%	7.7%	3.3%	1.2%	3.6%	3.7%
White Alone Not Hispanic or Latino	83.3%	7.1%	1.8%	1.1%	2.9%	3.9%
Minority	**65.4%**	10.5%	**11.6%**	2.1%	**7.5%**	2.9%
By Income	**Drive Alone**	**Carpool**	**Transit**	**Other**	**Walk**	**Work at Home**
At/Above 100% Poverty Level	82.3%	7.6%	2.7%	1.2%	2.7%	3.6%
Below 100% Poverty Level	**62.4%**	**9.7%**	**13.3%**	**1.9%**	**9.2%**	**3.5%**
By Age	**Drive Alone**	**Carpool**	**Transit**	**Other**	**Walk**	**Work at Home**
16-19 Years	**58.4%**	**14.6%**	6.0%	3.1%	**15.6%**	2.4%
20-64 Years	81.3%	7.5%	3.2%	1.2%	3.2%	3.6%
65+ years	81.7%	5.3%	2.2%	0.9%	2.3%	7.6%
By English Ability	**Drive Alone**	**Carpool**	**Transit**	**Other**	**Walk**	**Work at Home**
Speak English Very Well	71.5%	11.0%	4.9%	1.8%	6.8%	3.9%
Speak English Less than Very Well	68.0%	13.2%	5.6%	2.2%	7.6%	3.4%
By Disability Status	**Drive Alone**	**Carpool**	**Transit**	**Other**	**Walk**	**Work at Home**
Without any Disability	81.1%	7.4%	3.0%	1.2%	3.6%	3.6%
With a Disability	**69.7%**	11.6%	7.6%	2.2%	4.2%	4.7%
By Gender	**Drive Alone**	**Carpool**	**Transit**	**Other**	**Walk**	**Work at Home**
Male	80.8%	7.3%	2.9%	1.5%	4.0%	3.6%
Female	80.3%	8.0%	3.7%	1.0%	3.3%	3.7%

Data: CDRPC, from American Community Survey 2014 5-year estimates, tables S0802, B08105H, B08101, B08122, S0801, B08113, and S1811. Other includes taxi, motorcycle,


Environmental Justice Populations within the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook Focus Areas
N
Census Tract 610
13.3% Low Income
14.97% Minority
Environmental Justice Population
Institutional Focus Area
Downtown Focus Area
Residential Focus Area
0
0.25
0.5
0.75
Miles
CDTC
January 2020

MAP-1

Map 1 provides an overview of the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook focus areas. The Guidebook focus areas included in the Environmental Justice area based on the study area Census Tracts having a higher than regional average percentage of minority and low-income residents. The Environmental Justice population is within the downtown focus area and adjacent to both the institutional focus area and residential focus area.

Consideration for including minority and low-income residents in the planning process was given in the following ways:

•The Internet was used to display and advertise information about the study.
•Social media was used to provide information and input opportunities.
•An interactive NightSeeing^{TM} walk was held and open to the public.
•Public comment was accepted throughout the study process.
•Final products will be posted to CDTC's website, the Saratoga Springs website and on social media.

Conclusion

The Municipal Smart City Street Light Conversion & Evolving Technology Guidebook recommends upgrading streetlights in different areas of Saratoga Springs with light emitting diode (LED) lighting technology. The proposed LED lights provide for lower energy consumption, better quality lighting for open and public spaces at night, and improved safety for nighttime travelers, including those who work at downtown businesses and visitors traveling to downtown attractions.

CDTC defines plans and projects with a primary or significant focus on transit, bicycling, walking, or carpool as being "positive". As the primary purpose of the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook is to recommend lighting strategies using LED technologies improve areas in downtown, institutional, and residential areas in Saratoga Springs, which includes Environmental Justice populations, it has been determined that the Guidebook will have a positive impact on the affected populations. The Guidebook makes recommendations for improving lighting on roadways, sidewalks and street crossings to increase visibility and improve safety which will provide positive benefits for Environmental Justice populations in the focus area(s).

Environmental Mitigation : Introduction

Per federal requirements, the Capital District Transportation Committee (CDTC) undertakes an Environmental Features Scan as part of its metropolitan transportation planning process. In our studies we encourage smart growth as well as investment and development in urban areas as a method to protect natural resources. Smart growth policies also help to protect rural character and open space, and protect quality of life in the Capital Region. The Environmental Features Scan identifies the location of environmentally sensitive features, both natural and cultural in relation to project study areas. Although the conceptual planning stage is too early in the transportation planning process to identify specific potential impacts to environmentally sensitive features, the early identification of environmentally sensitive features is an important part of the environmental mitigation process. It should also be noted here that as specific projects advance through the project development process, the applicable NEPA and SEQRA regulations requiring potential environmental impact identification, analysis and mitigation will be followed by the implementing agencies as required by federal and state law. CDTC is not an implementing agency.

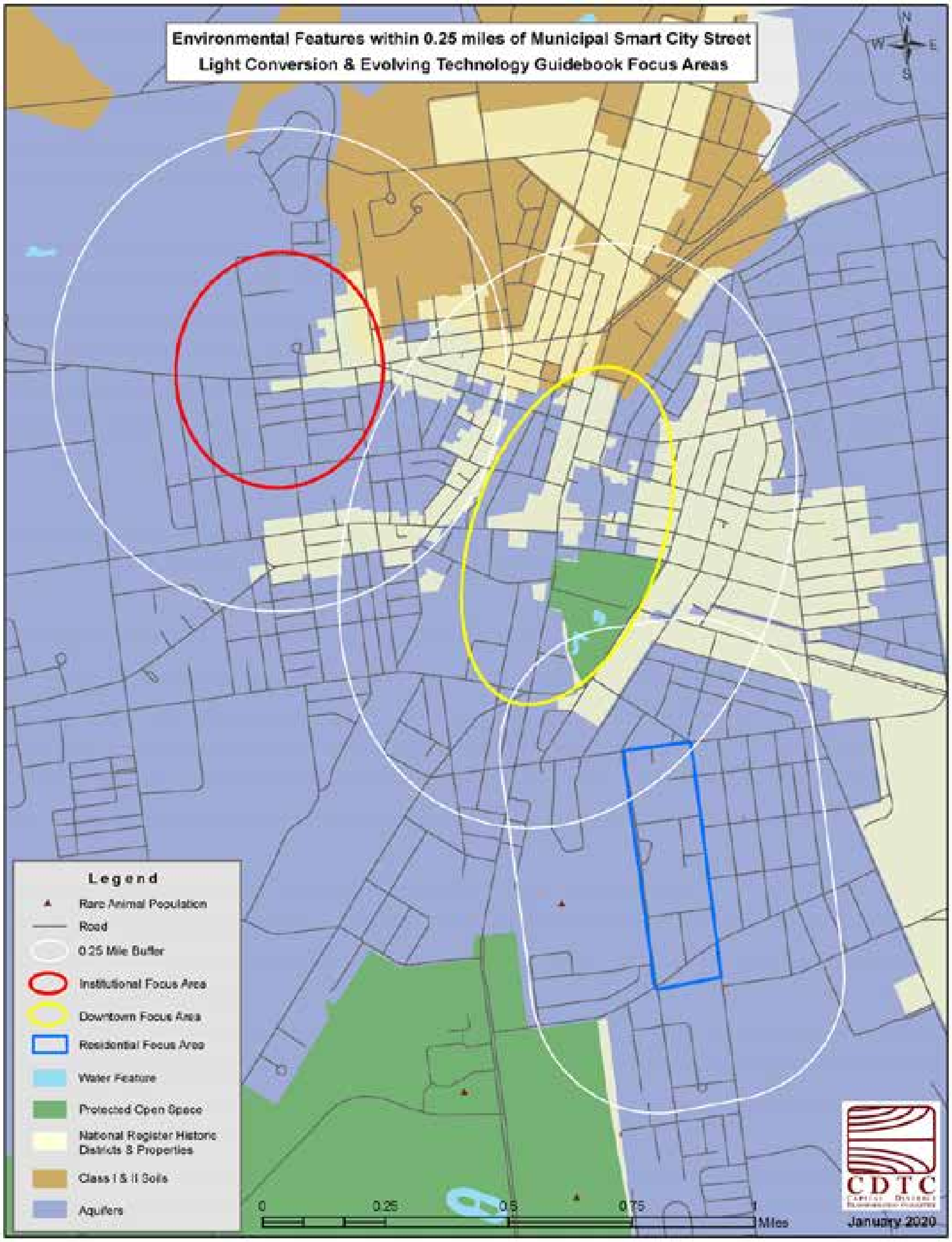
Data and Analysis

CDTC staff relies on data from several state and federal agencies to maintain an updated map-based inventory of both natural and cultural resources. The following features are mapped and reviewed for their presence within each study area as well as within a quarter mile buffer of the defined study area boundary.

- sole source aquifers
- aquifers
- reservoirs
- water features (streams, lakes, rivers and ponds)
- wetlands
- watersheds
- 100 year flood plains
- rare animal populations
- rare plant populations
- significant ecological sites
- significant ecological communities
- state historic sites
- national historic sites
- national historic register districts
- national historic register properties
- federal parks and lands
- state parks and forests
- state unique areas
- state wildlife management areas
- county forests and preserves
- municipal parks and lands
- land trust sites
- NYS DEC lands
- Adirondack Park
- agricultural districts
- NY Protected Lands
- natural community habitats
- rare plant habitats
- Class I & II soils

Conclusion

The Municipal Smart City Street Light Conversion & Evolving Technology Guidebook recommends lighting strategies using available LED technologies to improve the quality of Saratoga Springs at night time. These lighting features will have no impact on environmentally sensitive features within, and in close proximity to, the focus areas. These include: water features, open space, National Register Historic Properties (District), Class I & II Soils, and aquifers.



MAP-2

Map 2 provides an overview of the environmentally sensitive (cultural and natural) features located within the Municipal Smart City Street Light Conversion & Evolving Technology Guidebook focus areas as well as within a quarter mile buffer of the defined study area boundary.

Public Comments

Placeholder for Response to Comments after Public Comment Period.

Acknowledgments

Placeholder for Acknowledgments