CITY OF VANCOUVER

ADMINISTRATIVE REPORT

Report Date: June 25, 2019
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Meeting Date: July 23, 2019

TO: Vancouver City Council

FROM: General Manager of Planning, Urban Design and Sustainability and General Manager of Engineering Services

SUBJECT: Outdoor Lighting Strategy

RECOMMENDATION

A. THAT Council adopt the Street and Public Realm Lighting Design Guidelines, as described herein and as presented in Appendix D, to inform the installation and replacement of street and public realm lighting in the City, such that public safety, resiliency, comfort, energy efficiency and ecological health are prioritized.

B. THAT Council directs staff to accelerate the transition to LED and report back on a phased implementation strategy as part of the 2020 budget process.

C. THAT Council approve, in principle, amendments to the Untidy Premises By-law, generally as described in this report and as set out in Appendix F, to promote responsible outdoor lighting practices on private property, effective November 1, 2019;

FURTHER THAT the Director of Legal Services be instructed to bring forward for enactment the necessary amending by-law generally in accordance with Appendix F.

REPORT SUMMARY

In response to Council's motion in February, 2015, this report makes several recommendations to promote responsible outdoor lighting practices on public and private properties, together which constitute the Outdoor Lighting Strategy.

The Outdoor Lighting Strategy presents a coordinated approach of guidelines, policy and regulations to improve public safety and comfort, improve the resiliency of electrical infrastructure, reduce energy usage and cost, and minimize ecological impacts from lighting. The strategy is aligned with the City's broader strategic objectives to make

walking and biking safe and enjoyable, to reduce energy consumption and greenhouse gas emissions, and to encourage a more inclusive and healthy city. An intersectional lens will be taken in partnership with Arts, Culture, and Community Services (ACCS) in identification of projects.

The Outdoor Lighting Strategy was developed through extensive consultation with the public, community groups, stakeholders (including Vancouver Coastal Health, Greater Vancouver Home Builders Association, Urban Development Institute, and various industry groups), and Council-appointed committees (including the Persons with Disabilities Committee, the Active Transportation Committee and the Women's Advisory Committee, VPD and others).

COUNCIL AUTHORITY/PREVIOUS DECISIONS

In February 2015, Council adopted a motion "towards enacting a healthy, safe and energy efficient outdoor lighting strategy in order to control harmful outdoor lighting, set standards for outdoor lighting and provide for the designation of dark-sky preserves." The full Council motion can be found in Appendix A.

REPORT

Background/Context

Outdoor lighting is an integral part of urban life—it helps make our roadways and pedestrian pathways safe, it enhances our public spaces, and it allows us to enjoy our city at night in ways that would otherwise be impossible. Studies have shown that good lighting is particularly important for women and vulnerable populations, especially those who travel to or from work during non-daylight hours. From an equity perspective, outdoor lighting is an important, though often overlooked, consideration. In general, outdoor lighting is arguably one of the most important features of any community.

In Vancouver, the City is the largest single owner of outdoor lighting infrastructure, with approximately 55,000 roadway and pedestrian light fixtures along streets, recreational paths, lanes, and in public plazas. Many more exterior fixtures are installed in City-owned parking lots, as well as on and around community and housing facilities, and parks.

There are also numerous privately owned sources of outdoor lighting, which are typically provided for safe access and/or security–from porch lights on single-family homes to flood lights that are commonly installed in parking lots of retail stores. Decorative lighting features are also common, especially along commercial streets and increasingly in residential neighbourhoods.

Most outdoor lights in Vancouver use high-pressure sodium luminaires (HPS lights are recognizable by their amber glow). But in recent years, light emitting diode (LED) technology has become the norm for new outdoor lighting across North America. LEDs are far more energy efficient than HPS lights. LED lights are also more reliable, with

much longer lifespans than high-pressure sodium, and offer a significant safety improvement as well as cost savings. For these reasons, numerous cities have already fully transitioned to LED technology for their street lights (Burnaby, Surrey and Victoria for example).

Since the passage of Council's motion in 2015, the City has implemented a number of early actions while planning. For example, the City has installed LED street lights at 125 signalized intersections and seen a 21% reduction in collisions as well as a 65% reduction in traffic-related fatalities and injuries involving pedestrians. LED lights have also been installed as part of several recent road reconstruction and development projects, including the Burrard Bridge Corridor Project and the Point Grey Seaside Greenway Project. More intersection lighting improvements are planned, based on the significant safety improvements observed with the installations done thus far.

Without proper design, however, LED lights can have potential drawbacks. Firstly, LED comes in a range of colour temperatures—from very white through to more amber tones. The whiter tones provide greater visibility (i.e., safety benefits) while the more amber tones tend to be perceived as warmer and more inviting. There is also some concern that light above a certain colour temperature may have negative health impacts. For this reason, it's important to choose the right colour temperature for a given context. Fortunately, there is a significant body of research and best practices on this that can be used to guide decision-making.

The second potential concern with LEDs is their proliferation, particularly on private property. LEDs are relatively cheap and easy to install. For that reason, in recent years there has a significant increase in the amount of decorative outdoor lighting installed on private property. This can have a negative impact on neighbouring properties, as well as ecological impacts. These negative impacts can be mitigated by careful fixture selection and design. Groups such as the Royal Astronomical Society of Canada (RASC) and the International Dark-Sky Association (IDA) have worked to promote education and awareness about light pollution across the country and to encourage local governments to implement lighting best practice guidelines.

Changing light technology, along with concerns about light pollution, warrant the need for a strategic review of the City's outdoor lighting practices. With the shift to LED technology, there is a significant opportunity to improve outdoor lighting across the City, such that safety and comfort are enhanced, energy and operating costs are reduced, and negative impacts to people, birds and wildlife are avoided.

Strategic Analysis

The proposed Outdoor Lighting Strategy has five overarching goals:

1. **Improving public safety**: reducing collisions and enabling safe travel for people walking, cycling, driving and taking transit.
2. **Enabling accessible and inviting spaces**: facilitating the night-time use of public spaces for all.
3. **Reducing light pollution**: focusing light on where it is needed and minimising unnecessary glare and light spillage.
4. **Reducing energy use**: catalysing the adoption of energy-efficient technologies.

5. **Avoiding ecological and human health impacts**: ensuring lighting is designed such that it does not adversely impact people or ecological systems.

To achieve these goals, the Strategy was developed with five key components:

1. Street and Public Realm Lighting Design Guidelines;
2. Amendment to the Building By-law;
3. Amendment to the Untidy Premises By-law;
4. Exploration of a Dark Sky Designation;
5. Lighting Guidelines for City-owned Facilities

The approaches outlined herein are consistent with the Council-adopted Vancouver Bird Strategy as well as the Biodiversity Strategy, which identify reducing light pollution as an objective.

1. Street and Public Realm Lighting Design Guidelines and Implementation

Advancements in LED technology continue to provide increasingly energy-efficient options for outdoor lighting. Cities that have completed an LED transition of streetlights report about a 50% reduction in energy costs. In many cities, substantial energy savings have also translated into significant greenhouse gas emission reductions. While Vancouver's electricity supply is mostly renewable, a transition to LED streetlights would still reduce carbon emissions by about 200 metric tonnes CO2e annually. Given the safety benefits and significant cost savings, it is expected that City's roadway lights (excluding decorative) will be replaced with LEDs over the next three to five years, through rehabilitation, capital and development projects.

As Vancouver moves towards replacing high-pressure sodium streetlights with LED lighting, the Street and Public Realm Lighting Design Guidelines will ensure that new lighting is safe, comfortable and minimizes light pollution. The Guidelines recommend lighting levels and design options based on the street-specific context, with requirements to install shields where spill or glare could impact nearby residents. Warmer temperature lighting (e.g. more amber) will be used throughout the City, with the exception of high-collisions spaces where visibility (e.g. more white) is paramount for pedestrian safety. Proper fixture selection, include shielding where necessary, will ensure that light is focussed on where it is needed.

The Street and Public Realm Lighting Design Guidelines are also intended to make streets feel inviting and provide a sense of security for all residents. To meet this objective, guidance is provided to improve pedestrian comfort on streets and in public spaces, especially for persons with low-vision and those who may be more vulnerable to harassment or violence. Through our consultation process, we heard that safe, comfortable lighting can be particularly important for women; the guidelines have been written with this in mind and aim to provide for this. Sex worker safety may be negatively impacted by too much or too little lighting in areas and locations; for this reason, specific areas of the city where sex trade workers work will require additional sensitivity considerations and consultation with Social Policy staff and the sex work community.

The improvement program will prioritize failed HPS fixtures and locations with higher collision rates and vulnerable population spaces. Improvements will continue to be sought through development projects, especially focusing on resiliency of electrical

infrastructure, decorative lighting and upgrades to address pedestrian, cycling and transit movements. Transportation and public space improvement projects provide opportunities to upgrade and retrofit lighting, while adding pedestrian scale and unique lighting.

It should be noted that the City's lighting design for street lights is informed not only by the Street and Public Realm Lighting Design Guidelines but also by the recommendations of the Illuminating Engineers Society of Canada and the Transportation Advisory Council, as well Engineering Services' infrastructure design standards. The colour temperature recommended in the Street and Public Realm Lighting Design Guideline is informed through consultation with Vancouver Coastal Health and by the recommendations of the American Medical Association, to ensure human health impacts are minimized. The complete Street and Public Realm Lighting Guidelines are in Appendix D.

2. Amendments to the Building By-law

The proposed amendments to the City of Vancouver's Building By-law were brought forward to Council on July 16, 2019, and are intended to reduce unnecessary lighting and prevent light spillage from impacting neighbouring properties, while still allowing for any lighting necessary for safe access and egress. For all new residential buildings, or residential portions of buildings, the proposed amendments will require that permanent ancillary lighting:

i. have fixtures that are appropriately shielded;
ii. not be mounted higher than 4 m above grade or a balcony surface along the side yard, back yard, and similar outward facing courtyards or setbacks of the building;
iii. have dimmer and timer controls; and
iv. minimize light spillage onto adjacent properties and properties across a street, lane, or public way.

The proposed by-law amendments will replace the current outdoor lighting requirements in the Building By-law, which are based on a maximum lumen level at the property line. The current requirements are measurable only after construction is complete (i.e., after lighting has been installed and connected) and, even then, are difficult to enforce (lumen levels must be measured at night, using specialized equipment). The proposed requirements are clearer and easier to inspect and enforce.

Appendix E includes the proposed Building By-law amendments that were brought forward to Council on July 16, 2019.

In parallel with the proposed Building By-law amendments, staff have prepared an information bulletin to explain the light pollution requirements in the Bird Friendly Design Guidelines, see Appendix G. The bulletin provides more specific descriptions and images of best practices for outdoor lighting that should help both designers and plan reviewers.

3. Amendments to the Untidy Premises By-law

To enable staff to enforce egregious situations of light pollution, amendments to the Untidy Premises By-law are also proposed. The amendments are meant to parallel the Building By-law amendments, such that light pollution is curtailed on private property. The purpose of the Untidy Premises By-law amendments is to ensure that light glare is not cast directly onto a neighbouring window or other residential opening, creating a nuisance or negative community impact. These amendments will allow staff to refer to an enforceable by-law and to take action in egregious circumstances.

Appendix F includes the proposed Untidy Premises By-law amendments.

4. Dark Sky Designation Opportunities

In keeping with Council's motion, staff explored opportunities for achieving a Dark Sky Designation within the City. There are three different types of Dark Sky Designations for light-restricted protected areas: Dark-Sky Preserves, Urban Star Parks and Nocturnal Preserves. In Canada, the designations are based on standards established and administered by the Royal Astronomical Society.

The most likely area within the City to be eligible for a Dark Sky Designation would be in a large park such as Stanley Park, Vanier Park or perhaps Everett Crowley. The most appropriate designation to pursue would be an Urban Star Park, within which artificial lighting is strictly controlled and active measures are in place to educate and promote the reduction of light pollution. Sky glow from beyond the borders of an Urban Star Park may be visible to observers within the area, but the skies are still usable for astronomy. Based on the above information, Park Board staff and the Stanley Park Ecology Society are investigating opportunities to pursue an Urban Star Park designation for Stanley Park.

5. Lighting Guidelines for City-owned Facilities

To ensure that the City is leading by example, an Outdoor Lighting Guideline has been developed for City-owned facilities. This guideline is similar to the approach taken with the Street and Public Realm Lighting Design Guideline and is aimed at ensuring exterior lighting is thoughtfully designed and maintained to ensure public safety and comfort while minimizing light pollution and other unintended impacts.

Public/Civic Agency Input (if applicable)

Consultation took the form of stakeholder workshops, electronic surveys, a public open house event, as well as meetings and correspondence with individual stakeholders. The key considerations for the Outdoor Lighting Strategy were documented in a consultation paper, which was used to inform and solicit feedback from stakeholders and the general public.

The range of stakeholders engaged included:

- Active Transportation Policy Council
- Vancouver Bird Committee
- Persons with Disabilities Advisory Committee

- Seniors' Advisory Committee
- Women's Advisory Committee
- Vancouver Park Board
- Vancouver Police Department
- Vancouver Coastal Health
- Vancouver General Hospital Eye Centre
- H.R. McMillan Space Centre
- Royal Astronomical Society of Canada
- Stanley Park Ecological Society
- BIA Partnership
- BC Hydro
- Vancouver lighting designers
- Greater Vancouver Homebuilders Association
- Urban Development Institute

Public feedback was also collected through an online survey, of which there were nearly 1,500 responses. Overall, 82% of respondents believed the proposed actions addressed light pollution 'very well' or 'fairly well'. Approximately 5% of respondents from that not enough was being proposed to curtail light pollution, while another 5% felt that light pollution was not an issue worth pursuing. Somewhat surprisingly, roughly half of the respondents indicated that they had been negatively impacted by outdoor lighting in some form (e.g., glare from a neighouring property, poor public real lighting, etc.).

Local lighting designers provided constructive feedback, particularly around opportunities to improve lighting in public and private spaces so to create more aesthetically pleasing and better functioning night-time environments. Lighting designers were also very supportive of being involved in future projects and planning processes, where professional involvement and expertise on lighting could help improve public space and planning outcomes for the city.

The full Consultation Summary and the Consultation Paper can be found in Appendix B and C.

Implications/Related Issues/Risk

Financial

There are no direct financial implications as a result of the Outdoor Lighting Strategy presented herein.

Human Resources/Labour Relations

Near-term resources to support the Outdoor Lighting Strategy can be accommodated through existing staff.

Environmental

A transition to LEDs is expected to reduce energy use by roughly half.

Legal

The Vancouver Charter grants the City broad authority over building and nuisance issues.

CONCLUSION

The Outdoor Lighting Strategy presents a coordinated approach that focuses on setting guidelines for streets, public spaces and properties, and policy and regulatory approaches for homes and businesses. The strategy seeks to improve public safety, enable accessible and inviting spaces, minimize light pollution, reduce energy use and avoid ecological and public health impacts. The strategy includes updates to the Building By-law, amendments to the Untidy Premises Bylaw, and a Street and Public Realm Lighting Design Guidelines. The approaches are consistent with the Council-adopted Vancouver Bird Strategy as well as the Biodiversity Strategy, which identify reducing light pollution as an objective.

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Appendix A – Council Motion 2015

https://council.vancouver.ca/20150203/documents/regu20150203min.pdf

Appendix B - Consultation Paper

https://vancouver.ca/files/cov/outdoor-lighting-strategy-consultation-paper.pdf

Appendix C – Consultation Summary Paper

Appendix C summarizes the stakeholder groups, citizen advisory group, Workshops, Surveys and Open Houses that took place during the consultation for the Outdoor Lighting Strategy.

1. Introduction

To support public and industry engagement on the development of the Outdoor Lighting Strategy, a number of engagement events and activities were held throughout 2018 to gather input from public, citizen advisory groups, stakeholder groups and industry groups to provide input on outdoor lighting concerns, for input to the Outdoor Lighting Strategy.

Events and activities included meetings of the Citizen Advisory groups, individual stakeholder meetings, open houses and a Talk Vancouver survey. These activities and events are described in detail in the following sections, and participation numbers are summarized in the figure below.

In total, over 1,800 people were engaged through surveys, industry presentations, citizen advisory meetings and workshops, and our main partnership event with the HR McMillan Space Centre.

Consultation Activity	Touchpoints
Talk Vancouver Survey May 15 – June 12 2018	1,433 responses
"Vancouver Illuminated" event at the Space Centre June 2018	267 participants
Advisory Committee Meetings and Workshop	5 committees, 3-15 people each
Small Home Builders Meetings	30 attendees, 2 events
Lighting Designers Meetings	8 participants
Industry Survey May 15 – June 12 2018	24 responses
Letter to UDI Mar 2019	June 4, 2019
Emails received	
	~1800 total participants

2. Engagement Process

There were several citizen advisory groups that were consulted. A Consultation Paper was developed in May 2018 to provide guidance on the engagement.

The Consultation Paper outlined the main guiding principles of the Outdoor Lighting Strategy, key considerations and how feedback would be used. The following groups provided guidance and comments on policy ideas and concepts in response to the Consultation Paper.

Citizen Advisory Groups	Meeting Date
Women's Advisory Committee	Jan 23 2018, May 22,2018
Person's with Disabilities Advisory Committee	Dec 7, 2017, May 15, 2018
Seniors Advisory group	Dec 15, 2017, May 11, 2018,
Active Transportation Policy Group	Jan 17, 2018, May 9, 2018
Bird's Advisory Committee	June 11, 2018

Stakeholder Groups	Meeting Date
Design community	Workshops June 28, 2018, Feb 11, 2019 and Industry Survey
Small Home Builders Group	Workshops June 28, 2018, Feb 11, 2019 and Industry Survey
General Public	Talk Vancouver Survey and outdoor.lighting@vancouver.ca email "Vancouver Illuminated" event at the Space Centre June 2018
Vancouver Coastal Health	Presentations, emails Jan 25, 2018
Business Improvement Associations	Emails
Ian Ashdowne, lighting scientist	Emails June 7-8, 2018
Royal Astronomical Society of Canada, Light Pollution Abatement Chair – Pascal Pillot-Bruhat	Meeting, E-mails
Park Board - Presentation	Sept 11, 2017

2.1 Notification Process

Notification of opportunities to participate included:

• **Social media:** Open House notifications and survey links were posted on the City of Vancouver's social media accounts, including Twitter, Facebook, and Instagram.
In addition, the City used geo-targeted Facebook ads to encourage residents to attend the events.

• **Project website:** All materials were posted on vancouver.ca/outdoorlighting, including open house dates, a link to the survey, as well as the Consultation Paper

• **Newsletter:** An invitation to attend the Vancouver Illuminated event and take the survey was sent to 4,000Greenest City newsletter subscribers.

• **Email Invitations:** An invitation to attend a special open house was sent to members of the participating citizen advisory bodies

Partners: Event partners – Space Centre, RASC, Stanley Park Ecology Society – also sent notifications and distributed ads through their network.

• **Posters:** Posters and postcards advertising the event and outlining opportunities to get involved were delivered to all City of Vancouver community centres and libraries and Pop-Up City Hall.

2.2 How information was received

Each meeting included a briefing from staff on updates to the strategy, draft principals and goals, draft policy directions, and overall timeline. Information was received through roundtable discussion, and question and answer sessions about the general policy directions and concerns of the various groups. Information was also received through surveys and emails directly to outdoor.lighting@vancouver.ca.

3. Results: What We Heard

Talk Vancouver Survey

1,433 Respondents

"Have you ever been significantly bothered by outdoor lighting in a residential area? If so, how?"

- 715 (50%) respondents answered "Yes"

People are bothered by security/access lighting

- 179 respondents, with 153 resident-to-resident

Lower- and higher-density areas are affected

- 97 lower vs 82 higher

Flood lights and motion-activated lights were most problematic fixtures

- 156 complaints

Side yards and laneways were most problematic areas

- Light entering bedrooms were common grievance

Aesthetic lighting is increasingly becoming a problem

- 57 responses on single-family homes
- 21 responses on larger developments

Difference may be due to expectations and resources

- Low-density residential neighbourhoods expected to be darker
- Larger developments have more designers involved
- Businesses only drew 5 responses

Many responses about lighting left on 'all night'

- Some indicated curfew would be useful
- Others wanted motion-activated light

Comparison to other complaints

- 188: street lights
- 37: city lane lights
- 50+ sign or Landmark lighting (eg. BC Place)
- 11: event and filming lighting
- 13: park lighting

Industry Survey

24 Completed surveys, 36 partial completed

Architects, Construction industry, developer, lighting designer, trades, others responded

Light standards typically applied to projects:

IES recommended light levels	60.00%	15
CPTED lighting principles	40.00%	10
Light pollution reduction (e.g. LEED, dark-sky compliant fixtures)	64.00%	16
ANSI/ASHRAE lighting power intensity	60.00%	15
Other (please specify)	32.00%	8
Not sure	8.00%	2

Other standards applied:

Common sense	1
Full cutoff at property line considerations	1
IALD Advocacy Guidelines	1
IALD Code of Ethics, IALD Advocacy	1
LEED	1

How much to you agree or disagree with these draft approaches?

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Not Sure	Responses
	Row %	Row %	Row %	Row %	Row %	Row %	Count
Don't compromise emergency and access lighting	35.7%	35.7%	17.9%	7.1%	3.6%	%	28
Set limits to, but do not prohibit, aesthetic lighting	37.0%	33.3%	18.5%	3.7%	7.4%	%	27
Requirements that are easy to understand	69.0%	27.6%	3.4%	%	%	%	29
Minimize paperwork and submission requirements	34.6%	34.6%	26.9%	3.8%	%	%	26

Is there anything you would add? Do you have any concerns?

- Limt on pot light both side of the property but there should be no limit on front and back coz doesnot interferes with neighbour's Thanks
- Not any
- Keep it simple.
- Yes - these guideline are similar to the California model Title 24 and work very effectively
- Requirement for compulsory dimming and cut off luminaires are paramount to achieving City's Outdoor Lighting Strategy goals. Q 7- 4 above. More fixtures will allow to achieve higher uniformity=better visibility. Q 7-5 above.By-law restricting light trespass should include clause preventing direct glare and together with capped illumination and luminance levels will ensure that light is contained within the property and that intensity is appropriate. Q 7-7 above.Compulsory dimming in combination with capped illumination and luminance levels will ensure that light levels will be appropriate, irrespective of fixture's light output.
- light levels reflected off a surface are measured in candela/m2 not lux. this requires an expensive meter to measure but is related to surface reflectance ie: it should be ok to have a higer lux level on a dark building than a white building as the brightness and nuisance may be similar.
- Set a cap on the spectrum of light that is permitted outdoors at night. Minimize the blue light that is emitted; LED technology has advanced and we can now do this! Require SPD (Sectral Power Distribution) to asses lighting and not CCT which may not reflect blue light content.
- Consciousness of light pollution
- This is a gray area. I believe the design should be a responsible one but the Architecture has to part of the consideration in the overall strategy.

Are there any additional considerations on mitigating light pollution that you think that are missing from this list?

- No
- Bird friendly design should include non-lighting items such as glazing, decals and not allowing high rise buildings on flight path
- Selection needs to include colour temperature and spectral distribution parameters to reduce the range of blue light spectra.
- Limiting colour temperature of exterior lighting.
- No lighting that is considered caustic and too bright. Please! Thanks
- We should have exemptions for example In ASHRAE 90.1 registered Heritage buildings and monuments are exempt from Dark Sky.

What lighting design resources do you rely on that you think would benefit others in the industry?

- Technical articles
- IES standards,
- AGI32 software,
- industry partners
- No idea
- MLO
- B U G
- California Title 24 plus conservation mandates in areas adjacent to wildlife breeding and sanctuary areas.
- PLD and Rensselaer publications, seminars at IALD and PLDC annual conferences
- IES, IDA, CEPTED
- International Association of Lighting Designers Website
- Lighting Urban Community International Website
- Lighting Research Centre Website
- International Dark Sky Association
- ASHRAE

INDUSTRY SURVEY RESULTS (% of those who agree)

1. Requirement minimising impact on neighbours (92%)
2. Restrict use of unshielded fixtures (eg. flood lights) (92%)
3. Require full cut-off optics for high-lumen fixtures (88%)
4. Require timer and dimming controls (83%)
5. Set a cap on light levels from fixtures (63%)
6. Set a cap on light levels reflected from surfaces (63%)
7. Set a maximum height above surfaces (54%)
8. Set a maximum number of allowable fixtures (42%)

Other Industry Comments received through email or lighting designer survey

- Standardize but do not reduce the diversity of the landscapes
- Develop specific comprehensions of situations and places
- Consider commercial lighting contribution to sense of safety, and night-time situations
- Have a guiding document for lighting in the City of Vancouver
- More pilot projects for LED
- Many clients are older residents; seeks to develop homes compatible with multigenerational needs
    - Will install soffit lighting, especially around sides and rear of homes to allow safe access
- Suggests use of light on gimbals – allows light to be adjusted on angle
- Agrees with most of measures, providing that staff do not create more work.
- When replacing cobra head lighting one for one, the overall effect is too much light. Careful consideration is required in using warmer colour temperatures and spacing of luminaires. Perhaps the approach should be to use lower lumen output LED replacements than presently considered.
- The 3000K is not an accurate measurement. The majority of the wavelength needs to be aligned with what is considered a low blue wavelength and the CRI.
- Also it needs to be considered the light quality coming out of the optics/lens controlling the LED beams rather than judging the quality of light by the LED Diod alone.
- Light level measurements are not enough. Uniformity, vertical light levels are the key. It is proven that people feel safe generally not because of the light levels alone, but also uniformity plays an important role. (I can refer to those later of you want)

- Fixture selections need to be addressed by mock ups in various weather conditions
- The entire world is moving fast towards the Smart City Design Technologies. Although there are some grey areas the City needs to start about Future Proofing the City and put in place the infrastructure that is required to implement Smart City Technologies in near future.

Individual Stakeholder Engagement

Comments from BIAs

- Overall supports overarching goals of the strategy
- Of particular concern is balancing the needs in mixed commercial and residential areas, considering façade lighting, business signage, decorative elements
- Suggest recommended light pollution standards be restricted to solely residential areas
- Want minimal impacts to commercial areas with proper notification
- Working to develop outdoor lighting brochure to support BIAs and any energy efficiency upgrade programs
-

Comments received at Outdoorlighting@vancouver.ca

- Investigate the full spectral output of any LEDs you install. While a CCT of 3000K is generally indicative of drastically reduced blue-light output, most LEDs still emit some blue light, and the health effects of these low levels of blue light from 3000K LEDs have not yet been fully established. I would encourage seeking LEDs that emit no blue light at all.
- Pay attention to indoor light levels. Illumination from full moonlight is around 0.25-0.5 lux, so light levels even this "low" measured in a bedroom could make it harder for people to sleep.
- To pay special attention to glare and uneven lighting.
- Please consider the wonderful aquatic environments around Vancouver as worthy of protection. I would encourage you to prevent light from reaching aquatic environments as much as possible. Many aquatic organisms are adapted to very low light levels, so an increase in light of only ~0.5 lux can have a dramatic effect on their behaviors
- Consider impacts of greenhouse light pollution
- Consider impacts of botanical light pollution
- Consider differences in neighbourhoods, ie Gastown, Chinatown, West-end, consider warmer white lighting
-

Comments from VCH

- Human health hazard resulting from blue light or light pollution, at levels experienced from streetlights, has not been firmly established in scientific literature and research.
- Outdoor lighting has many public health benefits when properly designed, and must be taken into consideration in any light assessment.
- Ensure consistency in the language around the potential health concerns with respect to “blue” light; otherwise the document will produce confusion. The American Medical Association (AMA) does not use the term ‘human health risk’ to describe current street LED lighting. Suggest associating City’s selection of warmer colour temperatures as part of effort to create more inviting lighting and be more similar to existing lighting rather than any recommendation from the American Medical Association (AMA) as they have not directly indicated as such.

Comments from UDI

- Clarification questions on whether these are new requirements (they are not, just clarification on application)
    - Engineering already sets electrical conditions on RZs and DPs, as we are permitted through a CD-1 rezoning process and through discretionary ability under the Z&D bylaw.

311 Reports on Complaints from 2015-2017

- 13+ incidents: re house lighting
- 11 incidents: other residential buildings
- 20 reports: Telus architectural feature
- 10 incidents: other architectural lighting (mainly condo towers)
- 5 incidents: related to commercial
- 5 incidents: related to parking lots

Appendix D – Street and Public Realm Lighting Design Guidelines

CITY OF VANCOUVER

ENGINEERING SERVICES
STREETS, TRAFFIC AND ELECTRICAL BRANCH

STREET AND PUBLIC REALM LIGHTING DESIGN GUIDELINES

This document is to be used in conjunction with the City's Lighting Design and Construction Standards, Streetscape Design Guidelines, and other City policies such as public realm plans, which provide design direction for illumination of City streets, pedestrian and cycling pathways, and public spaces located on the City's street right of way.

Rev. July-19-19

STREET AND PUBLIC REALM LIGHTING DESIGN GUIDELINES

Contents

Street and Public Realm Lighting Design Guidelines

1 APPLICATION AND INTENT

This document is to be used in conjunction with the City's Lighting Design and Construction Standards[1], Streetscape Design Guidelines and other City policies such as public realm plans which provide design direction for illumination of City streets, pedestrian and cycling pathways, and public spaces located on the City's street right of way.

The City's Engineering Department operates and maintains over 50,000 luminaires in these spaces. The vast majority of these light sources are pole-mounted roadway luminaires that illuminate roads and sidewalks, with the remainder being pedestrian scale luminaires along sidewalks, paths, and plaza spaces.

Advances in light-emitting diode (LED) technology are enabling new streetlight products and design approaches that can improve the quality of lighting in cities, and reduce energy and maintenance needs. The Street and Public Realm Lighting Design Guidelines provide direction on coordinating a transition to LEDs from the existing streetlight network, which relies predominantly on high-pressure sodium lamps.

The intent of the guidelines is to:

1. Enable a responsible transition to LED technology to optimally provide safety benefits, reduce costs, and minimise light pollution and other environmental impacts of lighting
2. Highlight key outdoor lighting design priorities and considerations for various typologies of public spaces located on the street right of way
3. Identify considerations for planning and implementation of street light upgrades, including existing capital and maintenance processes under which outdoor lighting improvements can be integrated
4. Identify considerations for lighting controls and 'smart' technologies that can be enabled, which may be tested and trialed prior to a broader roll-out

[1] In Development

2 DESIGN GOALS

The primary purpose of the City outdoor lighting network is to ensure our streets and public spaces are safe and accessible at night. The lighting can also contribute to making spaces feel more welcoming and inviting for residents. The City aims to make streets safer and more accessible for those who walk, bike, roll, drive, or take transit to get around. The City recognises that light can also play a role in making spaces special and recognisable.

The Outdoor Lighting Strategy has five goals that aim to balance the benefits of outdoor lighting while minimising its impact on public. The goals are listed in order of prioritisation, and specific objectives for the illumination of public spaces such as streets, paths, and gathering spaces are indicated in this section.

2.1 Improve public safety

The City has set a zero traffic-related fatalities goal in its Transportation 2040 Plan. Street lighting should be designed to make road users and objects visible in ways to avoid collisions, fatalities and injuries at night. To meet this objective, guidance should be provided to:

- Enable safe travel after dark, specifically for high-collision areas (eg. intersections and crossings), pedestrian and cycling priority routes (eg. greenways, seawall pathways, local bikeways), and areas adjacent to transit and public facilities like schools and community centres.
- Ensure existing traffic collision data is used to prioritise site-specific lighting improvements.
- Catalyse the citywide adoption and use of LED technology for the illumination of streets and public spaces.
- Enable improved reliability of street lights using smart technologies that detect lighting failures so they may be more immediately addressed.

2.2 Enable accessible and inviting spaces

The City promotes accessibility, inclusiveness, and active living through a number of policies, including the Healthy City Strategy and Transportation 2040. Street lighting should be designed to make streets feel inviting and provide a sense of security for all residents. To meet this objective, guidance should be provided to:

- Improve pedestrian comfort and sense of security on streets and in public spaces, especially for persons with low-vision or those who may be more vulnerable to harassment or violence
- Facilitate improvements to commercial streets, priority routes for pedestrians and cyclists, and public spaces to make them attractive and inviting amenities for the community at night
- Align with the City's land use and urban design goals, including support for place-making initiatives

2.3 Reduce light pollution

While lighting of streets is provided for public safety and accessibility, its design should focus light where it is needed and minimise light pollution. To meet this objective, guidance should be provided to:

- Support the appropriate selection of luminaires and products that meet light pollution control specifications, such as requirements for full cut-off optics and glare-reduction ratings.
- Ensure that design and operation of street lighting avoids over-lighting, light trespass, and glare, including provisions for the installation of shielding where necessary.
- Allow trialing of dimming technology to enable light levels to be remotely adjusted and utilize programmed schedules to minimise over-lighting.
- Provide guidance to reduce light pollution for illuminated features (eg. public art) located on street right of way.

2.4 Reduce energy use

The City has goals embedded in its Greenest City and Renewable City initiatives to reduce its energy use and greenhouse gas emissions to lighten our ecological footprint. Lighting on streets should not use more energy than is needed to meet its function. To meet this objective, guidance should be provided to:

- Catalyse the citywide adoption and use of energy-efficient LED technology for the illumination of streets and public spaces
- Try and facilitate the use of lighting controls and approaches that can further reduce energy use
- Enable tracking of energy use data and greenhouse gas reductions by using monitoring equipment and software

2.5 Minimize ecological impacts

The City has goals in its Biodiversity Strategy and Bird Strategy to increase the quality of Vancouver's natural areas to support biodiversity and increase access to nature. Because artificial lighting can negatively impact ecological systems, careful approaches to lighting – especially in ecologically-sensitive contexts – should be followed to minimise disturbances on nocturnal behaviour. To meet this objective, guidance should be provided to:

- Set limits to lighting in areas where it may adversely affect wildlife and plant life
- Ensure lighting is focused on where it is needed, and not unnecessarily lighting surrounding areas
- Identify ecologically-sensitive approaches to lighting design where illumination is needed, such as streets and paths near park spaces.

2.6 Ensure Resilient infrastructure

The City is striving to build resilient infrastructure to support reliable lighting applications. The aging underground infrastructure can have negative impacts on outdoor lighting and the time it takes to address outages. Smart lighting applications require reliable power and communication cables. To meet this objective, guidance should be provided to:

- Upgrade underground conduits, taking advantage of capital projects and external developments. The City has developed a design criteria manual, constructions specifications and standard detail drawings to support the implementation. These documents will be updated from time to time by Engineering Services.
- Provide extra power capacity in neighborhoods where there will be a demand for future lighting and other applications.

2.7 Applying an Intersectional Lens

Different intersecting barriers to access such as social class, gender, race, ethnicity and disability have been recognised. Lighting can play an important role in supporting equity and ensuring that all people feel safe and secure in our city. In this way, guidance should be provided to:

- Ensure equity is considered as part of all outdoor lighting design projects.
- Work in in partnership with Arts, Culture, and Community Services (ACCS) to identify specific areas and projects where additional consultation may be needed to determine the optimum lighting approach.

3 APPROACHES AND CONSIDERATIONS

This section outlines approaches and design considerations aimed at meeting the goals and objectives set out in Section 2. High-level guidance on lighting design is provided in the section below.

3.1 Light levels and distribution

Light levels are typically higher on streets where there is greater vehicle and pedestrian traffic and where collision rates tend to be higher. Conversely, local streets in residential areas are typically lit to a lower light level, given the slower speeds and lower volumes of traffic. The City's lighting designs are guided by the recommended lighting practices established by the Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting, and the Illuminating Engineering Society of North America (IESNA) RP-8 "Recommended Practice for Roadway Lighting" [2] for roadways, streets, adjacent bikeways, and pedestrian ways and intersections.

However, there may be instances where light levels may be adjusted to account for location-specific factors (eg. reflectivity of nearby surfaces) or population-specific factors (eg. age and visual ability). For instance, higher light levels may be provided at locations where, and during times when, persons may be more vulnerable to collisions. Special attention should be given on streets adjacent to transit and public facilities in spaces during peak evening hours of traffic. To make routes and spaces more inviting, vertical illuminance, which enhances visibility of approaching people and objects, should be provided at appropriate levels.[3]

Likewise, light levels may lower in areas with lighter-coloured and more reflective surfaces. Additionally, recommended light levels may not be achievable on all streets, especially in areas with mature tree canopy where branches and vegetation may produce shadows or where existing light poles are spaced further apart. In such cases, professional engineering judgement will be exercised to determine the appropriate light level for the particular location.

In public gathering spaces such as plazas, a wider range of light levels should be considered to meet the aesthetic effects desired while ensuring enough light for safe

[2] The Illuminating Engineering Society (IES) of North America provides recommended roadway design criteria in its document called Recommended Practice 8, Roadway Lighting (RP-8). IES identifies methods and recommended light levels based on road classifications and pedestrian conflict area. It also provides recommended design criteria for pedestrian walkways and bikeways, as well as additional light level guidance and design considerations for intersections and crosswalks.

[3] Higher levels may also be considered in areas with security challenges to achieve Crime Prevention Through Environmental Design (CPTED)

passage. Desired levels and overall lighting outcomes can be met cumulatively with careful design of lighting between various light sources.

3.2 Colour temperature

Colour temperature of lighting plays an important role in terms of visibility, safety, and comfort. Generally, cooler temperatures of light enhance the colour contrast of objects, which makes them more visible at night for motorists. On the other hand, warmer colour temperatures are often used to make spaces more inviting. It is important to note that lights rated at similar colour temperatures may have differing abilities to render colour accurately. As such, light sources should be evaluated for quality prior to broad scale implementation.

The City will consider a range of colour temperatures to meet the specific needs of streets and spaces. Cooler white lights, at a maximum of 4000K, should be reserved for areas such as high-collision intersections and sections of streets where visibility is an issue. Generally, warm-white lights of 3000K should be used along all other city streets to balance collision reduction aims while providing a warm night-time aesthetic.

A greater range of colour temperatures (eg. 2200K–3000K) may be also considered in areas where vehicular access is restricted or limited. These contexts include public plazas, activated lanes and gathering spaces, as well as paths used for walking and/or cycling.

In ecologically sensitive areas, greater care should be given to select products with specific spectral content to reduce possible impacts on any specific species of wildlife. Special consideration should be given to streets and paths located near parks and other natural assets, such as shoreline habitats, waterways, and areas with substantial tree canopy and vegetation.

3.3 Luminaire design and selection

A range of luminaires are currently in use throughout the city to meet a variety of illumination needs. Luminaires should be evaluated based on performance criteria consistent with the Outdoor Lighting Strategy goals (such as lighting quality, energy efficiency, and light pollution mitigation) as well as considerations for cost, maintenance, and operations. Generally, LED products should be selected over less efficient technologies, such as high pressure sodium (HPS). The cost of LED luminaires has decreased sufficiently to the point that they are now competitive with HPS, reducing capital costs and payback periods.

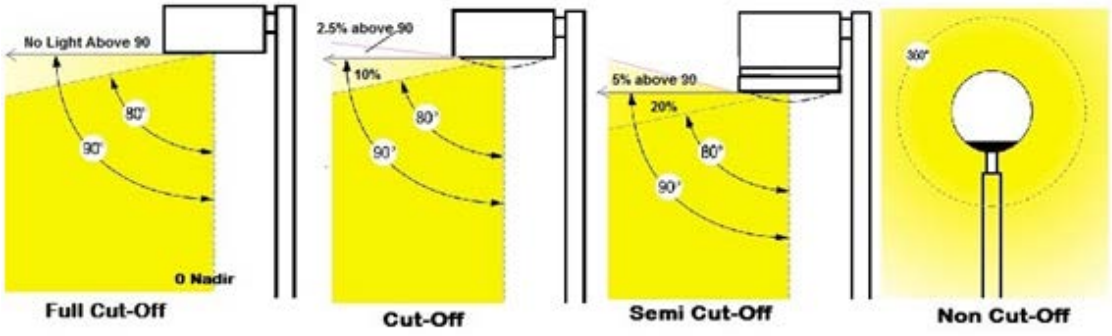
The vast majority of streets and sidewalks rely on pole-mounted roadway luminaires that provide cost-effective illumination. LED roadway luminaires replacing the HPS units must be able to meet the performance needs of the city's diversity of streets, and must be able to easily integrate with existing control technology and systems, but also be adaptable to new controls.

Pedestrian-scale lighting should be considered along streets and paths that prioritise walking and cycling, such as greenways and park connectors to encourage greater use of these spaces. Appropriate selection of luminaires can enhance the public realm and people's sense of security and comfort by improving the visibility of other road users and surrounding areas.

Low-mounted lighting, such as bollard lights, may be considered for paths and public spaces where modest illumination for wayfinding along paths or for ambience in gathering spaces may sometimes be desired. Additional consideration should be given to how lighting may improve wayfinding – for instance, to illuminate signage and pathways – or to enhance, or even provide visual cues to, the use of the space – such as designated seating areas.

Unshielded fixtures that direct light upwards into the sky or into areas where light is unwanted should be avoided to the greatest extent possible. Shielding should be considered where lighting may impact nearby residents and sensitive ecological areas.

Figure 1 Spectrum of Cut-off Lighting Fixtures and Light Throw



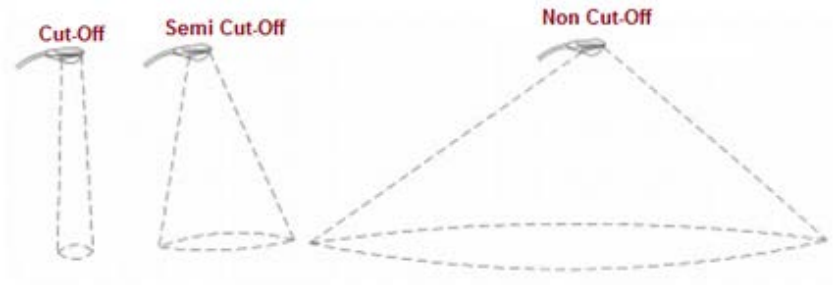
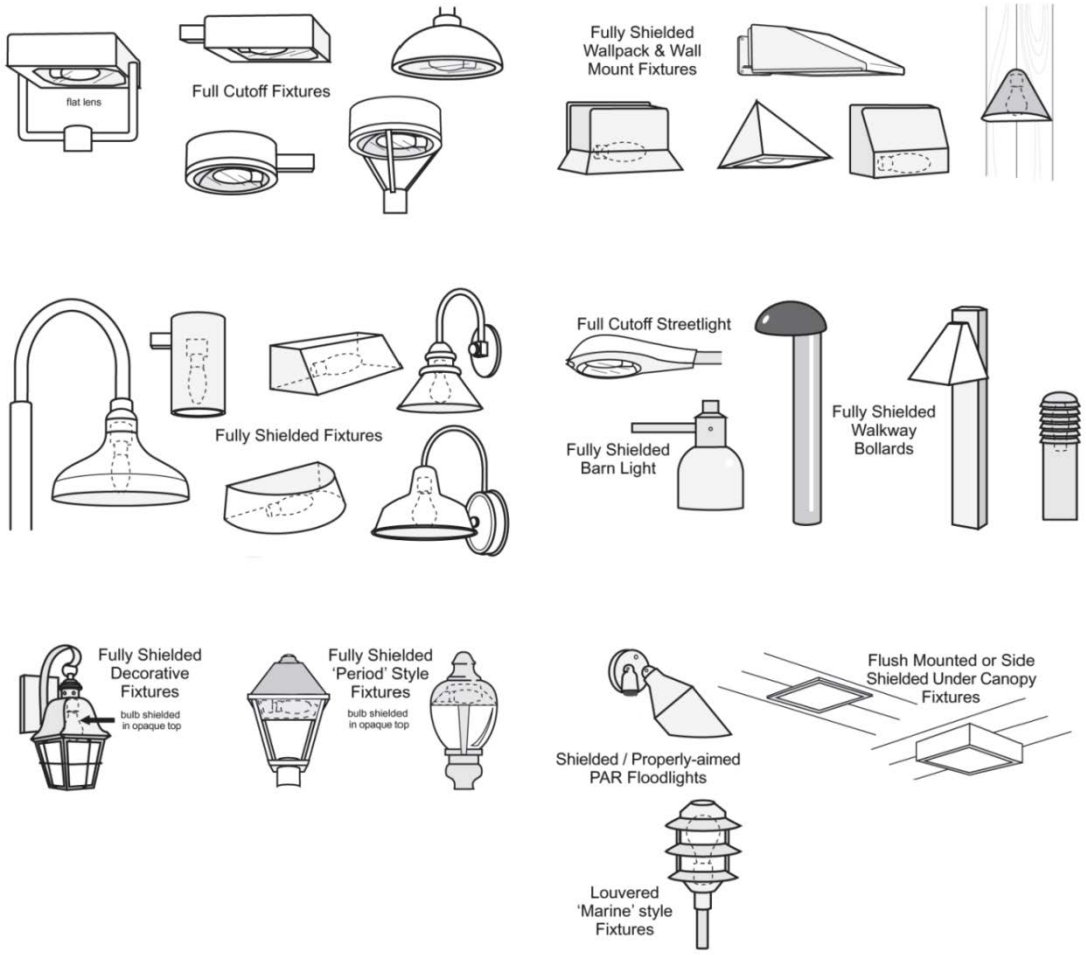
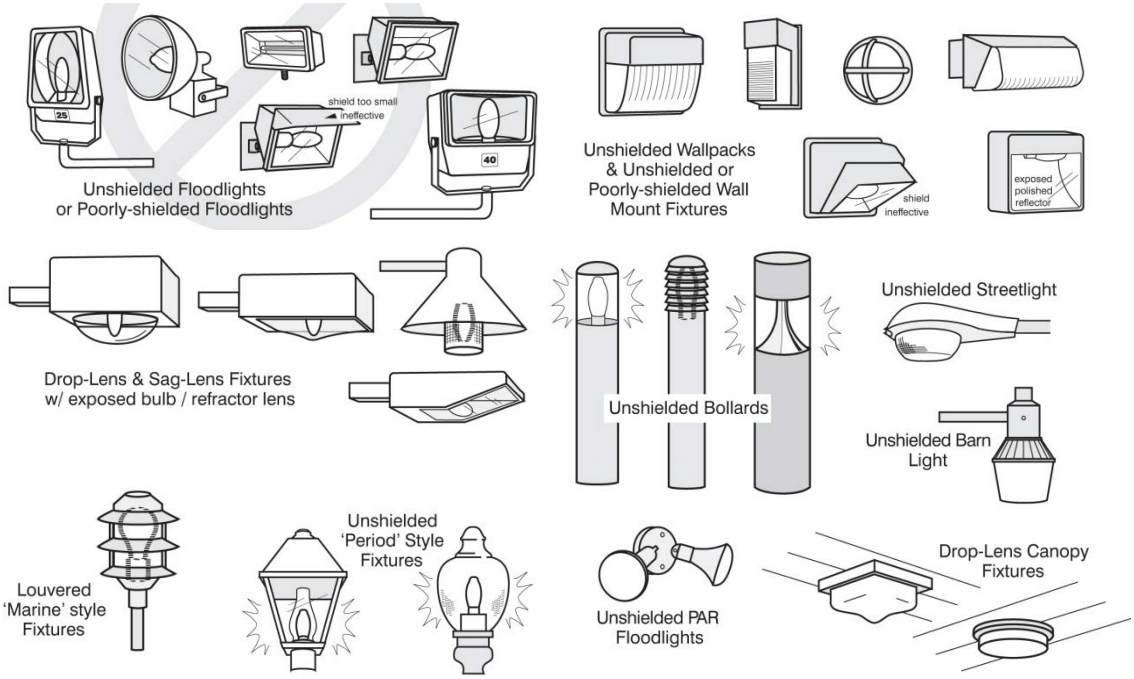


Figure 2 Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night



Illustrations by Bob Crelin ©2005. Rendered for the Town of Southampton, NY. Used with Permission. From Dark Sky Association.

Figure 3 Poorly Designed /Discouraged Light Fixtures that Produce Glare and Light Trespass



Illustrations by Bob Crelin ©2005. Rendered for the Town of Southampton, NY. Used with Permission. From Dark Sky Association.

3.4 Lighting controls and smart technology

The installation of an intelligent lighting control and monitoring system is strongly recommended to allow detection of lighting failures and adjustments to light levels at individual fixtures. The selection of new lighting control systems should be considered alongside other technological capabilities that the City is looking to integrate through its streetlight network.

New smart lighting technologies and design approaches should be considered to enable designs to meet different lighting needs of users, which may be location or time-specific. A combination of sensors and controls, such as photocells, timers, and dimmers, can accompany lighting installations and be used to achieve the time- and location-specific light levels.

For instance, light levels may be temporarily raised at high-collision and vulnerable spaces during hours of heightened risk (eg. peak evening traffic hours) and then lowered to regular levels to mediate impacts on nearby properties. Likewise, lighting in commercial areas may be programmed to lower light levels after rush-hour to improve ambience for pedestrians.

At times of night when many streets see infrequent use, including those in industrial areas or lower-density residential streets, a curfew may be set after which lights may be programmed to dim to lower light levels.

Motion sensors may be used to temporarily raise light levels when pedestrians are present to enhance visibility and provide a sense of security. Testing and piloting is recommended before a broader deployment of motion-sensor technology to ensure that sensors are reliable and lowered light levels do not compromise safety.

3.5 Aesthetic design

Lighting design should also meet the City's broader urban design goals for neighbourhoods and public spaces. From the fixture's selection and placement, to the light source's colour, light level, and distribution, lighting can provide visual cues that go beyond function and shape people's perception of place. Illuminated decorative features can also play a significant role in enhancing night time experience, especially along commercial streets and gathering spaces.

Where design guidelines are in place, as in heritage areas and commercial districts, consideration should be given to how lighting may be designed to enhance, and remain compatible with, the area character. For instance, warmer colour temperature may be considered for luminaires in heritage areas to provide ambience and aesthetic more similar to traditional light sources. Fixture designs themselves can contribute to the character of the neighbourhood, as they do in the historic Gastown district.

Special lighting treatments may be considered for public space improvement initiatives, street-to-parklet conversions and plaza projects to facilitate the social functions and aims for the space. Luminous surfaces and luminescent pavement treatments may also be considered where features may create visual interest or enhance visibility of walking paths at night. Lighting can subtly provide visual cues to distinguish the use of one space from another (eg. areas for gathering and areas for circulation). Where feasible, staff may seek opportunities to coordinate street lighting with other light sources from adjacent park spaces or semi-public plazas to enhance overall pedestrian experience. Lighting animation (eg. moving or sequenced lights) can provide a level of visual interest at night, and should be considered in areas where a vibrant night-life is desired. Where these features are being considered, special consideration should be given to ensure that safety and comfort of persons nearby are not impacted. Staff may require that designs avoid certain colours (eg. red and green at intersections) and effects (eg. sequences run too quickly or strobe lighting) to avoid these issues.

3.6 Summary

The table below provides a framework for lighting design for different typologies of streets, paths, and public spaces. The table is intended to provide guidance for lighting design but may vary from site to site, based on the unique site conditions and project goals.

	Light levels	Colour temp	Luminaires	Possible Controls	Aesthetic Design
Conventional street and sidewalk	General guidance from IES RP-8 based on pedestrian and vehicular traffic volumes. Overall levels may vary and be adjusted due to environmental factors	3000K – warm white source to balance aesthetic with safety	Standard pole-mounted roadway luminaire	Programmed scheduling of light levels; eg. higher levels during peak hours, lower after curfew	Consistent with surroundings: poles, fixture style, colour, and existing guidelines
ADDITIONAL CONSIDERATIONS					
High collision and vulnerable spaces	General guidance from IES RP-8 based on high pedestrian conflict area light levels	Up to 4000K – neutral white source to enhance colour contrast and object detection	Standard roadway luminaire, with infill lighting where necessary	Higher light levels at peak hours, aligned to traffic	Consistent with surroundings where possible
Priority pedestrian and cycling route (greenways, seawall)	May be adjusted to operate with surrounding ambient light levels and land use	Up to 3000K – warmer sources may be considered to meet ambience objectives	Low-glare pedestrian level lighting encouraged	Programmed dimmed light levels after curfew, with motion sensor to gradually raise levels when in use	Consider selection of fixtures that would provide a consistent public realm along the network
Commercial streets (BIAs)	Balance ambience with roadway safety.	3000K	Low-glare pedestrian level	Programmed scheduling of light	Area-specific decorative fixtures,

	Generally, 5 lux		lighting encouraged	levels to work with business hours and activity	public realm lighting features
Ecologically-sensitive areas	Minimal levels, and only where needed	Depending on species, but generally warmer is better	Low as possible for pathways, extra shielding where needed	Programmed dimmed light levels on streets, coordination with park hours and use	Where parks are nearby, ensure alignment with Park staff
Public plaza	Greater range of levels considered,	Dependent on design specifications	Range of decorative types considered	Programming consistent with hours and use of the space	In line with broader place-making objectives
Activated lanes and lanes of new developments with rear accesses	Appropriate levels for pedestrian walking access	Up to 3000K	Mounted on existing poles with external shielding. Where feasible, low level pedestrian lighting should be considered	Programmed dimmed light levels after curfew, with motion sensor to gradually raise levels when in use	

4 PRIORITISATION AND PLANNING GUIDANCE

To ensure that lighting priorities are met, this section highlights processes and steps that should be taken to enable responsible planning of lighting.

4.1 Identify priority street and sidewalk lighting improvements

While improvements to the existing streetlight network will likely be carried out over time due to resource and staffing availability, certain areas should be prioritised to ensure enhancements to visibility are provided where it is most needed. Greater priority should be given to:

- Intersections and corridors with higher rates of collisions at night[4]
- Un-signalled marked crosswalks
- Streets adjacent to public facilities[5]
- Pedestrian priority and cycling routes, such as greenways[6]
- Streets near major transit stations and along Frequent Transit Network and NightBus transit service routes[7]

4.1.1 Downtown Eastside

In neighbourhoods like the Downtown Eastside, lighting improvements should be designed with attention paid to unique safety challenges encountered by individuals and communities. Where sudden changes in lighting could affect persons at greater risk of violence or persons that have specific lighting needs, the City should:

- Work with the City's Social Policy and Projects Division and other neighbourhood advocacy and service organisations to ensure that changes to lighting do not adversely impact community members as the City aims to maintain safe illumination levels.
- Utilize the City's intersectionality tool[8] to engage with community stakeholders to make informed decisions on lighting where there may be competing demands for lighting and darkness. This framework will help staff ensure that perspectives of persons with lived experience are appropriately integrated.

[4] The City identifies priority intersections and corridors based on safety studies as part of its Moving Towards Zero Safety Action Plan initiative
[5] Lighting improvements may be carried out as part of the City's existing roadway safety improvements in these areas, including its School Active Travel Planning initiative
[6] The City seeks to improve walking and cycling through street and path improvement projects. including greenways and local bikeways.
[7] As identified by the Translink Transit Authority
[8] Currently in development

- Work with relevant agencies to notify community of upcoming lighting work in sensitive areas, and provide appropriate staff contact information to deal with inquiries and provide more information where necessary.

4.2 Adopt measures to minimise light pollution impacts

The City should adopt the following practices to reduce light pollution impacts, including strategies identified in IES RP-33-14 "Recommended Practice for Lighting for Exterior Environments". Recommended measures include:

- Avoid exceeding recommended light levels by more than 10%
- Install glare shields where light trespass cannot be avoided to reduce impacts onto nearby properties to the greatest possible extent. Use Recommended Light Trespass Illuminance Limits guidance as provided in IES RP-33 to evaluate complaints.
- Where public is requesting a glare shield, the City may perform work to install shielding, and may assess the cost to the property occupant or owner. The glare shield should be maintained by the City in the event the fixture is replaced.
- Complete an assessment of the spectral power distribution and melanopic lux[9] to measure blue-light content on widely deployed light sources.
- Seek to test and trial lighting control technologies to reduce light levels without compromising safety.

4.2.1 Ecological light pollution

In ecologically sensitive areas, greater care should be given to minimise impacts from artificial illumination on fish and wildlife. Special consideration should be given for fixture type, spectral content, and lighting design in streets and pathways located near:

- Shoreline areas, where lighting can degrade habitat for juvenile salmon that feed in urban intertidal areas.
- Parks and other natural areas with substantial tree canopy and vegetation, where nesting sites for birds are commonly located

Efforts to align with Park Board designs and practices should be made. Where possible, lighting designs near sensitive habitat should accommodate or be consistent with restoration efforts completed as part of the Biodiversity Strategy.

[9] Using established methodology, such as the Irradiance Toolbox derived 1st International Workshop on Circadian Neurophysiological Photometry based on work by the University of Oxford

4.2.2 Evaluation of decorative elements

For decorative applications, including the illumination of public art and decorative features, the City may, on its own or in consultation with local stakeholders, establish requirements or limits on the installation on a case-by-case basis, such as:

- Setting maximum light output levels to avoid over-lighting or glare
- Ensure light is appropriately directed, without causing undue impact on to nearby properties
- Time restrictions, requiring illuminated features to be dimmed or turned off at certain times
- Shielding requirements, to ensure glare is not impacting the safety or enjoyment of persons nearby
- Automated control requirements, such as timers, sensors, and dimmers to ensure features automatically turn off or dim after programmed activities or surrounding businesses are closed.

4.3 Select LED luminaires and controls for citywide deployment

Greater consideration should be given to the evaluation and selection of luminaires and control products that are expected to be deployed widely across the city. Specifically, the City should establish requirements for product procurement and selection processes for both standard roadway luminaires (eg. cobra-head style fixtures) and pedestrian level luminaires. The following should be included in the evaluation criteria:

- Optical performance: lighting efficacy, colour temperature availability, colour rendering performance, light distribution types.
- Durability and maintainability: construction quality, minimum rated hours, ease of cleaning, maintenance, replacement of optical assembly.
- Light pollution mitigation: full cut-off, dimmability, glare limitation, recessed optics, diffusing surfaces, internal shade and external shielding accessories.
- Smart lighting and technological compatibility: quality of lighting control and monitoring system, availability of accessories and settings, compatibility with broader technological requirements (eg. smart cities integration)

4.4 Integrate lighting considerations in planning

To encourage greater alignment of lighting provision with the City's transportation and urban design objectives, the City may provide more lighting design guidance within its policies and plans. Opportunities include:

- Along streets and in public spaces where improvements are being considered for pedestrian and cycling accessibility, a lighting assessment may be completed to identify issues and provide enhancements to existing lighting infrastructure
- Where land-use changes and development may introduce the need for lighting improvements, strategies and mechanisms to enable the provision of outdoor lighting should be considered. Such areas include developments where primary accesses of residential suites face on to lanes.
- Where public realm elements such as street trees have the potential to impact outdoor lighting provision, design practices and processes should be amended to minimise future conflicts.[10]

4.4.1 Pedestrian experience

Along streets and in public spaces where there are supportive policies for night-time activation, additional guidance may be provided to design and coordinate lighting from private and public sources in ways that enhance the pedestrian experience and visual identity of the neighbourhood. Opportunities include:

- Specifying colour temperatures, mounting heights, fixture types, styles, and features to be used in the public realm of a neighbourhood or district to create a distinct aesthetic
- Where appropriate, coordinate with local stakeholders (eg. business improvement associations) to explore special treatments and unique lighting features that may be deployed to enhance the public realm
- Where possible, align lighting designs from semi-public spaces to create attractive night time public realms and avoid over-lighting

4.5 Upgrades ancillary to other city strategies and goals

When electrical and light poles are being upgraded, consider opportunities to build in additional capacity or features to allow for future ability to support other city goals, such as:

- Additional capacity to support electric vehicle charging and access to power for curbside vendors

[10] Refer to the City of Vancouver Street Tree Guidelines and Street Restoration Manual

- Receptacles, banners, and pole specs needed to support illuminated decorations and features, which may be requested by local business improvement associations along commercial strips
- Integration of future intelligent lighting and smart city technology, which may be informed by the City's Digital Strategy
- Solar powered lighting capacity in areas near disaster support hubs to support deployment of relief efforts and gathering

5 IMPLEMENTATION

Upgrades to lighting on street right of way may be initiated in several ways. The section below outlines possible improvements, and the mechanisms that may trigger work on lighting and the scope of improvements that may be considered in each case.

5.1 Spot improvements for street lighting

City crews often upgrade lighting as part of ongoing maintenance work based on public requests and reported light failures. Staff conduct a site assessment and determine a course of action to address the issue. Among spot upgrades that should commonly be conducted:

- Replacement of failed high-pressure sodium fixture with equivalent LED unit meeting with the specifications in Section 4.3. Noting that: At intersections, light sources should not be mixed. Replacement of failed HPS luminaires with LED units at intersections should be consistent for the entire intersection.
- Adjustment to LED luminaires to lower or raise light output
- Pole installation and retrofits to improve lighting at high collision and vulnerable spaces, as identified in Section 4.1
- Upgrades of intersections, crossings, and corridors that experience higher rates of collisions, as part of the Moving Towards Zero initiative. Locations for upgrades should be determined based on collision data and be kept consistent with lighting within that intersection

5.2 Development-triggered lighting improvements

As part of development conditions, new streetlight infrastructure is often provided on the adjacent street of the developing property. The following considerations should be taken for lighting improvements:

- For standard roadway and pedestrian scale fixtures along the street, designs should meet considerations set in Sections 3 and 4 of this document, as well as the City Design Criteria Manual and Construction Standards
- Where pedestrian scale or special decorative fixtures are approved to be provided, luminaires should be in meeting with criteria set in Appendix B
- Additional conditions for fixtures and layout may be provided in planning or public realm documents and required by staff on a project to project basis, including seeking unique and decorative lighting installations

5.3 Demonstrations, trials and pilots

The City should install luminaires and lighting controls that are being considered for a broader citywide rollout at several demonstration sites in the city. This would allow staff and stakeholders to evaluate products and test out controls as needed. Consider installing demonstrations of new street lights in the following contexts:

- Commercial retail business street
- Local bikeway and/or greenway
- Residential street (detached houses)
- Mixed use street (multi-unit residential)
- Industrial street
- Lanes

The City may conduct pilot projects to test lighting concepts to better meet Outdoor Lighting Strategy goals. Opportunities may include:

- Installing luminaires and controls, and tuning levels and programs in select environments prior to broader deployment
- Adjusting light levels in high collision and vulnerable spaces during peak hours
- Dimming light levels in specific areas after peak hours to make more comfortable public spaces and conserve energy
- Trialing motion sensors to temporarily raise light levels on infrequently used pathways and streets

Stakeholder feedback should be sought when testing different lighting approaches, such as programmed dimming and motion-sensor activated functions. Review of technical performance may not require such feedback, although feedback may be sought from technical and design authorities.

Among key considerations in the development of a pilot project:

- Evaluation processes and procedures,
- Stakeholder engagement plan, including outreach to City advisory bodies and key stakeholder groups, public notifications, and on-site signage
- Feedback and survey data requirements, including gender and age disaggregated data to assess safety, accessibility, and security-related design typologies
- Location criteria, including safety and accessibility considerations to enable public and stakeholder feedback where necessary.

5.4 Citywide retrofit to LED

To catalyse improvements offered by a conversion to LED, the City should pursue a citywide transition to replace existing high pressure sodium and metal halide luminaires with LED units. While a LED replacement programme will generally improve light levels and distribution in most areas, new pole installations and electrical upgrades will not be considered as part of this work.

The timing and phasing of the citywide retrofit will ultimately be determined by availability of budget and staff capacity. As such, work to complete a broad citywide roll-out may be staggered over a time period of several years. The following measures should be taken to meet the lighting objectives.

- Lighting designs should be produced in meeting relevant luminaire specifications provided in Section 3 and Section 4
- Priority for deployment should be given to areas outlined in Section 4.1.
- In areas that require a unique approach to lighting, such as areas with special treatment (eg. plaza spaces) or sensitive contexts, additional effort should be made to tune light levels and designs to site needs
- If smart lighting or smart city system is to be installed, ensure devices are compatible and aligned with the broader Smart City capabilities being considered
- Should lighting work create disturbances to parking or electrical service, the City will follow protocol to inform residents and businesses through a mail-out notice in advance of expected work.

5.4.1 Visual inspections

As luminaires are switched out at each pole, staff will also conduct visual inspections on the lighting infrastructure to record any issues and report to the responsible City department. This may include:

- Visible damage to the pole
- Legibility of pole identification number
- Light obstruction resulting from trees and vegetation

5.5 Transportation projects

New lighting installations are the greatest opportunity to make substantive changes to the lighting design of a street or area. These installations may occur with:

- Larger roadwork and/or sidewalk construction

- Transportation re-design project (eg. Complete Streets)
- Broader community redevelopment (eg. Riverfront)
- Public realm improvements that occur at the time of private redevelopment

When lighting upgrades are included as part of a project, consider the following improvements:

- Install pedestrian level lighting along commercial streets and priority streets and sidewalks, as indicated in Section 4.1.
- Apply relevant streetscape design guidelines and the City's Design and Construction Standards
- Adjust pole placement at crosswalks and intersections to improve visibility and safety, consistent with approaches used in Moving Towards Zero Safety Action Plan improvements
- Align lighting design with public realm and aesthetic specifications, as identified in other planning and transportation policies for the work area.
- Coordinate with tree selection and planting locations to allow complementary layouts and designs that minimise future conflict
- Develop place-based lighting designs that can be integrated as part of the project, which may be particularly useful in areas like public plazas and pedestrian spaces.

5.6 Public space improvement projects

Lighting designs of public gathering spaces and plazas can have a considerable effect on how the spaces are perceived and used by the community at night. To meet with place-making objectives that inform many public space initiatives, the following considerations should be made for lighting design and implementation of these spaces:

- Enable unique and interesting illuminated features, such as catenary lighting and suspended luminaires.
- Where appropriate, allow for lighting control systems that enable stewardship parties to maintain programming of lighting features
- Coordinate among different luminaires and light sources to create the desired lighting effect while ensuring safe lighting levels are met and consideration for accessibility is given
- Where appropriate, work to ensure that adequate lighting is provided through new redevelopments in activated lanes, such as low-level bollards or luminaires

affixed to buildings, and to align designs with privately-owned publicly accessible spaces.

- Adequately develop and deploy strategies to minimise impacts on nearby properties, identified in Section 4.2

Appendix E - Proposed Building By-law Amendments (Brought Forth July 16, 2019)

10.2.2.10. Lighting in Residential Buildings

(See Note A-10.2.2.10.)

[…]

2) Except as permitted by Sentence (3), permanent ancillary exterior lighting of a *building* of *residential* occupancy or the *residential* portion of a multi-use *building,* or those parts of a *building* facing a *lane*, that is required to conform to this Article shall

a) be provided with fixtures that are appropriately shielded that

i) utilize full cut-off optics or are fully shielded fore luminaires that emit over 600 lumens, or any luminaire installed along the side or back yard, and

ii) are partially shielded and utilize a diffusing cover for luminaires that emit 600 lumens or less.

b) be mounted no higher than 4 m above grade or the balcony surface it illuminates along the side yard, back yard, and similar outward facing courtyards or setbacks of the *building*,

c) be provided with dimmer and timer controls,

d) minimize lighting of adjacent exterior properties and properties across a *street*, *lane*, or *public way*,

3) Where exterior lighting is required by this By-law or other regulator enactments to provide illumination along paths of pedestrian or vehicular travel, fire department access, or equipment signage or lighting, it need not comply with the requirements of Sentence (2).

A-10.2.2.10 Exterior Lighting in Residential Buildings

[…]

10.2.2.10.(2) Exterior Lighting A growing body of evidence exists that identifies that excessive amounts of nighttime lighting (frequently referred to as light pollution) may be potentially harmful to the environment and to human wellbeing. Poorly controlled night time lighting in urbanized areas has been widely documented to have significant effects on the environment, such as increased skyglow, and physiological and behavioral changes to individual organisms. Research suggests that excessive nighttime lighting may be detrimental to human health.

Consequently, Sentences 10.2.2.10.(2) attempts to limit the quantity and quality of exterior lighting of buildings to reduce the impact and consequences of external lighting. Interior lighting emitted through glazed openings is also a concern, but this is largely dependent upon human activity, and it is not presently considered as part of these requirements. Nonetheless, it can be seen that conceptually this would also have similar effect as exterior lighting, so an effort should be made to minimize the potential for lighting trespass where possible.

The key components of Sentence 10.2.2.10.(2) requirements are the requirements for appropriate lighting fixtures that eliminate the upwards emission of light, and cast more of the illumination produced across the intended surfaces. Horizontal emission of lighting across the property line is more challenging due to the varying heights of a given building, but measures should be taken to reduce the potential and extent of lighting trespass to the limits specified. Additionally, the reflectance of adjacent surfaces that may be illuminated must also be considered as these also contribute to the total lighting emitted into adjacent properties. The orientation, reflectance, and illumination of the adjacent surfaces should be evaluated to limit backscatter or unintended reflectance.

To increase the likelihood of meeting the requirements, designers opt to

- Choose light fixtures that minimize backlight, uplight, and glare (BUG). Light fixtures with a BUG rating of UO are optimal.
- Choose luminaires with the lowest possible intensity for the task needed
- Consider warmer tones of 2500-3000K to reduce impact. A practical maximum temperature is 4000K.

10.2.2.10.(3) External Illumination Understanding that there may be periodic needs to provide external illumination, the requirements of 10.2.2.10.(3) serve to exempt lighting specifically intended to enhance security, safety and improve visibility for limited periods of time.

Appendix F - Proposed Amendments to the Untidy Premises By-Law

1. This By-law amends the Untidy Premises By-law.

2. Council inserts a new section 7 as follows:

7. An owner or occupier of a parcel of real property shall not cause, permit or allow an outdoor light fixture to be placed or lit in such a way that:

(a) the light fixture casts light directly onto a window or other opening of a residential structure located across a street, or adjacent to, the real property; and

(b) the light unreasonably disturbs the peace, rest, enjoyment, comfort or convenience of the owner or occupier of the neighbouring real property.

3. Council renumbers section 7, 8, 9 and 10 as 8, 9, 10 and 11 respectively.

4. This By-law is to come into force and take effect on November 1, 2019.

Appendix G – Planning and Development Informational Bulletin for Outdoor Lighting

City of Vancouver *Planning By-law Administration Bulletins*

Planning, Urban Design and Sustainability Department

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OUTDOOR LIGHTING BULLETIN

Authority - Director of Planning
Effective July 19, 2019

1. APPLICATION AND INTENT

This bulletin provides guidance to design professionals and property owners on exterior lighting strategies that reduce light pollution supportive of the City of Vancouver's *Bird Friendly Design Guidelines*. This bulletin should be considered along with other City policies and regulations applicable to the proposed works, such as the provisions for exterior lighting in the *Vancouver Building Bylaw*.

Illumination standards and considerations when installing exterior fixtures are identified in this bulletin to satisfy the following key objectives:

- Reduce light pollution;
- Reduce energy use and maintenance needs;
- Provide adequate light levels for safe access and security;
- Enable accessible and inviting spaces; and
- Minimise light pollution impacts on the environment and the community.

2. APPLICABLE CONTEXTS

- Exteriors of buildings, including pathways, entries, exits, stairs, balconies and patios, public washrooms, where lighting is used to provide for security or for aesthetic affect;
- Outdoor areas near recreational facilities, including pedestrian and vehicular paths, outdoor parking areas, and recreational/gathering areas;
- Regulated spaces with specific lighting needs such as childcare facility outdoor play areas;
- Areas with high pedestrian circulation such as community centres, publically-accessible open spaces, and outside of event venues.

3. DESIGN STANDARDS AND APPROACHES

The Lighting Handbook developed by The Illuminating Engineering Society of North America (IESNA) provides industry standards for lighting levels and provide lighting design strategies. Following are key best practices as outlined in the *Handbook*:

- Light no more than the recommended levels required for a subject site or program, which vary based on site needs;
- Choose appropriate qualities of light which may include colour temperature, colour rendering ability, and distribution;
- Reduce glare and light trespass by selection proper light fixtures, lighting controls, and shielding.

Working in concert with other environmental and design factors (e.g. sight lines, security barriers), enhanced lighting is an important component to Crime Prevention Through Environmental Design (CPTED). Approaches to CPTED typically rely on enhanced lighting to meet two objectives: increasing natural surveillance and increasing perceptions of safety. Following are considerations for the impacts of exterior lighting design on crime prevention and safety:

- Reduce shadows and glare to minimise lighting contrast that can impact visibility by designing lighting with proper lighting uniformity;
- Strategically position luminaires to minimize conflicts with nearby vegetation and trees;.
- In some circumstances, strategic darkness or temporary motion-activated lighting can be employed as a CPTED tool. For examples, areas with limited surveillance (e.g. remote pathways, areas with dense foliage) may be kept mostly dark, where better walking options exist nearby will be provided with enhanced illumination;

4. LIGHTING DESIGN RECOMMENDATIONS

4.1. Light Levels

- Light fixtures should meet and moderately exceed the IESNA RP-33 (*Lighting for Exterior Environments*) and the *Lighting Handbook* recommendations for light levels in the appropriate context;
- For areas with specific security concerns, IES G-1 (*Guidelines on Security Lighting for People, Property, and Public Places*) may provide additional relevant guidance. Special consideration should be given to vertical illumination in areas where visibility of pedestrian and other users would improve the perception of security;

- Higher levels of lighting can be considered in accord with the *Lighting Handbook* where facilities and areas are frequented by seniors or others with mobility or visual limitations;
- Lighting levels should meet ASHRAE 90.1 where applicable, or the *National Energy Code* (NECB);
- Where necessary, use of professional lighting design software is recommended to define appropriate fixture placement, type, and light output to achieve the recommended illumination levels and lighting uniformity.

4.2. Light Distribution

- In public gathering spaces such as plazas, a wider range of light levels should be considered to meet the aesthetic effects desired while ensuring enough light for safe passage and reinforcing a sense of security;
- Low-level lighting, such as bollard lights, may be considered for paths and public spaces where modest illumination for wayfinding along paths or for ambience in gathering spaces may be desirable;
- Assess and take into consideration surrounding sources of light, such as street lights, and the reflectivity of surrounding surfaces, such as walls and pavement, in lighting designs to avoid over-lighting.
    - Note, the use of lighter-coloured, more reflective surfaces may improve overall lighting effect and sense of security.

4.3. Colour Temperature

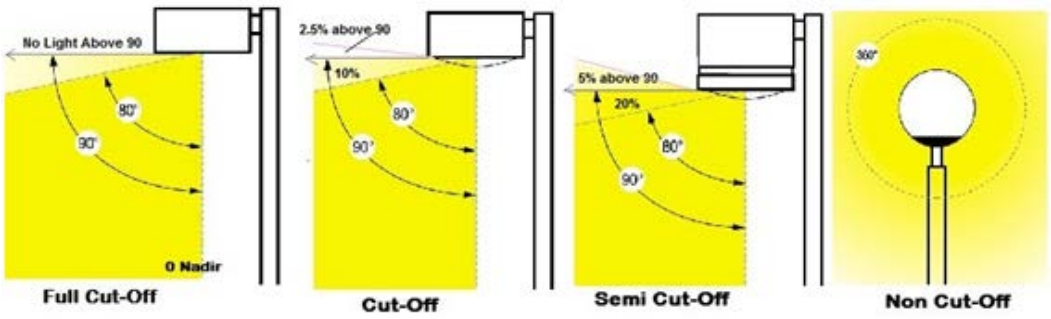
- Warm colour temperatures typically have lower impact on birds. Colour temperatures (CCT) should generally not exceed 3000K, and warmer colour temperatures (2200-2700K) should be considered in ecologically sensitive areas near bird habitats.
- Cooler white lights, at a maximum of 4000K, should be reserved for areas where safety is of special concern, such as locations where vehicle collisions may frequently occur;
- Warmer colour temperatures (e.g. 2700K or 3000K, or 2200K if light source meets desired aesthetic/colour rendering ability) may be selected for areas where a more ambient effect is desired. These contexts include plazas and gathering spaces, as well as paths used for walking and/or cycling.

4.4. Luminaire Design

- Section A-10.2.2.10.(2) of the *Vancouver Building Bylaw* (VBBL) requires that exterior lighting fixtures used for non-essential safety purposes should:
    - be full cut-off or fully shielded;
    - not to project light beyond property line; and,
    - maintain established lighting level limitations for reflectance;

- In general, fixtures should have full cut-off optics or be fully-shielded to reduce light spill and unnecessary light pollution (see Figure 1).
- Unshielded fixtures that direct light upwards into the sky and forward-throw wall packs and floodlights should be avoided, especially in areas with nearby residences that may be impacted.
- In addition, light fixtures should have a diffusing cover or lens, such as obscured glass, to reduce glare.
- Install glare shields where light trespass cannot be avoided to reduce impacts onto nearby properties to the greatest possible extent
- Select only LED light fixtures to reduce energy use and maintenance needs
- Where design guidelines are in place, such as in heritage areas or commercial districts, consideration should include how lighting design or fixture design can contribute to the character of the neighbourhood.

Figure 1 Spectrum of Cut-off Lighting Fixtures and Light Throw

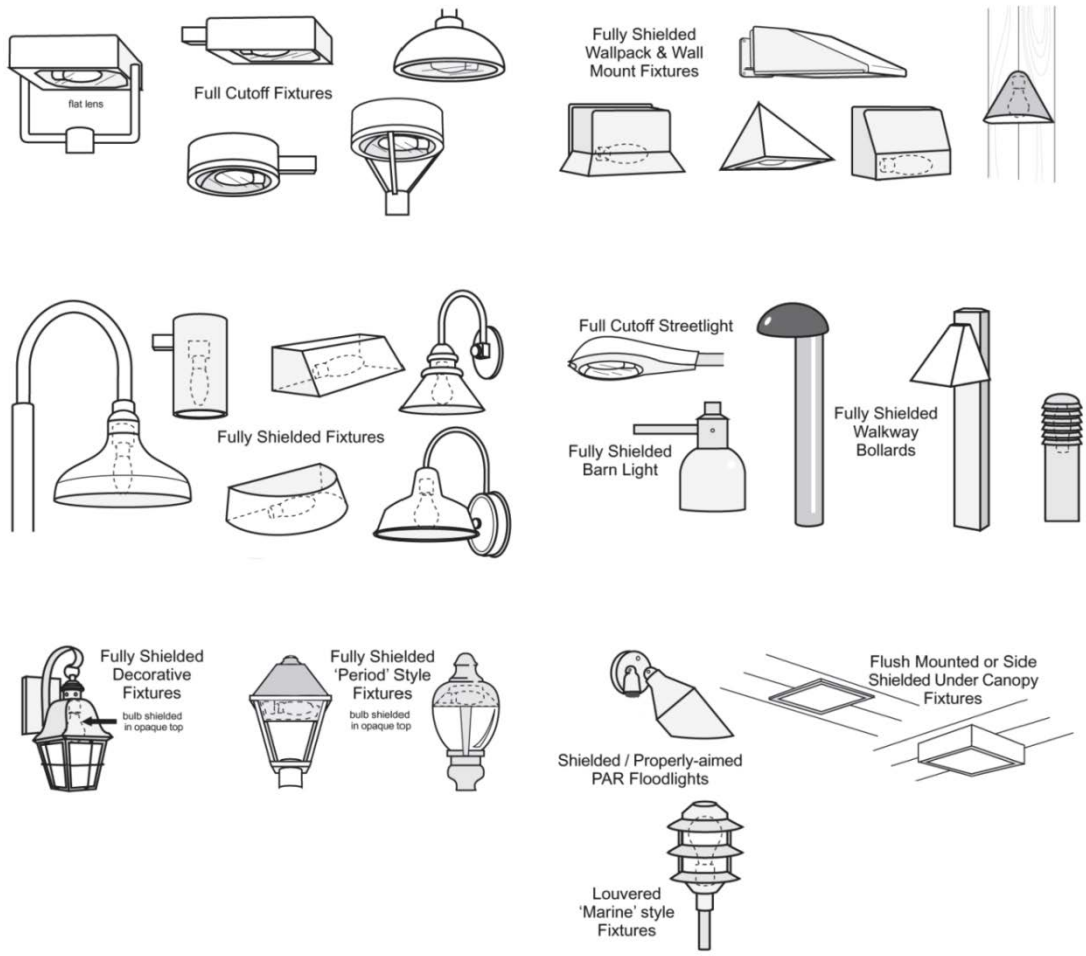


The nadir is represented by the lamp median perpendicular to the ground. IES classification of lights as 'full cut off', 'semi cut off' and 'non cut off' is based on the light dispersion 80 and 90 degrees above the nadir.

The table below shows the percentage light levels and their relation to classification of luminaries.

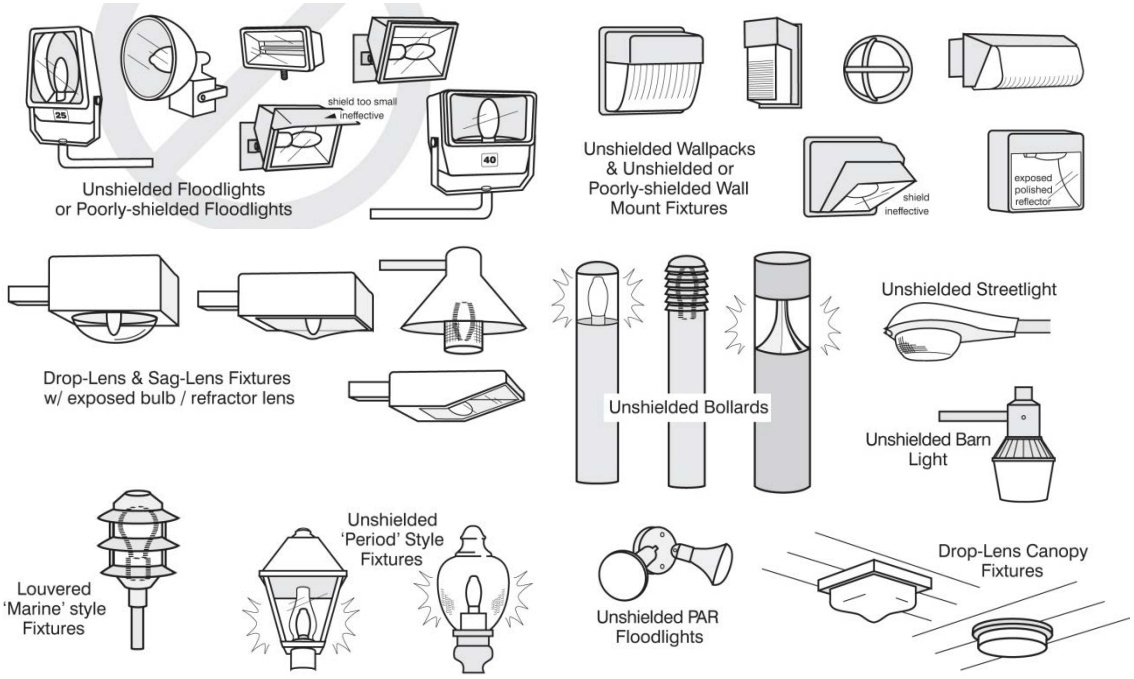
Classification of Luminaire	Percent of Total light output at 90° from Nadir	Percent of Total Candlepower at 80° from Nadir
Full Cut-off	0%	<=10%
Cut-off	<=10%	<=10%
Semi Cut-off	<=5%	<=20%
Non Cut-off	No limitation	No limitation

Figure 2 Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night



Illustrations by Bob Crelin ©2005. Rendered for the Town of Southampton, NY. Used with Permission. From Dark Sky Association.

Figure 3 Poorly Designed /Discouraged Light Fixtures that Produce Glare and Light Trespass



Illustrations by Bob Crelin ©2005. Rendered for the Town of Southampton, NY. Used with Permission. From Dark Sky Association.

4.5. Luminaire Orientation

- Fixtures should be oriented to minimize light spill or reflection on to nearby properties and reduce the effects of glare on people using, travelling through, or occupying a space. Use Recommended Light Trespass Illuminance Limits guidance as provided in IESNA RP-33;
- A lighting fixture should be installed no more than 4 meters above grade or other surface it illuminates (such as a patio) adjacent to or within the side yard and back yard of the building. Fixtures installed beyond this height limit may create unnecessary glare and light spill. Consideration should be given to providing a glare shield when lights are required to be installed at higher heights;
- Up-lighting that projects light directly to the sky should be avoided to minimize impacts on birds. Sensitive lighting near trees or other vegetation where birds may nest, or near shorelines where birds may feed should also be given additional consideration;
- Consider the proximity of illuminated decorative features to neighbouring properties, which should be avoided near the windows of dwelling uses that are occupied at night.

4.6. Lighting Controls

- Exterior lighting controls should be incorporated into a lighting design strategy in accordance with ASHRAE 90.1 or NECB;
- All outdoor light fixtures should have dimmers to allow for the adjustment of light levels. A combination of sensors and controls, such as photocells, timers, and dimmers may be used to reduce energy use and lighting. Where possible, dimming during off-peak hours is recommended;
- Consider turning off non-essential lighting between the hours of 11PM and 7AM.
    - Programmable light controls should be scheduled to dim or turn off lights after operating hours. Special consideration should be taken to allow access for after-hours or custodial staff;
    - As a general rule, decorative light features (e.g. public art) should be turned off after 11PM each night;
- Direct digital controls (DDCs) may be used to control the operation of outdoor lights, and to dim or turn them off after hours;
    - Outdoor lighting should be separately programmable from indoor lighting such that they can be controlled for ambient light levels and schedule;
- Motion/occupancy sensors may be utilized along infrequently used paths and parking lots to allow for safe passage when needed. In some applications, light levels should be raised from a lower, "default" setting (50%) to a higher "activity" setting during off-peak hours to avoid startling people walking in the sensor range.

5. REFERENCES

For more information, refer to the following sources:

Dark sky-friendly lighting fixtures: http://www.darksky.org/fsa/fsa-products/
IES RP-33-14 Standards:

In January 2015, Vancouver City Council adopted the Bird Friendly Design Guidelines following the Vancouver Bird Strategy. On May 2, 2017, Council directed that Bird Friendly Design Guidelines be applied separately as the following 'Bird Friendly Guidelines for Building Design' and 'Bird Friendly Guidelines for Landscape Design', both of which are to be applied as standard guidelines:

Bird Friendly Guidelines Design Guidelines - Considerations for Development Permit https://vancouver.ca/files/cov/appendix-a-bird-friendly-design-guidelines-rts-10847.pdf