Hamilton
Public Works

Comprehensive Outdoor Lighting Study

DMD
DMD & Associates Ltd.

G. O'CONNOR
CONSULTANTS INC.

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Executive Summary

In October 2008, the Task Force on Cleanliness and Security in the Downtown Core (TFCSDC) completed a study entitled: Protecting the Future: A Safety and Security Audit of the Downtown Hamilton Improvement Project Area. The results of this study concluded that improvements to the existing downtown lighting could contribute directly to improving the sense of security and reducing the fear of crime. The City therefore developed a terms of reference and issued a request for proposal to retain a firm to deal with these and other issues. Through a competitive request for proposal process in the fall of 2009 the team of DMD and Associates Ltd and O'Connor Consultants were retained and developed a comprehensive lighting study.

The goal of this project was to investigate and validate the reasoning for the requirement of lighting (or not lighting) and develop lighting guidelines. Specific elements include:

- Review and document applicable research related to outdoor lighting;
- Review existing lighting in the Downtown, Business Improvement Areas (BIA's) and specific road and land use types defined by the City;
- Review lighting standards and make recommendations as to when to light and how to light various areas and applications;
- Review and analyze the existing operations and maintenance strategies and make recommendations;
- Review new light sources and technologies.

The study analyzed existing lighting within the City. Lighting levels within the downtown boundary area and typical roads within the City were calculated, measured and recorded. These measurements included roadways, sidewalks, alleyways, parks and parking lots.

The results were used to evaluate the state of the existing lighting installations in comparison to nationally recognized lighting standards. These standards have been referenced and provide a comparison for evaluating existing conditions.

Based upon input from various internal and external stakeholders (prior to data collection), areas that were perceived to 'have good lighting and be most safe', were compared to the results of the condition assessment. This assessment confirmed that lighting, when applied properly, enhances positive perception of the nighttime environment.

In summary, public right-of-way findings:

- Roadways typically meet the lighting standard requirements
- Sidewalks typically fail the lighting standard requirements
- Parks typically exceed (are over-lit) the lighting standard requirements
- Parking lots (public and private) fail the lighting standard requirements

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When examining the findings, newer City lighting installations under streetscapes (example: Hughson, Bay) meet the standard requirements. Due to the absence of a lighting policy, the lighting levels are somewhat inconsistent across the downtown and throughout the City.

The City currently does not have an all-encompassing outdoor lighting policy to respond to safety and security concerns. Consequently, there is a wide variation in lighting levels and types lighting equipment.

Past industry practices have been focused on roadway lighting nearly exclusively. These resulted in a less pedestrian friendly environment and therefore do not meet the spirit of the City's walkability strategy.

When reviewing safety and security (real and perceived) a poorly lit environment can have a negative impact on the image of the downtown. When lighting is designed and installed to nationally recognized standards, safety and security is improved. However, it is difficult to measure or predict the exact benefits due to many variables.

Besides security benefits to good nighttime lighting include such things as:

- Enhancement of the City's image.
- Improved commerciality of the Downtown.
- An enhanced feeling of comfort.
- Increased public night usage/enjoyment of the Downtown

Prior to undertaking any improvements, it is recommended that the City develop a long-term capital improvement/replacement strategy for lighting upgrades, similar to those used for road streetscape improvement programs currently in place. Analyzing and assess each road in the downtown, provide a recommended solution and capital cost.

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1 General

1.1 Introduction

In October 2008, the Task Force on Cleanliness and Security in the Downtown Core (TFCSDC) completed a study entitled: **Protecting the Future: A Safety and Security Audit of the Downtown Hamilton Improvement Project Area**. The results of this study concluded that improvements to the existing downtown lighting could contribute directly to improving the sense of security and reducing the fear of crime.

The City of Hamilton currently does not have an all-encompassing lighting policy that may be used to respond to the conclusions of the safety and security audit study. As a result, the TFCSDC endorsed the development of a lighting study that would examine the existing lighting conditions and make recommendations to assist and support the task force objectives.

In addition, the City of Hamilton was awarded the 2015 Pan-Am Games. It was generally felt that with improved outdoor lighting, along with architectural enhancements, will play a big role in revitalizing the City of Hamilton and contributing to an overall feeling of pedestrian safety in the downtown.

The City of Hamilton drafted a formal request for proposal to select a lighting consultant and architect to prepare a detailed report which would form the basis of a comprehensive City-wide outdoor lighting policy. Through a competitive request for proposal process in the fall of 2009, the team of DMD and Associates Ltd and G. O'Connor Consultants Inc. were retained to prepare the report.

The report is broken down into four main sections:

- **Section 1 - General**: Provides general information specific to all areas of the City of Hamilton. Specifically the section includes the introduction, theory of lighting and basic issues.
- **Section 2 - City-Wide Outdoor Lighting:** Provides research, standards, current conditions, police comments and stakeholder input (where applicable) as well as recommendations for the following applications within the City of Hamilton:
  1. Urban Roadways Lighting
  2. Rural Roadways Lighting
  3. Urban Intersections
  4. Rural Intersections
  5. Alleyways

  Section 2 also makes recommendation on lighting hardware, maintenance practices, provides an implementation strategy, and a summary.
- **Section 3 - Downtown Area:** Provides current conditions and recommendations for roadway, sidewalks, parks, plaza and parking lots in the downtown.
- **Section 4 - BIA Lighting:** Provides a review of existing lighting within the BIA's.

The rational for lighting with a given City is typically as listed below. This will vary for each application listed in the report.

The rational for all lighting areas, excluding downtown's is as follows:

1. Vehicular Road Safety (Vehicle-vehicle conflicts)
2. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts)
3. Pedestrian Safety (Navigating sidewalks, off-road, etc).
4. Safety and Security – Real
5. Safety and Security – Perceived
6. Commercial and City of Hamilton image enhancement

The rational for lighting the downtown area is as follows:

1. Pedestrian Safety (Navigating sidewalks, off-road, etc).
2. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts)
3. Safety and Security – Real
4. Safety and Security – Perceived
5. Commercial and City of Hamilton image enhancement
6. Vehicular Road Safety (Vehicle-vehicle conflicts)

Under the Recommendations for each lighting application (ie; Urban Roadways, Rural Roadways) a brief paragraph is included that directly references the reasoning for lighting and how each criteria has been met, has not been met or is not applicable.

The City of Hamilton has developed a **Strategic Road Safety Program (SRSP)** which roadway lighting may benefit. The document contains the City of Hamilton emphasis areas and priority areas of traffic safety concern. How it relates to the objectives of street lighting is included in the recommendations for each lighting application. The primary emphasis areas of this program and how lighting could benefit (or not) are:

- Aggressive Driving – Roadway and sidewalk lighting will have little benefit here.
- Intersections – Lighting intersections can have substantial safety benefits as noted in this report. Lighting benefits are touched on in the City of Hamilton SRSP report.
- Vulnerable Road Users – Lighting has well proven safety benefit for pedestrians and cyclists.

Listed below is a news paper clipping from the Hamilton Spectator circa Aug.1885 which relates to the earliest street lighting installed in the City. The last sentence reads “The streets are much better lighted than before; people can see on another without much difficulty; and there is less danger of rows and disturbances at night now that the brilliant light streams everywhere and knocked the darkness into the next century”. This goes to show that the ideas, objectives and benefits of street lighting haven’t really changed in 125 years.

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BY THE BRIGHT LIGHT.

Hamilton Illuminated by Electricity—Ahead of Gas.

At exactly 9.40 o'clock Saturday evening a flood of light spread over Hamilton, and for the first time in its history it was illuminated by electric light. Forty lamps were up, and almost all of them were going. Here and there an imperfect one failed to perform its proper functions, and a dull red glow took the place of the usual dazzle. The recent burning of the factory in Montreal, destroyed the double lamps intended for use in the city, and the company had to make shift with the best ones possible. Some of them were not tested. Laboring under the disadvantages of the recent ruinous fire the company did remarkably well. The other fifteen lamps will be got in position as soon as possible, and the imperfect ones already up will be physiced. The double lamps will be got up as speedily as can be. A big crowd, larger than the usual Saturday night crowd—thronged the principal streets to witness the first lighting, and on every hand admiration for the cold glitter of the new light was heard. The march ahead of gas is marvelous. The streets are much better lighted than before; people can see one another without much difficulty; and there is less danger of rows and disturbances at nights now that the brilliant light streams everywhere and knocks the darkness into the next century.

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1.2 Theory of Lighting

Lighting is required to improve visibility during hours of darkness. In order to better understand lighting, an explanation of some of the lighting standards organizations and terminology referenced is provided throughout this report.

1.2.1 Reference Standards Organizations

Publications and documents used for the design of outdoor lighting are listed below.

1.2.1.1 Illuminating Engineering Society of North America (IESNA)

The IESNA produces a large number of recommended practice and design guides used for roadway lighting. The organization also provides education programs and certifications. The IESNA has committees made up of engineers, manufacturers, City and government staff, and others that commonly practice within the lighting industry who author their documents.

Specific roadway related IESNA documents are: Lighting Handbook, RP-8 American National Standard Practice for Roadway Lighting, RP-19 Roadway Sign Lighting, RP-20 Lighting for Parking Facilities, LM-50 Guide for Photometric Measurement of Roadway Lighting, DG-4 Design Guide for Roadway Lighting Maintenance.

An important resource for lighting designers is the IESNA's comprehensive listing of lighting products and suppliers. More information on the IESNA may be found on their web site, www.iesna.org.

1.2.1.2 Transportation Association of Canada (TAC) Roadway Lighting Design Guide

This guide is intended to promote uniformity in lighting across Canada, by providing guidance in the planning and design of roadway lighting and related outdoor lighting systems. The 430-page publication is divided into two major sections: Fundamentals and Design. The guide offers warranting criteria for each roadway application, with the warrants provided as a point-score system, a narrative definition or a combination of both.

In addition, the guide covers a number of other related topics. It emphasizes that roadway lighting, if properly designed, installed and maintained, should reduce vehicle collisions, improve safety for cyclists and pedestrians, and enhance personal security. It also discusses ongoing trends in the development of more energy-efficient light sources as well as the need to consider alternatives to lighting. Information in this guide is based on current IESNA practice. More information on TAC may be found on their web site, www.tac-atc.ca .

1.2.2 Terminology

Listed below are explanations of some of the key terminologies related to outdoor lighting design. For further explanation of these and other terminology, consult the IESNA Lighting Handbook.

1.2.2.1 Light

What is light? Light is radiant energy in the visible part of the electromagnetic spectrum between 380-770nm. The figure below shows the visible light part of the Electromagnetic Spectrum.

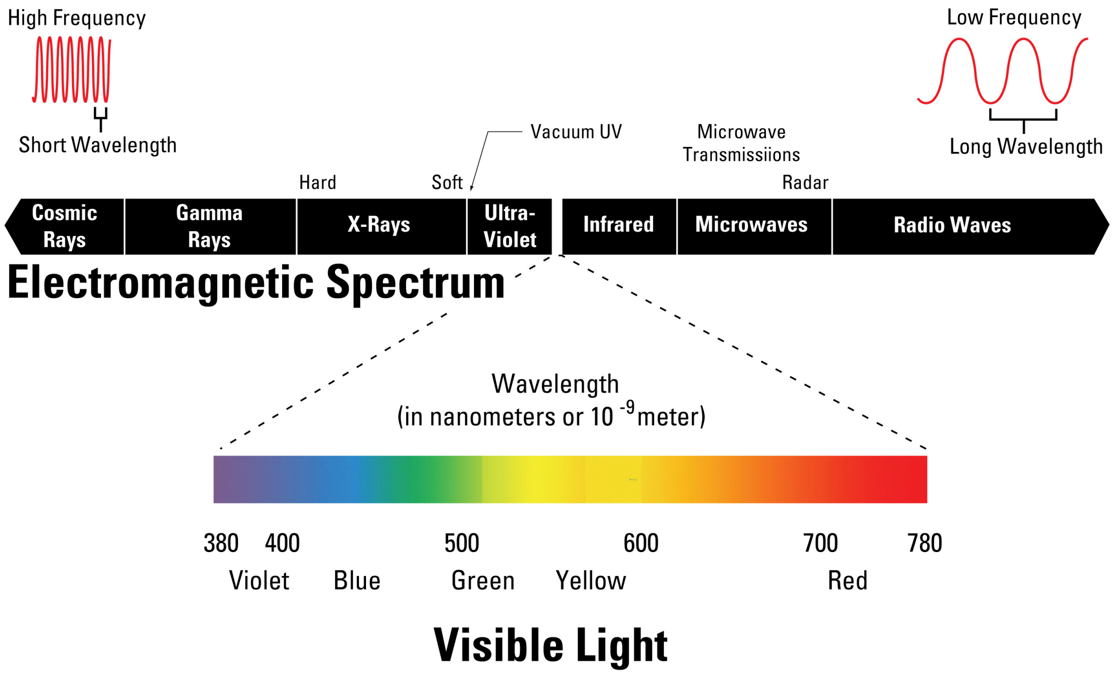


Figure 1 - Electromagnetic Spectrum

1.2.2.2 Lamp Lumens

A lamp generates radiant energy in the form of light referred to as luminous flux and is measured in lumens. As with most lamps, light is emitted in all directions therefore the lumen output of the lamp is normally the total amount of light emitted in all directions.

Initial lamp lumens are required for the type of lamp being used to complete a lighting calculation. This information can be obtained from the lamp manufacturer's published data typically available on the manufacturer's web site.

When defining lamp lumens, it is critical that the proper lamp be selected and the appropriate lumens for that lamp be used as the basis for lighting calculations. Published lamp lumens will typically vary slightly from one manufacturer to another.

1.2.2.3 Intensity (Candlepower)

Intensity (Candlepower) refers to the concentration of light in a particular direction, while lumens represent a total quantity of light emitted. Intensity is expressed in candelas (cd). The concentration of light will normally change for each direction of light emission. This is not required for a lighting calculation; however it is an important lighting fundamental.

1.2.2.4 Photometrics

Photometric testing of a luminaire involves gathering data that characterizes its candlepower distribution. Once the intensity values for all directions are known, software that reads the data can generate photometric test reports. The measurement device used in a laboratory is a goniophotometer. Light readings are taken at numerous points throughout the angular grid, in fine angular steps so that the full light distribution is accurately quantified.

Data processing software reads the collected candlepower arrays and produces test reports in a digital file format. This file can be used as input to numerous application programs that are available for computerized lighting design. Photometric files are available from luminaire suppliers for the various luminaires they supply.

1.2.2.5 Illuminance

Light is incident upon a surface will create “illuminance” on that surface. Illuminance is a measure of the light landing on a defined area. The more lumens on a given surface area, the higher the level of illuminance. Typically, illuminance is a poor measure of visibility. For example, imagine a half white/half black surface being measured by illumination. The appearance of the white surface would be totally different from that of the black surface, even though each may be receiving identical illuminance. This is due to the better reflectance of light on a white surface than on a black surface. Our eyes do not see illuminance or the light incident on a surface. They see only the proportion of the light reflected towards the viewer.

Illuminance is measured in lux. On a bright and sunny day, an outdoor area receives about 100,000 lux of illumination. Under bright moonlight, the figure is about 0.2 lux, about a millionth as much light.

Illuminance is used for most lighting applications with the exception of roadways which use luminance.

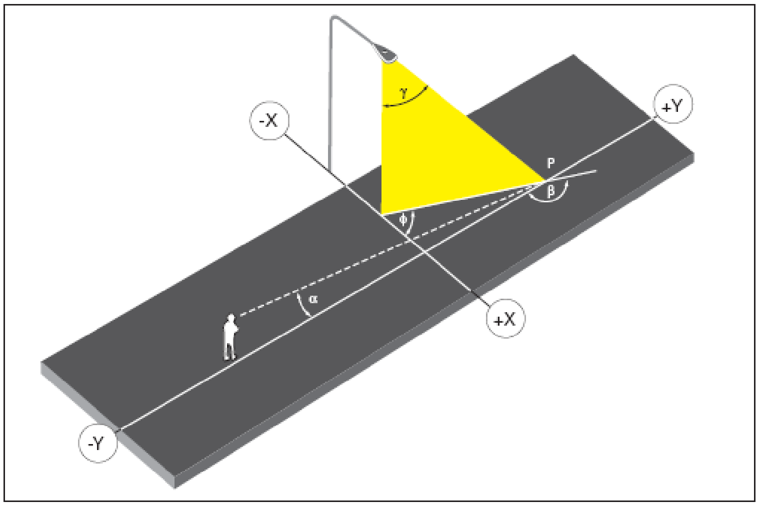
1.2.2.6 Luminance

Luminance is the concentration of light (intensity) reflected towards the eyes per unit area of surface.
As road surfaces do not reflect light uniformly, reflectance varies depending on the angle of the incident light in both the vertical and horizontal planes, and, on the angle that the driver views the pavement. For a luminance calculation the driver’s viewing angle is fixed at one degree below the horizontal and an observer distance of approximately 83 m.

The actual discernment of an object at night comes from the relative brightness of the surface and the object, or the contrast of the object against its background. Luminance represents the amount of illumination reflected into the eyes of the driver (or pedestrian). A small amount of roadway brightness reflects back into the driver’s eyes from the driver’s headlights, although most is reflected away, down the road, where it is of little value to the driver. At close distances (about 30 meters or less), the low beam vehicle headlights will also begin to effectively reflect back from the darker (but not black) clothing of a pedestrian.

Luminance is used for roadways and tunnels only and not for sidewalks, intersections, parking lots, etc.

Luminance is measured in candelas per square meter (cd/m2).



Graphic Reproduced with Permission of the IESNA

Figure 2-22 – Luminance Calculation Geometry

Figure 2 - Luminance Calculation Geometry

1.2.2.7 Uniformity

Uniformity is the evenness of the light over a given area. Even lighting throughout an area would have a uniformity ratio of 1:1. A high degree of uniformity of roadway lighting has generally been accepted as desirable. As lighting calculations consist of a series of grid points with calculated luminance or illuminance levels, uniformity is expressed as the ratio of the average-to-minimum levels and/or the maximum-to-minimum levels, but traditionally an average-to-minimum ratio is used for roadway lighting.

1.2.2.8 Veiling Luminance

The effect is termed veiling luminance (also referred to as disability glare) and it may be numerically evaluated. Because of contrast reduction by disability glare, visibility is decreased. Increasing the luminance level will counteract this effect by reducing the eye's contrast sensitivity. As glare limits our visibility, veiling luminance is an important, however often omitted, consideration. Veiling luminance must be considered as a design criterion along with illuminance or luminance levels and uniformity.

The effect of veiling luminance on visibility reduction is dependent upon the average lighting level, or average luminance level, of the pavement. A higher level of veiling luminance can be tolerated if the pavement luminance is high. Veiling luminance is calculated in terms of a ratio of the maximum veiling luminance experienced by the observer to the average pavement

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luminance. The veiling luminance ratio shall not exceed either 0.3:1 or 0.4:1, depending on the roadway type.

1.2.2.9 Luminaire Cutoff

To assess and mitigate glare and to reduce sky-glow (up-light emitted from the luminaire into the sky) the IESNA have developed cut-off classifications for luminaries based on how they emit light.

The amount of glare generated by a luminaire is strongly influenced by the intensity (candlepower) emitted at angles close to the horizontal.

Listed below are traditional IESNA cut-off classifications. These will be replaced in the future by the BUG system as defined under section 2.6.2.1.4.

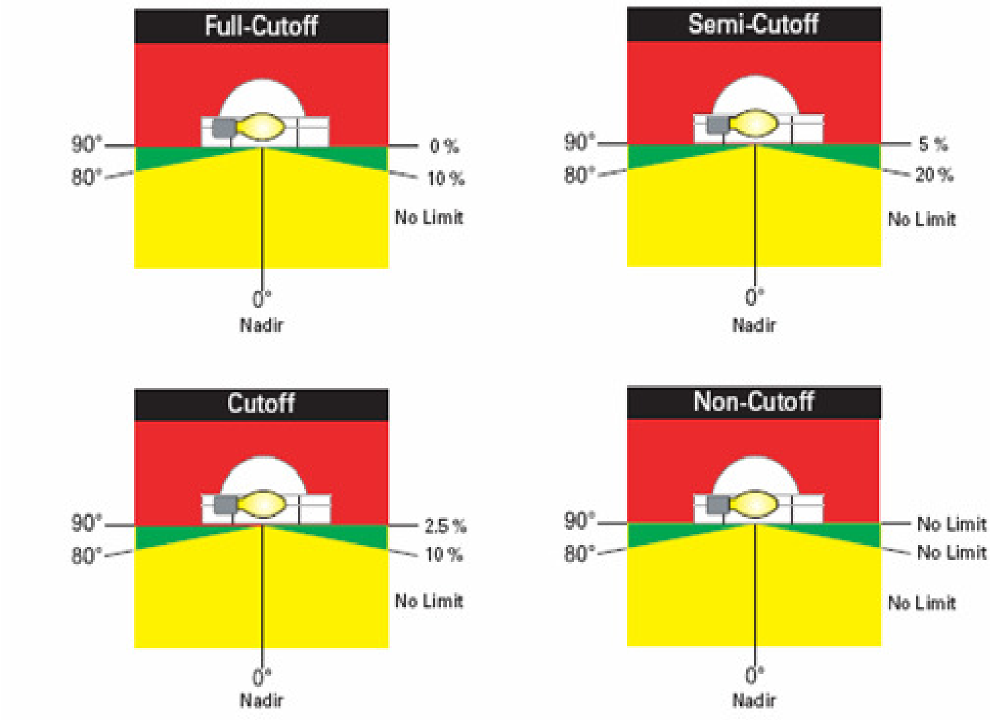

Figure 3 - Luminaire Cutoff Classifications

Typically groups like International Dark-Sky Association (IDA) endorse luminaires with full cut-off optics to better preserve the evening sky.

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1.2.2.10 Luminaire Distribution

The lateral light distribution classification is based on the general pattern and spread of light produced on the road surface. It classifies the luminaire as Type I through Type IV based on how the light is distributed out of the luminaire at defined mounting heights.

Distribution is an approximate guide to selecting a luminaire for a particular application. However, it should not be used as a substitute for full analysis using photometric data while designing a lighting system.

Typical IESNA roadway lighting distribution patterns are defined below.

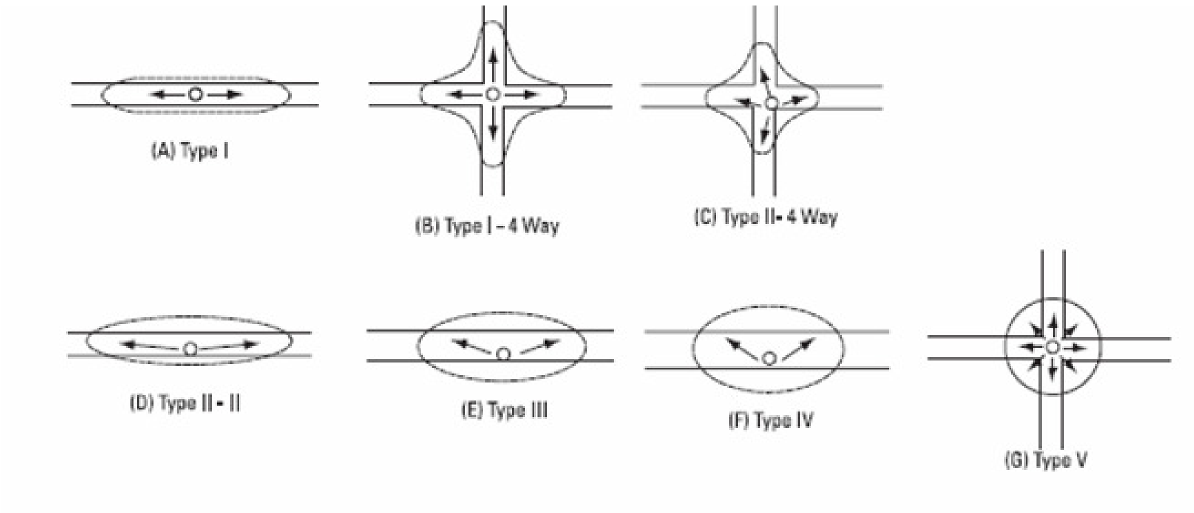

Figure 4 - Luminaire Distributions

1.2.2.11 Light Loss Factors

Light output from the luminaire will reduce over time as the lumen output from most lamps depreciates. Dirt will also build up on the lens reducing light output. Equipment will also depreciate over time. A light loss factor (LLF) is therefore applied to a design to compensate for these factors. When designing a lighting system, the design must be based on recoverable factors, such as lumen and dirt at end of lamp life, as well as unrecoverable equipment factors.

Several individual factors combine to form the overall LLF. These include the following:

- Lamp Lumen Depreciation (LLD) - All lamps, with the possible exception of low pressure sodium (LPS), experience a reduction of light output as the lamp ages. The rated lumen output, as published by the manufacturer, indicates the initial light output after the lamp has burned for 100 hours. Manufacturers' curves are available and show light output versus time, known as "lumen depreciation curves". The interval for lamp replacement should be determined and the applicable value of LLD from the lamp suppliers' depreciation curves should be applied. The lamp lumen depreciation factor applied to the design must relate to the re-lamping cycle.

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- Luminaire Dirt Depreciation (LDD) - This factor takes into account the reduction in luminaire output over time because of the accumulation of dirt on the luminaire. LDD is dependent upon the cleaning interval (typically done when re-lamping) and the amount of dirt in the atmosphere.
- Equipment Factor (EF) - These are factors such as manufacturing tolerances for both the luminaire and lamp, degradation of the luminaire over time due to anodization of the reflector surface, and variations in the input voltage. The EF is recommended at 0.95 and included in all LLF calculations.

Generally on single luminaire basis, the distribution and uniformity of lighting will not change as the lamp lumens decrease over time. Given the reduced lighting output, the distribution and uniformity relationship should not change. This is backed by recent testing undertaken by Lighting Sciences Inc. of Scottsdale, Arizona. The testing involved assessing the effects on luminaire photometrics with typical high pressure sodium cobra head style luminaires, dimmed in 1% intervals up 60%. No abnormal effects to the distribution of the luminaires and uniformity were found. Some metal halide lamps, for example, have a colour shift that has been identified at or near the end of the lamp life which could have some impact on distribution and uniformity. Without specific testing on a particular luminaire or lamp, it is difficult to accurately assess the impacts.

On a street wide basis, the light output of the lamps will not all depreciate at the same rate. Some will lose intensity at a greater rate than others. Lamp manufacturers produce graphs which define lamp lumen depreciation (light output from the lamp) over the life of the lamp, however, these curves are based on a very small percentage of the lamps tested.

The reason that lamps depreciate at different rates is because they have an arc tube which contains a mixture of gases which will diminish at varying rates over time. Lamps are also made by a number of different suppliers and are often manufactured en masse which accounts for variance.

When streets are spot re-lamped (i.e., the practice of changing out only the lamp which has failed and leaving others) the replaced lamp will be at full brightness whereas the existing lamps which may be near the end of life. Those existing lamps' well depreciated light output will affect the uniformity of the lighting system on a street wide basis.

The light output of various light sources will also vary. Metal halide (white light) lamps will typically depreciate much faster than say high pressure sodium. Based on general lamp data published by Venture Lighting and Philips Lighting, approximate lamp lumen depreciation is as follows:

Typical high pressure sodium:
- 10% lumen depreciation at 3 years
- 16% lumen depreciation at 4 years
- 22% lumen depreciation at 5 years.

Typical pulse start metal halide:
- 20% lumen depreciation at 1 year

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- 30% lumen depreciation at 2 years
- 35% lumen depreciation at 3 years.

Typical probe start metal halide:
- 40% lumen depreciation at 1 year
- 53% lumen depreciation at 2 years.

This information is important when undertaking a lighting design as the lighting levels are based on end of lamp lumen output which will vary depending on the re-lamping schedule as it will impact maintenance and operational costs. Where the City of Hamilton uses high pressure lamps and group re-lamping every four years, the use of metal halide would require group re-lamping every one to two years to maintain current lighting levels and uniformity of lighting.

1.2.2.12 Color Rendering Index

Color Rendering Index (CRI), is a measurement of a light source's accuracy in rendering different colors when compared to a reference light source with the same correlated color temperature. It generally ranges from 0 for sources like low-pressure sodium, which is monochromatic, to 100, for a source like an incandescent light bulb, which emits essentially blackbody radiation. Achieving a high CRI (70+) in can be important to commercial businesses in an urban downtown who want to display specific colour in display window and signing.

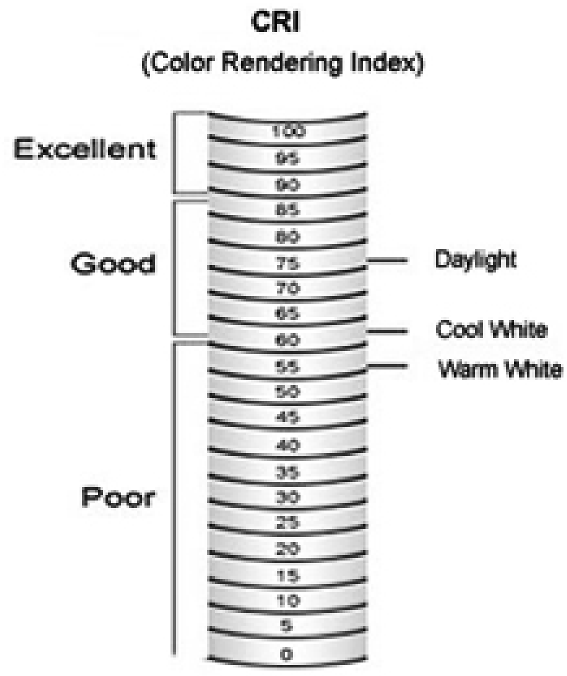

Figure 5 - Color Rendering Index

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1.2.2.13 Correlated Color Temperature

Color temperature is a description of the warmth or coolness of a light source. By convention, yellow-red colors (like the flames of a fire) are considered warm, and blue-green colors (like light from an overcast sky) are considered cool. Confusingly, higher Kelvin temperatures (3600–5500 K) are what we consider cool and lower color temperatures (2700–3000 K) are considered warm.

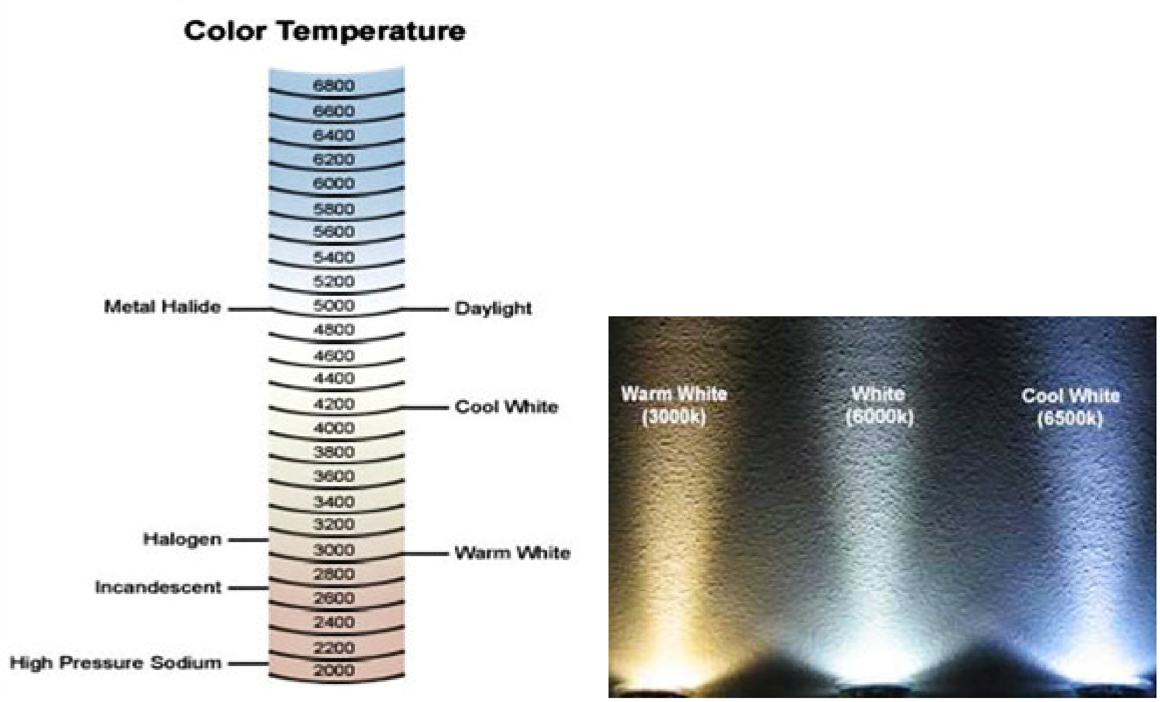

Figure 6 - Correlated Colour Temperature

The images below give examples of how correlated colour temperature can impact the colour rendering index of objects. In each image the scene is shown under the same light source with different colour temperatures. The image on the right uses a light source with a far cooler temperature than the image on the left.

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Figure 7 - Scene with Different Light Source Colour Temperatures

1.3 Issues

The following are key outdoor lighting issues. Some are specific to the City of Hamilton and others apply to all cities.

1.3.1 Visibility

A 2001 US study entitled "Top 10 Leading Causes of Death in the United States by Age Group", showed that motor vehicle collisions were the number one cause for death amongst the 4-25 year old population, the number three cause for the 26-44 year old population, and the number eight cause of death for those above 45. The significance in the collision statistics gathered throughout North America, is that they show that more than 50% of fatal collisions happen during night-time hours even though only an estimated 25% of travel takes place during these hours. This results in a fatality rate at night three times greater than during daytime hours. From this, one can conclude that driving during hours of darkness is less safe than driving during daylight hours. However, it is not known which percentage of roadways in the study had roadway lighting. Conclusions cannot be drawn concerning the value of roadway lighting from such statistics. However, the facts show that driving in the hours of darkness is less safe than driving in daylight hours.

Daytime vision of 20/20 can be reduced to 20/40 at night. As we age, visibility is further reduced. Over time, the lens of our eye discolours, allowing less light to penetrate the eye as shown in Figure 8.

As we age, we are more susceptible to glare. Diseases such as glaucoma can also reduce peripheral vision. This is significant as our population ages and life expectancy continues to increase.

It has been found that the eyes deteriorate considerably in their ability to adjust the pupil opening in proportion to the available light. The eye gate becomes smaller and smaller even in the daytime, but the critical feature is the inability to open up at twilight and in darkness to let in whatever little light might be available, particularly past the age of 60 (4).

A vital factor, is the ability to see the movement of objects, representing a potential hazard out of the corner of the eye. It has been found that the ability to see movement 40 and 80 degrees away from the line of sight, is reduced as much as 60% for those over 60 years old (4). A younger person can typically see in the presence of very little light, but this sensitivity to low brightness is reduced to approximately one half at 80+ years of age (4). It has been found that it can take up to 30 minutes for an 85 year-old person to adapt to lower outdoor night- time brightness after having been adapted to the higher interior brightness (4). This long eye adaptation can be greatly reduced with roadway lighting.

The visibility factors noted above also apply to pedestrians, as reduced visibility reduces the pedestrians' ability to see motor vehicles and avoid collisions. Reaction time for both the driver and pedestrian is also reduced as we age.

Statistics Canada estimates the percentage of Canadians 65 and older will increase from 13.2% to 14.4% from 2006 to 2011 and will increase from 14.4% to 23.4% from 2011 to 2031. As the general population age increases, roadway lighting becomes of greater value in improving driver visibility. This will be critical as the percentage of Canadians over 65 on the roads at night will also significantly increase over the next 20 years. The value and benefits of roadway lighting will increase over time as the population both increases and ages.

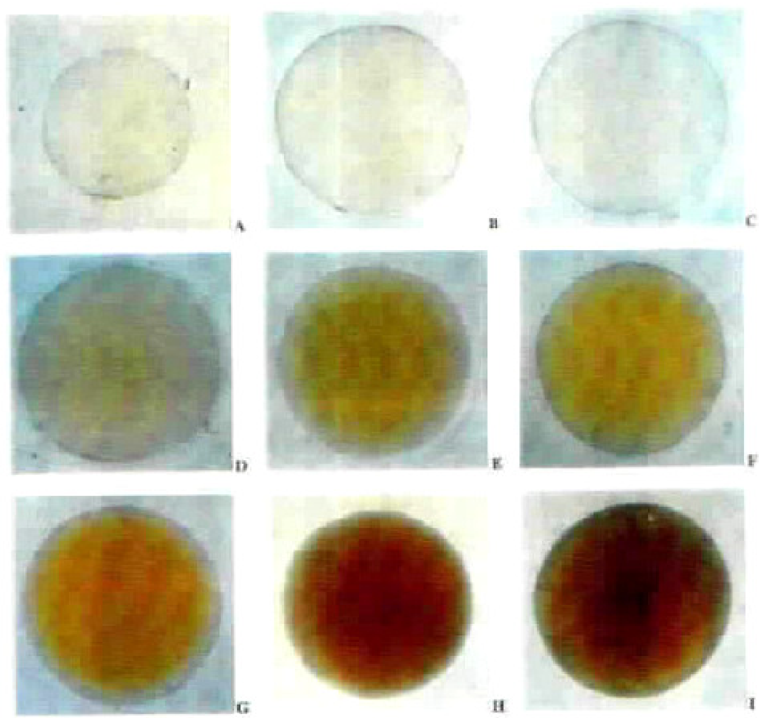

Fig. 3 Yellowing and transparency of the Human Lens from 6 month (A) to 8 years (B), 12 years (C), 25 years (D), 47 years (E), 60 years (F), 70 years (G), 82 years (H) and 91 years (I) of age.

Figure 8 - Age Effect on the Human Eye

Figure 8 show the effect age has on the human eye. As the figure shows as we grow older the lens discolours (darkens) thus reducing visibility.

In summary, as we age, our eyesight and visibility worsen, as does our vision at night. By the year 2031 it is estimated that over 23% of the population will be 65+ years. As the population ages, outdoor lighting will become of greater importance in the future.

1.3.2 City of Hamilton Barrier Free Design Standards

The City of Hamilton has historically been proactive in accommodating the needs of the disabled. Originating in 1985, as a response to provincial employment equity legislation, the Barrier Free Design Sub-Committee was formed. Its Mission Statement was to “provide the community with a set of design standards that will lead to the elimination of barriers facing persons with various disabilities in the built environment.”

Unable to find a single standard that was complete or satisfactory, the Sub-Committee’s mandate was transformed to put together a set of standards which, when applied, “shall provide the Region and the City of Hamilton with a complete and satisfactory set of Barrier Free Design Standards.” It was adopted by Hamilton-Wentworth Regional Council and Hamilton City Council in 1994 and was to be applied to all City-owned and leased facilities. It was to be reviewed every 3 to 5 years in order to maintain its status with advances in technology.

In 2001, the Province of Ontario passed the Ontarians with Disabilities Act. In June 2005 this was replaced by the Accessibility for Ontarians with Disabilities Act (AODA). The AODA makes Ontario the first jurisdiction in Canada to develop, implement and enforce mandatory accessibility standards applies to both the private and public sectors. The purpose of the act was to improve opportunities for persons with disabilities and to provide for their involvement in the identification, removal and prevention of barriers to their full participation in life.

The City of Hamilton established the Advisory Committee for Persons with Disabilities. Among its many recommendations, the committee has recommended the update of the City’s Barrier Free Standards. This standard has been developed for architects, designers, users, and building owners. It identifies barriers and obstacles and presents design requirements that, like the Ontario Building Code, should be considered as a minimum requirement. Users of this standard are encouraged to consider it a “performance standard” and to provide alternate design solutions that are equivalent or exceed the ability to access a facility.

Section 6.2 Lighting - City of Hamilton Barrier - Free Design Guidelines defines lighting levels listed below.

Design Requirements

Exterior lighting shall:

A. be in compliance with the illuminating Engineering Society of North America (IESNA) in regards to providing safe access for persons with disabilities from sidewalks, bus stops and parking areas to nearby facilities;
B. have a minimum of 100 lux (10 ft- candles) consistently over pedestrian entrances;

C. have a minimum of 30 lux (3 ft-candles) consistently over pedestrian routes including walkways, paths, stairs, etc.;
D. have a minimum of 30 lux (3 ft-candles) consistently over parking spots;
E. be bright enough to clearly illuminate treads, risers and nosings of frequently used steps and stairs;
F. be evenly distributed to minimize shadow;
G. provide a good colour spectrum;
H. highlight key signage and orientation landmarks;
I. be located at a height as to allow for normal snow removal; and
J. comply with Section 7.3 Waiting and Queuing Areas where applicable.

Commentary with respect to Section 6.2 Lighting - City of Hamilton Barrier - Free Design Guidelines is as follows:

- Item B) which requires 100 lux over pedestrian entrances is vague as it what area defines the building entrance. If it is the area outside, then this higher level may create over bright hot spots, which would reduce the overall uniformity on the sidewalk. The type of entrance would also have an impact on the level of lighting which should be applied
- Item C) 30 lux exceeds the IESNA recommended practice for a (walkway) pedestrian route.
- Item D) 30 lux exceeds the IESNA recommended practice for a (walkway) pedestrian route.

Section 8.17 Transit Facilities - City of Hamilton Barrier - Free Design Guidelines defines lighting levels listed below for transit platforms and boarding areas for transit facilities which are listed as bus stops, private buses, taxis, trains, and airplanes.

- Platform and boarding service lighting should be at a minimum lighting level of 100 lux;
- Ticketing areas should have a minimum lighting level of 200 lux.

These requirements should apply for only very high occupancy transit/train platforms where the risk is higher (e.g., falling onto the train platform) and should not be applied to a bus stop or taxi stand. It would be impractical to apply these very high light levels to buses and taxis. Lighting for bus stops, should be no higher than what is required or existing on the road where the bus stop exists or is proposed. Taxis should have no specific requirements as their pick-up and drop off locations will vary. Airplanes will have specific requirements as defined by Transport Canada.

It is recommended that the sections in the City of Hamilton Barrier Free Design Guidelines be revised by removing outdoor lighting level recommendations and referring to the recommendations contained in this report.

1.3.3 Crime

Crimes typically are either person related such as assault or robbery; or property related such as vandalism or theft. Unlike driver or pedestrian safety for roadway lighting, which both have substantial research and data to prove a quantifiable benefit, crime reduction benefits of lighting are much harder to define. Data is available in police files across the country, and research studies are urgently needed to compare crime statistics with lighting records (4). The City of Hamilton Police Services' crime statistics, do not distinguish between night-time and

daytime crimes, thus, no conclusions can be made by reviewing the City of Hamilton's crime statistics.

Research related to crime reduction and lighting are summarized as follows:

- A 2002 UK meta-analysis of the eligible studies found that improved street lighting led to significant reductions in crime, with an overall 20% reduction in recorded crime across all the experimental areas. The review assesses why street lighting has this impact on crime. The authors conclude that lighting increases community pride and confidence and strengthens informal social control and that this explains the recorded impacts, rather than increased surveillance or deterrent effects. The authors, however, suggest that these explanatory theories need to be tested more explicitly in future research and that there need to be further assessments of the impacts of different levels of illumination on crime. The authors conclude that improvements in street lighting offer a cost-effective crime reduction measure and should be considered an important element in situational crime reduction programs (16).
- A 2001 UK study investigated the effects of improved street lighting on crime in Dudley and Stoke-on-Trent. In Dudley, crimes decreased by 41% in the experimental area, compared with a 15% decrease in the control area. In Stoke-on-Trent, crimes decreased by 43% in the experimental area and by 45% in the two adjacent areas, compared with a decrease of only 2% in two control areas. In the two projects, the financial savings (from reduced crimes) exceeded the financial costs by between 2.2 and 9.4 times after one year. It is concluded that improved street lighting can be an extremely cost-effective way to reduce crime (17).
- A 2003 Australian study indicated that the presence of light tends to allay the fear of crime at night and it furthermore notes the balance of evidence, from relatively short-term field studies that increased lighting is ineffective for preventing or deterring actual crime. The report also notes evidence indicating that darkness inhibits crime, and that crime is more encouraged than deterred by outdoor lighting. Additional quantitative evidence supports this hypothesis. The study notes excessive outdoor lighting appears to facilitate some of the social factors that lead to crime (18).

The UK studies, define the benefits of lighting with respect to crime reduction, but were written by people with a non-lighting background. Therefore, no information is provided with respect to what defines the term "improved lighting" noted in the studies (especially in terms of the actual before and after lighting levels and uniformity). The study does not conclude as to what level or percentage of improvement constitutes "improved lighting." The fact that street lighting, led to a 20% or greater reduction in crime, is however, significant and it shows that lighting can benefit in crime reduction. However, without knowing the before and after lighting levels and if police presence patrols were increased, it is not possible to apply these findings elsewhere. The Australian study indicates lighting can encourage crime which is an opposite finding to the UK reports. In summary, from this research information is contradicting as to whether or not lighting will reduce crime.

The Illuminating Engineering Society of North America (IESNA) has produced a document titled G-1-03 Guideline for Security Lighting for People, Property, and Public Spaces (15). In terms of the justification for lighting with respect to security, the document makes the following significant statements:

“Lighting can affect crime by two indirect mechanisms. The first is the obvious one of facilitating surveillance by the authorities and the community after dark. If the presence of surveillance is perceived by criminals as increasing the effort and risk while decreasing the reward for a criminal activity, then the level of crime is likely to be reduced. Where increased surveillance is perceived by the criminal as not to matter, then better lighting will not be effective. The second mechanism by which an investment in better lighting might affect the level of crime is by enhancing community confidence and hence increasing the degree of informal social control. This mechanism can be effective both day and night but is subject to many influences other than lighting” (15).

The first statement with respect to surveillance is applicable to all communities. Good lighting will enhance night-time surveillance which is of great aid to police. The second statement with respect to economic investment will vary according on the circumstances of each community.

From a personal security standpoint, IESNA G-1-03 Guideline for Security Lighting for People, Property, and Public Spaces defines a minimum maintained average vertical illumination level of 5 Lux to 8 Lux, with average to minimum uniformity not exceeding 4:1 for facial recognition which is critical to enhancing surveillance and security.

An accepted way to integrate security elements into lighting design is by adopting Crime Prevention Through Environmental Design strategies (commonly known as CPTED, pronounced "sep-ted"). CPTED is a proactive crime prevention strategy utilized by planners, architects, police services, security professionals, and everyday users of space. CPTED is based on the concept that the proper design and effective use of the built environment can lead to a reduction in the fear of crime and the incidence of crime, and to an improvement in the quality of life (22).

Properly designed lighting improves the visibility of potential criminal activities thus reducing potential threat. For example, a well-lighted area allows police better night-time visibility and natural surveillance, and, also allows witnesses to see potential criminal activity and subsequently report it to the police.

As noted on CPTED Ontario’s website (http://www.cptedontario.ca/index.php), there are four underlying CPTED concepts:

- Natural Surveillance: the placement of physical features (or activities) and people that maximizes natural visibility or observation
- Natural Access Control: deters access to a target and creates a perception of risk to the offender
- Territorial Reinforcement: defines clear borders of controlled space from public to semi-private to private so that users of an area develop a sense of proprietorship over it
- Maintenance: allows for the continued use of a space for its intended purpose

CPTED principles encourage the protection of lighting system components from vandals while providing sufficient light levels for users (15). With respect to lighting, a CPTED strategy can be determined that may include some of the following (15):

- lighting should provide clear border definition of controlled spaces
- strategic lighting should clearly mark any transitional zones (i.e., areas where there is movement from public to semipublic to private spaces)
- in areas where people gather or where there is a need for access control for normal users, the lighting should provide for natural surveillance by observers
- distant or isolated areas should be evaluated for improvement using CPTED principles for lighting design
- lighting of formal gathering areas should be adequate for normal users, thus creating the perception that all other areas are "off limits"
- proper lighting and design of a facility or area should stimulate normal users and observers to scrutinize anyone not in proper areas; or lighting can create an environment wherein abnormal users perceive greater risk (with fewer excuses for being in the wrong areas

The City of Hamilton Police Force promotes CPTED concepts and performs assessments for downtown businesses to assist them in improving the safety and security of their properties. In addition, Hamilton Police Services participates in many City of Hamilton urban master plan projects and provides valued input.
To review conditions in City of Hamilton first hand in the evening, members of the consultant team and City of Hamilton engineering staff accompanied a local beat officer on a late night patrol of the downtown area on November 25, 2009. The team was able to review and observe first hand, how the police patrol the area and what hazards are encountered. On this night, criminal activity was quite low and no incidents took place. In general, the group felt relatively safe, except when walking down an alleyway not in direct view from the adjacent roadway.

The City of Hamilton police reported the Hess Village Lighting project is an example of how lighting was added to improve police surveillance and security. Hess Village is a vibrant entertainment area which comprises a number of bars and restaurants in close proximity and where people gather en masse, after closing at late hours of the evening. Typical issues encountered by the police were drunken and disorderly conduct due to large gatherings in the public areas. The City of Hamilton installed flood lighting that is turned on by the police at the closing time of the bars. The lighting aids in police enforcement and clearly demonstrates the benefits that lighting can have on safety and security in this given application.

The new lighting system in Hess Village has produced several benefits. Since it is key controlled by police it allows flexibility on illumination times on an as needed basis. This discretion is helpful when tempers begin to flare and the additional lighting assists police in the identification of instigators and allows for earlier intervention. With respect to the Hess Village lighting, City of Hamilton police force Staff Sergeant Mark Cox noted: "The new lighting, when deployed, enhanced the resolution of the video images from our CCTV cameras in the Village allowing investigators of serious incidents a better chance of suspect identification. (Some footage was even released to the media to further investigations). When routinely deployed at approximately 2:15AM on Friday and Saturday nights, the lights did not have the immediate crowd dispersing affect that was anticipated. However, the lighting did serve the purpose of deterring trouble makers from acting out in the Village due to the fear of identification and

apprehension. Those citizens that chose to stay once the flood lights went on were generally well behaved and used the lit areas for conversation and the trading of names and phone numbers before dispersing. Officers working in Hess Village reported an enhanced ability to identify problem situations at an earlier stage, due to better lighting and the resultant improved ,visibility. Overall, the enhanced lighting has improved police officer's ability to provide service and resulted in an increased sense of safety for patrons and police."

The Hess Village was therefore considered to be of great benefit to City of Hamilton police and show surveillance benefits of lighting sidewalk and plaza areas in an urban area.

1.3.4 Potential Impacts of Lighting

Though lighting has significant benefits, it also has some impacts. Specific impacts are listed below.

1.3.4.1 Costs

Lighting can be expensive to install and operate. A new street light with pole, foundation, and wiring can cost in the order of magnitude of between $5K and $15K depending on the scenario. Basic cobra head lighting installed in a new development, or where road a upgrade is being undertaken, would be on the lower side of these estimated costs. Decorative lighting in a more commercial/downtown application would be on the higher end of these costs. Pinning down more exact costs would depend on the specific application. The point is that lighting is not inexpensive to supply, install, and operate, even though it has known benefits.

In the case of a new development, lighting is often installed at the developer's expense and the City of Hamilton pays for the operation. These costs are ongoing and can be significant. The operation of streetlights includes both power and maintenance costs. In terms of power, the cost is approximately $6 to $12 for each luminaire per month or $72.00 to 144.00 per year depending on the wattage. Maintenance, which includes re-lamping and repairs, would cost approximately $2 for each luminaire per month, or $24.00 per year.

The City of Hamilton has faced substantial power supply costs over the last two years. Over the last few years the City of Hamilton's cost in supplying power to street lights has risen from $2.6M to $3.8M, thus representing a substantial rate increase.

We estimate a rough replacement cost of approximately $80M for the City of Hamilton street lighting system and given an estimated 25 year life for the electrical materials which make up the lighting system, the cost for upgrade and replacement to accommodate equipment upgrade and replacement would be around $3.2M per year. This is significant and often not considered when assessing the overall cost of street lighting.

1.3.4.2 Environmental

Potential lighting impacts have been researched on humans, animals, and plants. Impacts on plants and animal species are very general and require further research. Lighting impacts on humans have been identified as "Light Trespass" (also referred to as "Obtrusive Lighting") which occurs when unwanted light shines onto property or into a window, thereby impacting the resident. This is often a result of poor luminaire optics and poor lighting design. In general,

light trespass is any lighting that is discerned beyond the area that is intended to be lighted. By its very nature or presence it is obtrusive to individuals.

Light trespass is defined by three major interrelated elements, each considered separately. The three elements include the following:

- Spill light: Is light that falls outside the area it was intended to be lit.
- Glare: Is light that is viewed at the light source (luminaire) which reduces ones visibility. The figure below shows overly bright light sources with a poor distribution of light set against a dark sky which produces glare.

Figure 9 - Example of Glary Street Lighting

- Sky glow: Consists of light reflected from the light source, road or other surfaces up into the atmosphere. The figure below shows a night sky being illuminated by street lights. Though this is not a safety or security issue, groups such as the International Dark-sky Association (IDA) have mounted strong campaigns to reduce such sky glow and preserve our night sky. Sky glow in effect reduces one's ability to view stars in the night sky by casting unwanted light into the atmosphere.

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Figure 10 - Sky Glow Example

There is growing pressure by special interest groups such as the International Dark-sky Association (IDA) to reduce light trespass and sky glow.

Recent documentation produced by the IDA entitled *Blue-White Light and the Night Environment* has indicated potential health issues with respect to the effects of blue-white light sources (such as LEDs) shining in personal homes. Marianna Figueiro et al.'s 2006 research article in the Journal of Carcinogenesis examined the impact of Light at Night on residents from street lighting systems and states that: "These light levels rarely exceed 10 lux at the cornea outdoors. Indoors, behind closed curtains, the levels would likely to be much lower. Further, the human eyelids transmit only about 1% to 3% (Robinson et al., 1991) in the short wavelength region of the visible spectrum. Given the available published data on human melatonin suppression in response to light, light trespass through residential windows is an unlikely cause of melatonin suppression, simply because the light levels are so low, particularly with the eyes closed."

Research into these topics is ongoing and not yet conclusive. Thresholds for these non-visual effects are not clearly established at this time. The complexities and interactions, along with the long-term aspects of these issues, make definitive statements elusive. Therefore the Illuminating Engineering Society of North America (IESNA) has adopted the following positions with respect to lighting and potential health impacts:

- There is a confirmed need for additional research, particularly in "real-world" measurements.
- There is no confirmation that typical exposure to exterior lighting leads to cancer or other life-threatening conditions.
- There is a need for the IESNA to promote useful information in this field, addressing issues such as appropriate units, and providing education on this important topic.

In urban residential areas where light trespass is a concern, the impacts can be reduced by:

- Using luminaires with full-cutoff optics.
- Using house side shielding.
- Limiting luminaire mounting heights.

These control methods are typically available for typical roadway lighting luminaires, and is also available on a growing selection of decorative luminaires.

Maintaining the balance between the reduction of lighting trespass and good quality lighting requires good design and the selection of luminaires with cut-off or full cut-off optical systems. Good lighting design with full cut-off optics will typically reduce obtrusive lighting impacts. Moreover it will reduce veiling luminance (glare) from the luminaire, thus improving the overall visibility.

It is important to note that the reduction or elimination of light trespass must never take precedence over proper roadway lighting as traffic safety is of paramount importance. In some cases, the control of light trespass and the intent of roadway lighting may be in conflict. The primary objective should be proper lighting of the roadway and sidewalk, with secondary consideration given toward the reduction of off-site impacts. Lighting the area adjacent to roadway travel lanes (typically within or adjacent to the road allowance) can benefit a driver's peripheral vision. This also improves overall roadway user safety by providing visibility of crossroads, driveways, and sidewalks (7).

1.3.4.3 Pole Hazards

Lighting placed on poles may pose a hazard to an errant motor vehicle. This is typically more of an issue on high speed roads (70 km/hr or greater) with open shoulder and no curb and gutter in rural areas. Hazards can be reduced by placing poles outside of the vehicle run-off areas, outside the defined clear zone or by using break-away devices on the poles.

Pole hazards are less of an issue on urban streets where poles are located behind curb and gutter as the curb acts as barrier between the motor vehicle and the pole.

Poles can also be a hazard by falling down over time. Though poles falling down are not a common occurrence it has been known to happen to older poles during major wind storms.

1.3.4.4 Contact Voltage Hazards

If components are properly designed, installed and maintained, the risk of electrical shock is low. However, the potential exists for electrical shock when a person contacts metal poles, metal cover plates on concrete poles, metal manhole covers, electrical cabinets, etc. This condition is caused by wear and tear and the degradation of connections and insulation over time. This hazard should be assessed City of Hamilton-wide, on a regular basis.

1.3.4.5 Operational Failures

Over time, lighting systems can fail or the power supply can simply fail, thus leaving people in the dark. Where lighting exists, the public expect an operational lighting system and when it is not working, the hazard risk in increased. The risk of equipment failure can be reduced by following good maintenance practices as is the case currently in the City of Hamilton. The risk of power failures is one which needs to be discussed with the local power provider.

1.4 Lighting Level Assessments

Lighting level assessments have been undertaken and the results are listed throughout the report. The general process to establish the lighting levels is listed below.

Road information, pole locations, heights, and wattages were obtained from City of Hamilton's GIS database. The make of luminaire was established via consultation with the City of Hamilton and through contact with the supplier. From this photometric files to be used for the computer lighting calculations where obtained from the luminaire suppliers. Sidewalk and walkway lighting calculations were performed using the computer lighting software "Visual – Professional."

The light level calculations included light loss factors of:

- 0.72 for high pressure sodium
- 0.62 for metal halide.

Once the calculations were complete, they were compiled into a spreadsheet along with all relevant data and then compared with the recommended design criteria in this report. The end result being a pass or fail for both lighting levels and uniformity. The length of the roadway calculations were undertaken for the worst case luminaire cycle and also over the entire length of the road. This was deemed to be enough to capture typical lighting levels that generally reflect the extent of the roadway's existing lighting installation.

To verify the calculations, sample light level readings were undertaken at one location on each road and sidewalk. 10% of these measurements were then compared to the corresponding point measurements and related calculations.

Once the calculations were complete, they were compiled into spreadsheets along with all other relevant data. They were compared to our recommended design criteria in this report with the end result being a "Pass" shaded in green or "Fail" shaded in red for both lighting levels and uniformity on the sidewalk and roadway.

The spreadsheet defines elements listed below required to determine lighting criteria and to undertake calculations:

- area
- road segment and its extents (from/to)
- road classification (i.e., local, arterial, collector)
- land usage (i.e., commercial, industrial, residential)
- segment length
- number of lanes
- median (yes or no)

- sidewalk (yes or no)
- lighting pattern (staggered, opposite, median, one sided)
- number of lights (over entire segment)
- setback (i.e., the amount the pole is set back form the edge of lane)
- pole height
- lamp wattage
- luminaire Type (i.e., cobra head, acorn, etc)
- pole type (i.e., davit, post top)
- pole spacing
  1. Avg. - The average pole spacing is product of the total poles on the road segment divided the total length of the road segment.
  2. Max. - The maximum spacing is the worst case spacing (referred to a luminaire cycle).
- IES recommended levels (i.e., for roads and sidewalks)
- IES uniformity ratio (i.e., for roads and sidewalks)
- existing illuminance levels
- Road (Average) - Though this is not typically the basis of the lighting design but it gives an indication whether there is enough lighting on a per road segment basis.
- Road (Worst Case) - This is the basis of lighting and should be used as an indicator of the lighting level on a given roadway.
- Sidewalk (Average) - This is an average level on each sidewalk (typically two sidewalks exist on each roadway).
- existing uniformity ratio of road/sidewalk (i.e., uniformity ratio (average : minimum) on each road and worst of the two sidewalks)
- status - Road and Sidewalk (pass or fail) based on industry practice and standards recommended in this report.

Calculations were undertaken based on the worst case luminaire cycle over the entire length of the road. This is referred to as the “worst case.” Calculations were also undertaken based the average luminaire pole spacing over the entire length of the road. This is referred to as the “average”. This was deemed to be enough to capture typical lighting levels that generally reflect the extent of the roadway's existing lighting installation.

1.5 Public Open House

On November 26, 2009 a public open house was held at the Hamilton Convention Center to obtain input from the public regarding outdoor lighting. The public notice posted in local newspapers and at community centers throughout the City of Hamilton was as follows:

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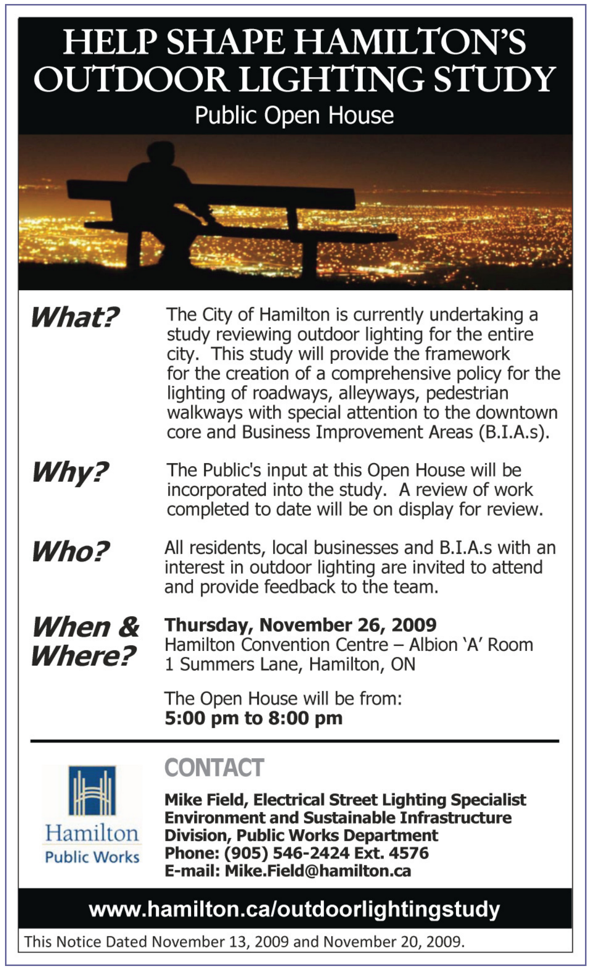
HELP SHAPE HAMILTON'S OUTDOOR LIGHTING STUDY

Public Open House

What? The City of Hamilton is currently undertaking a study reviewing outdoor lighting for the entire city. This study will provide the framework for the creation of a comprehensive policy for the lighting of roadways, alleyways, pedestrian walkways with special attention to the downtown core and Business Improvement Areas (B.I.A.s).

Why? The Public's input at this Open House will be incorporated into the study. A review of work completed to date will be on display for review.

Who? All residents, local businesses and B.I.A.s with an interest in outdoor lighting are invited to attend and provide feedback to the team.

When & Where? **Thursday, November 26, 2009**
Hamilton Convention Centre – Albion 'A' Room
1 Summers Lane, Hamilton, ON

The Open House will be from:
5:00 pm to 8:00 pm

Hamilton Public Works

CONTACT

Mike Field, Electrical Street Lighting Specialist
Environment and Sustainable Infrastructure Division, Public Works Department
Phone: (905) 546-2424 Ext. 4576
E-mail: Mike.Field@hamilton.ca

www.hamilton.ca/outdoorlightingstudy

This Notice Dated November 13, 2009 and November 20, 2009.

In preparation for the open house, a series of information boards was prepared and displayed on easels throughout the convention center room. A copy of the information boards is included in the Appendix A.3. Representatives from the City of Hamilton and the consultant team greeted attendees and responded to questions and comments.

A street lighting questionnaire was provided to those who attended the open house. It was also posted on a street lighting webpage posted on the City of Hamilton website at:

http://www.hamilton.ca/CityDepartments/PublicWorks/TrafficEngineeringAndOperations/Streetlighting.htm

The purpose of the questionnaire was to obtain input from City of Hamilton residents with respect to street and sidewalk lighting.

The survey was completed by only 16 residents. From the very small public response, it can concluded, lighting is not a major issue for the residents of the City of Hamilton. The response

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was too small to summarize in this report, however the comments received have been taken into account in the report.

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2 General Outdoor Lighting

2.1 Urban Roadway and Sidewalk Lighting

Urban roadways are those in developed or developing areas where curb and gutter and sidewalks often exist. Urban areas typically have greater population density than rural areas. The definition of whether an area is rural or urban is defined by the City of Hamilton.

The downtown area and BIA's are listed separately in this report.

2.1.1 Research

Research for roadway and sidewalk lighting is as follows:

2.1.1.1 Roadways

The majority of research undertaken with respect to lighting urban roadways is focused on collisions (ie; vehicle to vehicle or vehicle to pedestrian). The analysis of lighting effects on collisions is extremely complex. Before-and-after studies of lighted routes are often based upon the percentage of collisions at night, as compared with the total, before and after the improvement. In many cases, studies of before and after improvements are measured over years and many other road changes can take place during that time which may skew the results (e.g., road improvements such as line painting, road widening, new development, changes to traffic volumes and patterns, etc.). These are factors which are typically not considered in the before-and-after results.

Extensive traffic counts are needed for a comprehensive before and after analysis, since the amount of night traffic varies greatly with the seasons of the year (14). An important factor concerns the amount of collision data gathered. Small numbers of collisions should not be compared, since they may represent chance occurrences which may skew results at a much greater degree than those studies with larger sample sizes. In this report, an effort has been made to gather and present findings from statistical studies with a larger number of collisions.

A list of significant lighting studies analyzing the safety benefits of lighting on urban roadways are as follows:

- As part of a widespread study on Long Island, New York, five comparisons were made of collisions on roads on three unlighted sections totalling 10 km and on three lighted sections totalling 5 km. A total of 539 collisions were tabulated during approximately four years. From the data, it was calculated that night-day rate / per million kilometres on the unlighted sections was 1.5 times higher than that on the lighted sections (2).
- A Syracuse, New York study used data based upon approximately 7,500 collisions on approximately 170 km of major and collector streets. Those streets with little or no illumination were found to have substantially higher night-day collision ratios and collision cost ratios than the average for streets with lighting and the same roadway classification and abutting land use. Also, the type of street (local, collector, or arterial) appeared to be more of a factor in the collision-illumination relationship than the type of abutting land use (3).

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- The 1996 US Federal Highway Association Annual Report showed that lighting had the highest cost-benefit ratio based on fatal and injury related collision data collected over a 21 year period. The costs to benefits were viewed within a comparison of various safety improvements and not as an actual cost-benefit ratio (i.e., the various safety improvements that were compared included geometrics, signing, markings, channelization, etc.). This study showed that lighting has excellent value as a safety improvement to reduce collisions and injuries. This information was also published in the New York Times (8).
- A study in Naperville, Illinois used two years of “before” data and two years “after” data to study the effects of lighting a 2.8 km length of a 5 lane major traffic route. The collision sample exceeded 800. The reduction in night-time collisions per million vehicle km was 36%, corresponding to a reduction in the total (day plus night collisions) of 14% (4).
- For the period up to 1987, the International Commission on Illumination (CIE) reviewed over sixty studies from 15 countries with respect to the significance of street lighting as a collision countermeasure. They identified 40 studies which they calculated to have statistically significant results. Overall, it was determined reductions in night-time collisions, following installation of roadway lighting, ranged from 9% to 75%. Their findings also reflect the Kansas City, Missouri experience, that urban street lighting most benefits the pedestrian. This kind of collision was reduced by 45% to 57% by lighting versus 21% to 23% reductions for other types of collisions (5).
- The approximate overall safety effects of fixed roadway lighting are a 65% reduction in night-time fatal collisions, a 30% reduction in night-time injury collisions, and a 15% reduction in night-time property damage collisions (7).
- A study in Davidson County, Tennessee, covered four suburban highways totalling 51 km of length. The collision records for one year prior to lighting in 1965, and two years after, involved 2,528 collisions. With lighting, the night-time collisions were reduced by 22% and injuries were reduced by 39% during the after period. However, daytime collisions were also lower, and the night/day ratio of collision rates / per million vehicle kilometres showed an overall benefit of a 15% reduction (4).

In summary, the research provided over the last 50 years shows that properly designed street lighting aids in improving urban road users’ visibility and helps the viewer to locate objects on the roadway as well as other vehicles, pedestrians, and cyclists. The end result is increased safety for motorists, cyclists, and pedestrians. The crash rate at night is higher than during the daylight hours mainly because of reduced visibility. Other major factors at night generally include: greater driver fatigue and greater consumption of alcohol.

Much of the information related to safety was extracted from a document no longer in production, IESNA CP-31-1989 Value of Public Roadway Lighting. The fact that this document was taken out of production by the IESNA due to low demand indicates that many take the value of roadway lighting at urban roadways for granted and feel that its benefits require no further research(4).

At best, it is practical to only light a roadway to a fraction of one percent of the normal daylight level (100,000 lux). However, as the information below will demonstrate, a relatively low level of roadway lighting can significantly reduce the night-time collision rate and thus make roads safer.

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As all the research listed above shows, reducing the number and severity of collisions is a key benefit of urban roadway lighting. The benefits achieved through the installation of roadway lighting will vary depending on the type of roadway. For high volume multi-lane urban arterial and collector roadways, the benefits are shown to be the greatest in reducing vehicle to vehicle as well and vehicle to pedestrian / cyclist injuries and fatalities.

Based on a recent survey undertaken by DMD, all major Cities across Canada light all urban roadways.

2.1.1.2 Sidewalks

Research related to personal and property security (crime related) is covered under Section 1.3.3 Crime. We are unaware of any research related to lighting for a pedestrian to safely navigate a sidewalk. As there is a lack research in this area we can only assume the lighting levels defined by the IESNA and TAC for sidewalks provide sufficient visibility for a pedestrian to navigate a sidewalk thus no research is warranted.

2.1.2 Standards

When considering standards, two main criteria must be considered: Where to light and how to light. These are covered below.

2.1.2.1 Where to Light – Roadways and Sidewalks

Uniform standards as to where to light in urban areas is a decision left up to engineers and City of Hamilton policy makers. No definitive standards exist as to where to light. However most, if not all Cities across North America light all roads in urban areas. Sidewalks adjacent to the roadways are lit however more as product of spill over light from the roadway, rather than designed lighting.

We recommend all urban roads and sidewalks are lighted. Where the value of lighting is in question, a warrants analysis from the TAC Guide for the Design Roadway Lighting can be undertaken.

2.1.2.2 How to Light - Roadways

In recent years, the City of Hamilton has followed the recommended practice from the IESNA RP-8-00 American Standard Practice for Roadway Lighting (28) and the TAC Guide for the Design of Roadway Lighting (7). Prior to that, it is not clear what specific standards were followed by the City of Hamilton.

Most, if not all jurisdictions, base their lighting design criteria on what is defined in the IESNA RP-8-00 American National Standard Practice for Roadway Lighting or the nearly identical TAC Guide for the Design of Roadway Lighting (2006). The TAC Guide is based on IESNA recommendations however it provides far greater explanations, reviews, and details on lighting than IESNA RP-8-00. Either publication is recommended for the City of Hamilton.

While the IESNA currently uses both luminance and illuminance as the basis of design for roadways, their next edition (2010) will use luminance as the primary basis of design for

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roadway lighting. TAC currently uses luminance as the primary base of calculation. We therefore recommend the luminance design method for urban roadways.

Based on the research data which has gone into developing IESNA and TAC standards, it is not possible to create a very strong link between lighting levels and the crash ratio reduction. The American National Standard (IESNA-RP-8-00) represents the consensus of all groups having an essential interest in the provisions of the standard practice. IESNA-RP-8 is based on research, studies, and the expertise of the Roadway Lighting Committee which has been in existence for 70+ years. The IESNA, as a sponsor, have the viewpoints of groups interested in roadway lighting represented on the Roadway Lighting Committee.

The IESNA and TAC define various levels of lighting and uniformity by the type of road (local, collector or arterial) and the level of pedestrian conflict or activity on the street. The three categories are high, medium, and low as defined below.

- High Pedestrian Activity – Typically, these are commercial urban areas, downtowns, or City centers with a high night-time pedestrian activity. A high pedestrian activity area will typically have 100 or more pedestrians over a given one hour period at night on the sidewalks between side streets.
- Medium Pedestrian Activity - Typically, these are urban commercial or institutional areas such as multifamily residential, community centers, schools, hospitals, neighbourhood shopping centers, etc. A medium pedestrian activity area will have 11 to 99 pedestrians over a given one hour period at night on the sidewalks between side streets.
- Low Pedestrian Activity - This level of activity can occur in any of the above roadway classifications. For example some residential areas downtown may fall into this classification. However, it is typically areas with single-family homes and very low density residential subdivisions or industrial areas. A low pedestrian activity area will have 10 or fewer pedestrians over a given one hour period at night on the sidewalks between side streets.

The term activity (or conflict) is used when pedestrians are primarily present on the sidewalk or road shoulder. The higher the activity is, the higher the required lighting level. The logic here is with increased numbers of pedestrians, there is an increase in risk for those pedestrians to be on the roadway.

Consensus amongst lighting professionals is that when a road is lighted, it must meet the defined lighting criteria listed in IESNA RP-8 American National Standard for Roadway Lighting or the TAC Guide for the Design of Roadway Lighting. Both documents recommend the same lighting levels however TAC is much more comprehensive than IESNA RP-8.

We recommend the lighting criteria listed in the American National Standard (IESNA-RP-8-00) or TAC and related documents as they represent the consensus the Roadway Lighting Committee (i.e., suppliers, manufacturers, designers, engineers, researchers, government, etc.) having an essential interest in the provisions of the standard practice. IESNA-RP-8 is based on research, studies, and the expertise of the Roadway Lighting Committee over the last 70+ years.

The IESNA and TAC recommendation have credibility with the courts and as such is well accepted and proven as a good design practice. As they are well used and accepted throughout

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North America, following the recommendations of the IESNA documents represents an accepted design practice. IESNA and TAC requirements are listed in the figure below.

Road Area and Pedestrian Activity		Average Luminance cd/m^2	Average-to-Minimum Uniformity Ratio	Maximum-to-Minimum Uniformity Ratio	Maximum-to-Average Veiling Luminance Ratio
Road Type	Pedestrian Activity				
Freeway	--	≧ 0.6	≦ 3.5	≦ 6.0	≦ 0.3
Partial Lighting of Interchange On-Ramps/ Off-Ramps	--	≧ 0.6	≦ 3.5	≦ 6.0	≦ 0.3
Expressway-Highway	High	≧ 1.0	≦ 3.0	≦ 5.0	≦ 0.3
	Medium	≧ 0.8	≦ 3.0	≦ 5.0	≦ 0.3
	Low	≧ 0.6	≦ 3.5	≦ 6.0	≦ 0.3
Arterial	High	≧ 1.2	≦ 3.0	≦ 5.0	≦ 0.3
	Medium	≧ 0.9	≦ 3.0	≦ 5.0	≦ 0.3
	Low	≧ 0.6	≦ 3.5	≦ 6.0	≦ 0.3
Collector	High	≧ 0.8	≦ 3.0	≦ 5.0	≦ 0.4
	Medium	≧ 0.6	≦ 3.5	≦ 6.0	≦ 0.4
	Low	≧ 0.4	≦ 4.0	≦ 8.0	≦ 0.4
Local/Alleyway	High	≧ 0.6	≦ 6.0	≦ 10.0	≦ 0.4
	Medium	≧ 0.5	≦ 6.0	≦ 10.0	≦ 0.4
	Low	≧ 0.3	≦ 6.0	≦ 10.0	≦ 0.4

Figure 11 - Roadway Luminance Levels

2.1.2.3 How to Light – Sidewalks

Lighting of the sidewalks improves pedestrian visibility and guidance. Unlike motor vehicles, which have headlamps to improve visibility, pedestrians typically don't have such a feature unless they carry flashlights. Outdoor lighting is therefore the only real practical aid to visibility and guidance to the pedestrian. Therefore, it is critical to prevent personal injuries which may result from tripping, walking into others or objects.

Sidewalk lighting is designed using the illuminance calculation method as opposed to the luminance method used for roadways. From a pedestrian guidance standpoint and in the case of high pedestrian activity, a guidance and security standpoint the IESNA RP-8 and TAC recommend the following lighting sidewalk lighting design levels be met:

Pedestrian Activity	Maintained Average Horizontal Illuminance (lux)	Average-to - Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≧ 20.0	≦ 4.0	≧ 10.0
Medium	≧ 5.0	≦ 4.0	≧ 2.0
Low	≧ 3.0	≦ 6.0	≧ 0.8

Figure 12 - Sidewalk Illuminance Levels

From a security standpoint G-1-03 Guideline for Security Lighting for People, Property, and Public Spaces does not recommend a specific level for sidewalk applications. It does however define a minimum maintained average vertical illumination level of 5 Lux to 8 Lux with average to minimum uniformity not exceeding 4:1 for “facial recognition” which is critical to enhancing surveillance and security. These lighting levels should be applied in areas where one wishes to enhance personal security.

In the case of sidewalks with medium or low pedestrian activity the back light cast from the roadway lights will typically provide the required lighting on the sidewalk. In some cases the pole spacing used to light the roadway may need to be tightened up to meet the sidewalk lighting level requirements. Achieving the required lighting levels for sidewalks with high pedestrian activity level is very difficult with only roadway lighting and supplementary sidewalk lighting will typically be required. In fact in most cases the sidewalk lighting requirements will drive up the roadway lighting level by casting light onto the roadway.

2.1.3 Current Conditions

Computer based lighting software was used to model existing roadways in conjunction with sample physical night measurements to verify the calculations. Results are presented on the spreadsheet listed below.

2.1.3.1 Roadways

Roadway lighting was reviewed on various typical urban rural roads throughout the City of Hamilton. Results are listed on the table below.

Hamilton Public Works

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Road)
																	Avg.	Max.	Road	Road	Road (Average)	Road (Worst-Case)	Road	
Expressway	Lincoln Alexander Expressway	Upper Gage Off-Ramp	Upper Gage Off-Ramp	Expressway	Residential	117.0	2	No	No	One-Sided	3	2.0	9.0	250	Cobrahead	Davit	58.5	58.5	9.0	3.0	13.7	13.7	3.4	Fail
Residential Urban Arterial	Garth St	Mohawk Rd	Lincoln Alexander Expressway	Arterial	Residential	665.0	4	No	Yes	One-Sided	21	1.0	9.0	250	Cobrahead	Davit	33.3	43.4	9.0	3.0	18.8	14.3	2.8	Pass
Residential Urban Arterial	Nash Rd	Barton St	Queenston Rd	Arterial	Residential	1010.0	4	No	Yes	One-Sided	29	0.5	9.0	250	Cobrahead	Davit	36.1	56.0	9.0	3.0	17.8	11.4	2.7	Pass
Industrial/Commercial Urban Arterial	Industrial Drive	Gage St	Ottawa St	Arterial	Industrial	800.0	4	No	Yes	Staggered	31	2.0 / 1.0	9.0	250	Cobrahead	Davit	26.7	30.5	13.0	3.0	22.6	19.8	2.2	Pass
Industrial/Commercial Urban Arterial	Upper James St	Mohawk Rd	Lincoln Alexander Expressway	Arterial	Commercial	972.0	5	No	Yes	Opposite	52	0.5	9.0	250	Cobrahead	Davit	38.9	54.0	17.0	3.0	28.2	20.1	2.2	Pass
Residential Semi-Urban Arterial	Upper James St	Rymal Rd	Alderlea Ave	Arterial	Residential	731.0	5	No	Yes	One-Sided	19	2.0	9.0	250	Cobrahead	Davit	40.6	79.9	9.0	3.0	12.0	6.1	5.7	Fail
Industrial/Commercial Semi-Urban Arterial	Hwy 2	Trinity Rd	Hwy 2/Hwy 53 Split	Arterial	Industrial	172.0	5	No	No	Staggered	5	2.0	11.0	200	Cobrahead	Davit	43.0	47.7	13.0	3.0	7.9	7.1	2.5	Fail
Residential Urban Collector	Charlton Ave	James St	Queen St	Collector	Residential	766.0	2	No	Yes	One-Sided	26	2.0	7.5	100	Cobrahead	Davit	30.6	43.0	6.0	4.0	9.7	7.0	2.3	Pass
Residential Urban Collector	Cochrane Rd	Lawrence Rd	Greenhill Ave	Collector	Residential	996.0	2	No	Yes	One-Sided	17	2.0	7.5	100	Cobrahead	Davit	62.3	89.0	6.0	4.0	4.8	3.4	16.0	Fail
Industrial/Commerical Urban Collector	Beach Rd	Kennilworth Ave	Ottawa St	Collector	Industrial	744.0	2	No	Yes	One-Sided	25	1.0	9.0	250	Cobrahead	Davit	31.0	46.3	9.0	4.0	23.4	15.5	1.7	Pass
Industrial/Commerical Urban Collector	Arvin Ave	Grays Rd	Green Rd	Collector	Industrial	831.0	2	No	No	One-Sided	11	2.0	9.0	150	Cobrahead	Davit	83.1	127.0	9.0	4.0	5.4	3.5	27.0	Fail
Residential Semi-Urban Collector	Upper Mount Albion Rd	Rymal Rd	Highland Rd	Collector	Residential	842.0	2	No	No	One-Sided	13	2.0	7.5	70	Cobrahead	Davit	70.2	118.4	6.0	4.0	2.8	1.7	28.0	Fail
Industrial/Commerical Semi-Urban Collector	Tradewind Dr	Hwy 2	Osprey Dr	Collector	Industrial	262.0	2	No	No	One-Sided	6	2.0	7.5	70	Cobrahead	Davit	52.4	55.0	9.0	4.0	3.8	3.6	6.3	Fail
Residential Urban Local	Creanona Blvd	Baseline Rd	Wendakee Dr	Local	Residential	445.0	2	No	Yes	One-Sided	10	1.0	9.0	150	Cobrahead	Davit	49.4	54.5	4.0	6.0	9.1	8.2	4.6	Pass
Residential Urban Local	Elgar Ave	Lynbrook Dr	Limeridge Rd W	Local	Residential	491.0	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	54.6	62.4	4.0	6.0	5.9	5.2	9.8	Fail
Residential Urban Local	Markland St	Queen St S	James St S	Local	Residential	761.0	2	No	Yes	One-Sided	20	2.0	7.5	100	Cobrahead	Davit	40.1	62.8	4.0	6.0	8.0	5.2	3.3	Pass
Industrial/Commercial Urban Local	Frid St	Chatham St	End	Local	Industrial	433.0	2	No	Yes	One-Sided	8	1.0	7.5	100	Cobrahead	Davit	61.9	83.7	7.0	6.0	5.0	3.7	25.0	Fail
Industrial/Commercial Urban Local	Martindale Cres	Golf Links Rd	Golf Links Rd	Local	Commercial	714.0	3	No	Yes	One-Sided	16	1.0	9.0	150	Cobrahead	Davit	47.6	58.0	9.0	6.0	9.2	7.5	4.2	Pass
Residential Semi-Urban Local (*)	Alpha St	Mud St East	Gilanna St	Local	Residential		2	No	No										4.0	6.0				
Industrial/Commercial Semi-Urban Local	Dartnall Rd	Rymal Rd	End	Local	Industrial	470.0	2	No	No	One-Sided	9	2.0	9.0	250	Cobrahead	Davit	58.8	61.0	7.0	6.0	12.9	12.5	3.5	Pass
Minor Mountain Access	Beckett Dr	Aberdeen Ave	Fennell Ave W	Collector	Residential	1574.0	2	No	No	One-Sided	46	1.0	7.5	100	Cobrahead	Davit	35.0	47.6	6.0	4.0	8.5	6.3	3.1	Pass
Minor Mountain Access	James Mtn Rd	Aberdeen Ave	Gateview Dr	Collector	Residential	643.0	2	No	No	One-Sided	20	1.0	9.0	250	Cobrahead	Davit	33.8	40.0	6.0	4.0	21.5	18.1	1.8	Pass
Jolly Cut Access	Jolly Cut Access	John St S	Concession St	Arterial	Residential	550.0	4	No	No	One-Sided	19	1.0	9.0	250	Cobrahead	Davit	30.6	34.5	9.0	3.0	20.5	18.2	2.8	Pass
Jolly Cut Access	Jolly Cut Access	John St S	Concession St	Arterial	Residential	505.0	4	Yes	Yes	Staggered	23	1.0	9.0	250	Cobrahead	Davit	23.0	32.0	9.0	3.0	25.8	18.5	2.0	Pass
Claremont Access	Claremont Access	Charlton Ave E	Rosedene Ave	Arterial	Residential	1281.0	5	Yes	No	Median	41	Centre	9.0	250	Cobrahead	Double Davit	32.0	32.0	9.0	3.0	32.1	32.1	1.9	Pass
Upper James Bridge	Upper James Bridge	Mohawk Rd E	Stone church Rd W	Arterial	Commercial	350.0	6	Yes	Yes	Opposite	18	2.0	9.0	250	Cobrahead	Davit	43.8	52.9	17.0	3.0	18.3	15.2	2.0	Pass
Kenilworth Access	Kenilworth Access	Kenilworth Ave S	Woodcrest Dr	Arterial	Residential	2111.0	4	No	No	One-Sided	63	1.0	9.0	250	Cobrahead	Davit	34.0	35.0	9.0	3.0	18.5	17.9	2.8	Pass
Centennial Parkway Access	Centennial Parkway Access	Green Mountain Rd	King St E	Arterial	Residential	1775.0	4	No	No	Staggered	32	2.0	11.0	250	Cobrahead	Davit	57.3	83.8	9.0	3.0	9.3	6.3	2.3	Pass

No calculations performed due to no lighting in area

Table 1 - Existing Lighting Conditions for Typical Urban Roads

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Our comments on the failed results are as follows:

- Expressway On and Off Ramps - Uniformity barely failed.
- Residential Semi-Urban Arterial - Lighting failed on uniformity. This is maybe more of a random case and may not be common.
- Residential Urban Collectors - One of the roads failed on uniformity and maintained average illumination and the other passed both.
- Industrial/Commercial Urban Collector - Uniformity failed badly.
- Residential Semi-Urban Collector - Uniformity failed badly and maintained average illumination was half of what it should be.
- Industrial/Commercial Semi-Urban Collector - Lighting failed on uniformity and low average level.
- Industrial/Commercial Urban Collectors - On one road lighting failed on uniformity and low average level.

Overall, for the small sampling of roads analyzed a large percentage failed to meet required lighting levels or uniformity. We have undertaken similar analysis in other Cities and found results to be similar.

2.1.3.2 Sidewalks

Sidewalk lighting was reviewed on various typical urban rural roads throughout the City of Hamilton. Results are shown on the table below.

Hamilton Public Works

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Sidewalk)
																	Avg.	Max.	Sidewalk	Sidewalk	Sidewalk 1 (Avg)	Sidewalk 2 (Avg)	Sidewalk	
Residential Urban Arterial	Garth St	Mohawk Rd	Lincoln Alexander Expressway	Arterial	Residential	665.0	4	No	Yes	One-Sided	21	1.0	9.0	250	Cobrahead	Davit	33.3	43.4	3.0	6.0	14.9	3.3	1.3	Pass
Residential Urban Arterial	Nash Rd	Barton St	Queenston Rd	Arterial	Residential	1010.0	4	No	Yes	One-Sided	29	0.5	9.0	250	Cobrahead	Davit	36.1	56.0	3.0	6.0	N/A	3.5	1.1	Pass
Industrial/Commercial Urban Arterial	Industrial Drive	Gage St	Ottawa St	Arterial	Industrial	800.0	4	No	Yes	Staggered	31	2.0 / 1.0	9.0	250	Cobrahead	Davit	26.7	30.5	5.0	4.0	N/A	18.0	2.0	Pass
Industrial/Commercial Urban Arterial	Upper James St	Mohawk Rd	Lincoln Alexander Expressway	Arterial	Commercial	972.0	5	No	Yes	Opposite	52	0.5	9.0	250	Cobrahead	Davit	38.9	54.0	20.0	4.0	13.2	13.2	1.4	Fail
Residential Semi-Urban Arterial	Upper James St	Rymal Rd	Alderlea Ave	Arterial	Residential	731.0	5	No	Yes	One-Sided	19	2.0	9.0	250	Cobrahead	Davit	40.6	79.9	3.0	6.0	22.4	N/A	2.3	Pass
Residential Urban Collector	Charlton Ave	James St	Queen St	Collector	Residential	766.0	2	No	Yes	One-Sided	26	2.0	7.5	100	Cobrahead	Davit	30.6	43.0	3.0	6.0	5.9	4.5	1.7	Pass
Residential Urban Collector	Cochrane Rd	Lawrence Rd	Greenhill Ave	Collector	Residential	996.0	2	No	Yes	One-Sided	17	2.0	7.5	100	Cobrahead	Davit	62.3	89.0	3.0	6.0	3.0	2.3	14.5	Fail
Industrial/Commerical Urban Collector	Beach Rd	Kennilworth Ave	Ottawa St	Collector	Industrial	744.0	2	No	Yes	One-Sided	25	1.0	9.0	250	Cobrahead	Davit	31.0	46.3	5.0	4.0	16.3	10.8	1.2	Pass
Residential Urban Local	Creanona Blvd	Baseline Rd	Wendakee Dr	Local	Residential	445.0	2	No	Yes	One-Sided	10	1.0	9.0	150	Cobrahead	Davit	49.4	54.5	3.0	6.0	3.1	8.3	2.6	Pass
Residential Urban Local	Elgar Ave	Lynbrook Dr	Limeridge Rd W	Local	Residential	491.0	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	54.6	62.4	3.0	6.0	3.4	4.0	11.3	Fail
Residential Urban Local	Markland St	Queen St S	James St S	Local	Residential	761.0	2	No	Yes	One-Sided	20	2.0	7.5	100	Cobrahead	Davit	40.1	62.8	3.0	6.0	4.7	5.4	2.8	Pass
Industrial/Commercial Urban Local	Frid St	Chatham St	End	Local	Industrial	433.0	2	No	Yes	One-Sided	8	1.0	7.5	100	Cobrahead	Davit	61.9	83.7	5.0	4.0	1.3	3.0	13.0	Fail
Industrial/Commercial Urban Local	Martindale Cres	Golf Links Rd	Golf Links Rd	Local	Commercial	714.0	3	No	Yes	One-Sided	16	1.0	9.0	150	Cobrahead	Davit	47.6	58.0	20.0	4.0	2.1	3.5	2.1	Fail
Jolly Cut Access	Jolly Cut Access	John St S	Concession St	Arterial	Residential	505.0	4	Yes	Yes	Staggered	23	1.0	9.0	250	Cobrahead	Davit	23.0	32.0	3.0	6.0	20.2	N/A	1.9	Pass
Upper James Bridge	Upper James Bridge	Mohawk Rd E	Stone church Rd W	Arterial	Commercial	350.0	6	Yes	Yes	Opposite	18	2.0	9.0	250	Cobrahead	Davit	43.8	52.9	20.0	4.0	19.3	19.3	2.5	Fail

Table 2 - Existing Lighting Conditions for Typical Urban Sidewalks

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Our comments on the failed results are as follows:

- Industrial/Commercial Urban Arterial - Lighting level below what is required on the sidewalk. This is probably quite common as sidewalk lighting has not historically been considered in past designs.
- Residential Semi-Urban Arterial - Lighting failed on uniformity. This may be more of a random case and may not be common.
- Residential Urban Collectors - One of the roads failed on uniformity and maintained average illumination and the other passed both.
- Industrial/Commercial Urban Collector - Uniformity failed badly.
- Residential Semi-Urban Collector - Uniformity failed badly and maintained average illumination was half of what it should be.
- Industrial/Commercial Semi-Urban Collector - Lighting failed on uniformity and low average level.
- Industrial/Commercial Urban Collectors - On one road lighting failed on uniformity and low average level.

Overall, for the small sampling of sidewalks analyzed a large percentage failed to meet required lighting levels or uniformity. We have undertaken similar analysis in other Cities and found results to be similar.

It should be noted that reason most sidewalk lighting in commercial areas fails is because it is very difficult to achieve the required levels. In fact meeting the sidewalk lighting levels will often drive the roadway lighting levels higher than required as result of light spill over onto the roadway.

2.1.4 Public Stakeholder Input

From the very small public response one can conclude lighting is not a major issue for the residents of the City of Hamilton. The response was too small to summarize in this report however the comments received have been taken into account in the report.

2.1.5 Recommendations

Recommendations are as follows:

2.1.5.1 Where to Light - Roadways

The rational for lighting urban roadways, is as follows:

1. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): It can reduce the potential for collisions with pedestrians and cyclists on the roadway.
2. Vehicular Road Safety (Vehicle-vehicle conflicts): It is proven in reducing vehicle collisions.
3. Commercial and City of Hamilton image enhancement: Lighting can provide a level of comfort and can promote economic development.
4. Safety and Security – Perceived: This is more specific to sidewalk lighting.
5. Safety and Security – Real: This is more specific to sidewalk lighting.

6. Pedestrian Safety (Navigating sidewalks, off-road, etc): This is more specific to sidewalk lighting.

All urban roads should therefore be lighted as is common practice in major Cities throughout Canada.

The normal practice is to undertake lighting upgrades as part road upgrade or reconstruction projects. If budget exists for lighting upgrades where no road construction is being undertaken, the figure below shows recommended lighting priorities within the City of Hamilton.

Application	High Priority	Medium Priority	Low Priority
Expressway with sidewalk		X	
Expressway without sidewalk			X
Urban Arterial	X		
Semi Urban Arterial		X	
Urban Collector	X		
Semi Urban Collector		X	
Urban Local		X	
Semi Urban Local			X

Figure 13 - Street Lighting Priority

2.1.5.2 Where to Light - Sidewalks

In most Cities, the lighting of sidewalks is typically a secondary consideration to the roadway or not considered at all. This is a huge oversight.

The rational for lighting specific urban sidewalks, is as follows:

1. Pedestrian Safety (Navigating sidewalks, off-road, etc): Lighting is required to allow pedestrians to safely navigate the sidewalk. It provides increased visibility for those using sidewalk to allow them to see where they are going, reducing tripping or falling.
2. Safety and Security – Real: Lighting will improve one security by improving visibility which aids in surveillance. It allows those in motor vehicles to view pedestrian activity on the sidewalk and pedestrians crossing the road. The CPTED principals refer to the term "fight or flight" which means observing potential hazards from a distance allows a person to make a choice to avoid a hazard. This is aided by well designed outdoor lighting which should improve visibility. A well lighted area can allow drivers and pedestrians to observe and report any criminal activities through improved visibility. For

example, if someone is being assaulted on a well lighted sidewalk, adjacent to a roadway, motorists could report the criminal activity and could also stop and intervene. If the area was not visible to motorists, then the surveillance benefits would be greatly reduced.

3. Commercial and City of Hamilton image enhancement: Lighting can provide a level of comfort and can promote economic development. It adds a level of perceived safety for pedestrian and as such can add a level of comfort and can promote commercial development.
4. Safety and Security – Perceived: Lighting will provide a feeling of security which can lead increased pedestrians.
5. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): This is more specific to roadway lighting.
6. Vehicular Road Safety (Vehicle-vehicle conflicts): This is more specific to roadway lighting.

As noted above, lighting of the sidewalks improves pedestrian visibility and guidance. Unlike motor vehicles, which have headlamps to improve visibility, pedestrians typically don't have such a feature unless they carry flashlights. Outdoor lighting is the only real practical aid to visibility and guidance to the pedestrian. Therefore, it is critical to prevent personal injuries which may result from tripping or walking into others.

We also understand the City of Hamilton staff supports and promotes pedestrian and safe walking initiatives throughout the City of Hamilton as noted in the City of Hamilton Collaborative Pedestrian and Walkability Initiatives BOH09029a paper. Proper lighting of sidewalk would enhance key elements of this such as "reduced road danger" and "less fear of crime".

In urban applications, all sidewalks should be lighted. In some cases, lighting for sidewalks can be accomplished via the backlight from the street lighting. However in commercial areas or areas with heavy trees, additional lighting poles and luminaires for the sidewalk may be required. These concepts and findings support the original thinking and mandate of the Task Force for Cleanliness and Security in the Downtown Core (TFCSDC).

2.1.5.3 Lighting Levels - Roadways

We recommend light levels listed under 2.1.2.2 be applied on urban roads throughout the City of Hamilton.

2.1.5.4 Lighting Levels - Sidewalks

We recommend light levels listed under 2.1.2.3 be applied on urban roads throughout the City of Hamilton. For sidewalks, the levels from the TAC Guide for the Design of Roadway Lighting (7) are recommended as TAC does a much better job explaining what is required and how to calculate them than does IESNA RP-8.

Sidewalk lighting is always calculated in illuminance. Illumination levels can be misleading as the reflective properties of the sidewalks and buildings can impact the overall brightness and ones visibility. Ones visibility can be improved by the very light building finishes which reflect light much better than dark finishes.

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Figure 14 - Examples Dark and Buildings and Sidewalks

Figure 14 shows two examples of how the reflective properties of the sidewalk and buildings can impact, visibility. The open sidewalk in the figure to left along with the reflective building and sidewalk surfaces enhance the lighting which aids long range visibility and surveillance and creates a feeling of comfort. In the picture to the right the sidewalk and building are dark and don't reflect light well as a brighter surfaces in figure to the left. Though the recommended sidewalk illuminance levels don't take in account building and sidewalk surface reflectance's they can be a much greater factor with respect to visibility and creating a feeling of comfort than light levels themselves. Selecting the reflective properties of the building and sidewalk is beyond the control of the lighting designer, however will play major factor with respect to visibility. The City of Hamilton should encourage architects and developers to design building and sidewalk with good reflective properties (say 30% or greater) to enhance the sidewalk lighting and improve visibility. This is significant in the downtown where development is very dense.

Visibility on the sidewalk can also be reduced by trees blocking the light. As shown in the figure below trees block light and create shadows which reduce uniformity and visibility. A July 2008 study titled Trees, Lighting and Safety in Context Sensitive Design gave some examples of how a lighting system should be designed to allow for the presence of trees at all stages of maturity:

- the best design approach is to locate luminaires outside of the full growth lines of the species of tree along the roadway.
- when a roadway or pedestrian lighting project includes new or existing trees in close proximity to the lighting, then an additional light loss factor should be included in the design for light loss due to shading. Insufficient research is available at this time to quantify the factor but an additional 10% to 20% appears reasonable. That would be an additional 10% to 20% on the light loss factor. This will not help with uniformity issues.

We recommend these examples be followed. In addition we would recommend the required pole spacing be tightened up by say 20% - 30% to improve uniformity by compensating for the light blockage from the trees.

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Figure 15 - Example of Tree Impacts

2.2 Rural Roadways

Rural roadways are those in areas which typically have minimal commercial development and no sidewalk or curb and gutter. They typically have less population density than urban areas. The definition of whether an area is rural or urban is defined by the City of Hamilton.

2.2.1 Research

The majority of research undertaken with respect to lighting rural roadways is focused on collisions. The analysis of lighting effects on collisions is extremely complex. Before-and-after studies of lighted routes are often based upon the percentage of collisions at night, as compared with the total, before and after the improvement. In many cases, studies of before and after improvements are measured over years and many other road changes can take place during that time which may skew the results (e.g., road improvements such as line painting, road widening, new development, changes to traffic volumes and patterns, etc.). These are factors which are typically not considered in the before-and-after results.

Extensive traffic counts are needed for a before and after analysis since the amount of night traffic varies greatly with the seasons of the year (14). An important factor concerns the amount of collision data gathered. Small numbers of collisions should not be compared, since they may represent chance occurrences which may skew results at a much greater degree than those studies with larger sample sizes. In this report, an effort has been made to gather and present findings from statistical studies with a larger number of collisions.

A list of significant lighting studies analyzing the benefits of lighting of rural roadways are as follows:

- When driving at night, motor vehicle headlamps are the primary means for improving driver visibility. By law, all motor vehicles must have operating headlamps. When considering the benefit for fixed roadway lighting, the advancements in vehicle headlight systems and how they impact safety must also be considered. The University of Michigan Transportation Research Institute analyzed fatal crash trends on rural roads in the United States between 1990 and 2006. Changes in the ratio of crashes in darkness to crashes in daylight were assessed to determine whether recent improvements in vehicle headlights influenced the day to night crash ratio. The report noted that sharp declines were observed in rural crashes as result of improved vehicle headlamps while no significant changes were observed in levels of urban crashes. The research therefore indicates that advancements in vehicle headlights have had the biggest benefit on unlighted rural roads (26).
- The American Association of State Highway Transportation Officials (AASHTO) developed the Roadway Lighting Design Guide (27) based on Illuminating Engineering Society design practices (28). The AASHTO document includes a warranting system mostly geared at highway applications which would not apply to the City of Hamilton. ASSHTO did define some basic warrants for lighting on rural local, arterial, and collector roads. They define lighting is warranted where one or more of the criteria listed below is met:
    1. on sections or road where the ratio of night to day accident rate is higher than the Citywide average for unlighted similar sections
    2. locations where severe, or unusual, weather or atmospheric conditions exist
    3. hazardous locations on rural highways
- The Region of Waterloo, Ontario, tracked collisions on regional roads over a four year period. A summary of collision data provided by the Region showed that for mid-block roads between intersections, the night-to-day collision ratio without lighting was 0.65:1. The ratio with lighting was 0.26:1, a reduction of nearly 50%. This was based on nearly 10,000 collisions on roads with lighting, and 3,500 without lighting (7).
- Recent studies in Norway show personal risk increases by 17% in darkness on lighted rural roads and 145% in darkness on unlighted rural roads. The risk increase due to darkness is higher during rainy conditions (50% on lighted roads and 190% on unlighted roads) and was found to be higher for pedestrian collisions (140% on lighted roads and 360% on unlighted roads). Road lighting was defined as "a most efficient road safety measure, especially on road sections with mixed traffic, but even on motorways." The effect of road lighting was found to have the least impact during adverse weather conditions when darkness collision risk is highest and visibility measures are most needed. The report concludes not enough is known about the relationship between lighting levels and road safety (31).
- The CIE Report "Road Lighting as an Accident Countermeasure" includes a study of 137 km of lighted and 782 km of unlighted rural freeways in the Netherlands. The collision sample was over 6,300 and the ratio of night/day collisions for the unlighted routes was found to be 28% greater than for the lighted routes (4).
- Some municipal regulations allow streetlights for rural areas to be spaced two to three times further apart than the distance required in achieving the minimum recommended level of uniformity ratios (this is sometimes referred to as "half code" lighting). Another municipal streetlight practice that often creates a uniformity problem involves luminaires mounted intermittently on existing utility poles to reduce installation expense. Utility pole spacing is determined by wire distribution considerations, and often prevents achieving the minimum

> recommended level of uniformity for street lighting. Any street lighting practice that fails to use the necessary spacing to achieve recommended illumination levels and uniformity ratios will inevitably result in mediocre to adverse lighting conditions, forcing the eye to adapt to very pronounced shadows and very high contrast in the field of view. Reductions in the lighting levels stated in this recommended practice, or meeting some of the criteria and not others, will not result in "slightly less" visibility. Simply put, providing half the criteria will not result in half of the benefit. In fact, reductions in uniformity or increases in the allowed veiling luminance ratio may produce results that are more detrimental to minimum visibility than not providing any lighting (19).

There is now added pressure to more selectively choose where lighting may provide the best value. The IESNA is in the process of publishing a document referred to as DG-22 Design Guide for Residential Street Lighting (19) which has a section that defines “When Street Lighting May Not Be Needed.” In the final draft it states:

“While the purpose of the street light is to improve the driver’s visual performance, there are conditions where street lighting may not be necessary, and, under certain conditions, poor lighting design may actually make vehicular travel less safe. Vehicular headlights may provide adequate illumination to allow the driver sufficient time for reaction and stopping at speeds less than 50 km/h. Street lights may not be necessary for driver vision on such roads, except in commercial areas with high levels of ambient or stray light, or other areas with higher traffic volume, pedestrians or cyclists. This recommendation may provide for safe vehicular traffic but does not address lighting intended for pedestrian needs.”

The research for this statement was based on computer modeling of car headlamps on local roads. It was the consensus of the assigned IESNA Street Task Force, who undertook the task of defining when street lighting may not be required, that lighting may be of less value in low speed applications (rural residential roads) given the ongoing improvements to motor vehicle head light systems. This represents a significant change in philosophy from a lighting organization such as the IESNA. In the past, such organizations promoted roadway lighting without any real definition of where best to apply it. When the recommended practice only defines “how” to light and not when best to light, then designers will tend toward lighting all roads to be on the safe side. There is always debate between lighting researchers and designers as to “where and when” lighting provides the most value. Now, increased pressure is being applied to consider whether or not lighting is required. From this, it would appear that it is not necessary to light local low speed roads within rural residential subdivisions.

Based on a recent survey undertaken by DMD, most major Cities in Canada do not light rural roads. In rural areas, lighting is usually only installed at intersections only, unless otherwise warranted.

Though the research listed above is somewhat conflicting in terms of the benefits of lighting on rural roads in general, pedestrian activity is much lower in rural areas than in urban areas, which makes lighting of less benefit with respect to pedestrians. With minimal pedestrians driver guidance becomes the key factor. Retro-reflective pavement markings and signage will serve as less expensive option than lighting with respect to driver guidance. Improvements in motor vehicle head lighting has led to a reduction in crashes in rural areas.

2.2.2 Standards

When considering standards two main criteria exist: Where to Light and How to Light. They are defined as follows:

2.2.2.1 Where to Light

Typically, rural roads are not lighted, however the Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting (7) defines a street lighting warranting system in order to apply lighting where it will provide the most benefit. The TAC warrant system is based on criteria grouped into geometric, operational, environmental, and collision factors. For each criterion characteristic of the candidate installation, the warrant uses a numeric rating (R) corresponding to the relative degree of hazard presented or indicated by the feature. Each criterion is assigned a weight (W) to indicate its relative importance. The rating value (R) is multiplied by the weight (W) to obtain a point-score (R x W) for each criterion characteristic, indicating its relative significance. The overall point-score for all items indicates the need for lighting, as well as the relative risk on that road compared with other roadways. The TAC warrant point-score system is still heavily weighted towards the motorist, with less weighting for pedestrians. It is also very heavily weighted towards the “Night to Day Collision Ratio” which is often hard to determine. It is hard to determine especially in the case of a new road where there is no collision history. Therefore, determining a collision ratio would not be possible.

The TAC warranting system should really only be applied where considering installing street lighting on an existing road. As it would be difficult to undertake a warrant assessment for each existing roadway, it is recommended street lighting only be considered on a roadway with an annual night to day collision of two or greater. Using the TAC warranting system for new road, would be difficult as the night to day collision ratio (very large factor) would not be known.

2.2.2.2 How to Light

In cases where lighting maybe warranted on a rural road, the designer should follow the levels recommended in Section 2.1.2.2. Though it may seem intuitive that a rural would have lower lighting levels than an urban area, it is important to note any street lighting that fails to achieve the lighting levels stated in the recommended practices, or meeting some of the criteria and not others, will not result in "slightly less" visibility.

Some jurisdictions have taken it upon themselves to deviate from the recommended levels and eliminate every second pole. This is known as “half code lighting”. Simply put, providing half the lighting will not result in half of the benefit. In fact, reductions in uniformity or increases in the allowed glare may produce results that are more detrimental to visibility than an absence of lighting.

Departing from recommended lighting levels can pose a risk to public safety as well as to a City of Hamilton from a liability prospective. The lighting levels in published lighting guidelines and standards are widely used throughout the industry and as such are viewed by the courts as an accepted practice. Lighting levels for rural roadway would be the same for urban roadway with low pedestrian activity.

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2.2.2.3 Alternatives to Lighting

Retro-reflective markings and delineators can be a far more cost effective option than lighting. When roadway lighting is not present, night-time navigation generally depends upon on a road user's visibility of the roadway and pavement markings via vehicle headlamps.

Retro-reflective markings are designed to reflect light back to a road user's eye and, as such, they improve visibility. High performance pavement markings have been developed for both wet and dry road conditions. The benefits of wet pavement markings have been assessed in a report produced by the Virginia Polytechnic Transportation Institute (29).

Research undertaken in 2007 as part of a US Federal Highway Association project (20), shows that fixed roadway lighting can improve the visibility of pavement markings. With respect to a driver guidance aid where line painting has good retro-reflective properties and is properly maintained lighting is of less value (20).

Figure 16 - Retro-Reflective Pavement Markings

Post mounted delineators (PMDs) are another effective method for providing delineation of the roadway curves at night. PMDs consist of retro-reflective strips mounted on posts approximately 1.3 m above the pavement.

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Figure 17 - Post Mounted Delineators (PMDs)

PMDs are typically used for the benefit of marking out curves in a roadway. The Manuals of Uniform Traffic Control Devices (MUTCD) defines typical spacing for PMDs.

Retro-reflective pavement markings and post mounted delineators should be considered as alternatives to lighting for rural applications where pedestrians are not present. These devices will help drivers to navigate the road. However, they will not improve the visibility of pedestrians or cyclists.

2.2.3 Current Conditions

Existing lighting levels and uniformity have been assessed on a very small sampling of the existing lighting installations on roads defined by the City of Hamilton.

Computer based lighting software was used to model existing roadways in conjunction with sample physical night measurements to verify the calculations. Results are presented on the spreadsheet listed below.

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Road)
																	Avg.	Max.	Road	Road	Road (Average)	Road (Worst-Case)	Road	
Rural Arterial	Hwy 56	Hwy 20	Binbrook Rd	Arterial	Residential	614.5	4	No	No	One-Sided	12	2.0	9.0	150	Cobrahead	Davit	55.9	101.5	9.0	3.0	7.1	3.9	4.2	Fail
Rural Arterial	Hwy 20 East	Hwy 20 South	Tappleytown Rd	Arterial	Residential	475.0	5	No	No	One-Sided	7	2.0	9.0	200	Cobrahead	Davit	79.2	120.0	9.0	3.0	4.5	3.0	9.0	Fail
Rural Collector	Safari Rd	Brock Rd	Hwy 6	Collector	Residential		2	No	No										6.0	4.0				
Rural Local	Fourth Concession Rd West	Hwy 6	Sager Rd	Local	Residential		2	No	No										4.0	6.0				

(Grey cells) No calculations performed due to no lighting in area

Table 3 - Existing Lighting Conditions for Typical Rural Roads

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The results showed on the arterial road the lighting failed on uniformity and low average level for both arterial roads sampled.

2.2.4 Public Stakeholder Input

From the very small public response one can conclude rural street lighting is not a major issue for the residents of the City of Hamilton. The response was too small to summarize in this report however the comments received have been taken into account in the report.

2.2.5 Recommendations

Recommendations are defined below.

2.2.5.1 Where to Light

The rational for lighting (or not) rural roadways, is as follows:

1. Vehicular Road Safety (Vehicle-vehicle conflicts): Though the research shows benefit in lighting rural roads it is not practical from a cost benefit standpoint to light all rural roads. We recommend where the night to day collision ratio is 2:1 or greater lighting should be considered. In this case the decision to light a rural roadway should be based on a traffic engineering based analysis compared with other options to define the best cost benefit ratio. Less expensive alternatives to lighting such as retro-reflective pavement marking and / or post mounted delineators should typically be the first consideration. If these prove to have lower cost benefit ratio than lighting then lighting should be considered. In the case of a hazardous or high collision area retro-reflective pavement markings, delineators, signage or lighting should only be installed in and around the area of the hazard for a minimum of one safe sight stopping distance from the hazard and don't have to be installed for the entire length of the road.
2. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): This is more specific to urban roadways where pedestrian activity is much higher.
3. Commercial and City of Hamilton image enhancement: This is more specific to urban roadways.
4. Safety and Security – Perceived: This is more specific to sidewalk lighting.
5. Safety and Security – Real: This is more specific to sidewalk lighting.
6. Pedestrian Safety (Navigating sidewalks, off-road, etc): This is more specific to sidewalk lighting.

2.2.5.2 Lighting Levels

In special cases where lighting is required on sections of rural roads we recommend the IESNA/TAC luminance levels be adopted with low pedestrian conflict listed under Section 2.1.2.2.

2.3 Urban Intersections

An urban intersection includes two or more lighted roadways join or cross at the same level. An urban area often includes sidewalks, parking lanes, and nearby residential or commercial

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development. It is also usually characterized by pedestrian activity, particularly at night. Urban intersections also include mid block cross-walks.

2.3.1 Research

The majority of research undertaken with respect to lighting urban intersections is focused on collisions. The analysis of lighting effects on collisions is extremely complex. Before-and-after studies of lighted routes are often based upon the percentage of collisions at night, as compared with the total, before and after the improvement. In many cases, studies of before and after improvements are measured over years and many other road changes can take place during that time which may skew the results (e.g., road improvements such as line painting, road widening, new development, changes to traffic volumes and patterns, etc.). These are factors which are typically not considered in the before-and-after results.

Extensive traffic counts are needed for a before and after analysis since the amount of night traffic varies greatly with the seasons of the year (14). An important factor concerns the amount of collision data gathered. Small numbers of collisions should not be compared, since they may represent chance occurrences which may skew results at a much greater degree than those studies with larger sample sizes. In this report, an effort has been made to gather and present findings from statistical studies with a larger number of collisions.

A list of significant lighting studies analyzing the benefits of urban intersection lighting which respect to pedestrian safety are as follows:

- Based on research in Switzerland, it was found that a level vertical illumination of 20 lux or greater in crosswalks reduced night-time vehicle-to-pedestrian crashes by 66% (24).
- Although fewer than 6% of trips are undertaken on foot, 13% of all traffic fatalities occur among pedestrians. In 1997 and 1998, 13% of all traffic fatalities in the US were pedestrians (1). It is not known what percentage of intersections had lighting. Conclusions cannot be drawn on the value of lighting from these statistics. However, the facts show that walking through an intersection during hours of darkness is far less safe than in daylight hours.
- The University of Michigan Transportation Research Institute used information from the US Fatality Analysis Reporting System (FARS) to show that the added safety risk in darkness versus light is much higher for pedestrians in intersections than for any other road users. The use of alcohol by pedestrians appears to strongly magnify the effect of darkness for the risk of being killed. The comparative risk of a pedestrian crash is much higher in darkness than in daylight (by a factor of over 4 times), but the annual number of pedestrian crashes in darkness is sufficiently large to suggest that lighting targeted toward pedestrian visibility would save nearly twice as many lives as would be saved in collisions with other motor vehicles. Thus, the greatest lifesaving opportunity for lighting countermeasures appears to be in areas such as urban arterial intersections, where both speed and pedestrian density are high (23).
- The University of Michigan Transportation Research Institute analyzed 11 years of traffic data from the US Fatality Analysis Reporting System (FARS) to investigate the sensitivity to light level at fatal pedestrian crashes at intersections (6). One method of analysis examined the abrupt light changes associated with the annual transition to and from daylight savings time. Significant information related to lighting is as follows:

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1. pedestrians may be 3 to 6.75 times more vulnerable in the dark than in daylight, depending on the circumstances
2. the most practical means to extend the available time for avoiding pedestrian collision seems to lie in the improvement of lighting to illuminate objects farther ahead of the vehicle to extend available time to react.
3. one clear conclusion from roadway lighting research shows that it reduces crash rates and particularly those crash rates involving pedestrians.

- Providing high levels of vertical illuminance is critical in enhancing public safety by improving visibility in marked crosswalks. A mid-block crosswalk can potentially be less safe for pedestrians than a crosswalk at an intersection because drivers may not expect pedestrians on the roadway. Historically, the use of silhouette or negative contrast for the detection of a pedestrian was recommended. However, new research shows that positive contrast has many advantages, particularly when considering the reinforcement of positive contrast with headlamps. A study was undertaken by Virginia Tech University (10) to provide information, lighting parameters, and design criteria that should be considered when designing fixed roadway lighting for mid-block crosswalks. The information is based on static and dynamic experiments on driver performance with regard to detecting pedestrians and surrogates in mid-block crosswalks. Experimental condition variables included lamp type (high-pressure sodium and metal halide), vertical illuminance level, colour of pedestrian clothing, position of the pedestrians and surrogates in the crosswalk, and the presence of glare. The researchers found that a maintained average vertical illuminance of 20 lux or greater in the crosswalk, measured at a height of 1.5 meters (5 feet) from the road surface, provided adequate detection distances in most circumstances. Although the researchers only looked at mid-block placements of crosswalks, the report includes similar recommendation for intersection crosswalks. The TAC Guide for the Design of Roadway Lighting (7) defines recommendations for both mid-block and intersection crosswalk lighting based on the Virginia Tech research.
- At intersections in urban areas, the greatest benefit of lighting is in the saving of pedestrian lives. Reductions of 45% to 80% have been found in various cities, following the modernization of lighting. In general, reductions in the range of 21% to 36% have been found for all types of night-time collisions (4).
- According to the US Federal Highway Administration (FHWA) more than 40 percent of intersection fatalities occur during the late-night/early-morning hours. Further, the probability of being killed in a crash during late-night/early-morning hours is as much as three times greater than during the day. A primary reason for this difference in crashes is poor intersection visibility, where drivers are not able to see conflicting traffic and other road users.

A list of significant lighting studies analyzing the benefits of urban intersection lighting with respect to motor-vehicles collisions are as follows:

- For the period up to 1987, the International Commission on Illumination (ClE) reviewed over sixty studies from 15 countries with respect to the significance of street lighting as a collision countermeasure. They identified 40 studies which they calculated to have statistically significant results. Overall, it was determined reductions in night-time collisions, following installation of roadway lighting, ranged from 9% to 75%. Their findings also reflect the Kansas City, Missouri experience, that urban street lighting most benefits the pedestrian. This kind of collision was reduced by 45% to 57% by lighting versus 21% to 23% reductions for other types of collisions (5).The approximate overall safety effects of fixed roadway lighting are a 65% reduction in night-time fatal collisions, a 30% reduction in night-time injury collisions, and a 15% reduction in night-time property damage collisions (7).

- A study in Iowa assessed three year before-and-after data at 47 locations and 568 collisions. Overall, the night collision rate of 1.89 per million entering vehicles (before) dropped to 0.91 after lights were installed: a reduction of 52%. The lighting was of greatest benefit at urban intersections having raised concrete channelization, with a route turn, and having four legs. Also, intersections with the largest number of lights installed had the greatest collision reduction (4).
- A study in Illinois analyzed collision data from 18 unlighted intersections and 263 lighted intersections. The night/day ratio of collisions per million entering vehicles was reduced 25% wherever lighting was present. The night collision rate alone was reduced 45%. Furthermore, intersections with channelization but no lighting had higher ratios than those with both lighting and channelization (4).

As the research indicates lighting can reduce late-night/early-morning crashes at intersections. A high level of vertical illumination can improve pedestrian safety at mid-block cross walks.

Much of the information related to safety was extracted from a document no longer in production, IESNA CP-31-1989 Value of Public Roadway Lighting. The fact that this document was taken out of production by the IESNA due to low demand indicates that many take the value of roadway lighting for granted and feel that its benefits require no further research(4).

In general the research indicates lighting has a very high benefit at urban intersections.

2.3.2 Standards

Industry standards exist and are typically applied by cities, municipalities, and various jurisdictions. The bases for these standards are national publications by:

- Illuminating Engineering Society of North America (IESNA) namely the RP-8-00 American National Standard Practice for Roadway Lighting and The Lighting Handbook
- Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting.

The TAC lighting document is based on IESNA research and publications. Most, if not all jurisdictions, base their lighting design criteria on what is defined in the IESNA RP-8-00 American National Standard Practice for Roadway Lighting or the nearly identical TAC Guide for the Design of Roadway Lighting (2006). The TAC Guide is based on IESNA recommendation however it provides far greater explanations, reviews, and details on lighting than IESNA RP-8-00.

The American National Standard (IESNA-RP-8-00) represents the consensus of all groups having an essential interest in the provisions of the standard practice. IESNA-RP-8 is based on research, studies, and the expertise of the Roadway Lighting Committee which has been in existence for 70+ years. The IESNA, as a sponsor, have the viewpoints of groups interested in roadway lighting represented on the Roadway Lighting Committee.

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The levels of lighting and uniformity are defined by the level of pedestrian conflict or activity which is explained in Section 2.1.2.2.

Consensus amongst lighting professionals is that when a road is lighted, it must meet the defined lighting criteria listed in IESNA RP-8 or TAC. We therefore recommend the lighting criteria listed in the American National Standard (IESNA-RP-8-00) and TAC.

Intersection lighting levels are always calculated in illuminance as no luminance design method has been developed due to complexity of the calculations. Intersection lighting levels and uniformity are defined below.

Roadway Classification	Average Maintained Illuminance at Pavement by Pedestrian Conflict (lux)			Average-to-Minimum Uniformity Ratio
	High	Medium	Low	
Arterial/Arterial	34.0	26.0	18.0	≦ 3.0
Arterial/Collector	29.0	22.0	15.0	≦ 3.0
Arterial/Local	26.0	20.0	13.0	≦ 3.0
Expressway-Highway/Arterial	31.0	25.0	18.0	≦ 3.0
Expressway-Highway/ Expressway-Highway/	28.0	24.0	18.0	≦ 3.0
Expressway-Highway/Collector	26.0	21.0	15.0	≦ 3.0
Expressway-Highway/Local	23.0	19.0	13.0	≦ 3.0
Collector/Collector	24.0	18.0	12.0	≦ 4.0
Collector/Local	21.0	16.0	10.0	≦ 4.0
Local/Local	18.0	14.0	8.0	≦ 6.0

Figure 18 - Intersection Illumination

2.3.3 Current Conditions

From discussions with the City of Hamilton and a review of few selected urban intersections in general the lighting follows the current recommended design practices.

2.3.4 Recommendations

Recommendations are listed below.

2.3.4.1 Where to Light

The rational for lighting urban intersections, is as follows:

1. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): It is proven in reducing vehicle to pedestrian collisions. It allows those in motor vehicles to view pedestrians crossing the road. This reduces personal injuries from a collision with a motor vehicle.

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2. Vehicular Road Safety (Vehicle-vehicle conflicts): It is proven in reducing vehicle collisions. It improves vehicle safety by improving visibility to other vehicles and road side hazards.
3. Pedestrian Safety (Navigating sidewalks, off-road, etc): Lighting is required to allow pedestrians to safely navigate the sidewalk. It provides increased visibility for those using sidewalk to allow them to see where they are going, reducing tripping or falling.
4. Safety and Security – Real: Though their may be benefits this is more specific to sidewalk lighting. It provides an improved level of personal security by improving their visibility and allowing for improved surveillance.
5. Safety and Security – Perceived: This is more specific to sidewalk lighting.
6. Commercial and City of Hamilton image enhancement: This is more specific to sidewalk lighting.

All urban intersection should be fully illuminated.

2.3.4.2 Lighting Levels

We recommend the City of Hamilton adopt illuminance and uniformity levels as defined above in Figure 18.

2.4 Rural Intersections

A rural intersection is an intersection in a rural area at which two or more non-continuously lighted roadways join or cross at the same level. A rural area is characterized by the absence of sidewalks, parking lanes, and nearby residential or commercial development. It is also usually characterized by the absence of significant pedestrian activity, particularly at night; however, this may not be the case where the intersection is used as a transportation assembly point (such as a school bus pickup point). To distinguish a rural road from roads traversing isolated undeveloped areas within a suburban or urban context, a rural road environment should extend at least 500 metres along the road alignment (33).

2.4.1 Research

The majority of research undertaken with respect to lighting rural roadways is focused on collisions. The analysis of lighting effects on collisions is extremely complex. Before-and-after studies of lighted routes are often based upon the percentage of collisions at night, as compared with the total, before and after the improvement. In many cases, studies of before and after improvements are measured over years and many other road changes can take place during that time which may skew the results (e.g., road improvements such as line painting, road widening, new development, changes to traffic volumes and patterns, etc.). These are factors which are typically not considered in the before-and-after results.

Extensive traffic counts are needed for a before and after analysis since the amount of night traffic varies greatly with the seasons of the year (14). An important factor concerns the amount of collision data gathered. Small numbers of collisions should not be compared, since they may represent chance occurrences which may skew results at a much greater degree than those studies with larger sample sizes. In this report, an effort has been made to gather and present findings from statistical studies with a larger number of collisions.

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A list of significant lighting studies analyzing the benefits of rural intersection lighting with respect to pedestrian safety are as follows:

- Although fewer than 6% of trips are undertaken on foot, 13% of all traffic fatalities occur among pedestrians. In 1997 and 1998, 13% of all traffic fatalities in the US were pedestrians (1). It is not known what percentage of sidewalks had lighting. Conclusions cannot be drawn on the value of lighting from these statistics. However, the facts show that walking outdoors during hours of darkness is less safe than in daylight hours.
- The University of Michigan Transportation Research Institute used information from the US Fatality Analysis Reporting System (FARS) to show that the added safety risk in darkness versus light is much higher for pedestrians than for any other road users. The use of alcohol by pedestrians appears to strongly magnify the effect of darkness for the risk of being killed. The comparative risk of a pedestrian crash is much higher in darkness than in daylight (by a factor of over 4 times), but the annual number of pedestrian crashes in darkness is sufficiently large to suggest that lighting targeted toward pedestrian visibility would save nearly twice as many lives as would be saved in collisions with other motor vehicles. Thus, the greatest lifesaving opportunity for lighting countermeasures appears to be in areas such as urban arterials, where both speed and pedestrian density are high (23).
- The University of Michigan Transportation Research Institute analyzed 11 years of traffic data from the US Fatality Analysis Reporting System (FARS) to investigate the sensitivity to light level of three crash scenarios: fatal pedestrian crashes at intersections, on dark roads, and single-vehicle run-off-road crashes on dark and curved roads (6). One method of analysis examined the abrupt light changes associated with the annual transition to and from daylight savings time. Significant information related to lighting is as follows:
  1. pedestrians may be 3 to 6.75 times more vulnerable in the dark than in daylight, depending on the circumstances
  2. the most practical means to extend the available time for avoiding pedestrian collision seems to lie in the improvement of lighting to illuminate objects farther ahead of the vehicle to extend available time to react.
  3. one clear conclusion from roadway lighting research shows that it reduces crash rates and particularly those crash rates involving pedestrians.
- Anderson et al studied the cost-effectiveness of different illumination levels at rural at-grade intersections in Nebraska. Six high pressure sodium (HPS) illumination configurations were examined: three two-luminaire systems using 100-watt, 200-watt, or 400-watt lamps, and three one-luminaire systems using the same lamp wattages. Two-luminaire systems were located in a diagonal configuration; the luminaire in the one-luminaire system was located on the far side of the intersection relative to the study approach. Using average approach speed, deceleration rates, and traffic conflicts as indicators of safety, the authors concluded that:
  1. the safest traffic operations were observed with a luminaire system composed of two 200-watt HPS lamps;
  2. at each wattage level, traffic operations were safer under a two-luminaire system than under a one-luminaire system;
  3. traffic operations with the 100-watt HPS luminaire systems were no safer than those with no lighting system.

Results cited by both Anderson and Schreuder suggest that safety does not necessarily increase with increased illumination. Schreuder concluded that increasing illumination beyond an optimum level resulted in little or no increase in traffic safety (33).

A list of significant lighting studies analyzing the benefits of rural intersection lighting with respect to vehicle collisions are as follows:

- When driving at night, motor vehicle headlamps are the primary means for improving driver visibility. By law, all motor vehicles must have operating headlamps. When considering the benefit for fixed roadway lighting, the advancements in vehicle headlight systems and how they impact safety must also be considered. The University of Michigan Transportation Research Institute analyzed fatal crash trends in the United States between 1990 and 2006. Changes in the ratio of crashes in darkness to crashes in daylight were assessed to determine whether recent improvements in vehicle headlights influenced the day to night crash ratio. The report noted that sharp declines were observed in rural crashes as result of improved vehicle headlamps while no significant changes were observed in levels of urban crashes. The research therefore indicates that advancements in vehicle headlights have had the biggest benefit on unlighted rural roads (26).
- The Region of Waterloo, Ontario, tracked collisions on regional roads over a four year period. At stop-controlled intersections they found the night-to-day collision ratios to be similar whether lighted or unlighted (under 0.3:1). This was based on fewer than 3,800 collisions at intersections with lighting, and 700 collisions in intersections without lighting. Illumination levels and uniformities at intersections were not provided with this information. It is, therefore, unknown what level of illumination and what uniformity the intersections were designed (7).
- A study undertaken by the Kentucky Transportation Center, found a large number of the locations identified as having a high night-time crash rate were rural locations where the night-time crashes could be addressed with improved delineation (pavement markings and signing). There was found to be an overrepresentation of night-time crashes compared to night-time annual daily traffic. The higher percentage of crashes during darkness compared with the percentage of volume during this time period shows the higher crash rate at night. Using a limited number of sites, it was shown that night-time crashes were reduced approximately 45% after the addition of roadway lighting at intersections. In many cases, the cost of roadway lighting can be justified based on the reduction in crashes (11).
- A 2004 study analyzed the effects of street lighting on crashes at 34 rural Minnesota intersections before and after installing lighting. The lighting installation dates ranged from 1985 to 2000. The "before and after" analysis showed a 27% reduction in night crash frequency, a 32% reduction for the ratio of night to total crashes, and a 35 percent reduction in the night crash rates after lighting was installed. Late-night/early-morning injury related crashes decreased by 41% after the lighting was installed. Late-night/ early-morning crash severity (ratio of night-time injury and fatal crashes to total crashes) also decreased by 20% (34).
- A "before and after" study in Kentucky analyzed the safety benefits associated with roadway lighting at 9 intersections. The lighting installation dates varied between 1998 and 2000. A significant number of the locations identified were rural; however, some urban sites were also included. The number of crashes per year was obtained for up to 4 years prior to the

lighting installation and 3 years after installation. The analysis found that late-night/early-morning crashes were reduced by 45 percent after installing the lighting (34).

- Preston and Schoenecker (1999) conducted a "before and after" analysis for a sample of 12 intersections selected by Minnesota Department of Transportation. At intersections where street lighting was installed (between 1987 and 1994), researchers observed an overall decrease in the late-night/early-morning crash rate from 1.41 crashes per million vehicles entering before lighting to 0.84 after lighting resulting in a decrease of approximately 40% in the late-night/early-morning crash rate. After installing street lighting, the late-night/early-morning multiple-vehicle crash rates declined from 0.48 before lighting to 0.18 after lighting, a 63 percent reduction. The late-night/early-morning single-vehicle crash rate also declined from 1.55 before lighting to 1.03 after lighting, a 33% reduction. The results of this study concluded that installing street lighting at rural intersections resulted in a 25-40% reduction in the overall night-time crashes, as well as an 8-26% reduction in the night-time injury crashes (34).
- A survey of all states in the US, undertaken by the Kentucky Transportation Center (11), found that most states used information from either AASHTO Roadway Lighting Design Guide (27) or IESNA RP-8-00 American Standard Practice for Roadway Lighting (28) as a basis for their warrant and design of highway lighting. The survey notes that interactive night-time critical rate analysis programs should be used to identify high crash sites and sites with the highest critical rate factors. These should be evaluated to determine whether lighting or additional methods of delineation/guidance should be installed. Based on their survey of state highways and crash analyses, they recommend that roadway lighting is warranted in the following applications:
  1. rural intersections with traffic signal
  2. rural intersections with raised channelization
  3. high pedestrian volume areas
  4. railroad crossings with gates or signals
  5. rural intersection in location where fog is a common occurrence
  6. rural intersection with high volume of large trucks pulling from a side road (note that additional lighting might be necessary upstream from the intersection to allow the large trucks to attain travel speed while in the lighted area)
- Changes in the frequency of night-time collisions attributable to the presence of illumination are summarized in the figure below. Night-time collision reductions of about 25 to 50% have been observed at illuminated rural intersections (33).

REFERENCE[1]	EFFECT OF STREET LIGHTING	COMMENTS
Walker and Roberts	49% overall reduction in night-time collisions	based on collision frequency before and after introduction of lighting at 47 rural at-grade intersections in Iowa
Lipinski and Wortman	45% reduction in night-time accident rate	based on comparison of illuminated (263 intersection-years) and unilluminated (182 intersection-years) rural at-grade intersections in Illinois
J. Salminen (reported in CIE)	25% average reduction in night-time collisions	based on collision frequency before and after introduction of lighting at 74 non-freeway rural junctions in Finland; the results indicate a rise in casualty (fatal and injury) accidents for isolated intersections
Onser (reported in CIE)	25% reduction in night-time collisions	based on comparison of 82 illuminated and 85 unilluminated rural junctions in France, chosen for their similar traffic flows and physical characteristics

Figure 19 - Results from Previous Studies

- Walker and Roberts examined the performance of 21 intersections at which drivers were required to navigate a route that entered in one direction and departed in another. They reported that this group of intersections showed a significant reduction in the night-time collision rate after the introduction of illumination, from a rate of 2.45 collisions per million entering vehicles to 1.13 collisions per million entering vehicles. The authors concluded that the addition of lighting reduced the risks associated with this kind of night-time navigation (33).

In recent years a number of research projects have been undertaken to define the benefits of lighting rural intersections. The benefits of lighting are typically much greater in urban areas than in rural areas, with the exception being at rural intersections where the studies and benefit are well proven. The studies show that roadway lighting has significant collision reduction benefit at rural intersections. Rural intersection lighting has shown to reduce overall late-night/early-morning crashes across these intersections by a weighted average of 35 percent (34). Most research indicates providing overhead lighting where necessary, can reduce late-night/early-morning crashes at rural intersections.

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2.4.2 Standards

The Transportation Association of Canada (TAC) Illumination of Isolated Rural Intersections (34) provides a warranting system based on geometric, operational, environmental and collision factors. The critical factors determining the need for illumination are traffic volumes and night-time collisions.

The warrant point score indicates whether full intersection lighting, partial lighting or delineation lighting is needed. Full intersection lighting denotes illumination covering an intersection in a uniform manner over the traveled portion of the roadway. Partial lighting is the illumination of key decision areas, potential conflict points, and/or hazards in and on the approach to an intersection. The illumination of vehicles on a cross street or median crossing, or lighting that marks an intersection location for approaching traffic is referred to as sentry or delineation lighting.

2.4.3 Current Conditions

The City of Hamilton typically provides delineation lighting at rural intersections. This consists of a single davit pole to mark the intersection. No specific lighting levels or uniformity are adhered to. The City of Hamilton use cobra head style luminaries with a drop glass refractor optical system to allow the luminaire to be viewed from a distance.

2.4.4 Recommendation

Recommendations are as follows:

2.4.4.1 Where to Light

The rational for lighting specific urban intersections, is as follows:

1. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): It is proven in reducing vehicle to pedestrian collisions. It allows those in motor vehicles to view pedestrians crossing the road. This reduces personal injuries from a collision with a motor vehicle.
2. Vehicular Road Safety (Vehicle-vehicle conflicts): It is proven in reducing vehicle collisions. It improves vehicle safety by improving visibility to other vehicles and road side hazards.
3. Pedestrian Safety (Navigating sidewalks, off-road, etc): Lighting is required to allow pedestrians to safely navigate the sidewalk and crosswalk. It provides increased visibility for those using sidewalk and crosswalk to allow them to see where they are going, reducing tripping or falling.
4. Safety and Security – Real: This is more specific to sidewalk lighting. It provides an improved level of personal security by improving their visibility and allowing for improved surveillance.
5. Safety and Security – Perceived: This is more specific to urban areas
6. Commercial and City of Hamilton image enhancement: This is more specific to urban areas.

We recommend the TAC Illumination of Isolated Rural Intersections warranting system be applied to determine whether full, partial, delineation or no lighting is required.

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2.4.4.2 Lighting Levels

We recommend the intersection lighting requirement in the TAC Guide for the Design of Roadway Lighting be followed for all rural intersections.

2.5 Alleyways

Alleyways exist throughout the City of Hamilton. They are low speed and low traffic volume roads in urban and rural areas. Alleyway lighting was typically found to very inconsistent.

A residential alley (photo below to the left) and a commercial alley (photo below to the right) have different applications. In a residential application, the main usage would stem from local residents parking their cars. For commercial applications, some laneways could provide vehicle access to a business that may have higher night-time traffic and use.

Figure 20 - Residential and Commercial Alleyway Examples

2.5.1 Research

To the best of our knowledge there is no research to support lighting, or not lighting alleyways.

2.5.2 Current Conditions

Alleyway lighting was reviewed on various typical urban and rural roads throughout the City of Hamilton. Alleyway lighting was generally found to be very inconsistent with respect to lighting levels and uniformity

2.5.3 Police Comments

On November 24th, 2009, Glenn O'Connor, a member of the consultant design team, and Mike Field, the City of Hamilton Project Manager, met with Sergeant Michelle Moore and her team of 13 street beat officers to review lighting issues and concerns in the downtown core.

The police group also noted lighting of alleyways can be a challenge and a concern as it provides a sense of comfort and security which may in fact be misleading. It was noted that, when entering an alleyway, the criminal generally has the upper hand due to lack of natural surveillance from the roadway and the number of concealed areas within an alleyway for which a criminal can hide.

From a security standpoint, the police noted lighting a alleyway can pose a hazard in itself as it can lead pedestrians into an area of hidden danger. Many commercial alleyways have low night-time traffic with little natural surveillance from the City street or windows. Pedestrians may walk into a well lit alleyway thinking they are safe when, in fact, there may be hidden areas that pose risk.

It was strongly suggested by the police that an alleyway should not “invite one” into an unsafe area. In a situation where the alleyway is the only route, it should be well lighted throughout. However, personal safety would typically be improved if pedestrians used the sidewalk adjacent to the roadway, rather than side alleys which typically have little natural surveillance.

Where lighting is required, motion sensor activated lighting was strongly preferred over lights which are on continuously. If alleyways are lighted, then all alcoves and hidden areas must also be lighted to reduce surprise attacks. It was noted that the City of Hamilton should encourage private property owners to maintain and/or, where required, upgrade the existing lights. The police prefer motion sensitive lights; so that activity can be noticed by neighbours or from adjoining streets as the lights turning on indicate activity.

The Hamilton Police Service identified specific problem areas as follows:

- Alleyway, Mary St. to John St., King William/John, is an issue
- Alleyway, James to Wellington, between the parallel streets King to King William, is an issue.
- Concession St. alleys, some low-level lighting: not great.

2.5.4 Public Stakeholder Input

No public stakeholder input was received for alleyways.

2.5.5 Recommendation

Alleyways shall not be lighted unless they are the only route of access/egress or the application for lighting has been reviewed and approved based upon consultation with City Traffic Engineering Staff, Hamilton Police Services and the governing BIA Management board (if applicable). Alleyway lighting requests received by the City shall be reviewed on a case-by-case scenario.

The installation of privately owned and operated lighting within alleyways for security purposes shall be permitted. It is encouraged that motion sensor activated fixtures be utilized whenever possible.

When alleyway lighting is required, sidewalk lighting levels for a commercial area with low pedestrian activity shall apply unless medium or high pedestrian activity is anticipated then higher lighting levels for medium or high activity shall apply.

In addition to the above, it is recommended to install supplemental lighting at the entrance/exit of alleyways at the street, especially in commercial areas with high night-time pedestrian activity. From a safety standpoint, the additional lighting should benefit motor vehicle visibility from both the pedestrian's and driver's standpoint. From a security standpoint, the supplemental lighting will aid in the pedestrian's ability to see a potential attacker hiding in the alleyway.

2.6 Hardware

The current lighting equipment inventory in the City of Hamilton is comprised of a wide variety of different poles and luminaries of various ages. As a result, the operation and maintenance of the inventory can be complicated and expensive. Based on information provided by the City of Hamilton, we have reviewed the different types of equipment in order to determine if their functionality and distribution are appropriate to satisfy the requirements recommended. This report establishes a list of standardized lighting equipment that can be maintained consistently across the City of Hamilton.

2.6.1 Existing Lighting Equipment

In general, existing roadway luminaires in the City of Hamilton fall into two types: the cobra head and decorative lights.

Cobra head luminaires are a very inexpensive and efficient. They are the most widely used outdoor roadway lighting luminaire. They look the similar from one supplier to the other. Cobra head style luminaires of varying wattages make up a large percentage of the City of Hamilton’s street lighting inventory. The cobra head luminaires used throughout the City of Hamilton have a drop lens type optical system, as shown for the left luminaire in figure 21, whereas the luminaire to right in figure 21 has a flat glass optical system. A drop lens optical system in more effective at distributing light from the luminaire however is less effective in terms of control of discomfort glare and spill light onto local residences. The luminaire with the flat glass optical system is more effective in reducing glare and unwanted up-light, referred to as urban sky-glow. The City of Calgary recently replaced all their drop lens cobra head luminaires with flat glass to reduce up-light impacts.

Cobra head luminaires are typically installed on an arm referred to as a davit arm. The davit arm is intended to get the luminaire out over the roadway to improve the distribution of the light.

Figure 21 - Cobra Head Luminaires

Figure 22 - Examples of Cobra Head Lighting on Poles

Decorative luminaires are more unique in appearance than cobra head luminaires. In general, the City of Hamilton has a number of different styles of decorative luminaires. There is no exact industry terminology for each luminaire type, however general terminology has been applied across the industry. The typical styles which exist within the City of Hamilton are globe, acorn, traditional and teardrop.

Figure 23 - Globe Style Luminaire

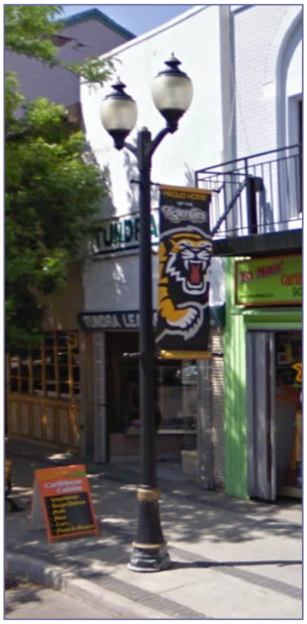

Figure 24 - Single and Double Acorn Style Luminaires

Figure 25 - Traditional Style Luminaires

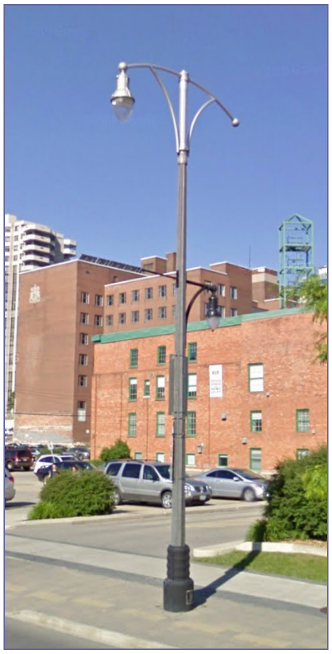

Figure 26 - Teardrop Style Luminaire

Globe, acorn, and traditional style luminaires are mounted on post top style poles. The teardrop style luminaires are mounted on ornamental davit style poles. Most poles which exist within the City of Hamilton are concrete. Some poles are steel with a powder coat finish. Steel poles are primarily located in the Downtown or in BIA's.

The inventory of existing poles and luminaires is shown in the table below. In general the existing lighting equipment is appropriate to satisfy the requirements recommended.

Area	Pole Type	Luminaire Type	Manufacturer	Model No.	Distribution Type	Pole Height (m)	Lamp Wattage (W)	Lamp Type	IES File No.	Remarks
Ancaster BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Ancaster BIA	Post-Top	Traditional	Cooper	TRR Traditionaire	Type III	5.0	100	HPS	TRR-100-HPS-XX-3	
Barton Village BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Barton Village BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	100	MH	LU200119	
Concession Street BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Dundas BIA	Post-Top	Single Acorn	King	K118	Type II	5.0	150	HPS	C1405P	
Dundas BIA	Davit	Codra Head	GE	M250A	Type II	7.5	150	HPS	GE7230	
Dundas BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Downtown Hamilton BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Downtown Hamilton BIA	Post-Top	Single Globe	US Architectural	LG16	Type V	5.0	100	HPS	LGWA-15S	
Downtown Hamilton BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	175	MH	LU200119	
Downtown Hamilton BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	200	MH	LU200119	
Downtown Hamilton BIA	Davit	Codra Head	GE	M250A	Type II	7.5	100	HPS	GE7230	
Downtown Hamilton BIA	Post-Top	Double Globe	US Architectural	LG16	Type V	5.0	100	HPS	LGWA-15S	
Downtown Hamilton BIA	Ornamental Davit	Teardrop	Holophane	ESPLANADE	Type IV	9.0	250	MH	ESU250MH00X4	
Downtown Hamilton BIA	Post-Top	Single Acorn	King	K118	Type II	5.0	100	HPS	C1405P	
International Village BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
International Village BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	200	MH	LU200119	
International Village BIA	Davit	Codra Head	GE	M250A	Type II	7.5	100	HPS	GE7230	
International Village BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	175	MH	LU200119	
International Village BIA	Post-Top	Single Acorn	King	K118	Type II	5.0	100	HPS	C1405P	
King Street West BIA	Post-Top	Double Acorn	Lumec	L50	Type V	5.0	200	MH	LU200119	
Locke Street BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Main Street West BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Ottawa Street BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Stoney Creek BIA	Post-Top	Single Acorn w/ Gold Ring	King	K118	Type II	5.0	150	HPS	C1405P	
Stoney Creek BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Stoney Creek BIA	Davit	Codra Head	GE	M250A	Type II	7.5	70	HPS	GE7230	
Stoney Creek BIA	Davit	Codra Head	GE	M250A	Type II	7.5	150	HPS	GE7230	
Waterdown BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
Waterdown BIA	Post-Top	Traditional	Lumec	L30	Type III	5.0	100	HPS	LU200131	
Waterdown BIA	Davit	Codra Head	GE	M250A	Type II	7.5	70	HPS	GE7230	
Waterdown BIA	Davit	Codra Head	GE	M250A	Type II	7.5	100	HPS	GE7230	
Westdale Village BIA	Post-Top	Single Acorn	King	K118	Type II	5.0	100	HPS	C1405P	
Westdale Village BIA	Davit	Codra Head	GE	M400A	Type II	9.0	250	HPS	GE1007	
General	Davit	Codra Head	GE				100	HPS		
General	Davit	Codra Head	GE				150	HPS		
General	Davit	Codra Head	GE				250	HPS		

Table 4 - Specific Lighting Equipment Inventory

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2.6.2 Recommended Equipment Requirements

Each style of luminaire used by the City of Hamilton may look similar to another style, however they have been supplied by a number of manufacturers with a number of varying optical configurations. Many of these luminaires may have been selected more from an appearance standpoint, rather than from the standpoint of optical performance.

2.6.2.1 Optical Systems

Listed below is a review and recommendation for luminaire optical systems.

2.6.2.1.1 Cobra Head Luminaires

All cobra head luminaires should have full cut-off or cut-off style (flat glass or sag lens) optics in residential areas to reduce the off roadway lighting impacts on local residents. In commercial and industrial areas luminaries with semi cut-off, cut-off or full cut-off style (flat, sag or drop lens) optics can be used however luminaries with full cut-off or cut-off style optics can improve driver visibility by reducing veiling luminance. For delineation lighting at rural intersections luminaries with semi cut-off (drop lens) optical systems should be used so the light source can be viewed from a distance to mark the intersection.

From an optical performance and energy efficiency standpoint, all cobra head luminaires should meet the minimum unit power density performance requirements of CSA C653 Photometric Performance of Roadway Lighting Luminaires.

2.6.2.1.2 Decorative Luminaires

In terms of common products used within the City of Hamilton, post top pole mounted acorn, globe, and cobra head style luminaires on davit arms are most commonly used. In the past, optical systems have been loosely specified more based on an appearance selection made by the architect.

When considering post top style luminaires, a wide range of optical systems are available. Common types available and used by the City of Hamilton along with a complete assessment of the various optical systems are as follows:

- **Internal Reflector Optics -** Located inside a protective glass or plastic enclosure, the internal refractor redirects the light into the desired light pattern (ref figure 27). This optical system is available in a wide range of luminaire styles. It is effective at getting the light out of the luminaire, however, it tends to be very glary. They have little to no up-light cut-off so they are not dark sky friendly. Future use of this optical system is not recommended.

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Figure 27 - Internal Reflector Optics

- **External Reflector Optics -** The light is redirected into the desired light pattern when passing through the external prisms located in the lens (ref figure 28). This optical system is available in a wide range of luminaire styles. It is effective at getting the light out of the luminaire, however, it tends to be very glary. They often have little to no up-light cut-off so they are not dark sky friendly. Further use of this optical system is not recommended.

Figure 28 - External Refractor Optics

- **Louvered Reflector Optics -** The lamp is surrounded by an aluminum louver system which shields the viewer from direct view of the lamp (ref figure 29). This provides cutoff and semi-cutoff performance, as the spun aluminum louver system reflects and redirects the light. Though not as efficient as the internal and external refractor optical systems, it provides reduced glare which aids in visibility. This optical system is recommended and could be considered for future use.

Figure 29 - Louvered Reflector

- **Segmented or Hydro-formed Reflector Optics -** The reflector and lamp are specifically located in the top of the luminaire to minimize glare and up-light, providing cutoff characteristics (ref figure 30). A segmented reflector, comprising various pieces of aluminum that are positioned around the lamp, produces the required light distribution. An alternate hydro-formed reflector can also be used. It differs in that it is formed out of a single sheet of aluminum. Hydro-formed reflectors are typically used for cobra head style luminaires as they can be easily mass produced. The reflector directly addresses the issues of glare, light pollution, and light trespass without significant loss of efficiency. This optical system is capable of producing cutoff and full cutoff light classification through the use of a horizontal lamp. This optical system is recommended and could be considered for future use.

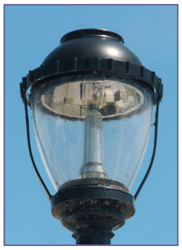


Figure 30 - Segmented or Hydro-formed Reflectors

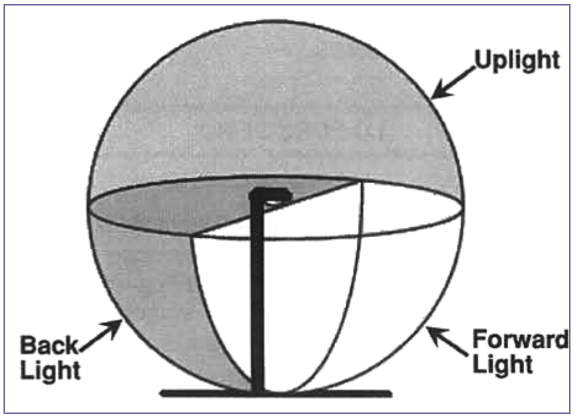
2.6.2.1.3 Photometric Comparison of Light for Various Luminaire Optics

A new method referred to as the Luminaire Classification System (LCS) has been developed to better define luminaire distribution and efficiency. IESNA TM-15 Luminaire Classification System for Outdoor Luminaires defines this system in more detail. The LCS replaces the traditional IESNA luminaire cutoff classification system which uses designations like cutoff, non-off, semi-cutoff, and full cut-off. The traditional system was very limited as it only assessed the light distribution at very high angles and above horizontal.

The LCS defines a method of evaluation and comparison of outdoor luminaires. It provides a basic model which defines maximum lumens within defined angles within primary areas. The primary LSC areas are forward light, back light, and up-light zones as defined in the left of figure 31. Each of these zones is further broken into solid angles within the area. An example of the forward light zone is shown in the right of figure 31.

The sum of percentages of lamp lumens within these three primary areas is equal to the photometric luminaire efficiency. The LCS enables designers to evaluate and compare the distribution of lumens for various types of luminaire optics, thus assisting in the selection of the luminaire most appropriate for the application. An example of measurements for various luminaires is defined in figure 32.

The benefit of this system, is that it allows a designer to better select the optimal optics for a given application while at the same time reducing light trespass impacts and sky glow. The new classification system is intended to be used as a tool to assess the light output of luminaires.



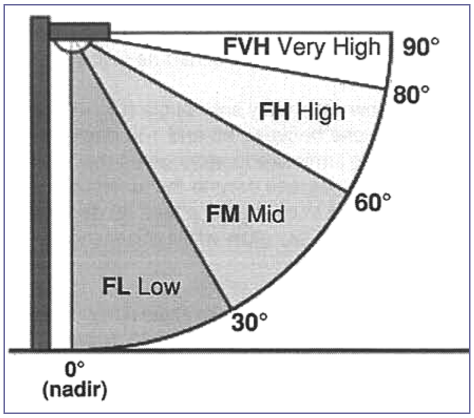


Figure 31 - Lamp Lumen Zones and Front Light Zone (from IESNA TM-15)

The LCS zones for various luminaire optical systems are calculated and shown in Figure 32 below.

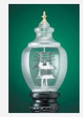
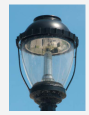
Metal Halide	 Internal Refractor Optic (250 W Type V)	 External Refractor Optic (250 W Type V)	 Louvered Reflector Optics (250 W Type III)	 Hydro-formed Refractor Optics with Horizontal Lamp (250 W Type I)	 Sag Lens Refractor Optics (250 W Type III)	 Sag Lens Refractor Optics (250 W Type I)	 Sag Lens Refractor Optics (100 W Type I)
Forward Light							
Luminaire Lumens	4133.4	5405.6	6306.5	6487.6	10115.6	10557.0	3716.3
% Lamp Lumens	19.70%	25.70%	30.00%	29.50%	46.00%	48.00%	45.90%
FL (0°-30°)	0.20%	0.90%	1.20%	2.40%	7.40%	13.10%	12.60%
FM (30°-60°)	5.40%	3.70%	14.40%	15.30%	27.20%	24.80%	23.40%
FH (60°-80°)	8.90%	17.30%	12.90%	11.20%	11.20%	10.00%	9.60%
FVH (80°-90°)	5.10%	3.80%	1.40%	0.50%	0.20%	0.10%	0.20%
Back Light							
Luminaire Lumens	4133.4	5352.5	4220.2	4880.5	5384.3	7138.1	2465.6
% Lamp Lumens	19.70%	25.50%	20.10%	22.20%	24.50%	32.40%	30.40%
BL (0°-30°)	0.20%	0.90%	0.80%	2.30%	5.40%	7.70%	7.20%
BM (30°-60°)	5.40%	3.60%	9.40%	13.20%	14.50%	17.00%	16.10%
BH (60°-80°)	8.90%	17.10%	8.80%	6.00%	4.40%	7.60%	7.00%
BVH (80°-90°)	5.10%	3.90%	1.00%	0.70%	0.10%	0.10%	0.10%
Up-light							
Luminaire Lumens	9997.6	2477.0	957.5	163.2	0.0	0.0	0.0
% Lamp Lumens	47.60%	11.80%	4.60%	0.70%	0.00%	0.00%	0.00%
UL (90°-100°)	10.70%	2.40%	1.40%	0.50%	0.00%	0.00%	0.00%
UH (100°-180°)	37.00%	9.40%	3.20%	0.20%	0.00%	0.00%	0.00%

Figure 32 - Lamp Lumens Zones for Various Decorative Luminaires

When reviewing the lumens for each area and angle the acorn style luminaires can be compared as follows:

- Internal Refractor - Good forward and back light distribution, however too much up-light and as such this optical system is not recommended.
- External Refractor - Better up-light control however too high a percentage of light in the Backlight High (BH) and Backlight Very High (BVH) angles. The same downfall applies for the corresponding front angles which means that the luminaire will be quite glary and should not be considered.

- Louvered and Hydro-Formed Optics - Both have fairly similar light distribution characteristics with minimal up-light. These are both good optical systems.

2.6.2.1.4 The BUG System

The LCS has been refined into the IESNA Backlight-Up-light-Glare (BUG) rating system which establishes back (B), up-light (U), and glare (G) zonal lumen limits for luminaires. See the IESNA TM-15-07 (Revised) Luminaire Classification System for Outdoor Luminaires for complete details.

The BUG ratings apply only to fixed position luminaires installed according to the photometric data. If the luminaire is aimable (e.g., such as with a floodlight), then it cannot have a BUG rating unless it is provided by the manufacturer for a specifically installed aiming angle.

Each category (backlight, up-light, and glare) consists of specific regions that surround the luminaire. Each region has specific upper limit criteria that must be met to obtain the rating. All of the criteria must be met for a luminaire to obtain the generalized B, U, or G rating. So, the rating for a specific metric is set by the lowest (highest zonal lumen value) performance criterion within the metric. The limits vary according to the lighting zone (LZ0 – LZ4) in which the luminaire is located.

Once this calculation is performed for each of the three metrics, the composite BUG rating can be reported. Forward, Back and Up-light Zones and Forward Light Zones show the BUG regions. Solid angle references are based on a sphere of data points around a luminaire.

Backlight considers the light leaving a luminaire in the opposite direction from the main aiming angle of the light. This is the percent lamp lumens or the luminaire lumens distributed behind a luminaire between 0º vertical (nadir) and 90º vertical. Within a lighting zone, the backlight rating will change depending on the luminaire's proximity to the property line. Backlight is evaluated for high (60º–80º), medium (30º–60º) and low (0º–30º) areas.

Up-light measures the total light propagating from the luminaire in a near-horizontal or above-horizontal direction. This is an overall measure of the amount of light directly leaving the luminaire that may be associated with sky-glow. This measures the percent lamp lumens or the luminaire lumens distributed above a luminaire between 90º and 180º vertical. Up-light is evaluated for high (sky-glow: 100º–180º), low (90º–100º), forward light very high (80º–90º), and backlight very high (80º–90º).

Glare is the sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted. It causes annoyance, discomfort, or loss in visual performance and visibility. Glare considers the light leaving a luminaire in the angles that are most likely to be a source of nuisance (or disabling) to passers-by either within or outside the property boundaries. The light that causes glare is also sometimes presumed to be a source of light trespass problems. However, in most cases, glare complaints are due to the brightness of the source and not because of spill light levels. For this reason, it is treated separately from the Backlight metric. Glare is evaluated for forward light very high and backlight very high (80º–90º), forward light medium (60º–80º) and backlight medium (60º–80º).

Note that the Up-light and Glare regions overlap as do the Glare and Backlight regions. While Glare is generally only considered important up to horizontal, the Up-light region has been shown to be important below horizontal, down to about 80°. Since these criteria regions are not intended to be additive or comprehensive to the complete output of the luminaire, this overlap is not a calculation inconsistency.

The region from directly below the luminaire forward to 60° is not considered in any of the criteria regions. This region is generally considered the 'safe' region of lumen output, where the light from a luminaire will be falling on the task area in an effective manner, and is also the region where the majority of lumens are outputted. Beyond this unmeasured region, the light may begin to be a source of glare, light trespass, sky-glow, or other concerns.

2.6.2.2 Key Luminaire Selection Considerations

A key task for the roadway lighting designer will be the selection and specification of products and equipment. Many manufacturers produce outdoor lighting equipment that is marketed and available throughout North America.

The use of high quality products is critical to prolonging the overall operating life of roadway lighting systems. Quality relates to the features and characteristics of a product that impact on its ability to satisfy stated or implied needs. Quality could be overlooked if low price is the primary criterion for product selection. Quality, however, should be a key consideration in product selection.

Focusing on price alone, typically, will not deliver best value installations when compared to a process that includes the scrutiny of quality considerations. In addition to quality, other key considerations when specifying a product should include the following:

- Certification – Electrical products must be certified by an organization accredited by the Standards Council of Canada, and shall bear an appropriate label such as Underwriters' Laboratories of Canada (cUL) or Canadian Standards Association (CSA).
- Photometric Performance (for luminaires) – A photometric comparison of luminaires is critical to selecting the best product for a given application. Cobra head luminaries can be compared using the CSA 653 model. Comparisons should be based on photometric data provided by the supplier from an independent testing laboratory. The IESNA cutoff classification for luminaires should be known and deemed appropriate for the situation. In general, cutoff or full-cutoff optics should be used wherever possible.
- Durability – Durability is the capability of a product to resist deterioration, damage, and corrosion over time. Designers should understand the potential for vandalism and the corrosive nature of the project's environment, and then relate those variables to the specific products under consideration.
- Aesthetics – Products selected should be aesthetically compatible with their surroundings. Manufacturers offer a wide range of equipment with respect to shape, configuration, colours, and styles. Similar or identical-looking products should be used, if possible, when the new installation will be integrated with existing installations. The height of lighting structures should be visually compatible with the height of other structures in the area.

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- Availability – Custom and/or decorative products or products manufactured in small quantities often have long lead times for replacement. Designers should verify that the products selected will be available to avoid construction schedule impacts. Also, they should confirm that parts or complete replacement units will be available following installation. If products or parts will not be readily available, the designer should advise the owner to consider purchasing replacement units or parts to stock for maintenance purposes.
- Maintenance Requirements – Maintenance considerations include ease of access for servicing as well as maintenance frequency and level of service required over the product's anticipated useful life.
- Operations Cost – Similar products can result in varying cost of operations. This is particularly true of products that consume energy. The designer should review operational costs when specifying products and choose those products that are both economical to operate and provide the required performance.

It is recommended that the use of polycarbonate and acrylic lens materials be avoided since lenses in luminaires above 150 watts will become discoloured and brittle due to the heat generated by operation of the luminaire.

The capital cost of an item (also known as the supply cost), though not listed previously, is an important consideration. Supply costs, however, should not be the primary factor when selecting products. To assess a product's true cost, other factors must be considered to confirm best value and performance, or life cycle of a product.

Whenever possible, individuals specifying products are encouraged to designate more than one manufacturer with similar or equal products to reduce costs via competitive bidding. All products proposed, however, should be reviewed for conformance to stated specifications and performance requirements. In some cases a specific product or manufacturer may need to be sole sourced because of the products enhanced performance, a special appearance or simply to match the existing adjacent conditions.

Designers should note that the physical appearance of a product may be unrelated to its performance. Products that look similar may perform quite differently. In order to allow competition in the marketplace and ensure that quality is maintained, performance specifications should be developed and strictly enforced. It is recommended that the owners develop product specifications that are applied throughout their jurisdictions. Based on these specifications, jurisdictions may wish to pre-approve standard products of known similar performance in advance of design or tendering.

If a specific custom product is required for a given application, the number of suppliers may be limited to one, which is known as "sole-sourcing." Prior to sole-sourcing a product, it is appropriate to consult the owner to determine if there are statutory or administrative restrictions to this form of procurement. Due to the unique nature of sole-sourcing, pricing should be negotiated up front with the supplier prior to bidding to maintain cost control. Products should not be sole-sourced if characteristics that make the product unique are incidental to their performance or the requirements of the project.

Specific luminaire requirements are as follows

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- Ingress Protection (IP) Rating - Optical systems should be well sealed to prevent the entry of dust and water. Luminaires should have an IP rating of 65 or 66 for maximum performance.
- Lens Material - Lenses should be composed of glass. Polycarbonate and acrylic materials, though more impact resistant, tend to discolour over time which will reduce light output and will often require replacement in around 5 years.
- Housing - The housing should be made of aluminum with a powder coat exterior finish. The luminaire should be designed to securely attach to the pole. The luminaire should be designed for easy access for electrical and lamp changes via a tool-less entry
- Internal Electrical - Internal components will include a ballast, a starter and, a capacitor. The ballast should be a constant wattage auto-transformer (CWA) type.
- BUG Ratings – The luminaire optics should meet the specific BUG ratings where they are available.

2.6.1 Recommended Styles

Luminaires are available in many different styles and shapes, which lend the immediate area, a unique appearance. Some different styles of luminaires for consideration are listed below. These luminaires all have excellent cutoff optical systems which reduce glare and urban sky-glow.

The challenge in developing street lighting styles that are appropriate for their context, is as a result of the dynamic changes which Cities constantly undergo. Traditionally-styled luminaires are very effective in neighborhoods where entire streets or sectors are comprised of heritage buildings.

However, many neighborhoods are comprised of buildings of mixed use and they might have been built during different historical periods. The challenge for these streets is to choose the appropriate luminaires that blend with a variety of building types and styles. For these areas, transitional luminaires may be an appropriate choice. Neighborhoods where contemporary buildings dominate may benefit from street lighting styles which are contemporary in appearance.

Notwithstanding all of the above, the choice of lighting and other street furnishings is a highly subjective process. There are many examples in European Cities (which have an abundance of centuries old buildings) where highly contemporary lighting and street furnishings are placed against ancient stone facades, resulting in a high quality aesthetic.

The following examples of street lighting are illustrations of typical heritage, transitional, and contemporary elements recommended for streetscape projects.

2.6.1.1 Traditional

All of the manufacturers have traditional styles of luminaires. The "acorn" type of luminaire seems to be reasonable with respect to the representation of a heritage style. It also appears to be the preferred style in downtown Hamilton's heritage areas.

Our preferred style is the plain one without much additional detailing aside from the glass cover itself. The reason for this is that it may lend itself to a greater variety of streetscapes. Some heritage districts may require the more detailed type of acorn luminaire, as seen in some of the other examples below.

Figure 33 - Acorn Style Luminaire Example

2.6.1.2 Heritage

The following examples are described as contemporary in some suppliers product literature. However, heritage might be a better description when compared to some of the other contemporary luminaires on the market.

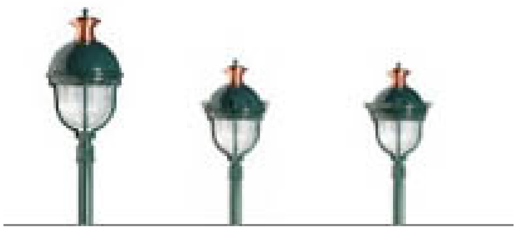

Figure 34 - Heritage Style Luminaire Example

2.6.1.3 Transitional

Transitional luminaires were chosen for their ability to be the "happy medium" in mixed neighbourhoods that may contain heritage and contemporary buildings (as well as a lot of in-between types).

Figure 35 - Transitional Style Luminaire Examples

2.6.1.4 Contemporary

Contemporary luminaires perform and mount similar to a cobra head style luminaire however offer a more unique look.

Figure 36 - Contemporary Luminaire Example

2.6.2 New and Developing Energy Saving Lighting Technologies

Listed below are new and developing energy savings technologies.

2.6.2.1 LED Luminaires

Light emitting diodes (LEDs) are currently the buzz of the lighting world, getting the majority of the attention. Nearly every major lighting manufacturer is promoting LEDs as the wave of the future. To date, LEDs have been used for decorative applications where color changing is required. They have also become the standard for traffic signals and emergency exit signage that in the past have used alternate sources.

LED street lights are very new and as such are still evolving very rapidly. A few years ago, such luminaires were not close efficiency-wise to proven sources such as high pressure sodium. Lighting manufactures are investing extensive capital and research into developing new LED products. The transition from suppliers producing high intensity discharge type sources to LEDs has been very rapid in the last few years.

To date, product specifications are lacking as LED street lights are very new to the market place and still evolving. Little is known about their long-term performance. Product design and quality varies from supplier to supplier as each has their own method of to how to utilize the technology. In street light applications, LEDs themselves continue to evolve and are now often outperforming traditional cobra head luminaires.

In one recent project in the autumn of 2009, LED Roadway Lighting Limited (LRL), the Province of Nova Scotia, ecoNova Scotia, and Conserve Nova Scotia partnered on a pilot project to retrofit existing high pressure sodium street lights with new LED street lights in at least 10 municipalities throughout Nova Scotia. About 1,100 existing high pressure sodium cobra head street lights were converted to LRL's LED Satellite series street lights. The installation involved street lighting on various municipal roads, and Halifax's Stanfield International Airport roads, a parking lot, and provincial highways. The results showed a 53% energy savings while maintaining or exceeding existing lighting levels. Public feedback was very positive. The City of Hamilton have installed some of the LRL product on short section of road in the downtown. The lights have performed very well and met all City of Hamilton staff expectations.

LED's are a very effective way to save power, however, as of 2010 the good products still cost far more than typical high intensity discharge products (ie; metal halide, high pressure sodium, etc)

Given the low cost of a cobra head luminaire, the energy savings payback for retrofitting from a cobra head to an LED luminaire is in the 10+ year range. As the market increases the costs of the LED luminaires should decrease with increased demand. Some suppliers are considering offering LED retrofit kits for existing decorative luminaires. This would allow one to retrofit an existing decorative luminaire with a more efficient LED light sources.

2.6.2.2 Electronic Ballasts

Electronic ballasts are most commonly used for fluorescent sources; however, are available for some high intensity discharge light sources.

Integrated circuit control allows most electronic ballasts to operate at multiple input line voltages and, in some cases, to operate more than one lamp wattage. The lamps are operated with constant lamp power that provides better light output regulation and more consistent light color over the life of the lamp.

Metal halide ceramic arc tube lamps typically using an electronic ballast technology are available. Potential benefits include improved color consistency, longer lamp life and energy, and improved ballast efficiency resulting in energy savings.

A hybrid light source (between high pressure and metal halide sources) with electronic ballast known as Cosmo™ lamp has been developed and is in use in Europe. To date it only offered by a few luminaire manufactures in limited voltages and wattages.

Electronic ballasts are typically available in limited light sources and wattages. It is doubtful they will be developed for anything other than specialized applications as suppliers are investing most of their efforts into developing LED products.

2.6.2.3 Induction (E-Lamps)

E-lamps, also referred to as Induction™ or Icetron™ lamps, use an induction coil to create a magnetic field inside a gas technically called “electron/ion plasma.” The mercury vapour generates ultraviolet light (UV), which excites a phosphor coating on the inside surface of the glass globe. The phosphor glows with visible light.

As there are no electrodes or filaments to wear out, lamp life is 60,000-100,000 hours. Electrode and filament deterioration is one of the main reasons for failures of typical high intensity discharge sources. The induction system comprises three components: the generator, the power coupler, and the lamp. Lumen maintenance for E-lamps is 75% of lumen output at 60,000 hours.

To date, induction has not been a cost effective alternative to conventional high pressure sodium street lighting. Suppliers are investing far more on LED’s, making LED a better choice.

2.6.2.4 Solar (Photovoltaic) Power Supplies

Solar powered street lighting is available. Typically, solar-powered systems utilize LEDs or compact fluorescent or a low pressure sodium light sources to reduce the power consumption and to minimize the size of the solar panels, the size and/or number of batteries, and the overall cost. Due to these restrictions, light output is very limited.

Solar-powered systems are generally self-contained systems requiring no external power supply. The solar panels charge the system’s batteries during daylight hours. The luminaire is powered from the battery when lighting is needed. A photo-control may be used to turn the lights on during darkness and off during daylight. Solar-powered lighting can be considered where no power is available or if it would be cost prohibitive to install a power line.

At this time this option is not cost effective.

2.6.2.5 Wind Power Supplies

Some suppliers have considered street lighting powered from small wind turbines. One such system was installed at Vancouver International Airport where a single luminaire was fed via a small wind turbine installed above the street light. The installation was more for demonstration purposes and the overall cost, while not verified, is believed to be over $20K for one pole.

At this time this option is not cost effective and has been installed on a demonstration basis only.

2.6.3 Poles

The majority of poles used in the City of Hamilton are concrete. Other types of poles available are steel, aluminum, and fiberglass. We recommend the practice of using concrete poles be maintained as these products are manufactured locally, durable, long lasting, low maintenance, and are available in number of decorative finishes, colours, and styles.

Figure 37 - Typical Concrete Poles

2.6.4 Energy Savings Considerations

Though lighting has a high value for dollar benefit, it is costly to install and operate. According to City of Hamilton staff, the City of Hamilton utility power supply bills have risen in the last 2 years (2007-2009) from approx $2.6M to over $3.8M. Hamilton's Corporate Energy Policy, passed by Council in November 2007, was designed to facilitate the achievement of City of Hamilton-wide energy reduction targets and define policies regarding energy-related procurement and capital investment.

In accordance with Bill 21 - The Energy Conservation Responsibility Act, the City of Hamilton should reduce energy consumption from 2005 levels by 3% by 2009, 7.5% by 2012, and 20% by 2012. As street lighting makes up approximately 20% of the City of Hamilton's power bill, more efficient practices and products should be investigated for potential cost reductions.

The City of Hamilton has already launched a number of initiatives that focus on overall energy management strategy, building design and retrofit practices, procurement policies, and operational practices for facilities managers and occupants. The execution of these strategies and policies to date has been very effective and has resulted in an energy consumption savings of 3.3% at the end of 2008 (in line with the target annual reduction of 1.5%). The specific projects that have resulted in these savings have included the retrofits of heating and cooling systems, indoor lighting and traffic signals, and the expansion of the district cooling loop to additional locations. Given the success of the projects to date, the City of Hamilton is eager to explore additional energy savings opportunities, including those related to outdoor lighting.

The development of policies and projects for the lighting of streets, sidewalks, parks, and other outdoor public spaces must consider the interests of a diverse stakeholder group. While these new policies must address energy consumption and the cost of lighting, they must also incorporate at least the minimum requirements for traffic and pedestrian safety, operation and maintenance activities, architectural function and aesthetics, commercial activities, security and law enforcement, and the avoidance of light pollution. The development of the City of Hamilton's outdoor lighting policy includes the input and review of outdoor lighting design experts, City of Hamilton staff, architects, business improvement association (BIA) representatives, and law enforcement officials. It is based on an evaluation of current conditions and expected needs, the best policies and practices for outdoor lighting (as defined by expert

technical committees and experienced by other jurisdictions), and the accommodation of local requirements

Based on our review, the City of Hamilton is generally not over lit and, in fact, many areas are under lit so no real opportunity exists to retrofit existing lighting to lower wattage units as was done in the City of Calgary.

There is however potential for energy savings by retrofitting to LED luminaires.

Turning off lights during off-peak periods in rural subdivisions would have a small energy savings benefit and could save perhaps $100K per year with low capital investment. So the payback has very high potential, however the risks involved would also be high. The cost savings of this option will require new utility rate tariffs to realize cost savings as the electrical services are un-metered.

A local program known as LightSavers provided some technical support for small pilot projects of which the City of Hamilton has taken advantage. According to a January 2010 interim report, LightSavers provided technical information which has some pilot projects involving the retrofit of lighting parking garages. The City of Hamilton staff has been very involved with the LightSavers committee.

In Nova Scotia, LED Roadway Lighting Ltd and the local utility were able to obtain some federal and provincial funding for the retrofit of 1,100 LED street lights. We are not aware of any Federal or Provincial programs where retrofit to an energy savings street lighting system is partly subsidized. In British Columbia, funding was obtained through National Resources Canada (NRCan) for adaptive lighting projects (dimming street lights in off peak periods), however, we understand that this funding is no longer available.

In our opinion, the City of Hamilton staff has done a good job in staying on top of and evaluating new energy savings technologies and should continue their efforts as products improve.

2.7 Maintenance

Maintenance and operations are important areas of consideration in roadway lighting design due to the significant portion of the life cycle cost represented. The lighting systems in public facilities are a significant investment of public resources. Good maintenance is warranted as a protection of that investment.

Any lighting system is subject to performance degradations over time. Exposure to the outdoor environment makes timely roadway lighting system maintenance of paramount importance. If a roadway lighting system is not properly maintained, system owners may expose themselves to potential liability as well as the increased costs of deferred maintenance. A properly designed street lighting installation that uses quality components can operate effectively for 30 plus years with proper corrective maintenance.

On an annual basis, the City of Hamilton responds to approximately 3,600 requested repairs. These requests are generally received by two different methods:

- public calls to the street lighting repair hotline at 905-546-2098 or 905-546-CITY (2489)
- monthly night-time City of Hamilton patrols.

The expected turnaround time (time between the repair request and the actual repair) is five working days or less. In order to maintain a high service level to the public, the City of Hamilton proactively performs maintenance on the street lighting system. This mainly consists of annual re-lamping of luminaires. The lamps are replaced before their expected end of life to ensure that a seamless replacement takes place with limited or no disruption to the public.

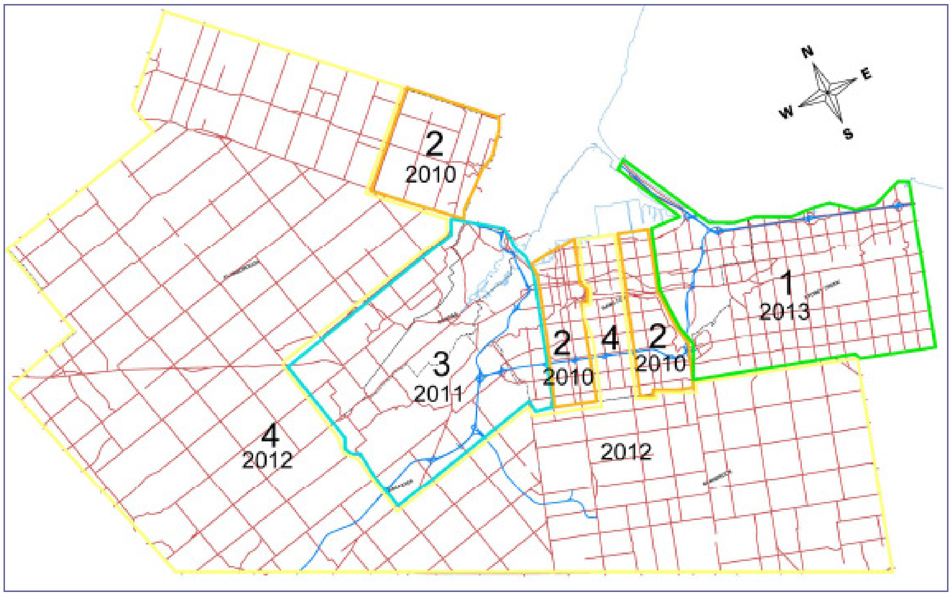

Figure 38 - Re-Lamping Zones

The City of Hamilton is responsible for the maintenance of 44,000 luminaires within the boundaries shown on this map. The City of Hamilton has divided up the boundaries into four zones of approximately equal numbers of street lights (11,000 per zone). The City of Hamilton will sweep each zone once every four years to replace every lamp within that zone. This is called group re-lamping and is generally more cost effective than replacing lamps when they burn-out. This typically takes place in the early New Year and is completed prior to spring. For more complicated repairs, (e.g., such as underground/aboveground wiring issues, vehicular collision damage, weather damage, etc.), the City of Hamilton evaluates each of them individually in order to determine how critically the repair is needed. This is a sound practice for high pressure sodium lamps, however metal halide lamps will have to be replaced every two years.

For the most critical issues, such as for fallen poles, the City of Hamilton responds immediately to ensure that the public's safety is maintained at all times. Other less critical issues that require repair are placed in a prioritized queue. This is a reasonable practice.

Maintenance in the downtown involves the replacement of mostly metal halide lighting sources which require replacement every 2 years as opposed to the 4 years for high pressure sodium. This increases to maintenance costs, however provides the white light source which is required.

In addition in the downtown new decorative poles have decorative covers at the base of pole which are prone to damage from cars and snow removal equipment. These base covers are easily damaged and very expensive to replace at $1500 to $1700 each. The City of Hamilton is investigating using an alternate cover made out fibre glass resin composite material to better resist damage cases by motor-vehicles.

Figure 39 - Decorative base Cover

In the downtown, the City of Hamilton uses a lot of in-ground hand-holes for wire and conduit connections. The steel box lids have the potential to be an electrical contact hazard to the public. Wiring and conduit connections should be made in the pole hand-holes to reduce contact hazards and installation costs. This will eliminate the need for most in-ground hand-holes.

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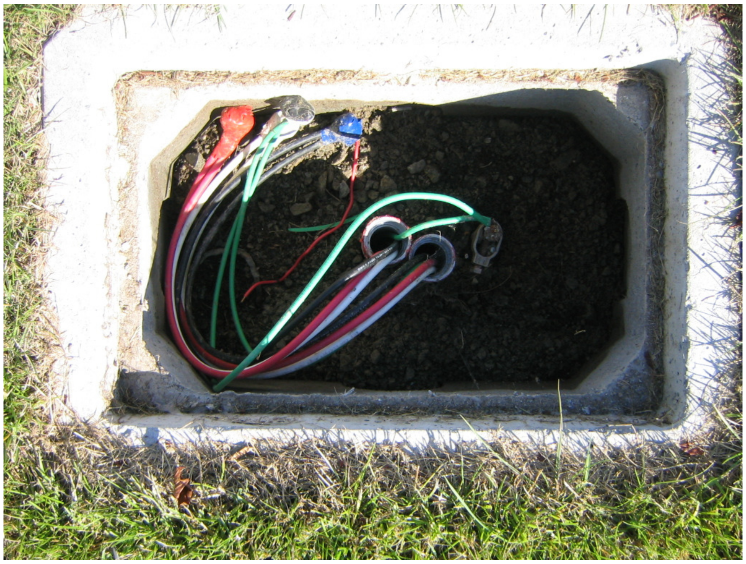

Figure 40 - Typical In-ground Hand-hole with Steel Lid Off

In the downtown electrical and lighting is more prone to vandalism than in the suburbs therefore equipment should have vandal resistance features such as tamper proof screws and finishes should anti-graffiti coatings so graffiti can be easily removed.

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3 Downtown Area

This section of the report covers the downtown area. Types of lighting specific to the downtown include:

- roadway and sidewalk lighting,
- parking lot lighting,
- park lighting,
- building façade lighting,
- theatrical and seasonal lighting
- monument lighting.

The intent of this section is to provide some options and recommendation for lighting which will enhance the feeling of safety and enhance the overall appeal of the Downtown.

The Downtown is shown on the figure below, which is bounded by Victoria Street to the East, Queen Street to the West, Hunter Street to the South, Cannon Street to the North, and James Street from Strachan Street to St. Josephs Drive (commercial streets only).

For the purpose of this report, we have included the Downtown and International Village BIAs in the downtown. These BIAs are therefore not included in Part 4 - Business Improvement Areas of the report.

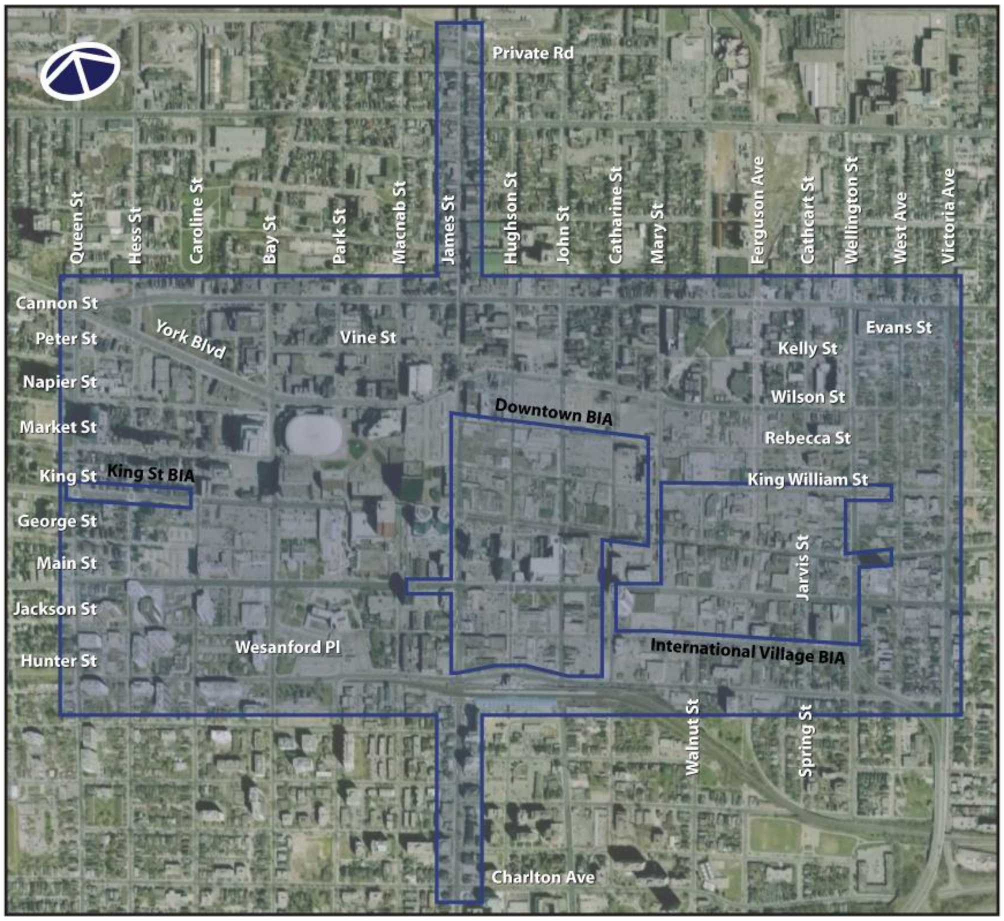

Figure 41 - Map of Downtown Hamilton

3.1 Stakeholder Input

On Nov 17, 2009 a meeting was held with the City of Hamilton, the consultant and Kathy Dewitt a representative from the Downtown BIA group. Comments from the BIA representative were as follows:

- Lighting in trees was added several years ago to enhance light levels, not for decoration. Reason decorative lighting approved and initiated was to add more lighting and was not just decorative. The BIA wanted the areas bright as possible.
- Issue is low light levels on side streets and sidewalks especially cobra heads lighted areas which are not pedestrian friendly.
- Concentrate efforts with City staff to look at options for the Gore Pedestrian Mall.
- King Street (south leg of King St.) has best lighted in BIA's opinion. North side of King, felt to be darker. James poorly lit north of King. King William also poorly lit, even the new section. Main Street has very poor lighting. King St., James to Bay also poorly lit. BIA group

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like Bay St. lighting (street/pedestrian). The new lighting downtown is generally good except side streets such as John/Catharine which is poorly lit (old cobra heads).

- Alleyways poorly lit, needs attention. Alleyways difficult to get lighted and repaired.
- Light levels proposed for public and private parking levels are of concern to BIA. Need to do conversion from old parking lot light levels to new light levels.
- BIA group does not want large overly bright building lighting. They want façade lights to fit streetscape. Potential for lighting manufacturers to give discount packages on lighting; qualifies for façade lighting funding. Potential issue, private lights may encroach onto public “air space”. Many downtown property owners were/are interested in doing architectural lighting. The BIA suggested façade lighting should be installed on a demonstration building with an interested owner. It could also be public building.
- BIA main lighting concerns:

  1. Parking lots
  2. Streets
  3. Facades
  4. Pedestrian
  5. Monument

On March 15, 2010 a meeting was held with the City of Hamilton, the consultant and Mary Pocius a representative from the International BIA group. Comments from the BIA representative were as follows:

- International Village is a “traditional BIA”, owner occupied, small scale business, independent owners, few chain owners/business.
- The BIA wants more than minimum light levels and are pushing to exceed minimum standards.
- BIA members will go with police and go to specific locations to make recommendations for alleyway lighting on a case by case basis. The BIA has changed its opinion on how alleyways should be addressed since this study was initiated.
- BIA wants sidewalks well lighted. To satisfy police requirements, white light source should be used. Complaints about light an issue however the BIA agreed it is mainly an issue of perception with lighting, rather than the actual lighting light levels. The BIA have a concern with consistency of the lighting downtown. Sidewalk lighting could be improved. International Village has 30 restaurants downtown. The aesthetics of the lighting is therefore an issue.
- Façade lighting – The BIA has been vocal in an effort to light building facades. Façade grants are available which include lighting, and the BIA is encouraging façade lighting. The BIA is encouraging lighting with façade grants. The BIA has an AGM held annually in October. They suggested they will highlight lighting & the façade lighting recommendations as 40-60%, of their members attend the AGM. They suggested a small lighting handout be available from the City of Hamilton. The BIA and the City of Hamilton will coordinate a presentation. The BIA has a bi-monthly newsletter where they can publish findings of the lighting study as available.
- Street tree lighting was installed to give impression of brightness downtown (similar to the Downtown BIA’s).

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- Generally, the BIA was pleased to have been consulted and agrees with the preliminary recommendations discussed at the meeting.

3.2 Roadways and Sidewalks

3.2.1 Current Conditions

Existing lighting levels and uniformity ratios have been assessed on all roads and sidewalks within the downtown area. Computer based lighting software was used to model lighting in conjunction with sample physical night measurements to verify the calculations.

3.2.1.1 Roadways

Results are presented on the spreadsheet listed below. Details of the information included on the spreadsheets below:

Hamilton Public Works

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Road)
																	Avg.	Max.	Road	Road	Road (Average)	Road (Worst-Case)	Road	
Downtown Hamilton	Cannon St W	Hess St N	Caroline St N	Arterial	Commercial	118.0	5	No	Yes	Opposite	10	0.5	9.0	250	Cobrahead	Davit	29.5	33.0	17.0	3.0	37.2	33.3	1.7	Pass
Downtown Hamilton	York Boulevard	Queen St N	Bay St N	Arterial	Commercial	372.5	4	No	Yes	Staggered	21	0.5	9.0	250	Cobrahead	Davit	18.6	20.7	17.0	3.0	34.6	31.0	1.7	Pass
Downtown Hamilton	King St W	Caroline St N	Bay St N	Arterial	Commercial	143.0	4	No	Yes	Opposite	20	0.5	5.0	200	Double Acorn	Post Top	15.9	19.0	17.0	3.0	40.9	34.5	1.2	Pass
Downtown Hamilton	Rebecca St	Mary St	Wellington St N	Collector	Residential	397.0	2	No	Yes	One-Sided	12	2.0	9.0	250	Cobrahead	Davit	36.1	46.0	6.0	4.0	19.2	14.9	2.0	Pass
Downtown Hamilton	King William St	West Ave N	Victoria Ave N	Local	Residential	74.0	2	No	Yes	One-Sided	4	2.0	9.0	250	Cobrahead	Davit	24.7	27.0	4.0	6.0	31.1	28.5	1.5	Pass
Downtown Hamilton	Spring St	Jackson St E	Hunter St E	Local	Residential	40.9	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	40.9	40.9	4.0	6.0	7.9	7.9	3.4	Pass
Downtown Hamilton	West Ave S	Cannon St E	Hunter St E	Local	Residential	809.0	2	No	Yes	One-Sided	20	2.0	7.5	100	Cobrahead	Davit	42.6	70.0	4.0	6.0	7.6	4.6	3.8	Pass
Downtown Hamilton	Victoria Ave S	King St E	Hunter St E	Arterial	Commercial	291.0	5	No	Yes	Opposite	18	2.0	9.0	250	Cobrahead	Davit	36.4	51.6	17.0	3.0	26.8	18.9	1.8	Pass
Downtown Hamilton	Cathcart St	Cannon St E	Rebecca St	Arterial	Residential	272.9	2	No	Yes	One-Sided	7	2.0	7.5	250	Cobrahead	Davit	45.5	63.5	9.0	3.0	20.1	14.4	3.0	Pass
Downtown Hamilton	James St N	Private Rd	Rebecca St	Arterial	Commercial	245.0	4	No	Yes	Opposite	28	0.5	5.0	200	Double Acorn	Post Top	18.8	31.4	17.0	3.0	34.9	21.1	1.3	Pass
Downtown Hamilton	MacNab St S	King St W	Main St W	Arterial	Commercial	142.6	4	Yes	Yes	Median	8	Centre	9.0	250	Cobrahead	Double Davit	20.4	22.6	17.0	3.0	53.8	48.9	1.6	Pass
Downtown Hamilton	Bay St N	Cannon St W	Main St W	Arterial	Commercial	375.1	4	No	Yes	Opposite	28	0.5	9.0	250	Teardrop	Decorative	28.9	30.0	17.0	3.0	26.4	25.4	1.4	Pass
Downtown Hamilton	King St W	Bay St N	James St N	Arterial	Commercial	375.0	5	No	Yes	Opposite	28	0.5	11.0	250	Cobrahead	Davit	28.8	42.3	17.0	3.0	35.0	23.8	1.5	Pass
Downtown Hamilton	King William St	Hughson St N	Mary St	Local	Commercial	205.0	2	No	Yes	Opposite	20	2.0 / 0.5	5.0	175	Double Acorn	Post Top	22.8	30.0	9.0	6.0	24.1	18.4	1.6	Pass
Downtown Hamilton	King St E	James St N	Mary St	Arterial	Commercial	408.0	4	No	Yes	Opposite	52	0.5	5.0	200	Double Acorn	Post Top	16.3	26.0	17.0	3.0	40.0	25.4	1.2	Pass
Downtown Hamilton	King St E	Hughson St S	John St S	Arterial	Commercial	93.0	2	No	Yes	Opposite	14	1.0	5.0	200	Double Acorn	Post Top	15.5	22.0	17.0	3.0	58.1	41.3	1.2	Pass
Downtown Hamilton	Main St E	McNab St S	Catharine St S	Arterial	Commercial	400.8	4	No	Yes	Opposite	30	0.5	9.0	250	Cobrahead	Davit	28.6	31.6	17.0	3.0	45.2	40.8	1.7	Pass
Downtown Hamilton	James St N	Rebecca St	Main St E	Arterial	Commercial	338.0	4	No	Yes	Opposite	36	0.5	5.0	200	Double Acorn	Post Top	19.9	30.0	17.0	3.0	33.0	22.0	1.3	Pass
Downtown Hamilton	James St N	Main St E	Hunter St E	Arterial	Commercial	170.0	4	No	Yes	Opposite	14	0.5	9.0	250	Cobrahead	Davit	28.3	32.0	17.0	3.0	45.7	40.3	1.7	Pass
Downtown Hamilton	Hughson St S	King St E	Hunter St E	Local	Commercial	248.0	2	No	Yes	Opposite	26	0.5	5.0	175	Double Acorn	Post Top	20.7	36.0	9.0	6.0	28.3	16.4	1.4	Pass
Downtown Hamilton	King St E	Mary St	Wellington St N	Arterial	Commercial	420.0	2	No	Yes	Opposite	54	0.5	5.0	200	Double Acorn	Post Top	16.2	32.0	17.0	3.0	57.8	29.6	1.2	Pass
Downtown Hamilton	Wellington St S	King St E	Jackson St E	Arterial	Commercial	170.0	4	No	Yes	Opposite	14	0.5	9.0	250	Cobrahead	Davit	28.3	36.0	17.0	3.0	45.7	35.8	1.7	Pass
Downtown Hamilton	King St W	Queen St N	Caroline St N	Arterial	Commercial	245.5	4	No	Yes	Opposite	34	0.5	5.0	200	Double Acorn	Post Top	15.3	17.4	17.0	3.0	42.4	37.6	1.2	Pass
Downtown Hamilton	Cannon St W	Queen St N	Hess St N	Arterial	Commercial	112.0	5	No	Yes	Staggered	7	0.5	9.0	250	Cobrahead	Davit	18.7	19.5	17.0	3.0	29.3	28.1	2.0	Pass
Downtown Hamilton	York Boulevard	Bay St N	Victoria Ave N	Arterial	Commercial	1370.0	4	No	Yes	One-Sided	52	0.5	9.0	250	Cobrahead	Davit	26.9	42.3	17.0	3.0	24.0	15.2	2.6	Pass
Downtown Hamilton	Napier St	Queen St N	End	Local	Commercial	242.4	2	No	Yes	One-Sided	8	2.0	7.5	250	Cobrahead	Davit	34.6	61.0	9.0	6.0	25.0	14.0	2.0	Pass
Downtown Hamilton	Main St W	Hess St S	MacNab St S	Arterial	Commercial	553.0	5	No	Yes	Opposite	30	0.5	9.0	250	Cobrahead	Davit	39.5	50.7	17.0	3.0	27.7	21.5	2.2	Pass
Downtown Hamilton	Vine St	Bay St N	James St N	Local	Commercial	383.0	2	No	Yes	One-Sided	14	2.0	7.5	100	Cobrahead	Davit	29.5	34.4	9.0	6.0	10.9	9.4	2.5	Pass
Downtown Hamilton	King St E	West Ave N	Victoria Ave N	Arterial	Commercial	64.9	4	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	32.5	32.9	17.0	3.0	19.8	19.6	2.6	Pass
Downtown Hamilton	Jackson St E	Catherine St S	Wellington St S	Local	Commercial	478.4	2	No	Yes	One-Sided	12	0.5	9.0	250	Cobrahead	Davit	43.5	47.7	9.0	6.0	18.7	16.9	2.5	Pass
Downtown Hamilton	James St S	Hunter St W	Charlton Ave E	Arterial	Commercial	392.6	4	No	Yes	One-Sided	12	0.5	9.0	250	Cobrahead	Davit	35.7	45.0	17.0	3.0	18.0	14.2	2.6	Pass
Downtown Hamilton	Wellington Ave N	Cannon St E	King William St	Arterial	Commercial	372.0	4	No	Yes	One-Sided	13	0.5	9.0	250	Cobrahead	Davit	31.0	41.0	17.0	3.0	20.8	15.7	2.6	Pass
Downtown Hamilton	Ferguson Ave N	Cannon St E	King William St	Local	Commercial	386.4	2	No	Yes	Staggered	33	2.0	5.0	100	Single Acorn	Post Top	12.1	13.7	9.0	6.0	19.0	16.9	1.5	Pass
Downtown Hamilton	Catherine St N	Cannon St E	Rebecca St	Collector	Commercial	229.0	3	No	Yes	One-Sided	8	2.0	9.0	250	Cobrahead	Davit	32.7	52.8	12.0	4.0	21.1	13.0	2.0	Pass
Downtown Hamilton	Mary St	Cannon St E	King St E	Collector	Commercial	452.7	2	No	Yes	One-Sided	17	2.0	7.5	250	Cobrahead	Davit	28.3	36.3	12.0	4.0	27.0	20.8	2.3	Pass
Downtown Hamilton	Catherine St S	Main St E	Hunter St E	Collector	Commercial	181.9	3	No	Yes	One-Sided	6	2.0	9.0	250	Cobrahead	Davit	36.4	42.3	12.0	4.0	19.0	16.3	2.1	Pass
Downtown Hamilton	John St N	Cannon St E	Rebecca St	Arterial	Commercial	252.7	3	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	28.1	42.6	17.0	3.0	26.7	17.5	1.7	Pass
Downtown Hamilton	Hughson St N	Cannon St E	Rebecca St	Local	Commercial	254.7	2	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	28.3	30.4	9.0	6.0	29.0	27.0	1.5	Pass
Downtown Hamilton	MacNab St N	Cannon St W	York Blvd	Collector	Commercial	203.0	2	No	Yes	One-Sided	7	0.5	7.5	250	Cobrahead	Davit	33.8	38.0	12.0	4.0	24.8	21.9	2.1	Pass
Downtown Hamilton	Park St N	Cannon St W	York Blvd	Local	Commercial	193.0	2	No	Yes	One-Sided	7	2.0	7.5	250	Cobrahead	Davit	32.2	49.0	9.0	6.0	27.0	17.5	1.9	Pass

Table 5 - Existing Lighting Conditions for Downtown Roads

(Continued)

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Hamilton Public Works

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Road)
																	Avg.	Max.	Road	Road	Road (Average)	Road (Worst-Case)	Road	
Downtown Hamilton	MacNab St S	Main St W	Hunter St W	Collector	Commercial	155.6	2	No	Yes	One-Sided	5	0.5	7.5	250	Cobrahead	Davit	38.9	59.0	12.0	4.0	21.4	13.9	2.3	Pass
Downtown Hamilton	Bay St S	Main St W	Hunter St W	Collector	Commercial	186.5	3	No	Yes	One-Sided	6	2.0	9.0	250	Cobrahead	Davit	37.3	42.4	12.0	4.0	18.5	16.2	2.1	Pass
Downtown Hamilton	Caroline St S	York Blvd	Hunter St W	Collector	Commercial	333.0	2	No	Yes	One-Sided	9	0.5	7.5	250	Cobrahead	Davit	41.6	73.6	12.0	4.0	19.9	11.2	2.6	Pass
Downtown Hamilton	Hess St S	King St W	Main St W	Local	Commercial	146.2	2	No	Yes	Staggered	9	2.0	5.0	200	Double Acorn	Post Top	18.3	23.0	9.0	6.0	21.2	16.9	1.5	Pass
Downtown Hamilton	Hess St N	York Blvd	King St W	Collector	Commercial	294.3	3	No	Yes	One-Sided	11	2.0	9.0	250	Cobrahead	Davit	29.4	46.1	12.0	4.0	23.6	14.9	2.0	Pass
Downtown Hamilton	Queen St N	Cannon St W	Hunter St W	Arterial	Commercial	547.0	3	No	Yes	One-Sided	19	2.0	9.0	250	Cobrahead	Davit	30.4	37.0	17.0	3.0	22.8	18.7	2.0	Pass
Downtown Hamilton	Rebecca St	James St N	Mary St	Local	Commercial	409.0	2	No	Yes	One-Sided	13	0.5	9.0	250	Cobrahead	Davit	34.1	37.9	9.0	6.0	24.0	21.7	1.8	Pass
Downtown Hamilton	King St E	James St S	Hughson St S	Arterial	Commercial	92.0	2	No	Yes	One-Sided	7	1.0	5.0	200	Double Acorn	Post Top	15.3	16.0	17.0	3.0	29.4	28.2	1.6	Pass
Downtown Hamilton	Jackson St E	James St S	Catharine St S	Local	Commercial	298.3	2	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	33.1	47.8	9.0	6.0	24.8	16.9	1.8	Pass
Downtown Hamilton	Hughson St N	Rebecca St	King William St	Local	Commercial	68.0	2	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	34.0	36.0	9.0	6.0	24.1	22.8	1.8	Pass
Downtown Hamilton	John St N	Rebecca St	Hunter St E	Arterial	Commercial	148.0	3	No	Yes	One-Sided	6	0.5	9.0	250	Cobrahead	Davit	29.6	34.0	17.0	3.0	25.4	22.0	1.7	Pass
Downtown Hamilton	Catherine St N	Rebecca St	King St E	Collector	Commercial	172.0	3	No	Yes	One-Sided	7	0.5	9.0	250	Cobrahead	Davit	28.7	36.0	12.0	4.0	26.2	20.8	1.7	Pass
Downtown Hamilton	King William St	Mary St	West Ave N	Local	Commercial	494.0	2	No	Yes	One-Sided	11	2.0	9.0	250	Cobrahead	Davit	49.4	62.0	9.0	6.0	15.4	12.3	2.6	Pass
Downtown Hamilton	King St E	Wellington St N	West Ave N	Arterial	Commercial	72.0	4	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	36.0	36.0	17.0	3.0	17.9	17.9	2.6	Pass
Downtown Hamilton	Main St E	Catherine St S	Wellington St S	Arterial	Commercial	420.0	4	No	Yes	One-Sided	16	0.5	9.0	250	Cobrahead	Davit	28.0	34.0	17.0	3.0	23.1	19.0	2.6	Pass
Downtown Hamilton	Walnut St N	King William St	King St E	Local	Commercial	50.0	2	No	Yes	One-Sided	3	2.0	5.0	200	Double Acorn	Post Top	25.0	26.0	9.0	6.0	15.4	14.9	2.1	Pass
Downtown Hamilton	Ferguson Ave N	King William St	King St E	Local	Commercial	106.0	2	No	Yes	Staggered	9	2.0	5.0	175	Double Acorn	Post Top	13.3	15.0	9.0	6.0	19.3	17.2	1.4	Pass
Downtown Hamilton	Ferguson Ave S	King St E	Main St E	Local	Commercial	64.0	2	No	Yes	One-Sided	4	2.0	5.0	175	Double Acorn	Post Top	21.3	22.0	9.0	6.0	12.1	11.7	2.0	Pass
Downtown Hamilton	Ferguson Ave S	Main St E	Jackson St E	Local	Commercial	76.0	2	No	Yes	Opposite	8	0.5	5.0	100	Single Acorn	Post Top	25.3	28.0	9.0	6.0	21.4	19.3	1.8	Pass
Downtown Hamilton	Jarvis St	King William St	End	Local	Commercial	42.0	2	No	Yes	One-Sided	3	2.0	9.0	250	Cobrahead	Davit	21.0	22.0	9.0	6.0	36.6	34.8	1.5	Pass
Downtown Hamilton	Wellington St N	King William St	King St E	Arterial	Commercial	110.0	4	No	Yes	One-Sided	5	0.5	9.0	250	Cobrahead	Davit	27.5	28.0	17.0	3.0	23.5	23.1	2.6	Pass
Downtown Hamilton	Hughson St N	King William St	King St E	Local	Commercial	78.0	2	No	Yes	Opposite	8	0.5	5.0	100	Double Globe	Post Top	26.0	36.0	9.0	6.0	9.0	6.5	2.4	Pass
Downtown Hamilton	Kelly St	Ferguson Ave N	Wellington St N	Local	Residential	148.2	2	No	Yes	One-Sided	4	0.5	7.5	100	Cobrahead	Davit	49.4	52.4	4.0	6.0	6.2	5.8	8.9	Fail
Downtown Hamilton	Cannon St W	Caroline St N	Victoria Ave N	Arterial	Commercial	1550.0	5	No	Yes	One-Sided	46	0.5	9.0	250	Cobrahead	Davit	34.4	43.0	17.0	3.0	15.9	12.7	4.4	Fail
Downtown Hamilton	Peter St	Queen St N	Hess St N	Local	Commercial	93.5	2	No	Yes	One-Sided	3	2.0	7.5	100	Cobrahead	Davit	46.8	60.3	9.0	6.0	6.9	5.4	4.6	Fail
Downtown Hamilton	Market St	Queen St N	Bay St N	Local	Commercial	383.6	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	42.6	62.5	9.0	6.0	7.6	5.2	3.8	Fail
Downtown Hamilton	George St	Hess St S	Bay St S	Local	Commercial	253.5	1	No	Yes	One-Sided	9	0.5	7.5	100	Cobrahead	Davit	31.7	51.0	9.0	6.0	7.4	4.6	2.3	Fail
Downtown Hamilton	Jackson St W	Queen St S	Bay St S	Collector	Commercial	352.4	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	39.2	55.0	12.0	4.0	7.6	5.5	2.8	Fail
Downtown Hamilton	Hunter St W	Queen St S	Victoria Ave S	Collector	Commercial	1728.0	3	No	Yes	One-Sided	56	2.0	7.5	100	Cobrahead	Davit	31.4	43.8	12.0	4.0	9.5	6.9	2.5	Fail
Downtown Hamilton	Wesanford Pl	Caroline St S	End	Local	Residential	54.6	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	54.6	54.6	4.0	6.0	5.9	5.9	9.8	Fail
Downtown Hamilton	Evans St	Wellington Ave N	Victoria Ave N	Local	Residential	110.0	1	No	Yes	One-Sided	3	2.0	7.5	100	Cobrahead	Davit	55.0	60.7	4.0	6.0	5.9	5.3	9.8	Fail
Downtown Hamilton	Main St E	Wellington Ave S	Victoria Ave S	Arterial	Commercial	133.8	5	No	Yes	One-Sided	5	0.5	9.0	250	Cobrahead	Davit	33.5	34.1	17.0	3.0	16.4	16.1	4.6	Fail
Downtown Hamilton	Walnut St S	Jackson St E	Hunter St E	Local	Commercial	59.0	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	59.0	59.0	9.0	6.0	5.5	5.5	13.8	Fail
Downtown Hamilton	Victoria Ave S	Cannon St E	King St E	Arterial	Commercial	282.5	5	No	Yes	One-Sided	14	2.0	9.0	250	Cobrahead	Davit	21.7	32.6	17.0	3.0	22.4	15.0	5.9	Fail
Downtown Hamilton	King William St	James St N	Hughson St N	Local	Commercial	87.0	2	No	Yes	Opposite	14	0.5	5.0	100	Single Globe	Post Top	14.5	16.0	9.0	6.0	7.7	7.0	1.4	Fail
Downtown Hamilton	John St N	King William St	Main St E	Arterial	Commercial	220.0	3	No	Yes	Opposite	24	0.5	5.0	100	Double Globe	Post Top	20.0	26.0	17.0	3.0	10.1	7.8	2.3	Fail
Downtown Hamilton	Walnut St S	King St E	Jackson St E	Local	Commercial	178.0	2	No	Yes	One-Sided	6	0.5	7.5	100	Cobrahead	Davit	35.6	36.0	9.0	6.0	8.5	8.5	3.5	Fail
Downtown Hamilton	Spring St	Main St E	Jackson St E	Local	Commercial	38.0	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	38.0	38.0	9.0	6.0	8.5	8.5	3.1	Fail
Bus Stop	King St W	Bay St N	James St N	Arterial	Commercial	375.0	5	No	Yes	Opposite	28	0.5	11.0	250	Cobrahead	Davit	28.8	42.3	17.0	3.0	35.0	23.8	1.5	Pass
Bus Stop	Upper James St	Fennell Ave E	McElroy Rd E	Arterial	Commercial	463.5	6	Yes	Yes	Opposite	24	2.0/1.0	9.0	250	Cobrahead	Davit	42.1	59.7	17.0	3.0	19.7	13.9	1.9	Pass

Table 5 - Existing Lighting Conditions for Downtown Roads

DMD & Associates Ltd.

G. O'CONNOR CONSULTANTS INC.

The results of the light level condition assessments are defined on the spreadsheets and for the downtown roads are illustrated on the figures below. The figures show separate area maps for roadways with coloured lines defining whether the lighting would pass or fail the proposed standards.

The figures for downtown roads are as follows:

- Roadway Illuminance and Uniformity
- Roadway Illuminance
- Roadway Uniformity

The figures illustrate in a graphic format the areas where lighting is below standard and by how much it is below recommended levels.

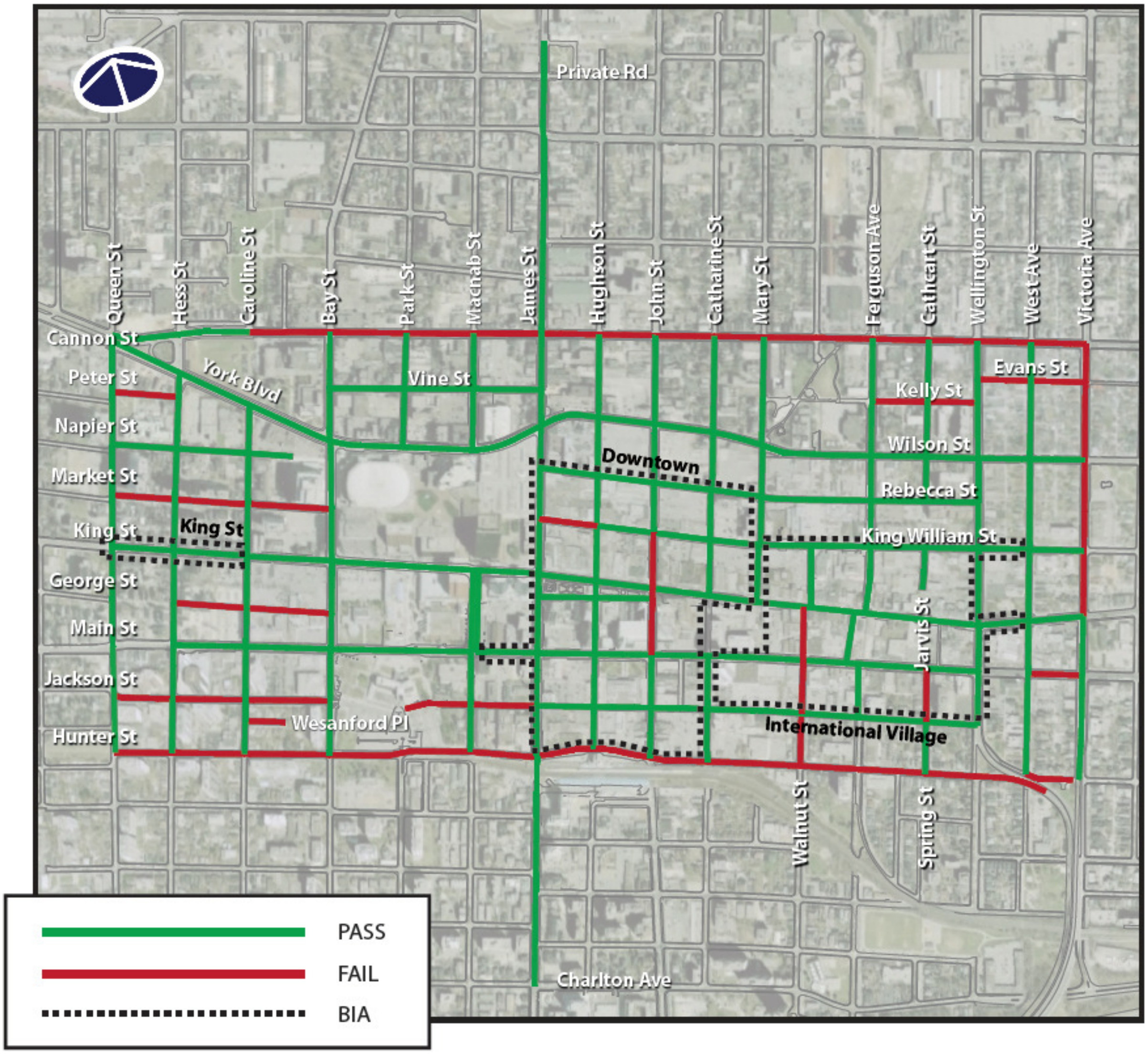

Figure 42 - Downtown Roadway Illuminance and Uniformity

Hamilton Public Works

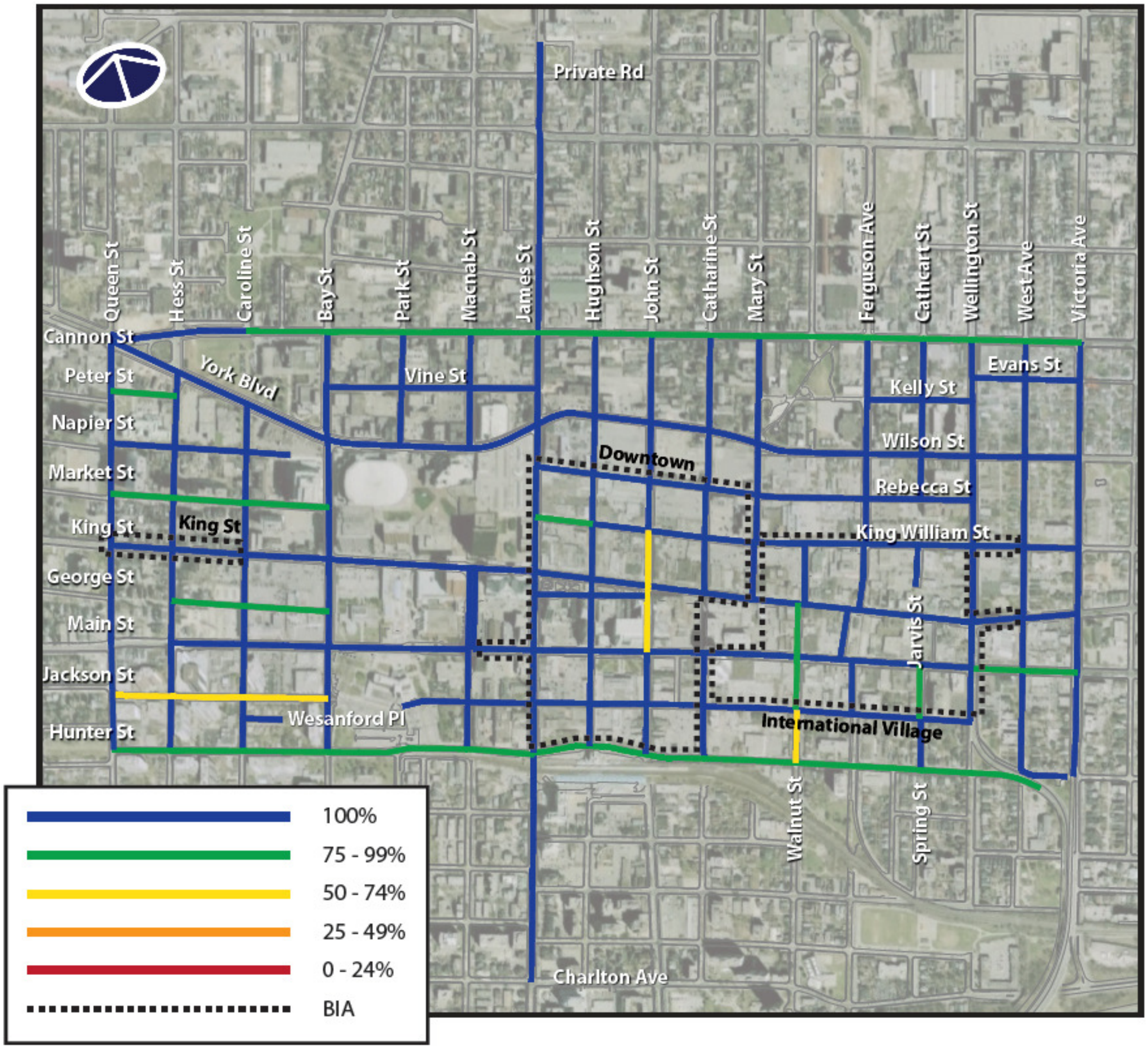

Figure 43 - Downtown Roadway Illuminance

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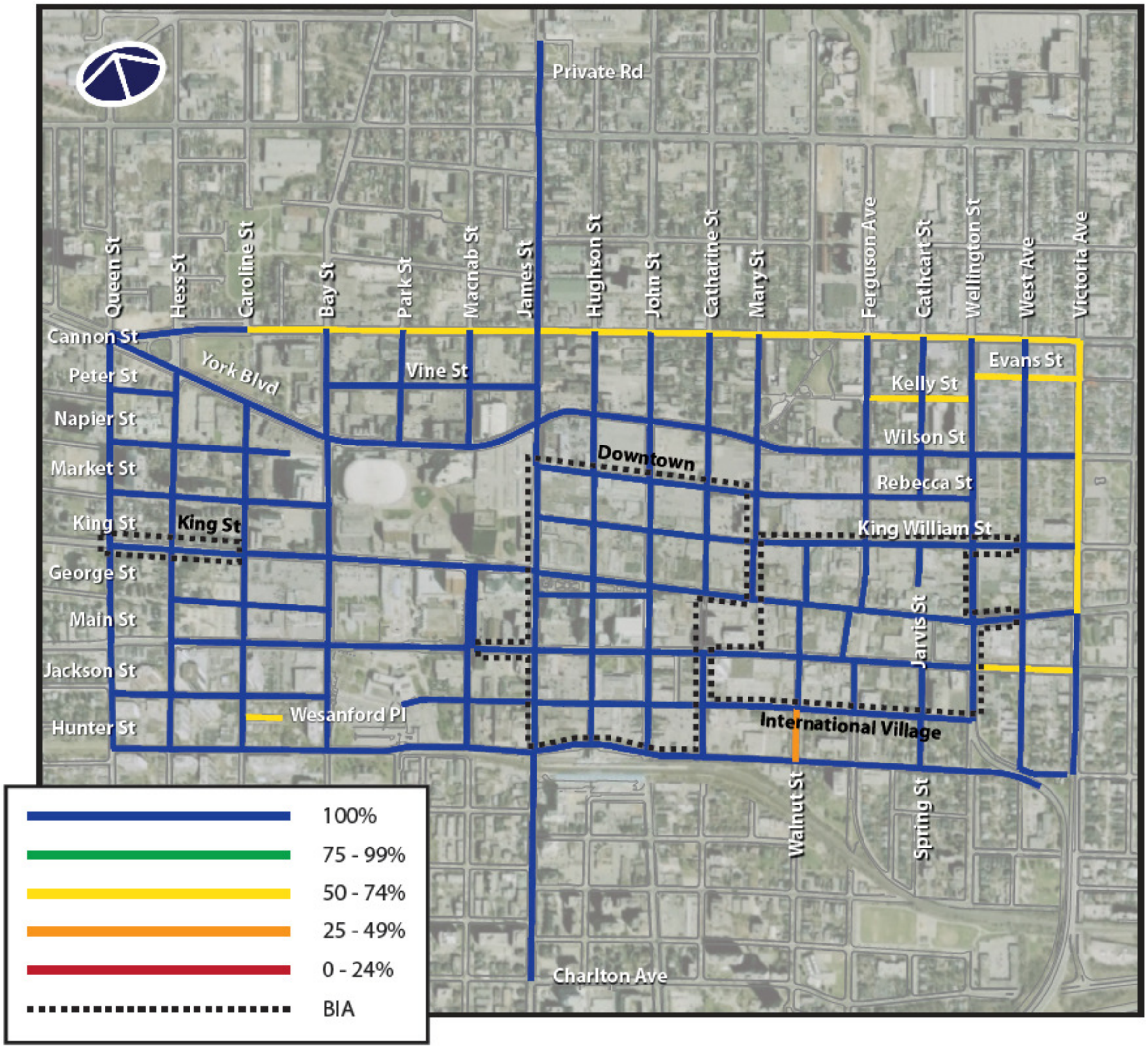

Figure 44 - Downtown Roadway Uniformity

Overall, most of the roadways downtown, with the exception of a few roads in the outer areas and a few shorter road sections where upgrades were completed, meet current industry lighting standards.

3.2.1.2 Sidewalks

Sidewalk lighting was reviewed in the downtown. They were calculated with roadway lighting the results are shown in tables below.

Hamilton Public Works

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Sidewalk)
																	Avg.	Max.	Sidewalk	Sidewalk	Sidewalk 1 (Avg)	Sidewalk 2 (Avg)	Sidewalk	
Downtown Hamilton	Cannon St W	Hess St N	Caroline St N	Arterial	Commercial	118.0	5	No	Yes	Opposite	10	0.5	9.0	250	Cobrahead	Davit	29.5	33.0	20.0	4.0	26.0	25.6	1.4	Pass
Downtown Hamilton	York Boulevard	Queen St N	Bay St N	Arterial	Commercial	372.5	4	No	Yes	Staggered	21	0.5	9.0	250	Cobrahead	Davit	18.6	20.7	20.0	4.0	22.6	22.6	1.4	Pass
Downtown Hamilton	King St W	Caroline St N	Bay St N	Arterial	Commercial	143.0	4	No	Yes	Opposite	20	0.5	5.0	200	Double Acorn	Post Top	15.9	19.0	20.0	4.0	39.3	39.3	1.2	Pass
Downtown Hamilton	Rebecca St	Mary St	Wellington St N	Collector	Residential	397.0	2	No	Yes	One-Sided	12	2.0	9.0	250	Cobrahead	Davit	36.1	46.0	3.0	6.0	22.8	7.7	1.1	Pass
Downtown Hamilton	King William St	West Ave N	Victoria Ave N	Local	Residential	74.0	2	No	Yes	One-Sided	4	2.0	9.0	250	Cobrahead	Davit	24.7	27.0	3.0	6.0	33.6	16.9	1.1	Pass
Downtown Hamilton	Spring St	Jackson St E	Hunter St E	Local	Residential	40.9	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	40.9	40.9	3.0	6.0	4.4	5.5	2.9	Pass
Downtown Hamilton	West Ave S	Cannon St E	Hunter St E	Local	Residential	809.0	2	No	Yes	One-Sided	20	2.0	7.5	100	Cobrahead	Davit	42.6	70.0	3.0	6.0	4.2	5.2	3.2	Pass
Downtown Hamilton	Victoria Ave S	King St E	Hunter St E	Arterial	Commercial	291.0	5	No	Yes	Opposite	18	2.0	9.0	250	Cobrahead	Davit	36.4	51.6	20.0	4.0	24.4	23.9	1.9	Pass
Downtown Hamilton	Cathcart St	Cannon St E	Rebecca St	Arterial	Residential	272.9	2	No	Yes	One-Sided	7	2.0	7.5	250	Cobrahead	Davit	45.5	63.5	3.0	6.0	19.6	11.1	1.8	Pass
Downtown Hamilton	James St N	Private Rd	Rebecca St	Arterial	Commercial	245.0	4	No	Yes	Opposite	28	0.5	5.0	200	Double Acorn	Post Top	18.8	31.4	20.0	4.0	33.7	33.7	1.2	Pass
Downtown Hamilton	MacNab St S	King St W	Main St W	Arterial	Commercial	142.6	4	Yes	Yes	Median	8	Centre	9.0	250	Cobrahead	Double Davit	20.4	22.6	20.0	4.0	31.5	31.0	1.1	Pass
Downtown Hamilton	Bay St N	Cannon St W	Main St W	Arterial	Commercial	375.1	4	No	Yes	Opposite	28	0.5	9.0	250	Teardrop	Decorative	28.9	30.0	20.0	4.0	27.2	27.2	1.1	Pass
Downtown Hamilton	King St W	Bay St N	James St N	Arterial	Commercial	375.0	5	No	Yes	Opposite	28	0.5	11.0	250	Cobrahead	Davit	28.8	42.3	20.0	4.0	25.3	25.3	1.2	Pass
Downtown Hamilton	King William St	Hughson St N	Mary St	Local	Commercial	205.0	2	No	Yes	Opposite	20	2.0 / 0.5	5.0	175	Double Acorn	Post Top	22.8	30.0	20.0	4.0	22.3	21.3	1.5	Pass
Downtown Hamilton	King St E	James St N	Mary St	Arterial	Commercial	408.0	4	No	Yes	Opposite	52	0.5	5.0	200	Double Acorn	Post Top	16.3	26.0	20.0	4.0	38.3	N/A	1.2	Pass
Downtown Hamilton	King St E	Hughson St S	John St S	Arterial	Commercial	93.0	2	No	Yes	Opposite	14	1.0	5.0	200	Double Acorn	Post Top	15.5	22.0	20.0	4.0	47.8	47.6	1.1	Pass
Downtown Hamilton	Main St E	McNab St S	Catharine St S	Arterial	Commercial	400.8	4	No	Yes	Opposite	30	0.5	9.0	250	Cobrahead	Davit	28.6	31.6	20.0	4.0	29.4	29.0	1.3	Pass
Downtown Hamilton	James St N	Rebecca St	Main St E	Arterial	Commercial	338.0	4	No	Yes	Opposite	36	0.5	5.0	200	Double Acorn	Post Top	19.9	30.0	20.0	4.0	32.1	32.1	1.3	Pass
Downtown Hamilton	James St N	Main St E	Hunter St E	Arterial	Commercial	170.0	4	No	Yes	Opposite	14	0.5	9.0	250	Cobrahead	Davit	28.3	32.0	20.0	4.0	29.3	29.6	1.3	Pass
Downtown Hamilton	Hughson St S	King St E	Hunter St E	Local	Commercial	248.0	2	No	Yes	Opposite	26	0.5	5.0	175	Double Acorn	Post Top	20.7	36.0	20.0	4.0	24.5	24.5	1.3	Pass
Downtown Hamilton	King St E	Mary St	Wellington St N	Arterial	Commercial	420.0	2	No	Yes	Opposite	54	0.5	5.0	200	Double Acorn	Post Top	16.2	32.0	20.0	4.0	49.4	49.4	1.1	Pass
Downtown Hamilton	Wellington St S	King St E	Jackson St E	Arterial	Commercial	170.0	4	No	Yes	Opposite	14	0.5	9.0	250	Cobrahead	Davit	28.3	36.0	20.0	4.0	28.8	28.9	1.3	Pass
Downtown Hamilton	King St W	Queen St N	Caroline St N	Arterial	Commercial	245.5	4	No	Yes	Opposite	34	0.5	5.0	200	Double Acorn	Post Top	15.3	17.4	20.0	4.0	40.9	40.9	1.1	Pass
Downtown Hamilton	Cannon St W	Queen St N	Hess St N	Arterial	Commercial	112.0	5	No	Yes	Staggered	7	0.5	9.0	250	Cobrahead	Davit	18.7	19.5	20.0	4.0	19.4	19.0	1.6	Fail
Downtown Hamilton	York Boulevard	Bay St N	Victoria Ave N	Arterial	Commercial	1370.0	4	No	Yes	One-Sided	52	0.5	9.0	250	Cobrahead	Davit	26.9	42.3	20.0	4.0	25.2	7.1	1.1	Fail
Downtown Hamilton	Napier St	Queen St N	End	Local	Commercial	242.4	2	No	Yes	One-Sided	8	2.0	7.5	250	Cobrahead	Davit	34.6	61.0	20.0	4.0	27.2	11.2	1.2	Fail
Downtown Hamilton	Main St W	Hess St S	MacNab St S	Arterial	Commercial	553.0	5	No	Yes	Opposite	30	0.5	9.0	250	Cobrahead	Davit	39.5	50.7	20.0	4.0	19.4	18.7	1.8	Fail
Downtown Hamilton	Vine St	Bay St N	James St N	Local	Commercial	383.0	2	No	Yes	One-Sided	14	2.0	7.5	100	Cobrahead	Davit	29.5	34.4	20.0	4.0	6.1	7.4	1.7	Fail
Downtown Hamilton	King St E	West Ave N	Victoria Ave N	Arterial	Commercial	64.9	4	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	32.5	32.9	20.0	4.0	20.8	6.0	1.1	Fail
Downtown Hamilton	Jackson St E	Catherine St S	Wellington St S	Local	Commercial	478.4	2	No	Yes	One-Sided	12	0.5	9.0	250	Cobrahead	Davit	43.5	47.7	20.0	4.0	15.7	11.8	1.5	Fail
Downtown Hamilton	James St S	Hunter St W	Charlton Ave E	Arterial	Commercial	392.6	4	No	Yes	One-Sided	12	0.5	9.0	250	Cobrahead	Davit	35.7	45.0	20.0	4.0	17.8	5.3	1.1	Fail
Downtown Hamilton	Wellington Ave N	Cannon St E	King William St	Arterial	Commercial	372.0	4	No	Yes	One-Sided	13	0.5	9.0	250	Cobrahead	Davit	31.0	41.0	20.0	4.0	21.6	6.2	1.1	Fail
Downtown Hamilton	Ferguson Ave N	Cannon St E	King William St	Local	Commercial	386.4	2	No	Yes	Staggered	33	2.0	5.0	100	Single Acorn	Post Top	12.1	13.7	20.0	4.0	14.2	14.3	1.9	Fail
Downtown Hamilton	Catherine St N	Cannon St E	Rebecca St	Collector	Commercial	229.0	3	No	Yes	One-Sided	8	2.0	9.0	250	Cobrahead	Davit	32.7	52.8	20.0	4.0	25.0	8.6	1.1	Fail
Downtown Hamilton	Mary St	Cannon St E	King St E	Collector	Commercial	452.7	2	No	Yes	One-Sided	17	2.0	7.5	250	Cobrahead	Davit	28.3	36.3	20.0	4.0	34.0	7.8	1.1	Fail
Downtown Hamilton	Catherine St S	Main St E	Hunter St E	Collector	Commercial	181.9	3	No	Yes	One-Sided	6	2.0	9.0	250	Cobrahead	Davit	36.4	42.3	20.0	4.0	22.6	8.1	1.2	Fail
Downtown Hamilton	John St N	Cannon St E	Rebecca St	Arterial	Commercial	252.7	3	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	28.1	42.6	20.0	4.0	24.0	13.3	1.1	Fail
Downtown Hamilton	Hughson St N	Cannon St E	Rebecca St	Local	Commercial	254.7	2	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	28.3	30.4	20.0	4.0	23.9	18.0	1.1	Fail
Downtown Hamilton	MacNab St N	Cannon St W	York Blvd	Collector	Commercial	203.0	2	No	Yes	One-Sided	7	0.5	7.5	250	Cobrahead	Davit	33.8	38.0	20.0	4.0	20.3	9.5	1.2	Fail
Downtown Hamilton	Park St N	Cannon St W	York Blvd	Local	Commercial	193.0	2	No	Yes	One-Sided	7	2.0	7.5	250	Cobrahead	Davit	32.2	49.0	20.0	4.0	29.7	12.5	1.2	Fail

Table 6 - Existing Lighting Conditions for Downtown Sidewalks

(Continued)

DMD & Associates Ltd.

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Hamilton Public Works

DMD & Associates Ltd.

G. O'CONNOR CONSULTANTS INC.

Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)	IES Uniformity Ratio (Avg : Min)	Exist. Illuminance Level (Lux)		Exist. Uniformity Ratio (Avg : Min)	Status (Sidewalk)
																	Avg.	Max.	Sidewalk	Sidewalk	Sidewalk 1 (Avg)	Sidewalk 2 (Avg)	Sidewalk	
Downtown Hamilton	MacNab St S	Main St W	Hunter St W	Collector	Commercial	155.6	2	No	Yes	One-Sided	5	0.5	7.5	250	Cobrahead	Davit	38.9	59.0	20.0	4.0	18.1	7.8	1.2	Fail
Downtown Hamilton	Bay St S	Main St W	Hunter St W	Collector	Commercial	186.5	3	No	Yes	One-Sided	6	2.0	9.0	250	Cobrahead	Davit	37.3	42.4	20.0	4.0	22.0	7.9	1.2	Fail
Downtown Hamilton	Caroline St S	York Blvd	Hunter St W	Collector	Commercial	333.0	2	No	Yes	One-Sided	9	0.5	7.5	250	Cobrahead	Davit	41.6	73.6	20.0	4.0	16.9	7.6	1.3	Fail
Downtown Hamilton	Hess St S	King St W	Main St W	Local	Commercial	146.2	2	No	Yes	Staggered	9	2.0	5.0	200	Double Acorn	Post Top	18.3	23.0	20.0	4.0	19.5	19.5	1.8	Fail
Downtown Hamilton	Hess St N	York Blvd	King St W	Collector	Commercial	294.3	3	No	Yes	One-Sided	11	2.0	9.0	250	Cobrahead	Davit	29.4	46.1	20.0	4.0	23.3	9.7	1.1	Fail
Downtown Hamilton	Queen St N	Cannon St W	Hunter St W	Arterial	Commercial	547.0	3	No	Yes	One-Sided	19	2.0	9.0	250	Cobrahead	Davit	30.4	37.0	20.0	4.0	27.0	9.4	1.1	Fail
Downtown Hamilton	Rebecca St	James St N	Mary St	Local	Commercial	409.0	2	No	Yes	One-Sided	13	0.5	9.0	250	Cobrahead	Davit	34.1	37.9	20.0	4.0	18.7	14.5	1.2	Fail
Downtown Hamilton	King St E	James St S	Hughson St S	Arterial	Commercial	92.0	2	No	Yes	One-Sided	7	1.0	5.0	200	Double Acorn	Post Top	15.3	16.0	20.0	4.0	35.7	12.7	1.0	Fail
Downtown Hamilton	Jackson St E	James St S	Catharine St S	Local	Commercial	298.3	2	No	Yes	One-Sided	10	0.5	9.0	250	Cobrahead	Davit	33.1	47.8	20.0	4.0	20.2	15.6	1.2	Fail
Downtown Hamilton	Hughson St N	Rebecca St	King William St	Local	Commercial	68.0	2	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	34.0	36.0	20.0	4.0	20.0	14.9	1.2	Fail
Downtown Hamilton	John St N	Rebecca St	Hunter St E	Arterial	Commercial	148.0	3	No	Yes	One-Sided	6	0.5	9.0	250	Cobrahead	Davit	29.6	34.0	20.0	4.0	22.9	12.8	1.1	Fail
Downtown Hamilton	Catherine St N	Rebecca St	King St E	Collector	Commercial	172.0	3	No	Yes	One-Sided	7	0.5	9.0	250	Cobrahead	Davit	28.7	36.0	20.0	4.0	23.3	13.0	1.1	Fail
Downtown Hamilton	King William St	Mary St	West Ave N	Local	Commercial	494.0	2	No	Yes	One-Sided	11	2.0	9.0	250	Cobrahead	Davit	49.4	62.0	20.0	4.0	16.2	8.6	1.5	Fail
Downtown Hamilton	King St E	Wellington St N	West Ave N	Arterial	Commercial	72.0	4	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	36.0	36.0	20.0	4.0	18.9	5.2	1.1	Fail
Downtown Hamilton	Main St E	Catherine St S	Wellington St S	Arterial	Commercial	420.0	4	No	Yes	One-Sided	16	0.5	9.0	250	Cobrahead	Davit	28.0	34.0	20.0	4.0	24.1	6.7	1.1	Fail
Downtown Hamilton	Walnut St N	King William St	King St E	Local	Commercial	50.0	2	No	Yes	One-Sided	3	2.0	5.0	200	Double Acorn	Post Top	25.0	26.0	20.0	4.0	21.8	7.0	1.2	Fail
Downtown Hamilton	Ferguson Ave N	King William St	King St E	Local	Commercial	106.0	2	No	Yes	Staggered	9	2.0	5.0	175	Double Acorn	Post Top	13.3	15.0	20.0	4.0	17.3	17.3	1.5	Fail
Downtown Hamilton	Ferguson Ave S	King St E	Main St E	Local	Commercial	64.0	2	No	Yes	One-Sided	4	2.0	5.0	175	Double Acorn	Post Top	21.3	22.0	20.0	4.0	17.1	5.5	1.1	Fail
Downtown Hamilton	Ferguson Ave S	Main St E	Jackson St E	Local	Commercial	76.0	2	No	Yes	Opposite	8	0.5	5.0	100	Single Acorn	Post Top	25.3	28.0	20.0	4.0	8.5	8.5	1.2	Fail
Downtown Hamilton	Jarvis St	King William St	End	Local	Commercial	42.0	2	No	Yes	One-Sided	3	2.0	9.0	250	Cobrahead	Davit	21.0	22.0	20.0	4.0	38.4	19.5	1.1	Fail
Downtown Hamilton	Wellington St N	King William St	King St E	Arterial	Commercial	110.0	4	No	Yes	One-Sided	5	0.5	9.0	250	Cobrahead	Davit	27.5	28.0	20.0	4.0	22.8	7.3	1.1	Fail
Downtown Hamilton	Hughson St N	King William St	King St E	Local	Commercial	78.0	2	No	Yes	Opposite	8	0.5	5.0	100	Double Globe	Post Top	26.0	36.0	20.0	4.0	9.0	9.0	2.6	Fail
Downtown Hamilton	Kelly St	Ferguson Ave N	Wellington St N	Local	Residential	148.2	2	No	Yes	One-Sided	4	0.5	7.5	100	Cobrahead	Davit	49.4	52.4	3.0	6.0	2.5	5.4	5.0	Fail
Downtown Hamilton	Cannon St W	Caroline St N	Victoria Ave N	Arterial	Commercial	1550.0	5	No	Yes	One-Sided	46	0.5	9.0	250	Cobrahead	Davit	34.4	43.0	20.0	4.0	19.5	2.5	1.1	Fail
Downtown Hamilton	Peter St	Queen St N	Hess St N	Local	Commercial	93.5	2	No	Yes	One-Sided	3	2.0	7.5	100	Cobrahead	Davit	46.8	60.3	20.0	4.0	3.9	4.7	4.3	Fail
Downtown Hamilton	Market St	Queen St N	Bay St N	Local	Commercial	383.6	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	42.6	62.5	20.0	4.0	4.3	5.2	3.3	Fail
Downtown Hamilton	George St	Hess St S	Bay St S	Local	Commercial	253.5	1	No	Yes	One-Sided	9	0.5	7.5	100	Cobrahead	Davit	31.7	51.0	20.0	4.0	4.4	12.8	1.7	Fail
Downtown Hamilton	Jackson St W	Queen St S	Bay St S	Collector	Commercial	352.4	2	No	Yes	One-Sided	10	2.0	7.5	100	Cobrahead	Davit	39.2	55.0	20.0	4.0	4.7	3.6	1.4	Fail
Downtown Hamilton	Hunter St W	Queen St S	Victoria Ave S	Collector	Commercial	1728.0	3	No	Yes	One-Sided	56	2.0	7.5	100	Cobrahead	Davit	31.4	43.8	20.0	4.0	5.8	4.6	1.2	Fail
Downtown Hamilton	Wesanford Pl	Caroline St S	End	Local	Residential	54.6	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	54.6	54.6	3.0	6.0	3.3	4.1	11.0	Fail
Downtown Hamilton	Evans St	Wellington Ave N	Victoria Ave N	Local	Residential	110.0	1	No	Yes	One-Sided	3	2.0	7.5	100	Cobrahead	Davit	55.0	60.7	3.0	6.0	3.3	6.7	11.0	Fail
Downtown Hamilton	Main St E	Wellington Ave S	Victoria Ave S	Arterial	Commercial	133.8	5	No	Yes	One-Sided	5	0.5	9.0	250	Cobrahead	Davit	33.5	34.1	20.0	4.0	20.3	2.5	1.1	Fail
Downtown Hamilton	Walnut St S	Jackson St E	Hunter St E	Local	Commercial	59.0	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	59.0	59.0	20.0	4.0	3.1	3.8	15.5	Fail
Downtown Hamilton	Victoria Ave S	Cannon St E	King St E	Arterial	Commercial	282.5	5	No	Yes	One-Sided	14	2.0	9.0	250	Cobrahead	Davit	21.7	32.6	20.0	4.0	38.3	2.5	1.0	Fail
Downtown Hamilton	King William St	James St N	Hughson St N	Local	Commercial	87.0	2	No	Yes	Opposite	14	0.5	5.0	100	Single Globe	Post Top	14.5	16.0	20.0	4.0	8.0	8.0	1.5	Fail
Downtown Hamilton	John St N	King William St	Main St E	Arterial	Commercial	220.0	3	No	Yes	Opposite	24	0.5	5.0	100	Double Globe	Post Top	20.0	26.0	20.0	4.0	11.1	11.1	2.0	Fail
Downtown Hamilton	Walnut St S	King St E	Jackson St E	Local	Commercial	178.0	2	No	Yes	One-Sided	6	0.5	7.5	100	Cobrahead	Davit	35.6	36.0	20.0	4.0	3.7	7.3	1.9	Fail
Downtown Hamilton	Spring St	Main St E	Jackson St E	Local	Commercial	38.0	2	No	Yes	One-Sided	2	2.0	7.5	100	Cobrahead	Davit	38.0	38.0	20.0	4.0	4.7	5.8	2.4	Fail
Bus Stop	King St W	Bay St N	James St N	Arterial	Commercial	375.0	5	No	Yes	Opposite	28	0.5	11.0	250	Cobrahead	Davit	28.8	42.3	20.0	4.0	25.3	25.3	1.2	Pass
Bus Stop	Upper James St	Fennell Ave E	McElroy Rd E	Arterial	Commercial	463.5	6	Yes	Yes	Opposite	24	2.0/1.0	9.0	250	Cobrahead	Davit	42.1	59.7	20.0	4.0	20.3	12.2	2.3	Fail

Table 6 - Existing Lighting Conditions for Downtown Sidewalks

The results of the light level calculations and measurements are defined in the spreadsheets and illustrated on the figures below. The figures show separate area maps for roadways and sidewalks with coloured lines defining whether the lighting would pass or fail the proposed standards.

The figures show:

- Sidewalk Illuminance and Uniformity
- Sidewalk Illuminance
- Sidewalk Uniformity.

The figures illustrate in a graphic format the areas where lighting is below standard and by how much it is below standard.

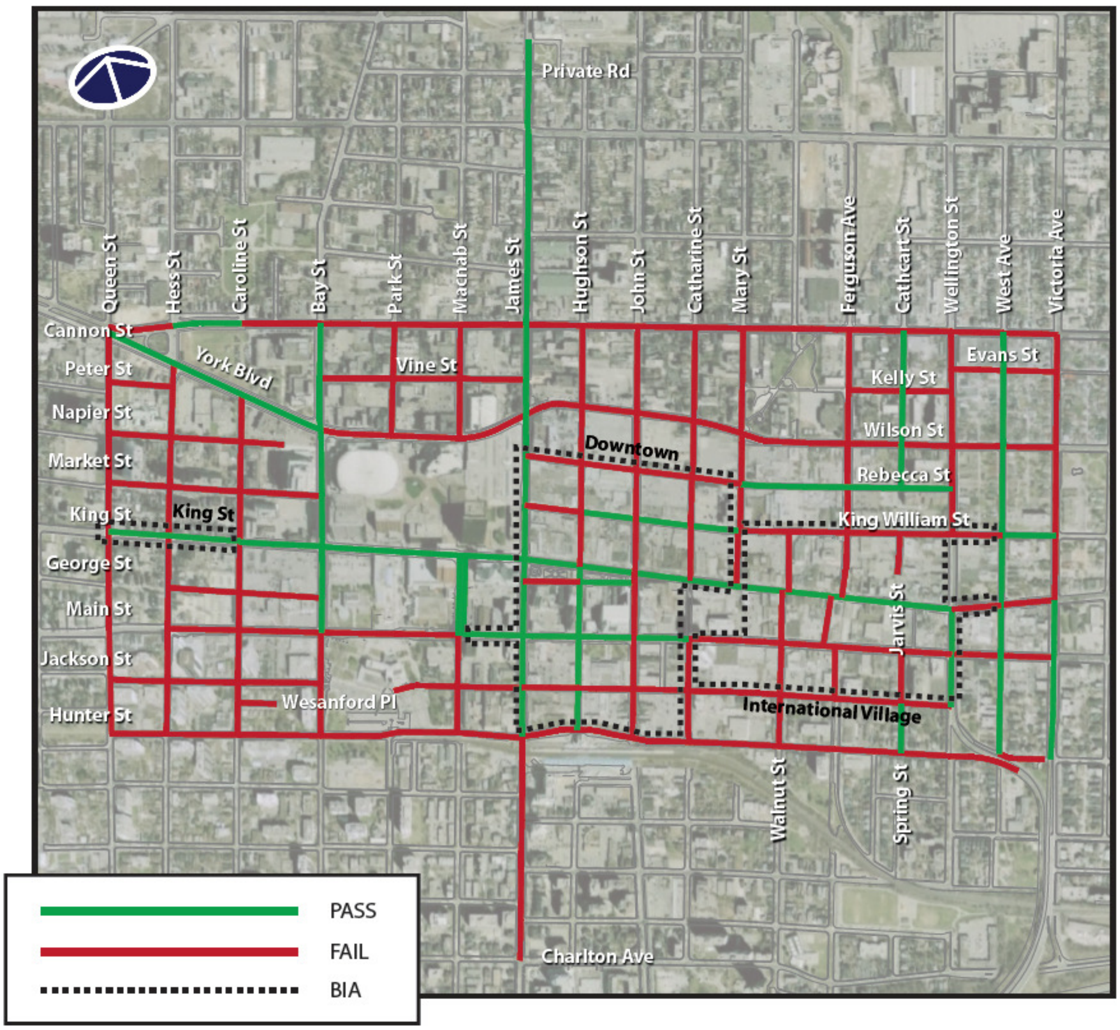

Figure 45 - Downtown Sidewalk Illuminance and Uniformity

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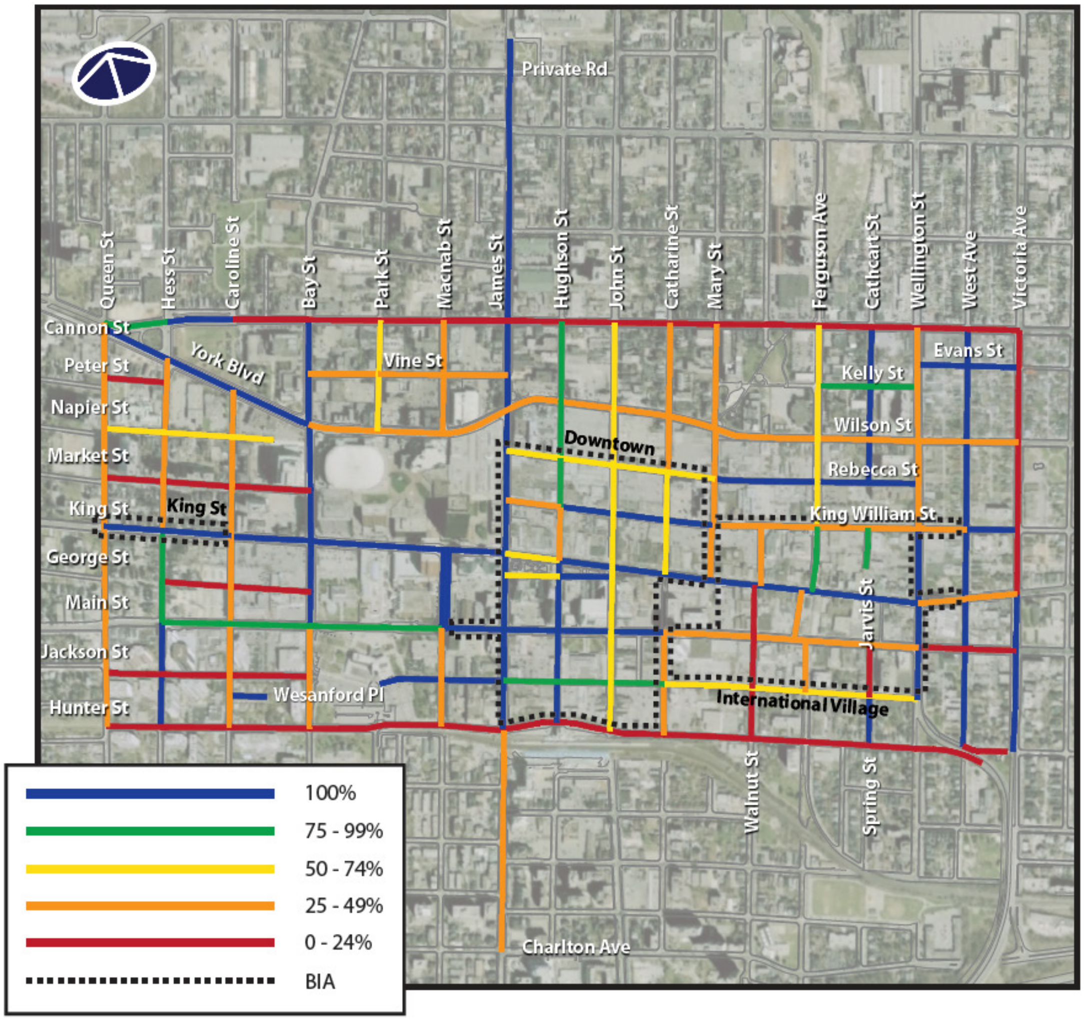

Figure 46 - Downtown Sidewalk Illuminance

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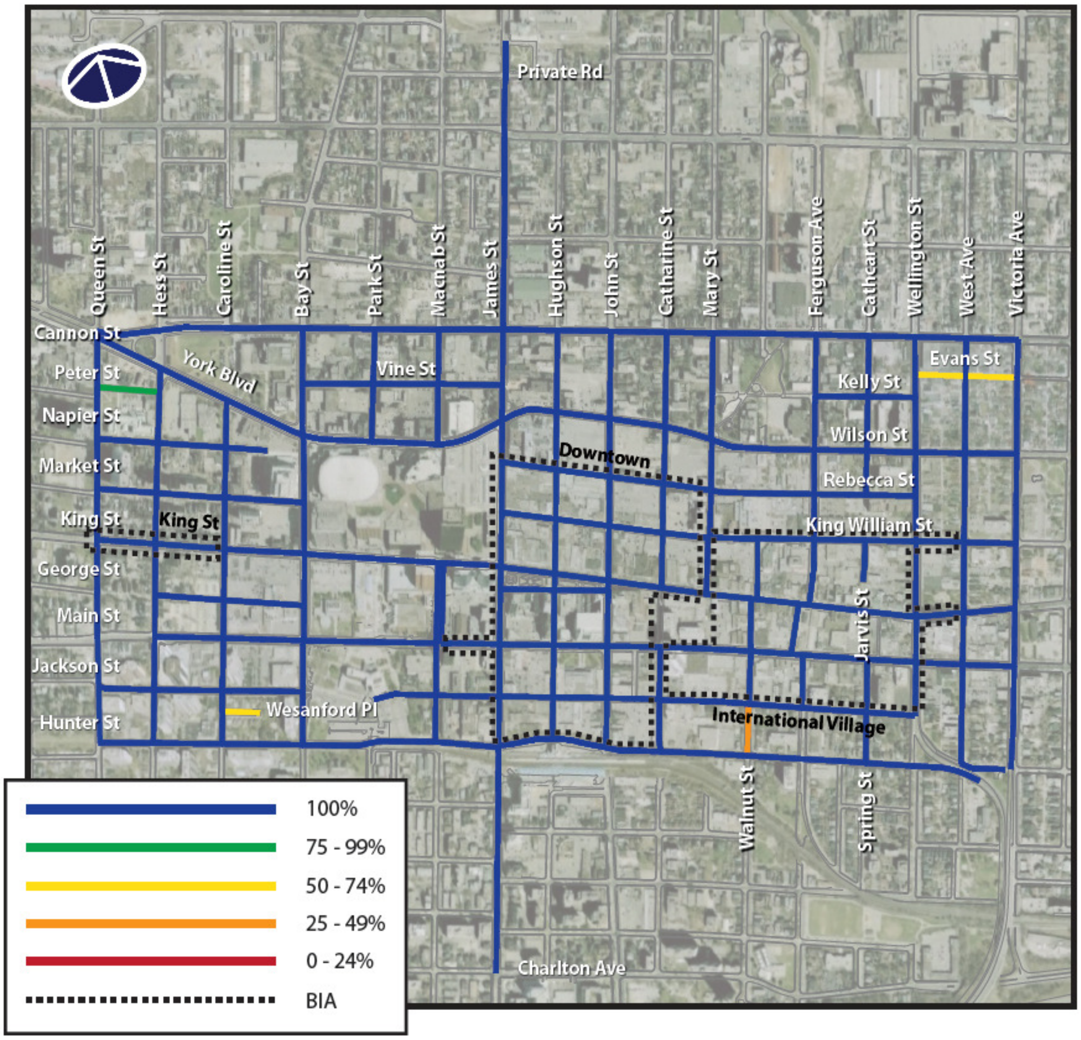

Figure 47 - Downtown Sidewalk Uniformity

Generally the lighting on most sidewalks downtown fell below the recommended lighting standards. In most cases, the lighting on the sidewalk meets the expected uniformity requirements. However, many of the sidewalks are well below the required level of illumination.

3.3 Standards

Standards for lighting roadways and sidewalks are covered in section 2.1.2.2 and 2.1.2.3 of the report. Standards for lighting parks would follow security level recommendations covered in section 2.1.2.3 of the report.

3.3.1 Police Comments

On November 24th, 2009, Glenn O'Connor, a member of the consultant design team, and Mike Field, the City of Hamilton Project Manager, met with Sergeant Michelle Moore and her team of 13 street beat officers to review lighting issues and concerns in the downtown core. Following a brief introduction and project outline, their issues, concerns, and observations were noted. From an overall lighting standpoint, the police group unanimously preferred "white light" sources and did not like the "yellowish/orange" high pressure sodium sources due to the lack of colour rendition, which is important for suspect vehicle and general colour identification.

In general, the police did not find cobra head style lighting as effective as the post top lighting. This was due to the fact that the cobra head street lights are typically much taller poles than post top lighting. The post lighting is also a white light source, whereas the cobra head style lighting is generally the yellowish/orange high pressure sodium source with poorer colour rendition.

The Hamilton Police Service identified specific problem areas as follows:

- Lighting on sidewalks and roads is uneven in many areas, especially on side streets
- South of the GO Station, south of the tracks, residential areas are poorly lit.
- North side of King, James to Bay: not well lit.
- Bowen, Jackson to Main, is an issue.
- Lighting near bar areas could be improved (they like the new lights at Hess Village).
- North side of York Street, near Copps Coliseum, lighting is poor.
- Market St., west side of Bay, at rear of Copps Coliseum: dark.
- James St. North, west side near Mulberry, alley south of James to Hughson, near to and behind 231 Hughson.
- Main St., Catharine to Walnut, is poorly lit.
- There are three methadone clinics downtown and several bars: high number of people with issues.

3.3.2 Obstructions which Impact Designs

Obstructions can impact lighting performance by blocking out light and creating shadows which reduces ones visibility. Issues and how they can be mitigated are as follows:

- Building awnings, bus shelters, etc - Where building awnings, bus shelters or similar exist or are proposed and are in conflict with the lighting the awning or shelter should be modified or additional poles added to accommodate for the blockage of light. Because these are solid objects with fixed size and shape computer lighting design software may be used identify the impacts of light blockage and define on where to add additional poles and luminaires to compensate.
- Trees – Because trees are not solid objects it is impractical to use computer software to define their impact. Where trees are present or proposed one can mitigate impacts by methods noted in Section 2.1.5.4.

What is noted above will typically impact the sidewalk more than the roadway.

3.3.3 Recommendations

All roads in the Downtown should be lighted as is common practice in major Cities throughout Canada. Roads and sidewalks should be lighted as defined in section 2.1 Urban Roadways.

The rational for lighting in the downtown, is as follows:

1. Pedestrian Safety (Navigating sidewalks, off-road, etc): Lighting is required to allow pedestrians to safely navigate the sidewalk. It provides increased visibility for those using sidewalk to allow them to see where they are going, reducing tripping or falling.
2. Safety and Security – Real: Lighting will improve one security by improving visibility which aids in surveillance. It allows those in motor vehicles to view pedestrian activity on the sidewalk and pedestrians crossing the road. The CPTED principals refer to the term “fight or flight” which means observing potential hazards from a distance allows a person to make a choice to avoid a hazard. This is aided by well designed outdoor lighting which should improve visibility. A well lighted area can allow drivers and pedestrians to observe and report any criminal activities through improved visibility. For example, if someone is being assaulted on a well lighted sidewalk, adjacent to a roadway, motorists could report the criminal activity and could also stop and intervene. If the area was not visible to motorists, then the surveillance benefits would be greatly reduced.
3. Commercial and City of Hamilton image enhancement: Lighting can provide a level of comfort and can promote economic development. It adds a level of perceived safety for pedestrian and as such can add a level of comfort and can promote commercial development.
4. Safety and Security – Perceived: Lighting will provide a feeling of security which can lead increased pedestrians.
5. Vehicular Road Safety (Vehicle-vehicle conflicts): It is proven in reducing vehicle collisions.
6. Pedestrian-Vehicular Safety (Pedestrian-vehicle conflicts): It can reduce the potential for collisions with pedestrians and cyclists on the roadway by improving visibility.

Based on the assessment of the existing lighting levels, the lighting on downtown roadways generally meets the recommended practices (exceptions include some low lighting in certain areas as defined). The lighting on most of the sidewalks is generally below the recommended practices and upgrades to sidewalk lighting are therefore recommended. The exceptions are areas shown which met lighting requirements, including most of the upgraded streetscape projects.

We also understand the City of Hamilton staff supports and promotes pedestrian and safe walking initiatives throughout the City of Hamilton as noted in the City of Hamilton of Hamilton Collaborative Pedestrian and Walkability Initiatives BOH09029a paper. Proper lighting of sidewalk would enhance key elements of this such as “reduced road danger” and “less fear of crime”.

Prior to undertaking any improvements, it is recommended that the City of Hamilton develop a long-term capital improvement/replacement program for lighting upgrades, similar to those

used for road improvement programs currently in place. This would involve analyzing or assessing each road in the Downtown and applying the recommended solution and capital cost.

Given the age of most of the existing lighting, it is recommended on primary (high profile) roads, that the existing lighting be replaced, as opposed to supplementing or replacing the existing luminaires. This will need to be assessed on a road by road basis. Recommendations will vary depending on the condition of the existing lighting and where the existing lighting levels are given compared to the recommendations (i.e., low illuminance levels, poor uniformity, etc.).

On existing secondary (lower profile) roads with high pressure sodium cobra head style lighting, it is recommended the existing lighting be replaced with LED type lighting. This will improve lighting levels, improve colour (white light source) and reduce energy costs.

On primary roads where the lighting needs be replaced, it can be provided in numerous options including various shapes and styles of luminaires mounted on tall or short poles, span wires, structures, etc. Mounting luminaires on poles is by far the most common and practical mounting method. The height of the pole directly affects the throw of light. Simply put, the taller the pole the better the throw of light. The height of the poles must also be in scale with the surroundings. Short poles, about 4.5 m in height, are at the scale of pedestrians and work well in lighting sidewalks and roads of two lanes. Tall poles, usually 9 m to 11 m in height, work well on 4 to 8 lane roads where the light has to be distributed across a large width.

For the Downtown, we have developed two lighting options: an overhead option and a pedestrian lighting option. Different styles of luminaires noted in the report can be applied to these options.

3.3.3.1 Overhead Lighting Option

For wider roads, or roads with numerous street trees, street lighting should be mounted on 9 m to 11 m tall poles. The street lighting shall be mounted over the roadway beyond any tree canopy (to whichever extent practical) as shown below.

Sidewalk lighting requires separate pedestrian scale lighting mounted on poles at 4.5 m to 6 m above the sidewalk. Pedestrian luminaires can be mounted on the backside of the main poles, however, additional pedestrian level poles will be required to provide high levels of uniformity. Where street trees are proposed or existing, the sidewalk and street lighting systems shall be calculated separately with no contribution from each other to ensure good lighting uniformity and that pedestrian precincts are properly lighted.

Figure 48 - Overhead Lighting Example

Recommended pole layouts and elevations are shown on figure 50 below.

3.3.3.2 Pedestrian Scale Lighting Option

Pedestrian scale lighting must be in scale with the pedestrian as shown in figure below. Poles typically use luminaires mounted 4.5 m to 6 m above the sidewalk. This lighting will light the street and sidewalk provided no trees are present and the road doesn't exceed 2 lanes in width. Poles should be arranged on both sides of the road in a staggered or alternate pattern.

Well designed pedestrian scale lighting contributes to the quality of urban design in the City of Hamilton, both during daytime and nighttime. Well designed luminaires and poles that fit their context and nearby street furnishings, contribute to the ambiance of the City of Hamilton.

Figure 49 - Pedestrian Scale Lighting

Recommended pole layouts and elevations are shown below

Cost estimates specific to each given option recommended are provided as guidance. The lighting costs listed below include all labour, materials, and equipment required to complete the installation. Costs will vary for each application. Prior to starting any project, a lighting cost estimate should be developed for the specific project.

Based on the lighting concepts provided in this section, the order of magnitude costs for the supply and installation of roadway/sidewalk lighting applications are defined as follows:

- 2 Lane Rd - Pedestrian Scale roadway and sidewalk lighting (new road construction) - $530.00/m or assuming a 200m block, $106K.
- 2 Lane Rd - Pedestrian Scale roadway and sidewalk lighting (no road construction) - $679.00/m or assuming a 200m block, $136K.
- 4 lane Rd - Overhead lighting with sidewalk lighting (new road construction) - $602.00/m or assuming a 200m block, $120K.
- 4 lane Rd - Overhead lighting with sidewalk lighting (no road construction) - $744.00/m or assuming a 200m block, $149K.
- 6 lane Rd - Overhead lighting with sidewalk lighting (new road construction) - $886.00/m or assuming a 200m block, $173K.
- 6 lane Rd - Overhead lighting with sidewalk lighting (no road construction) - $1045.00/m or assuming a 200m block, $209K.

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The above costs are only a small part (maybe 10% to 20%) of an overall streetscape project. If lighting was upgraded it would than likely be undertaken as part of an overall streetscape project involving new sidewalks, curbs, pavement, benches, planters, etc.

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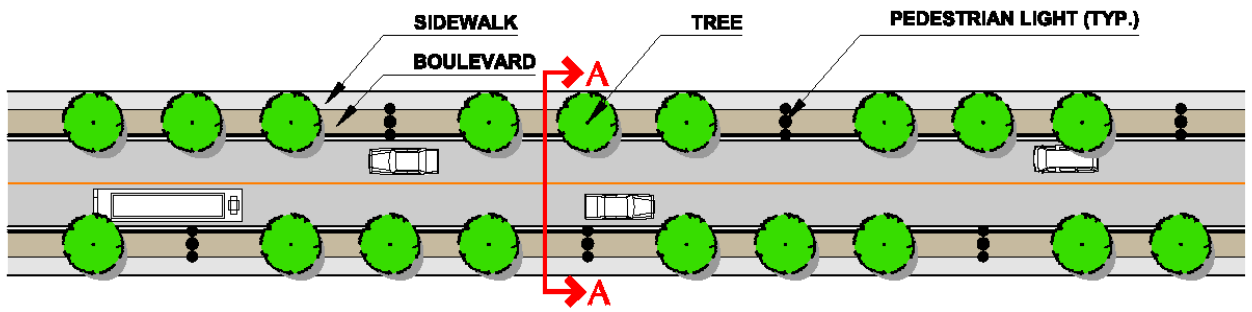
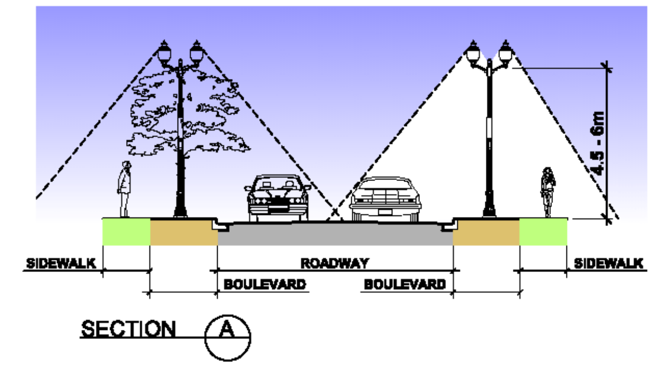
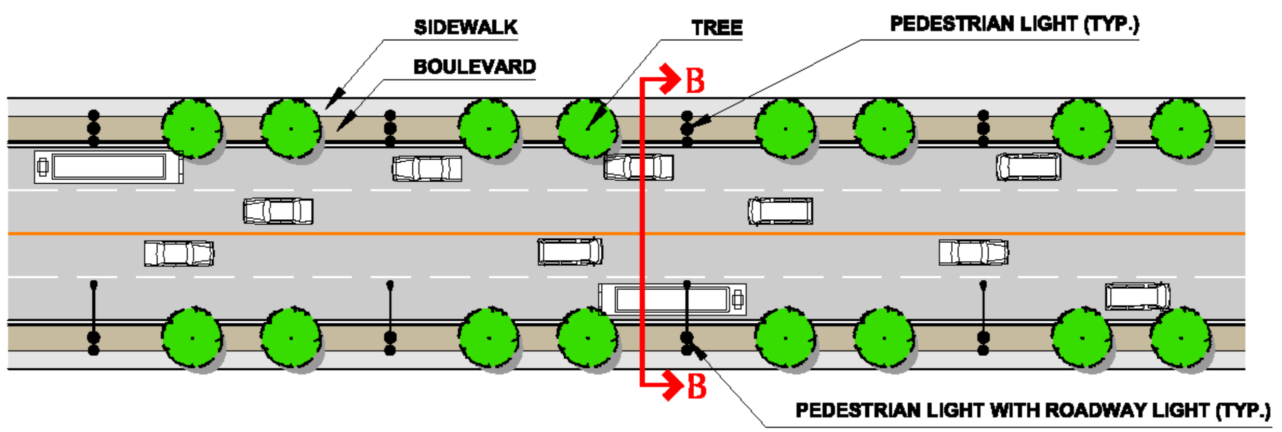
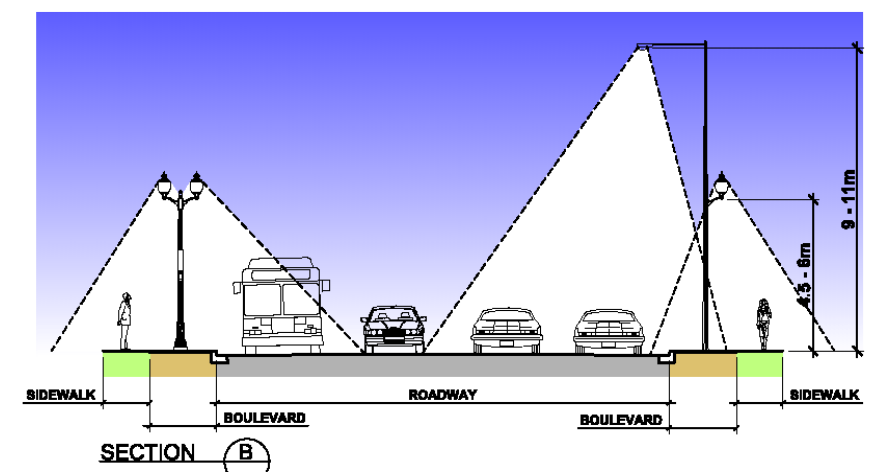


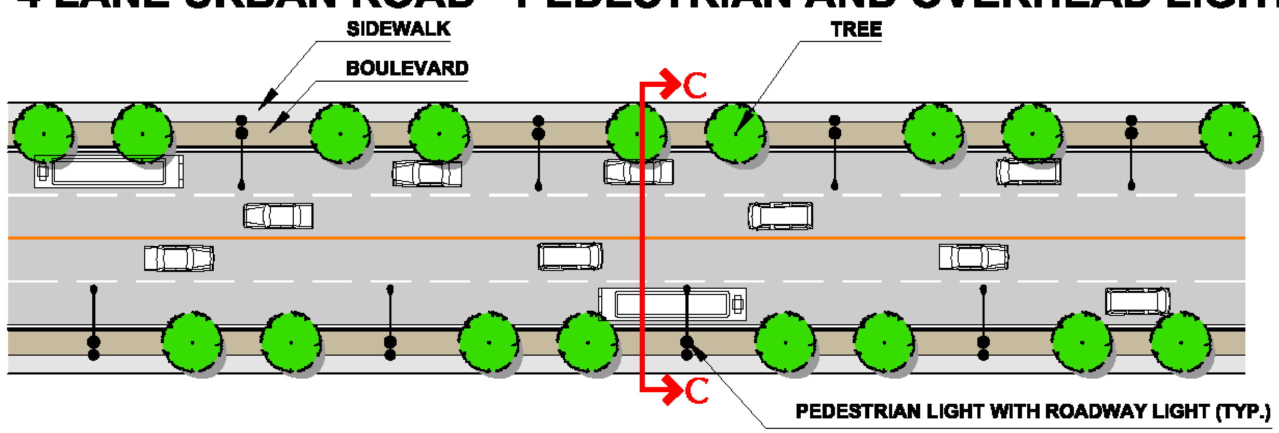


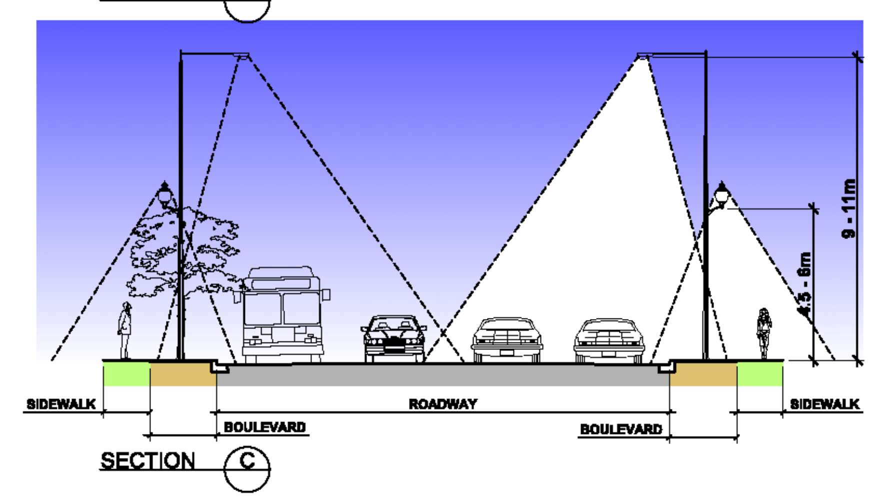
2 LANE URBAN ROAD - PEDESTRIAN LIGHT OPTION





4 LANE URBAN ROAD - PEDESTRIAN AND OVERHEAD LIGHT





4 LANE URBAN ROAD - PEDESTRIAN AND OVERHEAD LIGHTS, BOTH SIDES

Figure 50 - Overhead and Pedestrian Scale Lighting Options

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3.4 Parks

The primary purpose of lighting areas surrounding the interiors and exteriors of an urban park is to enhance personal security and either encourage or discourage nighttime usage.

Standard practices in the City of Hamilton Parks System indicate that seating areas, play equipment areas, or pathways are generally not lighted. The intent is not to encourage pedestrian activity in areas where natural surveillance is low during the evening. Traveling through a park can pose a significant risk if the area has limited sightlines or low pedestrian activity. In this case, lighting may encourage a person to enter the park. However, this behavior may result in compromised personal safety through reduced visibility of what may be ahead, including shrubs, trees, walls, or other elements that could create hiding places.

Occasionally, lighting is provided in parks due to neighborhood perceptions of increased safety. In this case, City of Hamilton staff works with local residents to light areas that are considered to be of concern, ideally with the result being increased safety. Some exceptions occur when a walkway is deemed a primary walkway between important destinations in a neighborhood or other significant urban features. As an example, the Escarpment stairs are lit as they are considered part of the primary pedestrian circulation system of the City of Hamilton. They link neighborhoods of the upper and lower areas of the City of Hamilton while traversing open space lands.

Active recreation activities such as tennis, soccer, football, baseball, and other team sports are sometimes lighted. This is also the case for neighborhood activities such as outdoor skating rinks in winter. Timers are generally used to control the duration that the lights are in use. The undersides of park shelters are also generally lighted, to discourage loitering and vandalism.

Parks also include monuments which have significance as they typically mark a historic event or honor significant achievements.

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Figure 51 – Typical Park Pathway

3.4.1 Current Conditions

Currently, park shelters and sports fields are lit through the use of metal halide, while high pressure sodium is commonly used for the walkways.

Several City of Hamilton parks were assessed for lighting levels in the downtown including the Gore, Wellington, and Beasley parks. From a pedestrian guidance and security lighting level perspective, the lighting on the pathways in these parks easily exceeds the standards recommended. Even if we consider higher lighting levels required for a plaza area (10 lux for a plaza as compared to 6 lux for walkway) the lighting levels that exist exceed what is required by 2 to 4 times.

The lighting of the monuments at Gore Park existed but was not operational at the time review.

3.4.2 Standards

From a security standpoint G-1-03 Guideline for Security Lighting for People, Property, and Public Spaces does not recommend a specific level for sidewalk applications. It does however define a minimum maintained average vertical illumination level of 5 Lux to 8 Lux with average to minimum uniformity not exceeding 4:1 for “facial recognition” which is critical to enhancing surveillance and security. These lighting levels should be applied in areas where one wishes to enhance personal security.

The lighting of monuments should follow recommendations listed under section 3.6 Building and Monuments (Architectural Lighting).

3.4.3 Police Comments

According to the police, parks which are out of the view of City of Hamilton streets can poise high risk. Even if the park is well lit if can't be viewed from adjacent street lack of surveillance maybe add risk. Trees and shrubs typically found in parks restrict police ability to provide surveillance regardless of the lighting levels.

Where a park is lighted pedestrian pathways should be open to provide police and public surveillance.

3.4.4 Recommendations

Pathways in parks and open spaces should only be lighted where it is a defined nightime destination used by the public. In the urban environment, the general public may not have immediate access to green space and utilize parks more frequently than in suburban areas. The lighting of parks within the downtown project is therefore justified in most instances.

When park lighting is required (either through park reconstruction or upgrades) a comprehensive review and design should be undertaken to ensure that all factors are considered. Consultation with the appropriate sources such as Police, Urban Planners and landscape architects is recommended to take place to determine the ideal configuration of parks in order to create an inviting, and safe environment for users. Lighting should be designed to the recommendations listed in this report and poles should be to a pedestrian scale and vandal resistant equipment should be used.

Provisions should also be considered for any seasonal lighting requirements, entertainment lighting (accessibility to power), or special event lighting as they are often required in parks. Outlet boxes and associated power distribution should be design to accommodate park programming and be flexible to allow for different requirements. This type of equipment should be vandal resistant and lockable when not in use.

Public monuments in parks and plaza areas should be lit to draw attention and highlight features allowing them to be viewed during hours of darkness. An example of monument lighting is shown in Figure 52 below. Recommendations for lighting of monuments are difficult to make as these applications are generally not similar and need to be evaluated on a case-by-case scenario.

Figure 52 - Monument Lighting Example

3.5 Parking Lots

Parking lots maybe covered (parkade) or open type. Lighting parking lots should provide both safety and security. The safety benefit comes from improving visibility for both motor vehicles and pedestrians. Although parking lots are low speed, drivers are often backing up with reduced visibility and their motor vehicle’s headlamps provide little benefit for this task.

As parking lots are large open areas, lighting has significant security benefits as it allows the users to see activities of concern, and, it allows those outside the parking area to view possible criminal activities within and take action accordingly.

The figure below shows an excellent example of a well lit open parking lot.

Figure 53 - Open Parking Lot Lighting Example

3.5.1 Research

To the best of our knowledge, the safety and security benefits specific to the lighting of parking lots has little research available. Security benefits would be similar to those listed for sidewalks and have therefore not been repeated. In terms of safety a study was undertaken in 1999 to examine the night proportion of vehicle collisions by type as well to explore pedestrian incidents such as slip and fall, assault, etc. This study showed vehicle collisions with pedestrians had the highest proportion of all night-time collisions. The study concludes lighting of parking facilities should be directed towards the need of pedestrian as opposed to the driver (35).

3.5.2 Standards

The Illuminating Engineering Society of North America (IESNA) has produced a document titled G-1-03 Guideline for Security Lighting for People, Property, and Public Spaces (15).

The lighting of urban parking lots will provide security and safety benefits. Lighting rural parking lots may be of less benefit, particularly if they are not well used at night.

Parking lots need to be illuminated in a uniform fashion. Flood lighting on poles or buildings should not be used. Lighting levels should be as defined below.

Misc Areas	Illuminance (Lavg)	Uniformity (Lavg:Lmin)	Vertical Illuminance (Vavg)
Covered Parkade (1)	60	4.0:1	15
Open Parking Lot (1)	30	4.0:1	n/a

(1) - form IESNA DG-1-03

Figure 54 - Recommended Parking Lots

3.5.3 Current Conditions

Most parking lots within the City of Hamilton are not lighted. In the Downtown, even where lighting does exist, it fall's well below required lighting levels. Floodlights are often used which can actually reduce visibility by casting excessive glares into people eyes. No flood lighting should be allowed.

Figure 55 - Typical Downtown Parking Lot

3.5.4 Police Comments

The police noted lighting in parking lots in the Downtown is poor and in many cases is non-existent. The police did note drinking at night is an issue in the parking lots across from night clubs on King William, across from 77 King William, Catharine, and King William.

The police noted good lighting is required to monitor and provide proper police surveillance.

3.5.5 Recommendations

All parking lots should be lighted as defined above. This will apply to existing parking lots as no new parking lots are allowed within the Downtown. The City of Hamilton can't force private parking lot owners to upgrade lighting however, the City of Hamilton could upgrade lighting in its own parking lots to set an example.

Open parking lot lighting should be via horizontally luminaires with cut-off optics mounted on 9m to 11m tall poles. Pole bases should extend 600mm out of the ground to protect poles against damage.

Figure 56 - Recommended Parking Lot Lighting

3.6 Building and Monuments (Architectural Lighting)

Lighting architectural exteriors of buildings and monuments is much different than roadway lighting. There are no defined standards for architectural lighting as it provides more of an effect than a specific function. The complexity of the visual environment and the speed with which pedestrians and vehicles travel and navigate dictates an approach that includes

consideration of historic context, scale, and colour. There is a need to prioritize the visual and architectural features as well as streetscape areas such as 3D and 2D art.

Nighttime lighting of streetscapes and architecture requires that a complex series of questions and ideas be carefully considered and evaluated by the designer. These include, but are not limited to:

- the surface reflectance (luminance) colour and texture
- the surround (i.e., light or dark)
- the lighting effect required (i.e., wash, grazing, accent, silhouette)
- lighting source colour
- luminaire placement and mounting
- controls (i.e., colour changing, turning off and on).

Inherent in all lighting design, but especially in exterior lighting design, are the issues affecting how people see. These include glare, visibility, colour, illuminance, luminance, and brightness. Of these issues, glare and colour are the most critical elements. Glare should be minimized as it can be very annoying and in extreme cases can even hinder visibility.

Figure 57 - Lighting Examples

Figure 57 shows some examples of building lighting effects.

A key consideration is that dark objects absorb more light than lighter objects, so their luminances (reflected light back to one's eye) will be different. Residential areas typically have a low luminance, while urban areas tend to have a higher luminance.

Building and monument surrounds are defined as a luminance ratio. In nighttime exterior environments, the luminance values of building surrounds should not exceed a maximum-to-minimum ratio of 20:1 or glare will result. There are times, however, when the need for a lower ambient lighting level may cause values in excess of the 20:1 ratio. Surrounds in excess of 20:1 luminance ratio values must be carefully analyzed as feature elements. The luminance ratio can be calculated by first defining the surface reflectance and then using computer lighting rendering software to calculate the ratio.

Figure 58 - Example of Light and Dark Surrounds

Figure 58 above shows both light surrounds (concrete) and darker surrounds (windows).

A benefit of designing for different brightness levels on adjacent objects is that it creates visual focus, a technique often used by designers of nighttime streetscapes. To create a visual accent and contrast, a minimum ratio of 3.0:1 in luminance values is required. As the ratio increases, visual focus on the brighter object also increases. If there is a surface or object that is not desired to be noticed in the nighttime scene, leaving it unlighted or with only a very low level of lighting will reduce its visibility.

Colour has an effect on visibility as well. Just as objects lighted to higher levels stand out from more dimly lighted objects, the use of colour can create focus and drama. In the IESNA Lighting Handbook, 9th Edition, the term "colour" is defined as the characteristic of light by which an observer can distinguish between patches of light of the same size, shape, and structure.

Colour can be added to a surface in different ways. A very nice effect is created by lighting adjacent surfaces using different colours of light.

Figure 59 - Examples of Colour and Lighting

The lighting of vertical surfaces, both hardscape and softscape, is essential to creating a positive visual impact in the exterior nighttime environment and creating a sense of place, safety, and enjoyment. People see the vertical planes of objects much more than the horizontal planes, with the exception of the street itself. In urbanized areas, due to the scale of typical commercial streets and complexity of buildings, the lower portions of vertical surfaces are very important clues for wayfinding from both a pedestrian and road user standpoint.

Types of vertical surface illumination include washing and grazing effects. Choice and placement of the equipment is very important, particularly with respect to obtrusive light (i.e., unwanted light and glare cast offsite). It is becoming unacceptable to place lighting equipment in such a way that the light beam is allowed to escape directly into the sky. If equipment must be aimed up, it is a good idea to have a defined turn-off time to reduce sky-glow impacts. This will not only alleviate legitimate environmental concerns, but will also save energy dollars.

When lighting a building with a general wash from a floodlight, whether at a high or low level, the floodlight must be placed away from the building and aimed at the area to be lighted. The effect will be an overall uniform illumination. The choice of equipment and lamp wattage, as well as the number of luminaires used, will determine the overall luminance of the area being lighted. Surfaces illuminated in this manner will be visually quite flat without specific definition, shade, texture, or shadow.

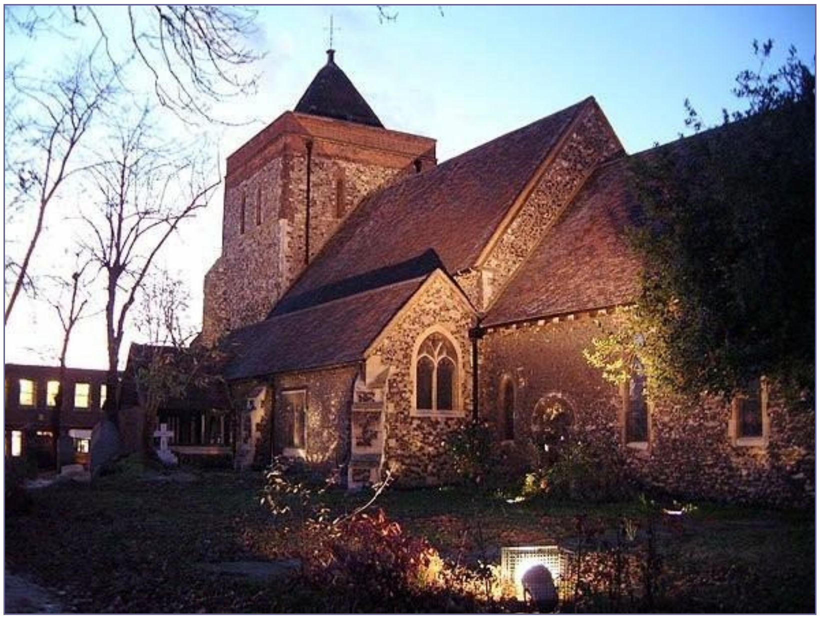

Figure 60 - Example of Building Wash Effect

Figure 60 shows luminaires placed a distance away from the building in the foreground which creates an even wash of illumination.

When highlighting interesting architectural details such as a building structure, a building material texture (i.e., brick or stone), or lighting a more defined area, the luminaire should be moved onto the surface and positioned so the light grazes the surface. If the luminaire is mounted close to the ground, the designer must consider the issue of glare if the luminaire is in view of the public, and, potential vandalism if it is in reach of the public. Furthermore, people may also be working or living in the buildings that are being illuminated.

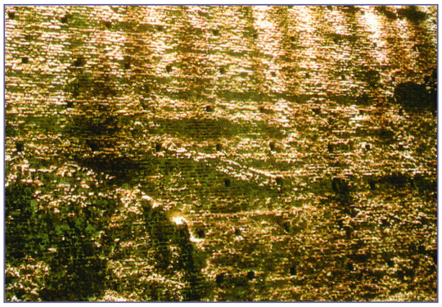

Figure 61 - Examples of Grazing Lighting Effect

Figure 61 shows how the surface can be highlighted and shows the contrast created with a grazing lighting effect.

Grazing light adds drama to the scene, revealing the texture and architectural structure or features. As the luminaires are brought closer to the surface being illuminated, shadows and highlights are created by the projecting elements of that surface.

Placement of the luminaire for grazing light is based on the height the designer wants the light to reach up or down the surface. It is usually placed below the area being illuminated, but placement above the area to create grazing down-light may also be considered. Careful attention to masking the source brightness is important when using the down-light method. If the object to be highlighted is small, relative to an overall wall, the luminaire should be placed in close proximity to that object.

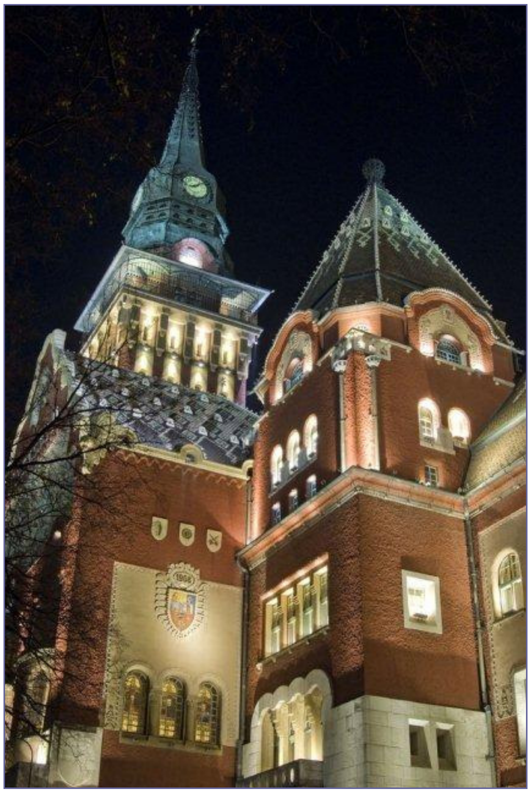

Figure 62 - Example of Accent Lighting Effect

Figure 62 shows the effects of accent lighting on brick surface. This has a more even illumination effect than grazing.

Accent light is a more focused illumination than a wash or grazing light effect. The luminaire is either placed in close proximity to the object being accented, or it has a sufficiently narrow distribution such that it can be located further away from the object. Often surfaces that have a low level of general illumination can have light added to highlight important details or features. The accented details must be lighted to a minimum of five times the general level of light in order to create the focus needed.

Figure 63 - Colour Changing Lighting

Figure 63 shows the effects that can be created with coloured light sources. Changing the colour of the light, through colour media or the use of a different colour source, can also create contrast for an interesting effect.

Lighting can also be designed to change colour and turn on and off at preset times or even to music. This lighting is pre-programmed to a number of preset musical programs which change during the night and for events.

Three-dimensional objects such as sculptures/art can be illuminated in many different ways. If the objective is to reveal most of the object it is important it be illuminated uniformly from multiple angles. The use of multiple luminaire locations will create a three-dimensional effect. Changing the colour of the light can also be effective in lighting a three-dimensional object.

An object can be illuminated by silhouette. This technique often reveals more of the form than simple direct lighting or accent lighting. Silhouette lighting can also be used to feature patterns of objects or to create a glow. The light behind or inside these objects should be as uniform as possible and should not be glary.

Figure 64 - Example of Silhouette Lighting Effect

Figure 64 depicts the case where an internal light source provides a silhouette effect to the surface.

The intensity of light on the background should be carefully considered as too much light will overwhelm a small silhouetted object and too little will not create the proper effect.

Illumination recommendations for architectural lighting scenarios such as building façades, monuments, and sculptures are defined in the figure below.

Architecural Features	Target Illuminance (Lux)
Bright Surrounds with Light Surfaces (1)	60
Bright Surrounds with Medium Light Surfaces (1)	70
Bright Surrounds with Medium Dark Surfaces (1)	100
Bright Surrounds with Dark Surfaces (1)	150
Dark Surrounds with Light Surfaces (1)	20
Dark Surrounds with Medium Light Surfaces (1)	30
Dark Surrounds with Medium Dark Surfaces (1)	40
Dark Surrounds with Dark Surfaces (1)	50

(1) - IESNA Handbook

Figure 65 - Lighting Requirements for Architectural Features

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3.6.1 Hardware and Mounting

Building and monument lighting is aesthetic in nature and, as such, each installation is somewhat unique. With the lighting of building façades the positioning of the luminaires is critical to creating the desired effect. Positioning the luminaire away from the building and washing the building in light will highlight more of the surface than positioning the luminaire close the surface. Luminaires can also be positioned to light up or down a surface.

Typically, the luminaires would be attached to the building exterior surface and above the reach of the public. Mounting luminaires on the ground or in locations accessible to the public should be avoided in order to reduce the potential for damage due to vandalism. Typically, most commercial buildings in the Downtown area abut the City of Hamilton property/street line at the sidewalk therefore most luminaires will have an aerial trespass on City of Hamilton property. In order to allow an owner to install lighting on buildings, the City of Hamilton must develop a simple process where building owners are granted an easement to install lighting which may trespass on City of Hamilton property/air space.

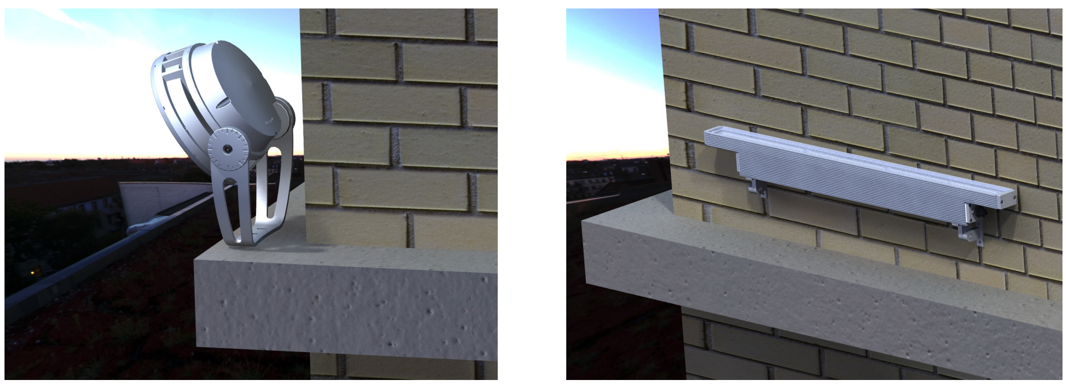

Figure 66 - Luminaire Mounting Examples

With respect to the luminaire and light sources today, many options are now available with the introduction of various LED luminaires. LED luminaires are much more compact and offer colour changing options that traditional metal halide or high pressure sodium light sources do not have. The compact size also allows them to be less noticeable during the daytime.

LED lighting has excellent controls to allow colour changing and turning on and off at preset times. LEDs are also long lasting, have many beam shapes and light distribution patterns, are very energy efficient, and compact in size and shape. All of these qualities make them an excellent solution for architectural lighting applications.

The in-ground luminaire shown in figure 57, may be mounted in the ground to up-light a wall surface, statue, or monument. For monuments and statues lighting maybe required from multiple angles to highlight various features.

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Figure 67 - Typical In-ground Lighting

3.6.2 Recommendations

As noted lighting of building exteriors can be added to improve aesthetics and highlight architectural features of a building. To improve building appearances the City of Hamilton offer a Commercial Property Improvement Grant (CPIG) program to provide incentive to downtown building owners to enhance their building appearance. It is recommended based on the information provided that the City of Hamilton provide supplemental lighting criteria and guidelines, together with examples of building lighting and distribute to downtown businesses to promote lighting improvements.

The City of Hamilton should allow arterial trespass of luminaires over sidewalks, provided the luminaire attachments are properly engineered. Examples of this style of lighting have been provided. Given the specialty of this type of lighting, it must always be reviewed on a case basis.

It is recommended the City of Hamilton consider lighting selected monuments to highlight features.

3.7 Theatrical and Seasonal Lighting

Theatrical Lighting is typically specific to an event, production, or mood. It is typically used in a plaza or stage application in a central gathering area. However, the lighting can also be the event or production as it can be designed and controlled to change colour in a defined timed sequence or set to music.

An example of such lighting is shown in the figure below where a defined lighting show was designed at the event plaza for the 2010 Olympic Athletes Village in the Downtown Vancouver False Creek area. In this case, colour changing LEDs are controlled by a DMX controller, which has been programmed with defined lighting shows.

Any theatrical lighting must be designed so it does not distract drivers and increase their risk for collisions.

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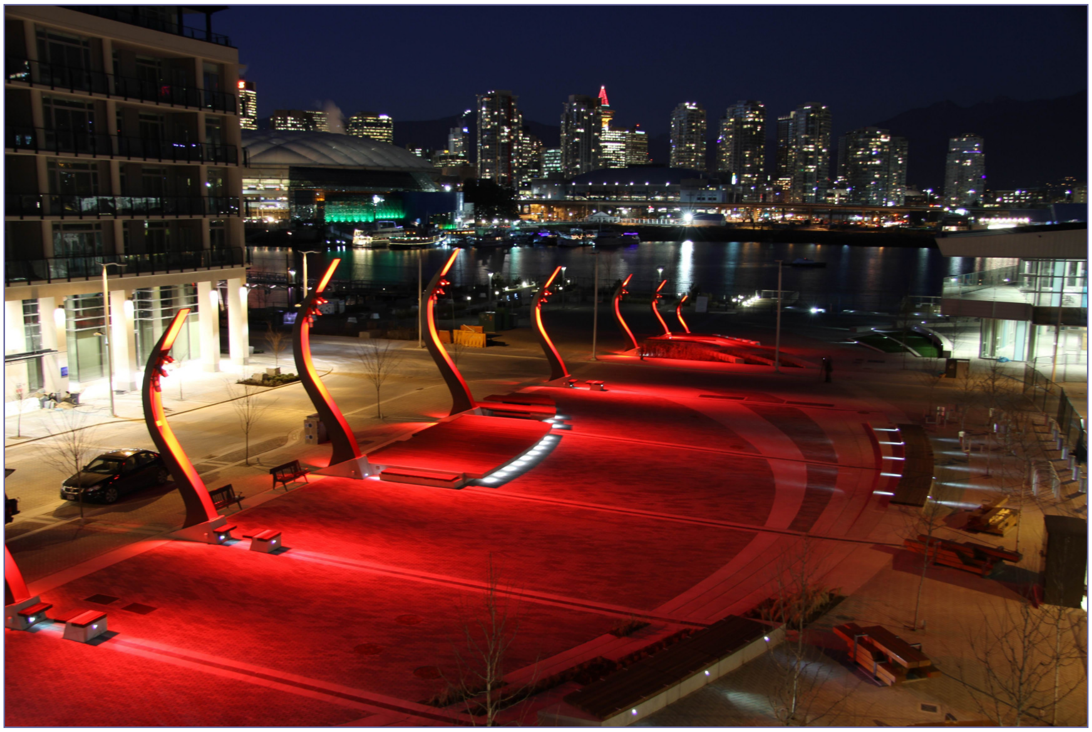

Figure 68 - Colour Changing Lighting

Figure 68 shows an example of colour changing LED lighting at the 2010 Olympic Athletes Village in Vancouver, BC.

A gobo projector can be used to project defined images such as logos, shapes or patterns on to walls or floors. The projector can move the images in defined patterns, change sizes and shapes.

Decorative seasonal lighting typically involves installing strings of rope lights on trees and other features to provide a level of sparkle at certain times of the year, particularly the Christmas season. The purpose of these lights is more for effect than function. This lighting does not have specific design criteria or specific requirements other than to provide aesthetic effects which should not be overly bright to distract those using the street and sidewalk.

Seasonal lights are typical strings of LED rope lights, attached to tree limbs and connected to a 120V outlet mounted on the tree or at the base of light poles. Seasonal lighting should not be placed around traffic signal displays as it may distract motorists. Other accent flood or spotlighting may be added on a seasonal basis to accent or articulate feature elements. Where possible, the BIA should work in consultation with the City of Hamilton with respect to theme, colours, and coordination of these lights.

Figure 69 demonstrates the effects of lighting trees in a downtown streetscape environment. In this case, LED rope lighting is installed in the trees to provide a level of sparkle to the trees. This lighting could be installed on a permanent or seasonal basis.

Seasonal lighting may also include lighting for seasonal holidays such as Christmas. If seasonal lighting is undertaken, we recommend it be an LED technology and designed and installed in such a way as to not distract motorists. Seasonal lighting should not be placed at traffic signals as the colours of the displays may cause confusion for motorists' viewing of traffic signal displays.

Figure 69 - Example of Seasonal Tree Lighting

3.7.1 Recommendations

Theatrical lighting and seasonal lighting needs to be planned and included in plaza, park or road upgrade projects. As these types of lighting are often installed and removed during the year 120V receptacles need to be provided so lighting can simply be plugged in and removed when the event is complete.

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4 BIA Lighting

Within the City of Hamilton there are 13 Business Improvement Areas (BIAs). The Downtown and International Village areas have been covered in Part 3 of the report.

The purpose of this section of the report is to:

- Determine what exists for each BIA in terms of lighting levels and uniformities on streets and sidewalks.
- Meet with BIA groups to define lighting issues and concerns. To date this has been undertaken with Ottawa Street, Waterdown, Concession St, Dundas, Stoney Creek, Ancaster and Barton Village BIA committees. Notes of meetings are included in the Appendix.

The 13 Business Improvement Areas (BIAs) are listed on the map below.

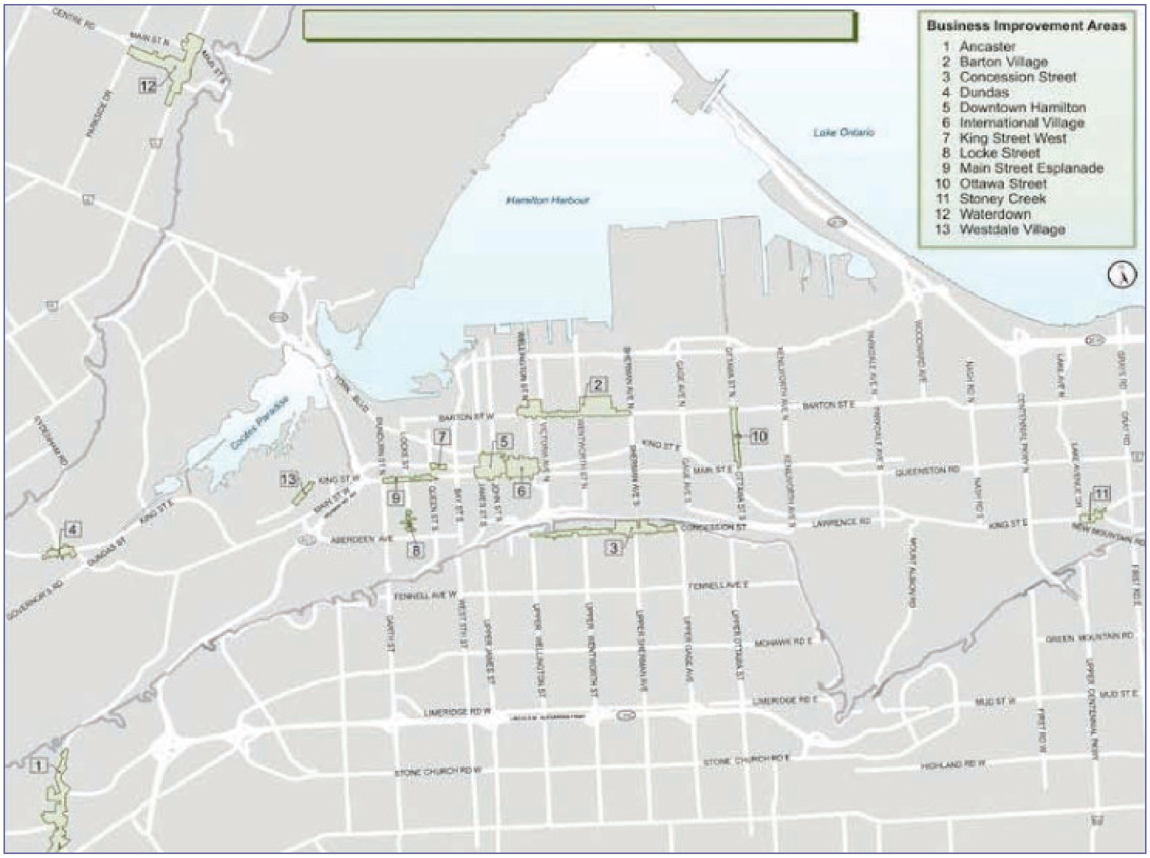

Figure 70 - Map of BIAs

Lighting installations in each of the remaining BIAs were examined as part of an information gathering process.

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On November 10, 2009 a presentation was given for members of the Hamilton Association of Business Improvement Areas (HABIA). The presentation involved a review of the project scope and basic light elements in order to get general feedback. In general, feedback was positive, however, it was noted that too much focus was typically applied to lighting the roadway with not enough consideration given to lighting the sidewalks. For the assessment of existing lighting the sidewalk lighting has been thoroughly reviewed.

Each BIA group was contacted to discuss any lighting issues and to obtain feedback. All BIA groups were contacted to set up meetings with the City of Hamilton and the consultant team. Not all BIAs responded therefore only feedback is included from those BIA's of whom we met with.

The current lighting equipment inventory contains a wide variety of different poles and luminaires of various condition and ages. As a result, the operation and maintenance of the inventory can be complicated and expensive. We have examined the condition of the lighting equipment and provided an opinion on its condition where its condition is in question.

The existing lighting levels and uniformity on roadways and sidewalks in the BIAs have been assessed. Computer based lighting software was used to model existing roadways in conjunction with some physical night-time measurements to verify the calculations.

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Area	Road Segment	From	To	Road Classification	Land Usage	Segment Length (m)	Number of Lanes	Median	Sidewalk	Lighting Pattern	Number of Lights	Setback (m)	Pole Height (m)	Lamp Wattage (W)	Luminaire Type	Pole Type	Pole Spacing (m)		IES Recommended Level (Lux)		IES Uniformity Ratio (Avg : Min)		Exist. Illuminance Level (Lux)				Exist. Uniformity Ratio (Avg : Min)		Status (Road)	Status (Sidewalk)
																	Avg.	Max.	Road	Sidewalk	Road	Sidewalk	Road (Average)	Road (Worst-Case)	Sidewalk 1 (Avg)	Sidewalk 2 (Avg)	Road	Sidewalk		
Ancaster	Wilson St E	Montgomery Rd	Rousseaux St	Arterial	Commercial	783.0	2	No	Yes	One-Sided	19	2.0	9.0	250	Cobrahead	Davit	43.5	71.0	17.0	20.0	3.0	4.0	18.5	11.3	18.7	11.3	2.2	1.4	Pass	Fail
Ancaster	Wilson St E	Rousseaux St	Dalley Dr	Arterial	Commercial	828.0	2	No	Yes	Staggered	47	2.0	5.0	100	Traditional Coach Lantern	Post Top	18.0	20.0	17.0	20.0	3.0	4.0	6.8	6.1	7.8	7.8	1.3	1.6	Fail	Fail
Barton Village	Barton St E	Ferguson Ave N	Sherman Ave N	Arterial	Commercial	1776.0	4	No	Yes	One-Sided	49	0.5	9.0	250	Cobrahead	Davit	37.0	40.0	17.0	20.0	3.0	4.0	17.4	16.1	18.4	5.2	2.7	1.1	Pass	Fail
Barton Village	Barton St E	East Ave N	Wentworth St N	Arterial	Commercial	495.0	4	Yes	Yes	Opposite/ Median	38 / 15	0.5	9.0 / 5.0	250 / 100	Cobrahead / Double Acorn	Davit / Post-Top	27.5	41.0	17.0	20.0	3.0	4.0	48.3	32.5	30.2	30.2	1.5	1.2	Pass	Pass
Concession St	Concession St	Vola Ct	East 39th St	Arterial	Commercial	2362.5	2	No	Yes	One-Sided	76	1.0	9.0	250	Cobrahead	Davit	31.5	39.0	17.0	20.0	3.0	4.0	26.8	21.6	16.0	14.4	1.7	1.2	Pass	Fail
Dundas	King St W	John St	Main St	Arterial	Commercial	493.0	2	No	Yes	Opposite	60	0.5	5.0	150	Single Acorn w/ Gold Ring	Post Top	17.0	30.0	17.0	20.0	3.0	4.0	39.9	23.3	17.1	17.0	1.2	1.2	Pass	Fail
Dundas	McMurray St	King St W	Hatt St	Local	Commercial	24.5	2	No	Yes	One-Sided	2	0.5	7.5	150	Cobrahead	Davit	24.5	24.5	9.0	20.0	6.0	4.0	20.7	20.7	9.5	17.5	2.3	1.3	Pass	Fail
Dundas	Foundry St	King St W	Hatt St	Local	Commercial	27.0	2	No	Yes	One-Sided	2	0.5	7.5	150	Cobrahead	Davit	27.0	27.0	9.0	20.0	6.0	4.0	18.9	18.9	8.6	16.0	2.6	1.4	Pass	Fail
Dundas	Millers Lane	King St W	Hatt St	Local	Commercial	61.0	1	No	Yes	One-Sided	3	2.0	7.5	150	Cobrahead	Davit	30.5	30.5	9.0	20.0	6.0	4.0	17.7	17.7	10.4	N/A	2.6	1.8	Pass	Fail
Dundas	Ogilvie St	King St W	Hatt St	Local	Commercial	100.8	2	No	Yes	One-Sided	4	2.0	9.0	250	Cobrahead	Davit	33.6	43.0	9.0	20.0	6.0	4.0	22.8	17.8	24.4	12.3	1.7	1.2	Pass	Fail
King St West	King St W	Queen St N	Caroline St N	Arterial	Commercial	245.5	4	No	Yes	Opposite	34	0.5	5.0	200	Double Acorn	Post Top	15.3	17.4	17.0	20.0	3.0	4.0	42.4	37.6	40.9	40.9	1.2	1.1	Pass	Pass
Locke St	Locke St S	Homewood Ave	Alexander St	Local	Commercial	348.4	2	No	Yes	One-Sided	12	2.0	9.0	250	Cobrahead	Davit	31.7	37.7	9.0	20.0	6.0	4.0	24.2	20.3	25.3	13.6	1.7	1.2	Pass	Fail
Main St West	Main St W	Dundurn St S	Hess St S	Arterial	Commercial	740.3	5	No	Yes	Opposite	44	0.5	9.0	250	Cobrahead	Davit	35.3	46.3	17.0	20.0	3.0	4.0	31.1	23.5	20.4	20.0	2.0	1.5	Pass	Pass
Ottawa St	Ottawa St N	Main St E	Barton St E	Arterial	Commercial	801.0	4	No	Yes	One-Sided	31	0.5	9.0	250	Cobrahead	Davit	26.7	37.3	17.0	20.0	3.0	4.0	24.2	17.3	24.0	7.1	2.6	1.1	Pass	Fail
Stoney Creek	King St E	Lake Avenue Dr	Elm Ave	Collector	Commercial	234.0	2	No	Yes	Staggered	20	0.5	5.0	150	Single Acorn w/ Gold Ring	Post Top	12.3	15.0	12.0	20.0	4.0	4.0	32.0	26.4	11.9	11.9	1.9	1.2	Pass	Fail
Stoney Creek	King St E	Elm Ave	New Mountain Rd	Collector	Commercial	130.0	2	No	Yes	One-Sided	7	0.5	5.0	150	Single Acorn w/ Gold Ring	Post Top	21.7	34.0	12.0	20.0	4.0	4.0	18.1	12.0	8.9	5.4	2.6	1.1	Pass	Fail
Stoney Creek	King St E	New Mountain Rd	Applewood Ave	Collector	Commercial	54.0	2	No	Yes	One-Sided	2	0.5	9.0	250	Cobrahead	Davit	54.0	54.0	12.0	20.0	4.0	4.0	13.7	13.7	12.0	6.7	3.1	1.7	Pass	Fail
Stoney Creek	Mountain Ave S	King St E	Maple Ave	Local	Commercial	34.0	2	No	Yes	One-Sided	2	2.0	5.0	150	Single Acorn w/ Gold Ring	Post Top	34.0	34.0	9.0	20.0	6.0	4.0	11.5	11.5	13.0	4.1	3.3	1.5	Pass	Fail
Stoney Creek	Elm Ave	King St E	Maple Ave	Local	Commercial	40.0	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	40.0	40.0	9.0	20.0	6.0	4.0	5.0	5.0	2.4	4.4	4.5	2.7	Fail	Fail
Stoney Creek	Jones St	King St E	Mountain Ave N	Local	Commercial	42.0	2	No	Yes	One-Sided	3	2.0	9.0	150	Cobrahead	Davit	21.0	22.0	9.0	20.0	6.0	4.0	22.1	21.1	13.1	16.9	1.5	1.1	Pass	Fail
Waterdown	Dundas St E	Goldenview Ct	Hamilton St N	Arterial	Commercial	544.0	5	No	Yes	One-Sided	14	2.0	9.0	250	Cobrahead	Davit	41.8	56.0	17.0	20.0	3.0	4.0	11.6	8.7	19.4	1.5	5.8	1.1	Fail	Fail
Waterdown	Dundas St E	Hamilton St N	Mill St N	Arterial	Commercial	460.0	4	No	Yes	Opposite	46	2.0	5.0	100	Traditional Coach Lantern	Post Top	20.9	20.9	17.0	20.0	3.0	4.0	11.2	11.2	11.5	11.5	1.2	1.7	Fail	Fail
Waterdown	Mill St N	Private Rd	Griffin St	Collector	Commercial	182.0	2	No	Yes	One-Sided	5	0.5	7.5	70	Cobrahead	Davit	45.5	56.0	12.0	20.0	4.0	4.0	4.3	3.5	2.0	2.7	6.1	4.0	Fail	Fail
Waterdown	Franklin St	Dundas St E	Griffin St	Local	Commercial	47.0	1	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	47.0	47.0	9.0	20.0	6.0	4.0	3.3	3.3	2.0	5.9	5.5	4.0	Fail	Fail
Waterdown	Main St N	Church St	Griffin St	Collector	Commercial	254.0	2	No	Yes	One-Sided	6	0.5	7.5	70	Cobrahead	Davit	50.8	70.0	12.0	20.0	4.0	4.0	3.8	2.8	1.8	2.5	12.7	6.0	Fail	Fail
Waterdown	Flamboro St	Dundas St E	Barton St	Local	Commercial	60.0	2	No	Yes	One-Sided	3	2.0	7.5	70	Cobrahead	Davit	30.0	32.3	9.0	20.0	6.0	4.0	7.1	6.6	4.0	4.8	2.5	1.7	Fail	Fail
Waterdown	Barton St	Hamilton St N	Main St S	Local	Residential	306.0	2	No	Yes	One-Sided	7	2.0	7.5	70	Cobrahead	Davit	51.0	95.0	4.0	3.0	6.0	6.0	4.2	2.3	2.4	3.0	7.0	8.0	Fail	Fail
Waterdown	Griffin St	Main St S	Mill St S	Local	Commercial	26.0	2	No	Yes	One-Sided	2	2.0	7.5	70	Cobrahead	Davit	26.0	26.0	9.0	20.0	6.0	4.0	8.2	8.2	4.5	5.7	2.2	1.5	Fail	Fail
Waterdown	Hamilton St N	Barton St	Rockhaven Lane	Arterial	Commercial	585.0	3	No	Yes	One-Sided	16	0.5	7.5	70	Cobrahead	Davit	39.0	50.2	17.0	20.0	3.0	4.0	5.0	3.9	2.3	3.4	4.2	2.3	Fail	Fail
Waterdown	Cedar St	Hamilton St N	Fern Ave	Collector	Commercial	36.5	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	36.5	36.5	12.0	20.0	4.0	4.0	5.3	5.3	2.5	3.4	3.5	2.1	Fail	Fail
Waterdown	Whiteoak Dr	Hamilton St N	Chudleigh St	Local	Commercial	56.0	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	56.0	56.0	9.0	20.0	6.0	4.0	3.6	3.6	1.7	3.1	18.0	8.5	Fail	Fail
Waterdown	Rockhaven Lane	Hamilton St N	Harnesworth Cr	Collector	Commercial	90.0	2	No	Yes	Staggered	3	0.5	7.5	100	Cobrahead	Davit	45.0	45.0	12.0	20.0	4.0	4.0	6.5	6.5	3.7	3.5	3.0	1.8	Fail	Fail
Waterdown	Parkside Dr	Hamilton St N	Private Rd	Collector	Residential	84.0	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	84.0	84.0	6.0	3.0	4.0	6.0	2.3	2.3	1.1	1.6	N/A	N/A	Fail	Fail
Waterdown	Perrelli St	Dundas St E	Culotta Dr	Local	Commercial	39.0	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	39.0	39.0	9.0	20.0	6.0	4.0	5.2	5.2	2.4	4.5	4.3	2.4	Fail	Fail
Waterdown	Culotta Dr	Culotta Dr	Perrelli St	Local	Residential	50.0	2	No	Yes	One-Sided	2	0.5	7.5	70	Cobrahead	Davit	50.0	50.0	4.0	3.0	6.0	6.0	4.0	4.0	1.9	3.5	10.0	6.3	Fail	Fail
Westdale Village	King St W	Cline Ave N	Cline Ave N	Arterial	Commercial	358.0	4	No	Yes	Opposite	20	0.5	5.0	100	Single Acorn	Post Top	40.0	44.0	17.0	20.0	3.0	4.0	9.6	8.8	4.5	4.3	1.8	2.0	Fail	Fail
Westdale Village	King St W	Paisley Ave N	Marion Ave N	Arterial	Commercial	60.0	4	No	Yes	One-Sided	3	0.5	9.0	250	Cobrahead	Davit	30.0	30.0	17.0	20.0	3.0	4.0	21.5	21.5	21.3	6.3	2.6	1.1	Pass	Fail

Table 7 - Existing Lighting Conditions for Business Improvement Areas

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4.1 Ancaster BIA

The figure below shows a map of the area. The colours on the map indicate the different lighting types used. The existing lighting is made up of coach lantern style luminaires on post top poles (the area shaded in yellow) and cobra head luminaires on utility poles (the area shaded in blue).

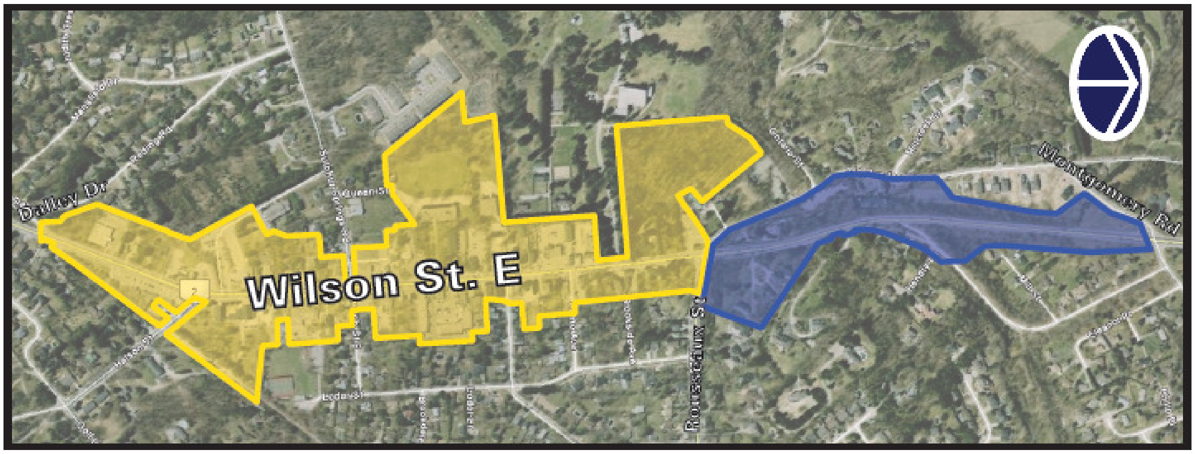

Figure 71 - Ancaster BIA

Figure 72 - Lantern Style Lighting

In the area shaded in yellow, the existing light levels on the roadway and sidewalks as shown on the table below are well below recommended standards. The coach lantern style lighting is fairly old and has reached the end of its useful life. In addition, much tighter pole spacing should be applied to compensate for light blockage from street trees.

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Figure 73 - Cobra Head Lighting on Utility Pole

In the area shaded in blue, the existing light levels on the roadway and sidewalks as shown on the table below are slightly below recommended standards. The cobra head lighting is only slightly below recommended standards and, therefore, could remain as is at present.

The figure below shows a map of the area. The colours on the map indicate the different lighting types used. The existing lighting is made up of cobra head luminaires on davit arms on concrete poles (the area shaded in yellow) and single acorn style luminaires on post top poles with cobra head lighting on davit arms on concrete poles (the area shaded in blue).

Figure 74 - Barton Village BIA

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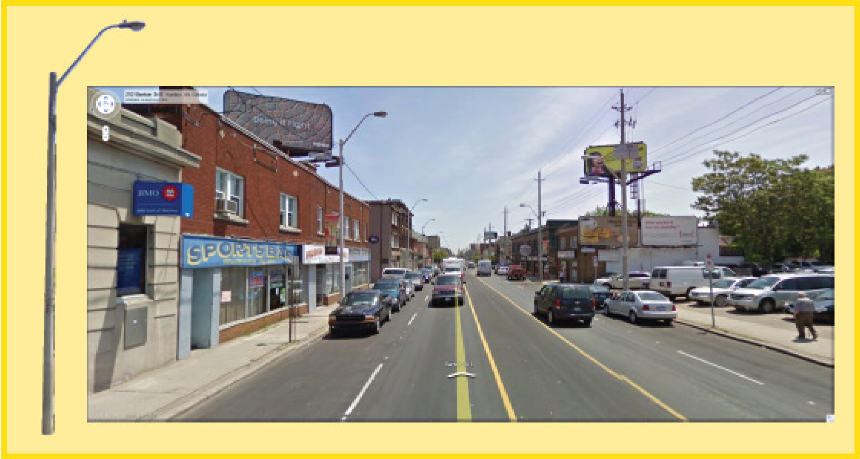

Figure 75 - Cobra Head Lighting

The existing light levels on the roadway and sidewalks for the yellow area are as shown below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

Figure 76 - Cobra Head and Acorn Style Lighting

In the area shaded in blue, the existing light levels on the roadway and sidewalks are as shown on the table below are above the recommended standards. The double acorn style lighting in the median is in good condition.

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4.2 Concession Street BIA

The figure below shows a map of the area. The existing lighting is made up of cobra head luminaires on utility poles (the area shaded in yellow).

Figure 77 - Concession Street BIA

Figure 78 - Cobra Head Lighting on Utility Poles

The existing light levels on the roadway and sidewalks for the yellow area are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

4.3 Dundas BIA

The figure below shows a map of the area. The various colours on the map show the different types of lighting used. The existing lighting is made up of cobra head luminaires on utility poles

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(the area shaded in yellow) on the side streets and single acorn style luminaires on post top poles (the area shaded in blue) on the main street.

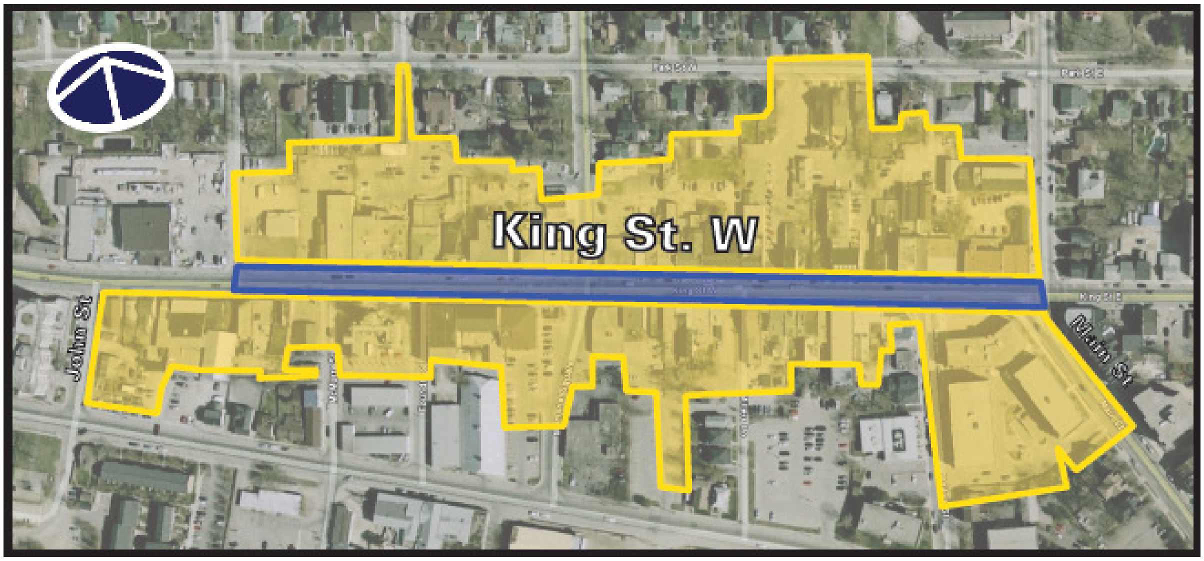

Figure 79 - Dundas BIA

Figure 80 - Cobra Head Lighting on Utility Poles

The existing light levels on the roadway and sidewalks for the yellow area are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

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Figure 81 - Acorn Style Lighting

The existing light levels on the roadway and sidewalks for the blue area are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights on the crossroads. This is due to the single side pole spacing. On the main road (King Street) the lighting is well above what is required on the roadway and very slightly below what is required on the sidewalks.

4.4 King Street West BIA

The figure below shows a map of the area. The existing lighting is made up of double acorn style luminaires on post top poles (the area shaded in yellow).

Figure III-1 - King Street West BIA

In the area shaded in yellow, the existing light levels on the roadway and sidewalks as shown on the table below meets and well exceed the recommended standards (by double).

Figure 82 - Double Acorn Lighting

In the area shaded in yellow, the existing light levels on the roadway and sidewalks as shown on the table below to meet the recommended standards.

4.5 Locke Street BIA

The figure below shows a map of the area. The existing lighting is made up of cobra head luminaires on utility poles (the area shaded in yellow).

Figure 83 - Locke Street BIA

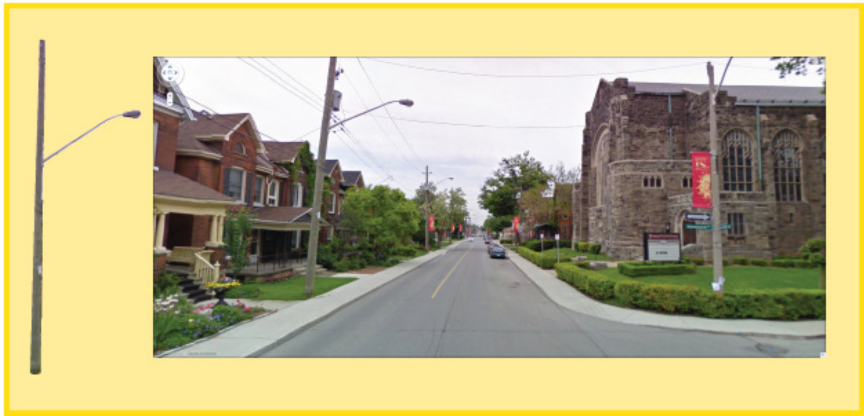

Figure 84 - Cobra Head Lighting on Utility Poles

The existing light levels on the roadway and sidewalks for the yellow area are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

4.6 Main Street West Esplanade BIA

The figure below shows a map of the area. The existing lighting is made up of teardrop style luminaires on davit poles (the area shaded in yellow).

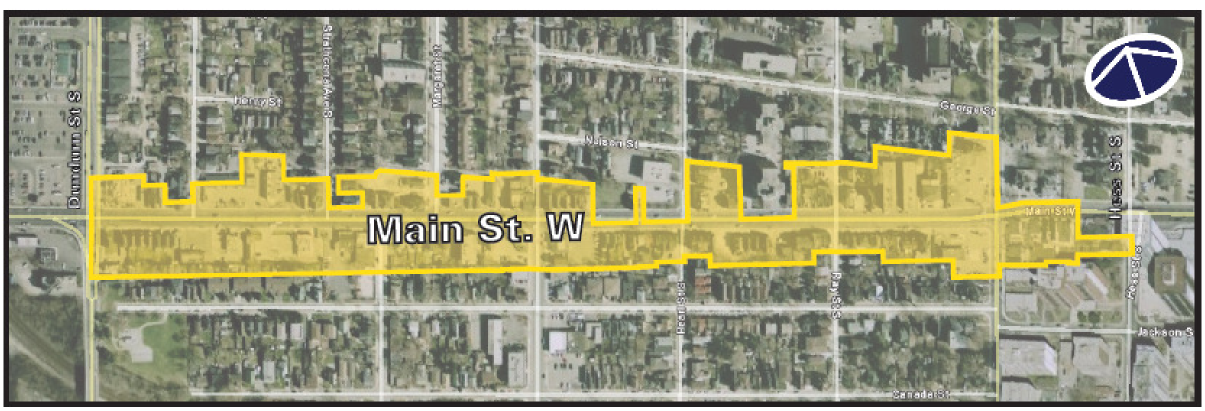

Figure 85 - Main Street Esplanade

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Figure 86 - Acorn Davit Lighting

In the area shaded in yellow, the existing light levels on the roadway and sidewalks as shown on the table below meets the recommended standards.

4.7 Ottawa Street BIA

The figure below shows a map of the area. The existing lighting is made up of cobra head luminaires on utility poles (the area shaded in yellow).

Figure 87 - Ottawa Street BIA

Figure 88 - Cobra Head Lighting

The existing light levels on the roadway and sidewalks are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

4.8 Stoney Creek BIA

The figure below shows a map of the area. The existing lighting is made up of single acorn style luminaires on post top poles (the area shaded in yellow) and cobra head luminaires on utility poles (the area shaded in blue).

Figure 89 - Stoney Creek BIA

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Figure 90 - Acorn Style Lighting

The existing light levels on the roadway and sidewalks are as shown on the table below. The roadway levels meet the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

Figure 91 - Davit Style Lighting

The existing light levels on the roadway and sidewalks for the blue area are as shown on the table below. The roadway levels meet the recommended standards with the exception of Jones St. from King St. E. to Mountain Ave. N. which is very slightly below what is recommended. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

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4.9 Waterdown BIA

The figures below shows a map of the area. The existing lighting is made up of cobra head luminaires on utility poles (the area shaded in yellow) and single acorn style luminaires on post top poles (the area shaded in blue).

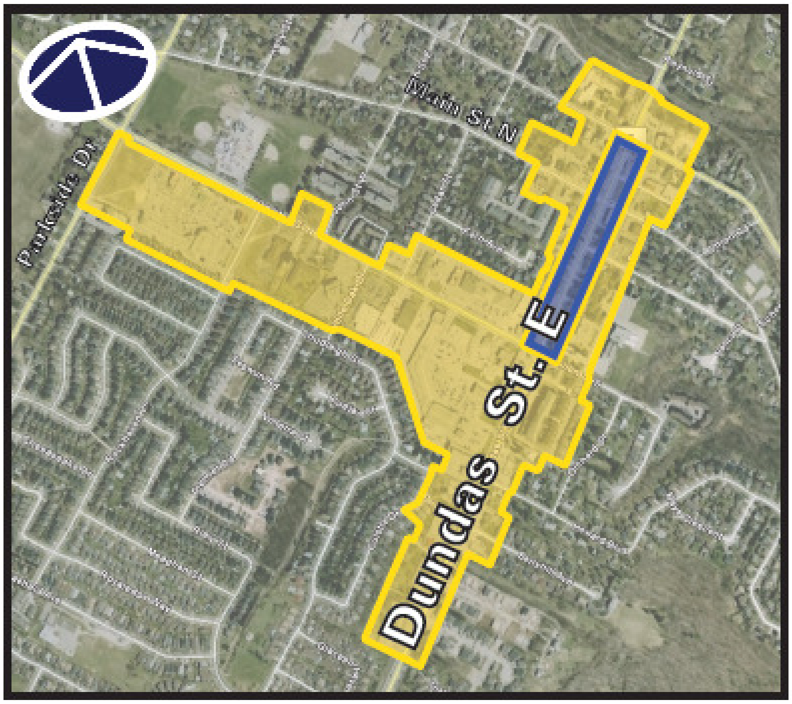

Figure 92 - Waterdown BIA

Figure 93 - Cobra Head Lighting

The existing light levels on the roadway and sidewalks are as shown on the table below. The roadway lighting uniformity is below the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

Figure 94 - Acorn Style Lighting

The existing light levels on the roadway and sidewalks for the blue area are as shown on the table below. The roadway and sidewalks lighting levels are below the recommended standards. The sidewalk lighting is slightly below what is required on the near side of the road under the street lighting and well below on the far side across from the lights. This is due to the single sided lighting spacing.

4.10 Westdale Village BIA

The figure below shows a map of the area. The colours on the map indicate the different lighting types used. The existing lighting is made up of single acorn style luminaires on post top poles and cobra head lighting on davit arms on utility poles (the area shaded in yellow).

Figure 95 - Westdale BIA

Figure 96 - Acorn and Cobra Head Lighting

In the area shaded in yellow, the existing light levels on the roadway and sidewalks are as shown on the table below. Light levels are below the recommended standards with the exception of the roadway lighting on King St. W. from Paisley Ave. N. to Marion Ave. N. which meets the recommended standards.

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Appendix A.1

November 25, 2009 Task Force Presentation

Comprehensive Outdoor Lighting Study – Task Force Presentation

Don McLean
DMD & Associates Ltd.
Surrey, BC
www.dmdeng.com

Today's Presentation

- Review Project Scope - Informational
- Lighting Basics – Learn
- Provide Examples – Stimulate ideas
- Get feedback – Input (at end of presentation)

The Consultant Team

Don McLean – Bio

- President of DMD and Associates Ltd – Specialist Firm
- Active lighting designer
- 30+ years outdoor lighting experience
- Authored numerous national outdoor lighting publications
- Involved with numerous lighting standards committees
- Member of International Dark Sky Association
- Designed building façade lighting
- Undertaken many urban streetscape projects

Glenn O'Connor – Bio

- Landscape architect and principal with G. O'Connor Consultants Inc.
- Mr. O'Connor is a resident of the downtown
- Local firm with local knowledge and understanding
- Will liaise with all BIA and task force groups

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Hamilton Study - Overview

1. Justification for Lighting and Standards
2. Downtown Hamilton Improvement Project Area
3. Business Improvement Areas (BIA's)
4. Lighting Equipment Inventory Applicability
5. Infrastructure Operations and Maintenance
6. Energy Savings Initiatives and New Technology Implementation

Hamilton Study - Meetings

An important part of the project is getting input from stakeholders

Meetings set-up and / or undertaken for:

- Hamilton Association of Business Improvement Area (HABIA) – Some meetings undertaken
- Nov 25 – Task Force on Cleanliness and Security in the Downtown Core (TFCSDC)
- Nov 26 – Public Information Consultation forum (PIC) – Open House
- Feb/Mar – Follow-up Task Force Meeting

Part 1 - Justification for Lighting and Standards

Justification

- Define impact and justification for lighting based on best evidence, research and investigation

The justification for lighting must first be established to define "where and when" to light. Guidelines and Standards can then be developed accordingly

Standards

- Develop lighting guidelines and standards
- Based on a defined sampling of existing streetscapes typical lighting levels and installations will be recorded for various locations
- Recommend lighting criteria (lighting levels)

Part 2 - Downtown

- Review and analyze the existing lighting conditions in Hamilton's downtown core with an emphasis on safety, security and cleanliness related to the application of lighting
- Investigate and make recommendations regarding lighting of streetscapes, parks, parking lots (public and private) buildings and commercial areas
- Provide input into how lighting can enhance the downtown core and promote re-development (ie; lighting up building facades)
- Review crime statistics provided and meet with local police to define areas of concern
- Define and document existing lighting level
- Meet and consult with Task Force and get input (key item)
- Develop concepts and cost and present and refine

Part 3 - Business Improvement Areas

- Review and analyze the existing lighting conditions within the thirteen (13) Business Improvement Areas (BIA's)
- Investigate and make recommendations regarding lighting of the BIA's in relation to how it can enhance each area.
- Provide input into how lighting can enhance the area and promote re-development (ie; lighting up building facades)
- Define and document existing lighting level
- Meet and consult with BIA's and get input (key item)
- Develop concepts and cost and present and refine

Part 4 - Lighting Equipment Inventory

- Existing inventory has wide variety of poles and fixtures
- Review and comment on equipment
- Assist in the development of a list of approved products that can be maintained across the City
- Recommend products which meet the first part of the study

Part 5 - Operations and Maintenance

- City received multiple requests for infrastructure upgrades
- Make recommendations to ease maintenance and operations
- Develop framework for schedule of priorities for new installations and retrofits of existing

Part 6 - Energy Savings Initiatives and New Technologies

- Advocate, through the study's recommendations, the use of energy efficient light sources and design practices in order to reduce environmental impacts
- Review and determine the applicability of various energy saving initiatives and make recommendations on how outdoor lighting can contribute to the goals of the "City Corporate Energy Policy for City Facilities & Operations"

Why Light?

1. Provides an adequate visual environment during hours of darkness.
2. Enhanced security and safety which can lead to a increased level of comfort.
3. Can help to stimulate local commercial development
4. Can enhance the look of commercial areas. It can stimulate activity by creating a feeling of security

We congratulate the area on being awarded the 2015 Pan-Am Games. Lighting along with architectural enhancements can play a big part in revitalizing a City

How to Light?
Standards and Organizations

1. Illuminating Engineering Society (IESNA)
2. Transportation Association of Canada (TAC)
3. Canadian Standards Association (CSA)
4. International Dark-Sky Association (IDA)
5. Leadership in Energy and Environmental Design (LEED)
6. CPTED – Crime Prevention Through Environmental Design

How to Light?
Reference Standards and Guidelines

Roadways and Sidewalks:

- IESNA RP-8 Roadway Lighting
- IESNA DG-22 Residential Lighting (soon to be published)
- TAC Roadway Lighting Design Guide

Architectural Feature and Buildings

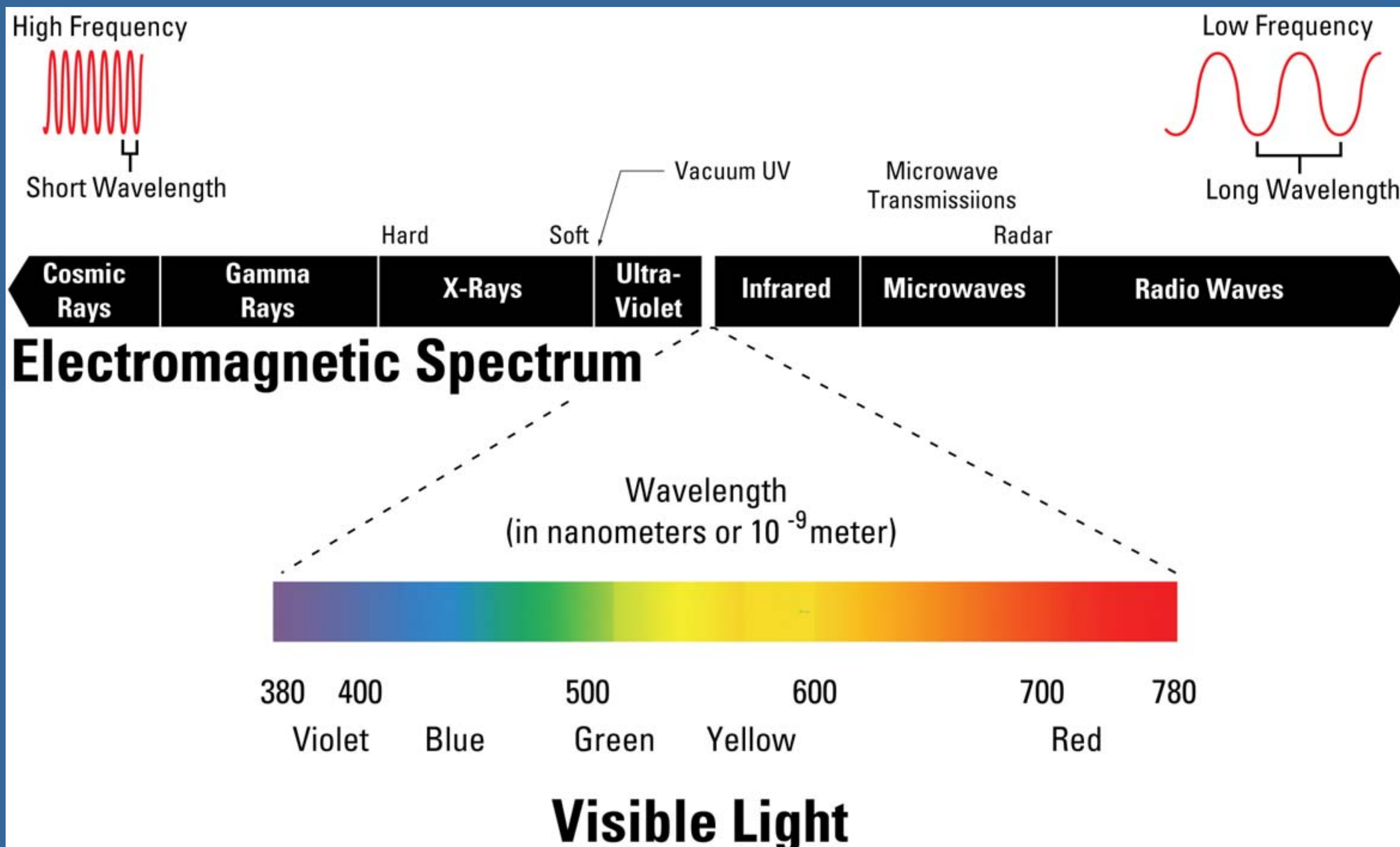
- IESNA RP-33 Lighting for Exterior Environments
- IESNA Lighting Handbook

Security

- IESNA G-1-03 Guideline on Security Lighting for People, Property, and Public Spaces
- CPTED – Crime Prevention Through Environmental Design

Basic Principals of Lighting Design

What is Light? – Light is radiant energy is the visible spectrum between 380-770nm



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Basic Principals of Lighting Design

Lumens

- Light emitted from the luminaire
- A measure of the perceived power of the light
- Lumen output for each lamp type are measured by test labs
- Output for a 100W HPS lamp is ***9500 lumens*** whereas output for a 100W MH lamp is ***8500 lumens.***

Basic Principals of Lighting Design

Illuminance

- Amount of Lighting falling on a given area
- Measured in Lux (metric) or foot-candles (imperial) 1fc = 10.76 Lux
- Vertical and Horizontal Illuminances
- Examples of light levels:

    Sunny day = 10,000 Lux
    Overcast day = 1,000 Lux
    Supermarket = 750 Lux
    Office = 500 Lux
    Typical street lighting = 4 to 17 Lux
    Moonlight (full moon) = 0.1 Lux

- Light Meter used to measure

Basic Principals of Lighting Design

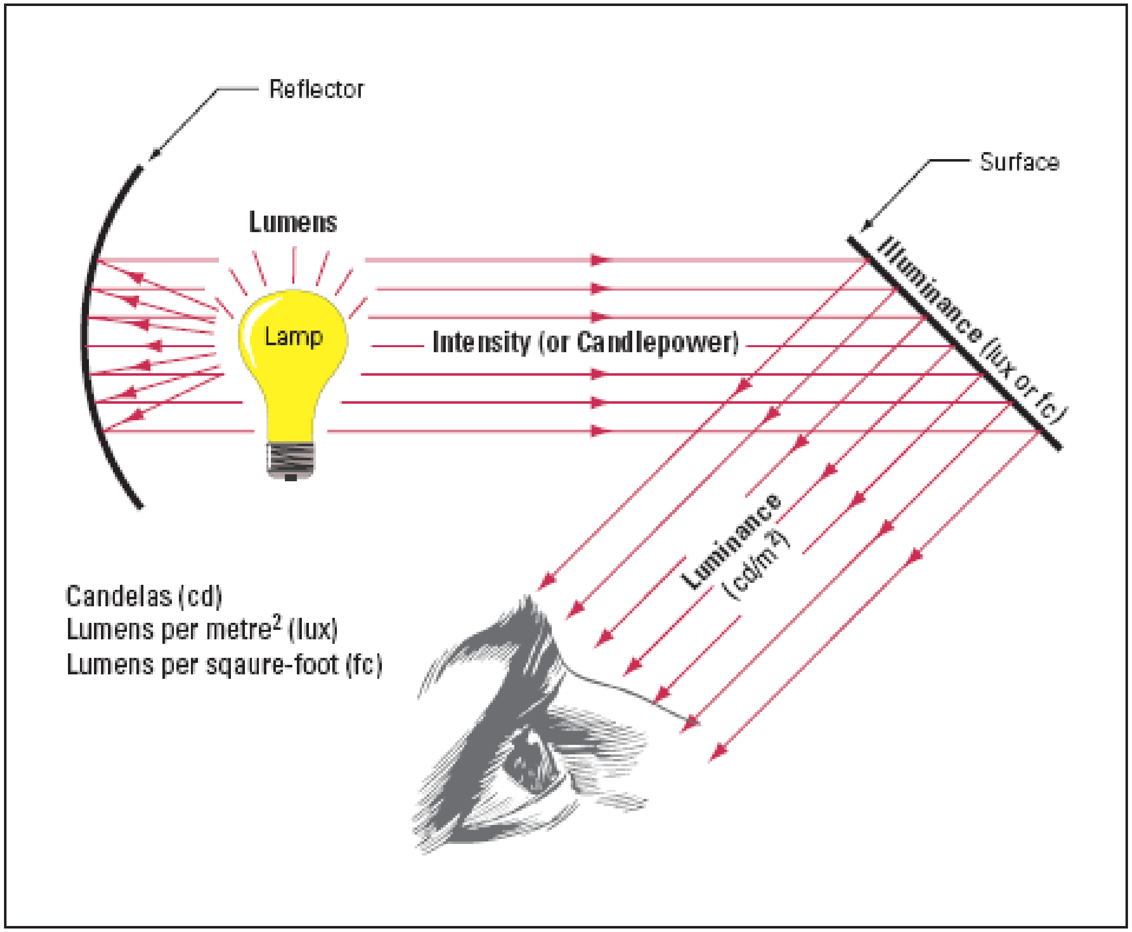
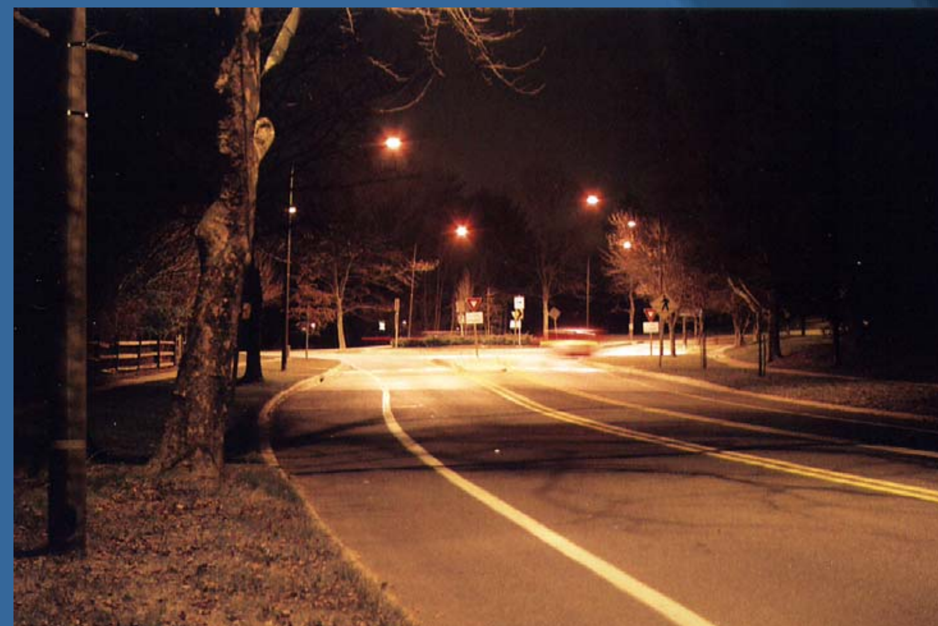


Figure 2-7 – Understanding Lighting Terminology

Basic Principals of Lighting Design

Uniformity

- The distribution or evenness of the lighting or given area
- Measured as a ratio of *average : minimum and / or maximum : minimum*



Very important factor as dark spots can reduce visibility

Basic Principals of Lighting Design

Contrast

We need contrast to see objects

- Negative / Positive - Prefer positive

Figure 2-14 – Examples of Negative and Postive Contrast.

Basic Principals of Lighting Design
Visibility – What is it?

For outdoor applications, visibility is defined as the distance at which something can just be perceived by the eye. *Ref - IESNA Handbook Volume 9, 2000*

Basic Principals of Lighting Design
Visibility Concept - Glare

Glare – A sensation encounter when light scatters in one eye

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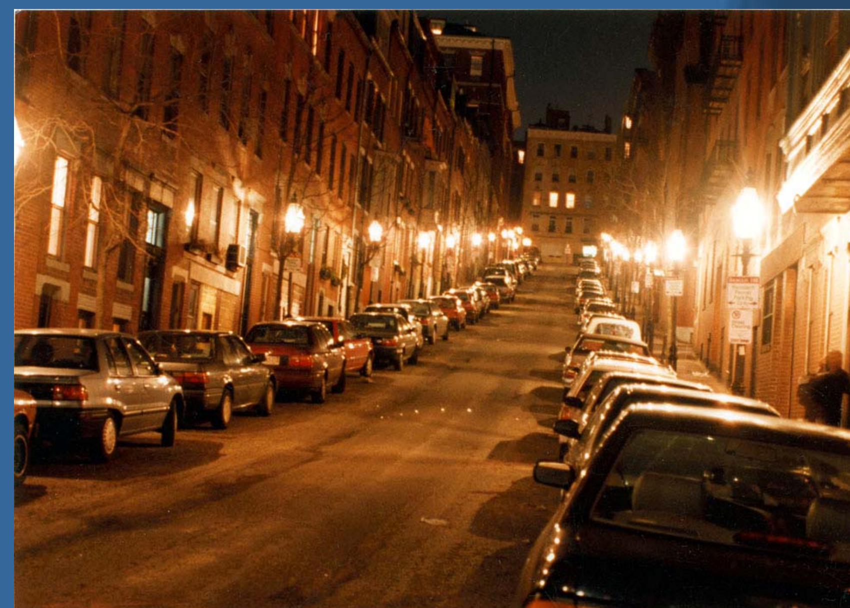
Basic Principals of Lighting Design
Visibility Concept - Glare

Three classifications of glare are:

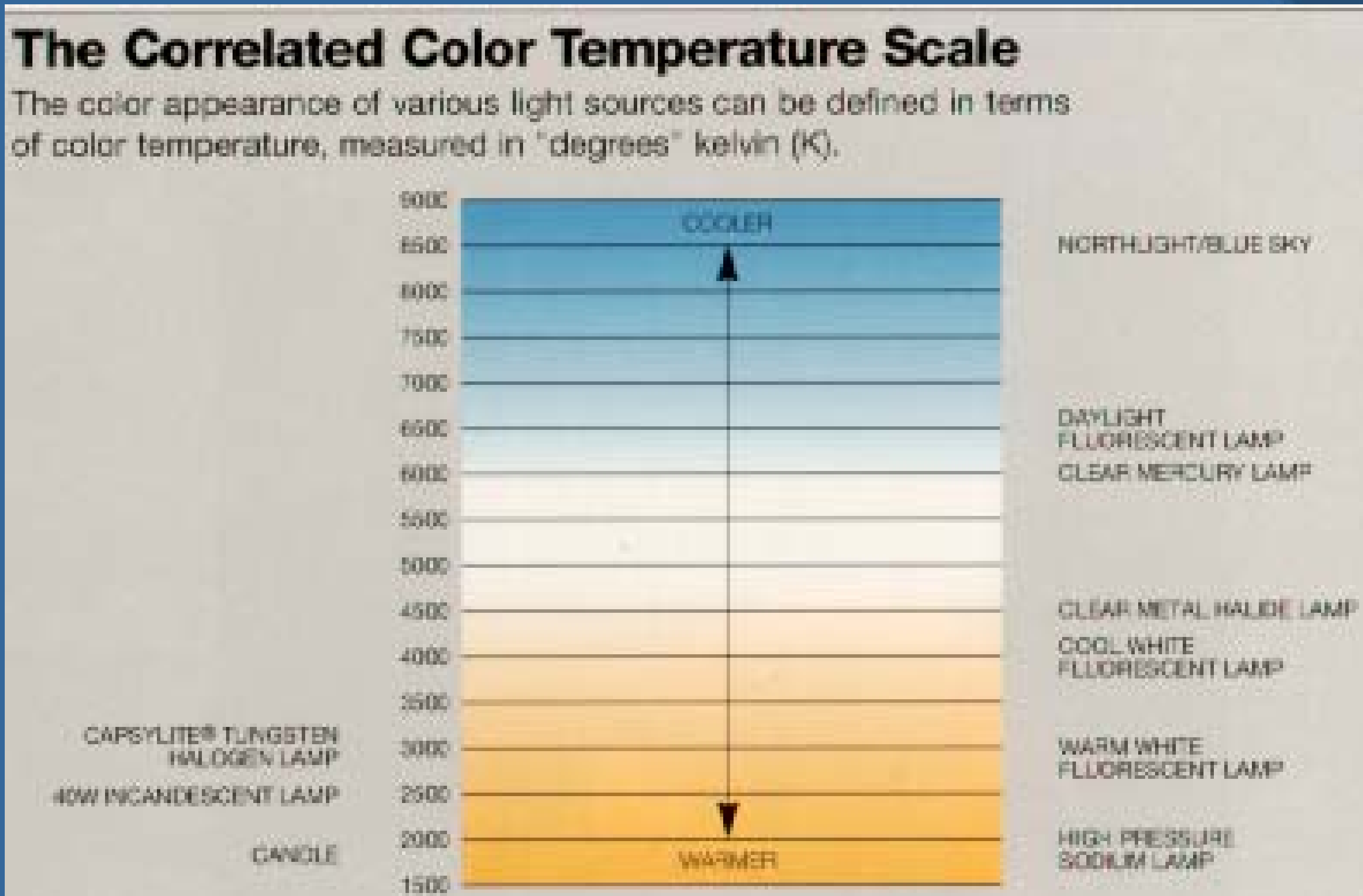
Disability Glare – Blinding (car head lamps on high beam)

Discomfort Glare – Causes discomfort over time (bright lamp nearby when reading a book)

Nuisance Glare – Bothersome over time (street lights viewed from distance)



Basic Principals of Lighting Design



Basic Principals of Lighting Design - Light Source Comparison

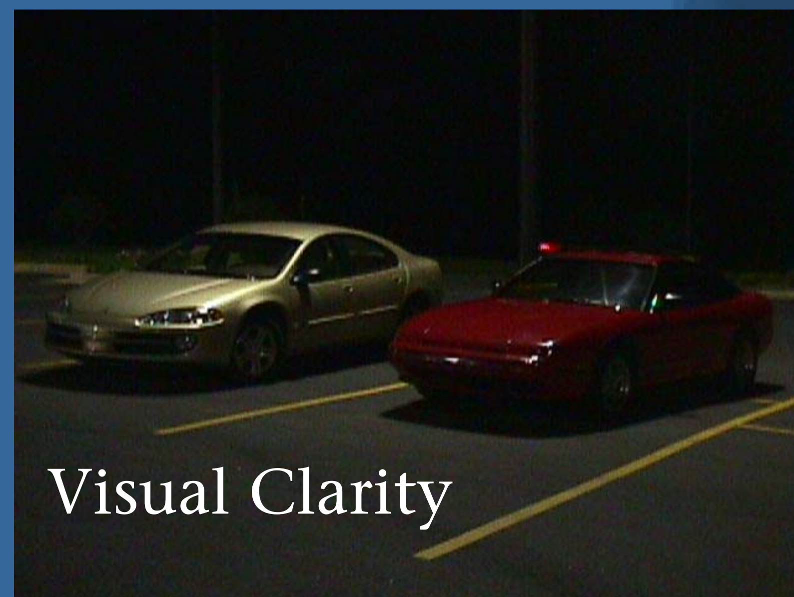
Lamp Type	Efficacy (lumens per watt)	% Lamp Lumen Depreciation at End of Life	Average Lamp Life (Hours)	Color Rendering Index
Fluorescent	30 - 70	0.9	7K – 12K	80
Mercury Vapor	30 - 65	0.54	24K +	45 - 50
Metal Halide	75 - 125	0.50	7K to 30K	65 - 80
High Pressure Sodium	45 - 150	0.73	24K +	22
Low Pressure Sodium	145 - 185 (Poor Utilization)	1.0 (Watts Increase)	10K -18K	0
E-Lamps (induction)	75	.70	50K-100K	70

Information on LED's not included

Basic Principals of Lighting Design
HPS vs Metal Halide

High Pressure Sodium

Metal Halide



Basic Principals of Lighting Design
Colour Rendering Index (CRI)

- The CRI describes how well an object's colors are rendered by a source.
- The colour chips are examined under daylight and under the source. The less color shift, the higher the CRI (0-100).
- The higher the CRI the better the color rendition

Lighting Design Process

- Define Lighting Criteria – Lighting levels, effects, etc
- Select Style and Type of Lighting
- Select luminaires and mounting
- Undertake lighting calculations and renderings
- Prepare drawings and specs for tender

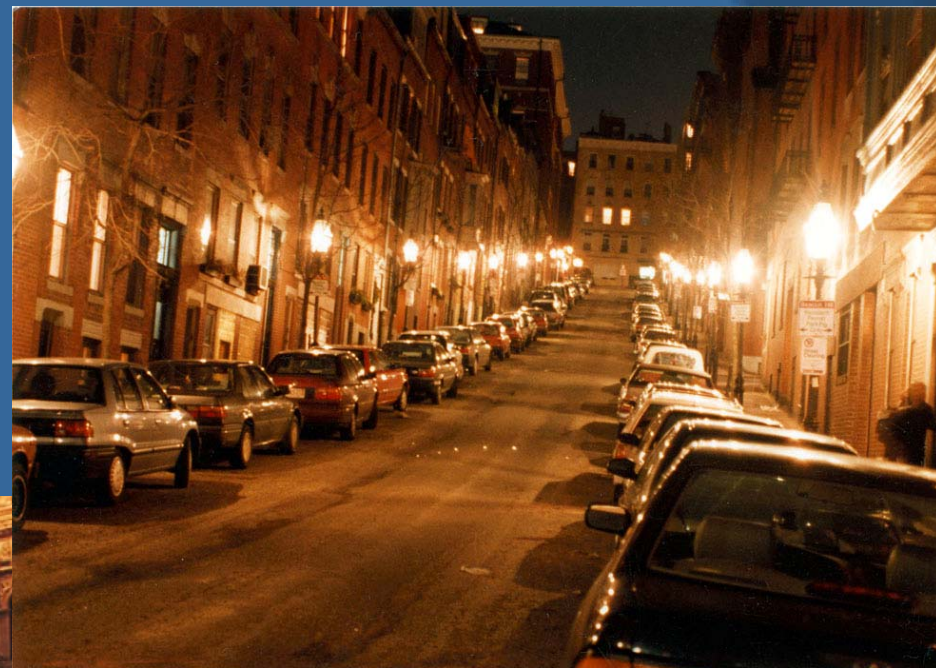
Lighting Design Process
Design Considerations

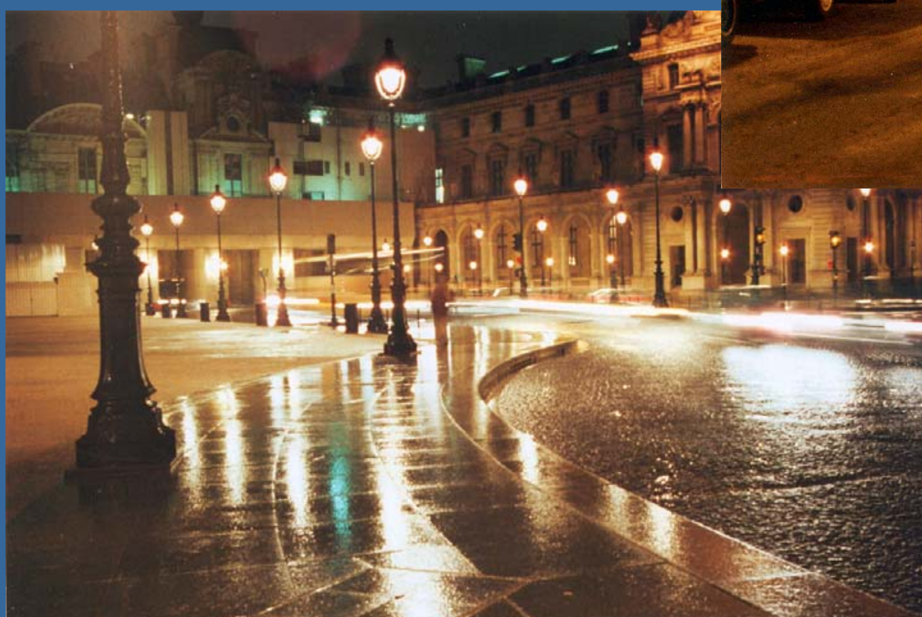
- Conflicts with other utilities
- Conflicts with buildings
- Light blockage from trees and shrubs
- Restricted mounting heights
- Luminaires with poor optics
- Impacts on local businesses
- Spill light impacts on local residents

Sidewalk Lighting - Levels

Pedestrian Activity	Maintained Average Horizontal Illuminance (lux)	Average-to - Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≧ 20.0	≦ 4.0	≧ 10.0
Medium	≧ 5.0	≦ 4.0	≧ 2.0
Low	≧ 3.0	≦ 6.0	≧ 0.8

Sidewalk Lighting Examples





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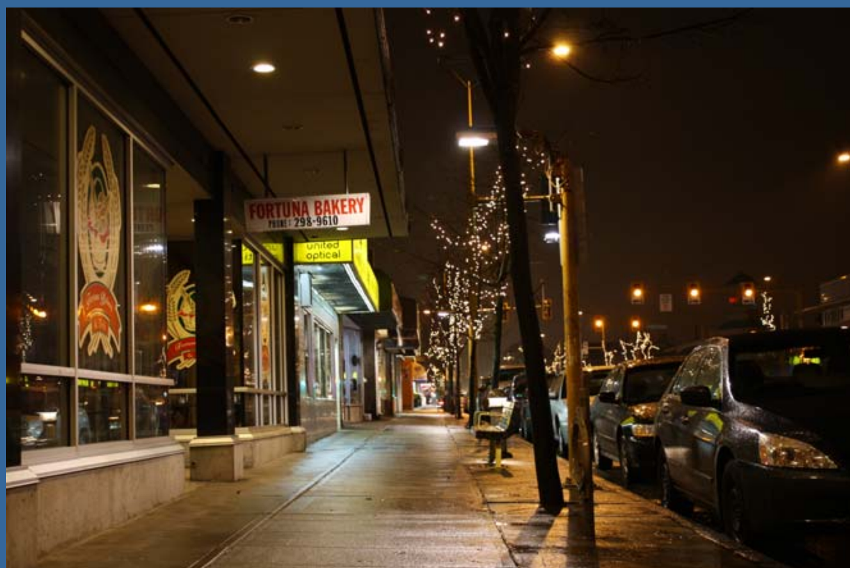
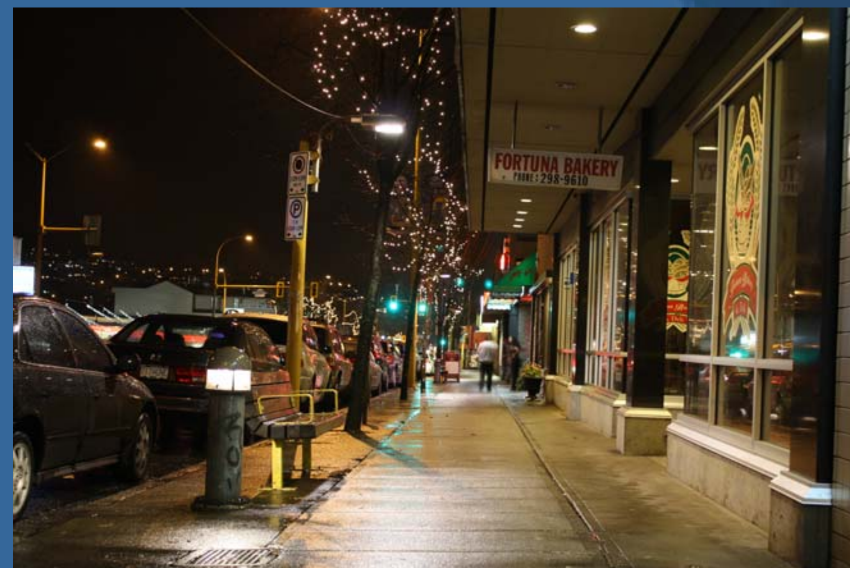
Sidewalk Lighting Examples





Roadway Lighting - Levels

Road and Pedestrian Conflict Area		Pavement Classification (Minimum Maintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{min}	L_{Vmax}/L_{avg}
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class B		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.0	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.0	4.0/0.0	6.0	0.4

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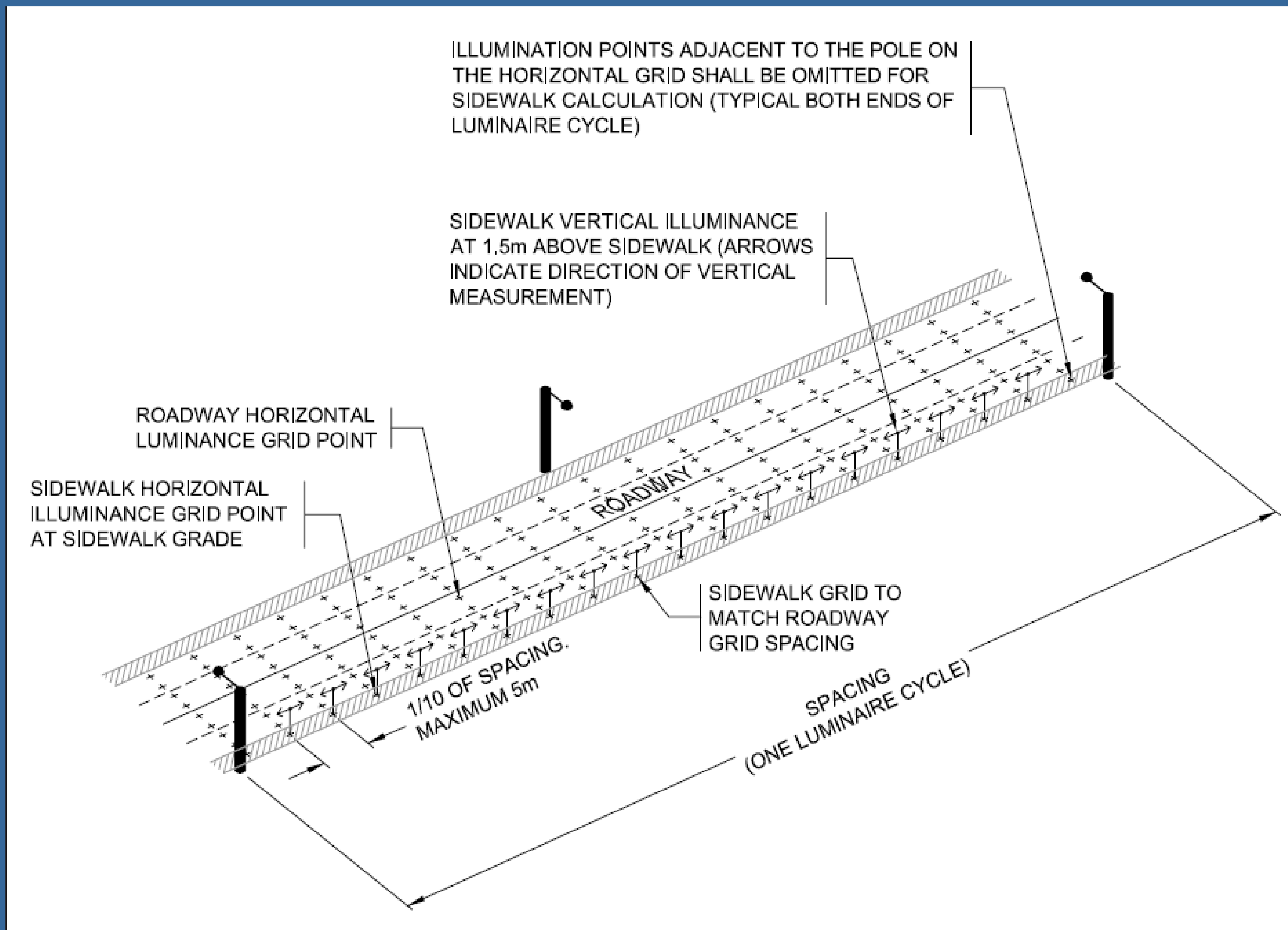
Roadway / Sidewalk Calculation Grids



Luminaires – Cobra Head

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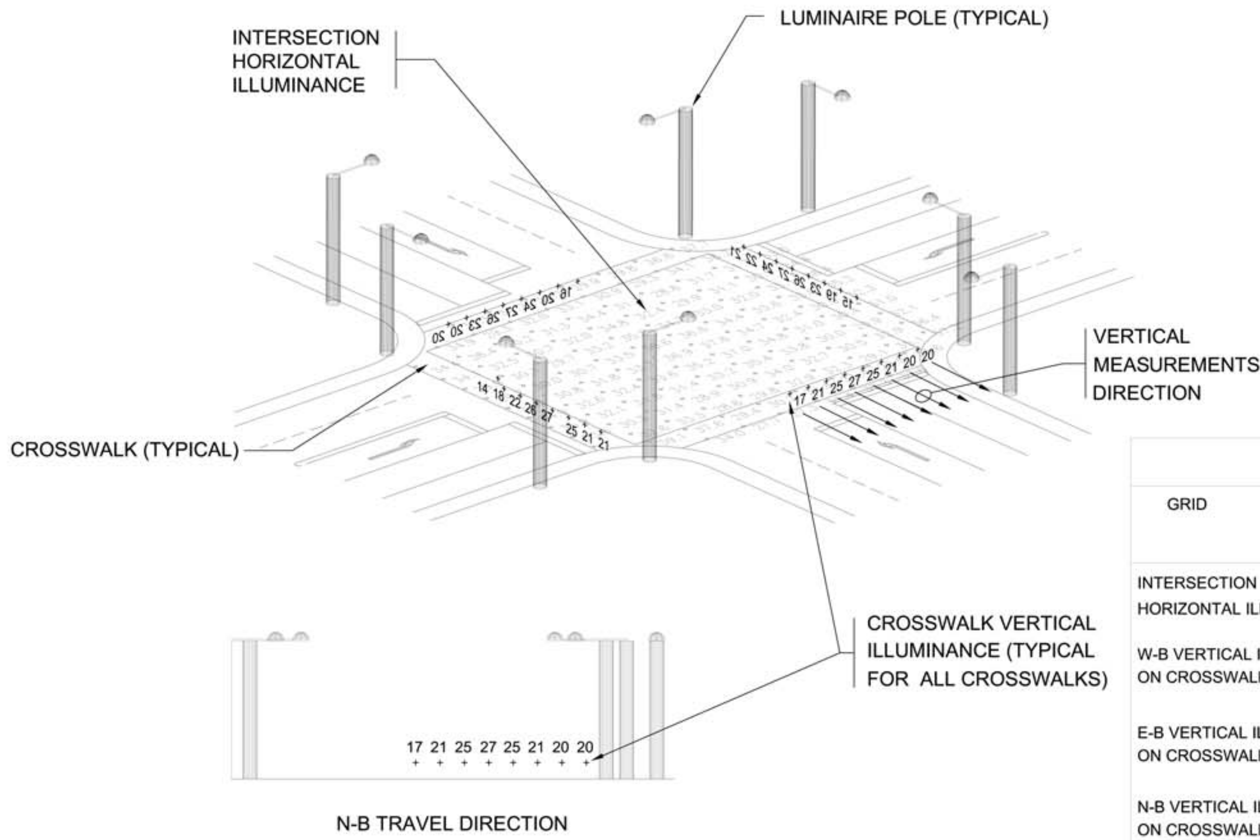
Luminaires - Decorative

Intersection Lighting - Levels

Roadway Classification	Average Maintained Illuminance at Pavement by Pedestrian Conflict (lux)			Average-to-Minimum Uniformity Ratio
	High	Medium	Low	
Arterial/Arterial	34.0	26.0	18.0	≦ 3.0
Arterial/Collector	29.0	22.0	15.0	≦ 3.0
Arterial/Local	26.0	20.0	13.0	≦ 3.0
Expressway-Highway/Arterial	31.0	25.0	18.0	≦ 3.0
Expressway-Highway/ Expressway-Highway/	28.0	24.0	18.0	≦ 3.0
Expressway-Highway/Collector	26.0	21.0	15.0	≦ 3.0
Expressway-Highway/Local	23.0	19.0	13.0	≦ 3.0
Collector/Collector	24.0	18.0	12.0	≦ 4.0
Collector/Local	21.0	16.0	10.0	≦ 4.0
Local/Local	18.0	14.0	8.0	≦ 6.0

Intersection Calculation Example



OUTPUT RESULTS		
GRID	MAINTAINED AVERAGE	UNIFORMITY RATIO (AVG./MIN.)
INTERSECTION HORIZONTAL ILLUMINANCE	32.7 lux	1.2:1
W-B VERTICAL ILLUMINANCE ON CROSSWALK	22.0 lux	N/A
E-B VERTICAL ILLUMINANCE ON CROSSWALK	22.0 lux	N/A
N-B VERTICAL ILLUMINANCE ON CROSSWALK	22.2 lux	N/A
S-B VERTICAL ILLUMINANCE ON CROSSWALK	22.3 lux	N/A

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Architectural Lighting - Issues

Luminaires

- Lighting must not be glary
- Locating luminaires critical

Vertical illumination impacted by:

- Surrounds – Light or dark
- Object surface – Light or dark, texture
- Color (LED's, color changing)

Effects:

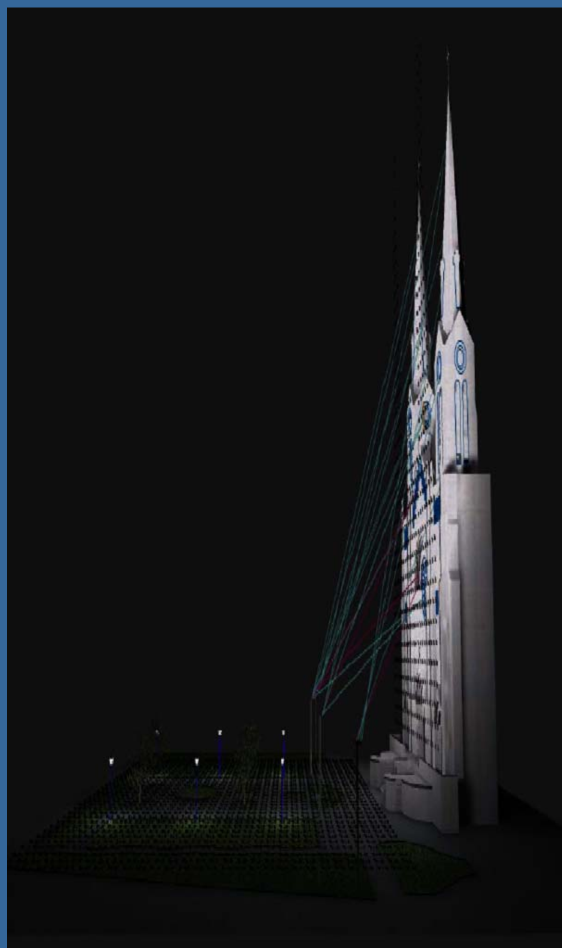
- Grazing - Effect on surface
- Accent – Spot lighting

Architectural Lighting - Levels

Area Description	Average Target Vertical Illuminance
Bright Surroundings and Light Surfaces	50 lux
Bright Surroundings and Medium Light Surfaces	70 lux
Bright Surroundings and Medium Dark Surfaces	100 lux
Bright Surroundings and Dark Surfaces	150 lux
Dark Surroundings and Light Surfaces	20 lux
Dark Surroundings and Medium Light Surfaces	30 lux
Dark Surroundings and Medium Dark Surfaces	40 lux
Dark Surroundings and Dark Surfaces	50 lux

Architectural Lighting Grazing Effects

Architectural Lighting - Rendering



Architectural Lighting - Rendering

Architectural Lighting - Examples

Architectural Lighting - Examples

Architectural Lighting - Examples

Architectural Lighting - Examples

Architectural Lighting - Examples

Copy of this presentation can be downloaded from City web site at:

www.hamilton.ca/outdoorlightingstudy

Questions and Answer

Appendix A.2

Minutes of BIA, Police and City of Hamilton Meetings

G. O'CONNOR CONSULTANTS INC.
Landscape Architecture ■ Environmental Planning ■ Resource Analysis

3310 South Service Road, Suite 205, Burlington ON L7N 3M6 Tel: 905 681-7604, Fax: 905 681-2944
E-mail: ocon@oconnor-consultants.com Website: www.oconnor-consultants.com

MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	1
Client:	City of Hamilton	Date:	11/17/2009
Location:	20 Hughson Street, Suite 807, Hamilton	File No.	1160
Present:	**Kathy Drewitt**, Downtown Hamilton B.I.A. Rep. **Mike Field**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with representatives from each B.I.A. area to review any lighting issues/concerns.

ITEMS	
1.1	Overall BIA precinct – McNab (west), Rebecca (north), Mary (east), Hunter (south).
1.2	Lighting in trees added several years ago to enhance light levels, not for decoration.
1.3	Reason decorative lighting approved and initiated was to add more light, not just decorative! Wanted bright as possible.
1.4	Issue, low light levels, on side streets, sidewalks especially, cobra heads, not pedestrian friendly area.
1.5	Concentrate efforts with Le' Ann Seely, look at options for the Gore Pedestrian Mall.
1.6	Concern light levels on sidewalks, generally low.
1.7	What is best lighted area? King Street, high level (south leg of King St. best lighted) in BIA opinion.
1.8	North side of King, felt to be darker.
1.9	James poorly lit north of King.
1.10	King William also poorly lit, even new section.
1.11	Main Street very poor lighting.
1.12	New work downtown is generally good except side streets John/Catharine, poorly lit (old cobra heads).
1.13	Alleyways poorly lit, need attention.
1.14	McNab Street – Kathy requested long term pedestrian through Impark McNab site to Gore. GOCI provided some history on 2009 site plan application and issues.
1.15	Light levels proposed for public and private parking levels are of concern to B.I.A.
1.16	Need to do conversion from old parking lot light levels to new light levels.
1.17	This study also includes façade lighting.
1.18	BIA does not want bit pixel board lighting.
1.19	Want façade lights to fit street.
1.20	Potential for lighting manufacturers to give discount packages on lighting; qualifies

	under façade program.
1.21	Potential issue, private lights (fixtures) may encroach onto public "air space".
1.22	Many downtown property owners were/are interested in doing architectural lighting.
1.23	Alleyways difficult to get lighted/repaired.
1.24	Suggestion 18, 24, 30 (1820's) building façade, one owner King Street, south leg. Do as a demonstration building, owner interested. Kathy will look for previous "design idea".
1.25	New City park on Rebecca St. b/w John and Catharine.
1.26	Hamilton Downtown B.I.A. main lighting concerns: 1. Parking lots 2. Streets 3. Facades 4. Pedestrian 5. Monument
1.27	Other area – GO centre at Hunter.
1.28	Contacted Mark Cox – Police Officer, 6 beat Officer; issue with bright and dark spots.
1.29	King St., James to Bay poorly lit, bad/worst dark.
1.30	Liked Bay St. lighting (street/pedestrian), good.

Yours truly
G. O'CONNOR CONSULTANTS INC.

Glenn A. O'Connor OALA CSLA

C.C. **Mike Field**, City of Hamilton
Don McLean, DMD & Associates Ltd.

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MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**2**
Client:	City of Hamilton	Date:	11/17/2009
Location:	204 Ottawa Street North, Hamilton	File No.	1160
Present:	**Patty Despinic**, Ottawa Street B.I.A. Rep. **Mike Field**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with representatives from each B.I.A. area to review any lighting issues/concerns.

ITEMS	
2.1	Big issue, overhead hydro wires only on east side of Ottawa St.
2.2	Ottawa Street widened sidewalks pre-1996.
2.3	Commercial assessment study, John Archer, doing 5 BIA's. Near end of study, to be completed in 2009.
2.4	Commercial district, many BIA serve local area only, service and shops used by local people.
2.5	Ottawa Street – completely disproportionate draw of commercial, therefore draws more City-wide and outside City users.
2.6	Traditionally, area was furniture, then sewing, now home décor. Need larger market segment and geographic draw.
2.7	More recent evolution, to become home décor/district; umbrella is bigger with home décor.
2.8	This is a driver for big trade area, greater proportion of shoppers from outside of City, from many other cities whose expectations differ.
2.9	Lighting poor, lighting Main to Barton generally all poor.
2.10	All visual clues, everything at same sight line above eye.
2.11	Banners merge in with other sign elements.
2.12	Gaps in decorative poles on street.
2.13	Pole at Ottawa near Main.
2.14	Ottawa, nothing different from Ottawa St. to side streets.
2.15	25 decorative poles on Ottawa St.
2.16	Lighting is currently for road, not people.
2.17	Sidewalks are ±3m which is great, also unusual.
2.18	Ottawa St. has had over 60 applications for façade improvements; lighting has had little attention to date. Needs encouragement, demonstration project.

2.19	Suggested to encourage lighting in façade applications.
2.20	Concern with Municipal parking lot lighting.
2.21	Recent cameras installed late fall 2009, Police prefer white light for safety and cameras to identify colours carefully/correctly.
2.22	Issue with alleyways, report being prepared for draft report to go to Council December 2009.
2.23	Some alleyway lighting provided now, historically, when an issue was identified by police, then could get lights.
2.24	BIA promote alleyway lighting, but encourage private sector to undertake work.
2.25	Alleyway not treated differently assumed or unassumed.
2.26	Question on responsibility for alleyway lighting. What is purpose of lighting alleyway? Alleyway lighting program.
2.27	Issue with how alleyway is used; recommendation to classify alleyways, rank them, etc. Class 1 to Class 10; get certain components for a type of ranking.
2.28	Recommendation to develop a ranking; future initiative? In this regard, lighting could then systematically be prioritized.
2.29	Doug Onishi (Dillon Consulting) doing study of alleyways. Primary focus/concern is Ottawa St.
2.30	**Ottawa St. BIA Wish List** 1. Want overhead wires buried (overhead hydro) 2. Want better pedestrian lighting, brighter, more even 3. Break up vertical space (clutter) within same zones above eye level top of doors to gutter of eaves trough 4. Capture façade lighting within grants (City grant) o Eclectic street, outside of box, therefore not heritage banners and lights all on City poles. Banners, hanging baskets, lights, want different and unique. o Prefer not to have heritage lights, something interesting, different o Asked for guidelines for façade lighting o Façade lighting, reason not being done is a lack of vision and costs to business are unknown

Yours truly
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MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	3
Client:	City of Hamilton	Date:	11/17/2009
Location:	223 Wilson Street East, Ancaster	File No.	1160

Present:
Bob Wilkins, Ancaster B.I.A. Rep.
Karen Wilkins, Ancaster B.I.A. Rep.
Rev. Brownlie, Ancaster B.I.A. Rep.
Jim Panoff, Ancaster B.I.A. Rep.
Mike Field, City of Hamilton
Glenn O'Connor, G. O'Connor Consultants Inc.

Purpose of the Meeting: To meet with representatives from each B.I.A. area to review any lighting issues/concerns.

ITEMS	
3.1	Looking at City-wide lighting.
3.2	Looking at all BIA areas.
3.3	Issues/concerns – Ancaster is scheduled to have streetscape rebuilt in 2012/2014.
3.4	Rail trail link an issue.
3.5	Ancaster Heritage Village BIA, 1798 – 3rd oldest community in Ontario.
3.6	Sympathetic to heritage/empathetic, buildings, lights, furniture, want to discourage, through traffic encourage pedestrian friendly walk/bike enjoy shopping/business district.
3.7	"Heritage" is big issue, visually inviting and safe place to be.
3.8	Streetscape currently very poor quality.
3.9	Roseau St. well lit. Wilson Street poorly lit, want distinctive lighting, friendly. Different, special and differ from other communities.
3.10	Existing lights very old, bad spacing, retrofitted and poorly functioning.
3.11	Wilson Street, Montgomery at Old Mill, Valley Drive – asking for lighting of trail (rail trail) and trail at Fieldcote want to light trail.
3.12	Great loop trail system; want to develop lighting on trails.
3.13	Light Farmer's Market area (at St. John's Anglican Church).
3.14	Town Hall area and park; many lighting were burnt out, need maintenance.
3.15	Wilson poorly lit; want flexibility for tree lighting, pole lights – want all 46 poles and double-hanging baskets all lighted.
3.16	Want LED spot lights on hanging baskets.
3.17	Want banners.
3.18	Want light duplex for Christmas lights.

3.19	Make a system for all parts.
3.20	Ideally want two level lights, combined pedestrian and vehicular lighting.
3.21	Ancaster BIA issues to be addressed: 1. Pole spacing poor, road and sidewalk lighting uneven 2. Ancaster will have a special zoning C-7. Special side yard and front yard setback 3m setback; 3m between commercial buildings Ancaster want side yard sightlines 3. Want special treatment in front of Town Hall 4. Concern regarding safety issue and brightness and even 5. Want flexibility for tree uplighting from ground given large # of mature trees (high maintenance)
3.22	Want tree and wreath lighting programs in future.
3.23	Balance amount of light with well lighted and low level.
3.24	Façade lighting important.
3.25	<u>Concerns</u> • Parking lots and roads • Pedestrian routes/walkways • Building façade lighting • Specialty areas • Widen sidewalks where possible

Yours truly
G. O'CONNOR CONSULTANTS INC.

Glenn A. O'Connor OALA CSLA

C.C. **Mike Field**, City of Hamilton
Don McLean, DMD & Associates Ltd.

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MINUTES OF B.I.A. MEETING

Project: Hamilton Outdoor Lighting Study
Meeting No. **4**
Client: City of Hamilton
Date: 11/25/2009
Location: 79 Hamilton St. North, Waterdown Legion
File No. 1160
Present:
Linda Naccarato, Waterdown B.I.A. Rep.
Other Waterdown B.I.A. Reps, not identified
Don McLean, DMD & Associates Ltd.
Mike Field, City of Hamilton
Glenn O'Connor, G. O'Connor Consultants Inc.

Purpose of the Meeting: To meet with representatives from each B.I.A. area to review any lighting issues/concerns.

ITEMS	
4.1	Mike provided an overview of study and work completed to date.
4.2	Discussion on perception of lighting issues in downtown and safety, crime, etc.
4.3	Generally, felt Waterdown main are streets well lit. Very good, core BIA not a problem; overall look more an issue than brightness/darkness.
4.4	Could use updating of fixtures, consider newer technology. Given the lighting was installed in approximately 1992/1993.
4.5	City of Hamilton goal to have a 20% energy reduction by 2012.
4.6	Generally, B.I.A. is happy with lighting. Issue with plexiglass housing falling out, exposes bulb. Ongoing, a recurring issue.
4.7	Report will go to City Council with recommendations and policy. Report will be completed May or June 2010.
4.8	Good lighting, people are not afraid to go out at night, people feel safe in Waterdown.
4.9	Lighting generally reliable, not frequent, but lights do go down in groups. Wondered about replacement program, frequency and program.
4.10	Issue with photocell and age of sensors; they need to be replaced.
4.11	Not entire BIA area covered, currently only #5 (east-west), Mill St. to Hamilton Dr.; areas north of #5 not covered. This was not deemed to be a high priority.

Yours truly
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MINUTES OF MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**5**
Client:	City of Hamilton	Date:	11/24/2009
Location:	155 King William, Hamilton	File No.	1160
Present:	**Sergeant Michelle Moore**, Hamilton Police Service Team of 13 Beat Officers present **Mike Field**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with representatives from the Hamilton Police Service area to review any lighting issues/concerns in the Downtown Core.

ITEMS	
5.1	Wellington to Bay is defined as Core Downtown.
5.2	This Outdoor Lighting Study came out of task force for safety and cleanliness.
5.3	Public versus private parking, including issue regarding lighting alleyways, will it be considered in study.
5.4	Alleyway, Mary St. to John St., King William/John an issue.
5.5	James to Wellington, between King to KW parallel, alley an issue.
5.6	Parking lots KW, across from 77 King William, Catharine and KW from clubs – drinking at night an issue.
5.7	Beside Connaught is dark, street lights near parking lots would help.
5.8	Sidewalks and roads are uneven in many areas, especially side streets.
5.9	Off beaten path, alcoves, doorways are issues, off side of buildings property STDS – hidden, dark areas are an issue, especially lack of lighting.
5.10	South of GO Station, south of tracks not well lit residential areas.
5.11	North side of King, James to Bay not well lit.
5.12	Gore Park being redeveloped, open up park, lighting will be revisited.
5.13	White lights preferred, do not like HPS. White light needed for colour rendition and identification.
5.14	Bowen, Jackson to Main an issue.
5.15	Lighting near bar areas could be improved (they like new lights at Hess Village).
5.16	North side of York Street poor, near Copps Coliseum.
5.17	Prefer lights on Bay St. high/low style.
5.18	Market St. at rear of Copps is dark, west side of Bay.
5.19	This will displace crime to other areas.
5.20	James St. North, west side near Mulberry, alley south James to Hughson, near behind 231 Hughson.

5.21	Alleyways lighting be careful. Provides a sense of comfort. Gives the criminal the upper hand; sets normal user up for issue with "trapped" spots. Perception of safety in lit alleys, be cautious. If lighted, must do alcoves and hidden areas so as to not create a false sense of safety and security.
5.22	Concession St. alleys, some low-level lighting; not great.
5.23	Watch to ensure you are not inviting them into an unsafe area. Light hiding spots in alleys; look at individual alleys and develop a strategy for City.
5.24	Look at what area should be lighted, look at threat assessment.
5.25	Pressure property owners to upgrade lights.
5.26	Police prefer motion sensitive lights, so activity is noticed.
5.27	Encourage private sector to light alcoves, especially with motion detectors.
5.28	Main St., Catharine to Walnut is poorly lit.
5.29	Double check video camera projects.
5.30	Hess Village, successful new lighting added; assists police in their work.
5.31	John Street North (McLaren Park) is dark, 181 John St.
5.32	Parkette beside Reardon is dark (demolition park) on King William.
5.33	Beasley Park, path lighting, ok. Edges dark, pathway to Hell? Park generally dangerous.
5.34	John to James/Gore Park, Caroline and Main parking lot poor, King and Hughson.
5.35	3 methadone clinics downtown, bars. High # of people with issues.
5.36	Central crime analyst, check for night/day stats.
5.37	Pedestrian lights new streets, ok.
5.38	Cobra heads provide poorly lit pedestrian areas.

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MINUTES OF MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**6**
Client:	City of Hamilton	Date:	03/08/2010
Location:	City Centre, 334 R.H.	File No.	1160
Present:	**Ken Coit**, City of Hamilton **Mike Field**, City of Hamilton, Electrical Street Lighting Specialist **Khaldoon Ahmad**, City of Hamilton **Dave Zimmer**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To review project with urban design staff, including work completed to date on draft report, comments from public, study status and next steps.

ITEMS	
6.1	Rail trail: Chedoke Golf Course to McMaster (C.P. rail trail) is being lighted by City.
6.2	Add a paragraph in report to state custom lights not recommended in City.
6.3	Document must leave flexibility for public art in future (nothing in report restricts this). A section on monument lighting is provided related to public art.
6.4	A simple encroachment agreement for lighting should allow the lights to encroach on right of way (R.O.W.).
6.5	Check site plan guidelines to ensure the report is in alignment.
6.6	Character zones downtown, heritage character zones, part of zoning by-law addresses existing building and new buildings. GOCI to review "Downtown Heritage Character Zone Design Guidelines" report. Check for applicability.
6.7	Check on urban design www. Heritage zone guidelines. Site plan guidelines on web.
6.8	Call Ken D'Andrade, Planning Department re: requirements. Standard conditions, pole lighting, needs an engineer to review clauses in site plan guidelines. Are they correct/appropriate?
6.9	How do you approve fixture types? Commentary on criteria.
6.10	Welland is doing an entire city wide conversion to LED (FYI).
6.11	Draft recommendations, show to staff for comments. Guidelines, not policy documents. Lighting better if non-staggered on streets. Comment on day versus night crimes.

6.12	Anticipate questions of task force (clean and safe).

Yours truly
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MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	7
Client:	City of Hamilton	Date:	03/15/2010
Location:	249 King Street East, Hamilton (International B.I.A. office)	File No.	1160
Present:	**Mary Pocius**, International B.I.A. Rep. **Mike Field**, City of Hamilton **Devon King**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with the representative from the B.I.A. area to review any lighting issues/concerns and update on work to date.

ISSUES	
7.1	Quality of light.
7.2	The B.I.A. want more than minimum light levels. B.I.A. pushing to exceed minimum standards.
ITEMS	
7.3	General introduction/overview of work to date. 6 part study, report in draft mode.
7.4	Alleyway lighting. Sidewalk lighting was discussed.
7.5	Alleyway lighting: often an entrance to residential has access to walkups from alleyway. 2nd/3rd floors. Access not on King Street to residential, generally at rear alleyway.
7.6	When apartments upgraded, B.I.A. has recommended gates from alley to secure entry.
7.7	Entrances to apartments, B.I.A. encourages safe rear entries, good visibility.
7.8	Alleyways: report will recommend consultation with police 1st before any alley lighting.
7.9	Street light computer modeling was completed. Confirmed calculations in field. All downtown streets were checked and reviewed with photometer against model.
7.10	Roadways generally passed. Most sidewalks did not pass. Results consistent across North America. Generally, sidewalk/pedestrian lighting given little attention.
7.11	"Decorative lighting" misused term. The lighting is more than decorating, it was called this to differentiate from standard street lighting.
7.12	A pilot project on Vine Street between James and McMaster – replaced Cobrahead with L.E.D. lights. This is being monitored. First impression is that it is good. More efficient optics, less shadow spots, more uniform "white light".
7.13	Want sidewalk well lighted, satisfy police requirements, white light source.
7.14	B.I.A. will go with police and go to location, specific to make recommendations for alleyway lighting on a case by case basis. Not universal solution. Report will set out principles. Individual applications or circumstances will be looked at on an as required basis to determine best solution(s).

7.15	B.I.A. has changed its opinion on how alleyways should be addressed. They now agree with police and report.
7.16	Quality of light. Complaints about light an issue.
7.17	They agreed it is partially issue of perception with lighting, rather than the actual lighting light levels.
7.18	Concern with consistency of lighting downtown. Sidewalk lighting could be improved.
7.19	International Village has 30 restaurants downtown.
7.20	Aesthetics of lighting also an issue. Report offers commentary.
7.21	Façade lighting – B.I.A. has been vocal to light facades. Façade grants include lighting, B.I.A. encouraging façade lighting. Encouraging King William to be improving façade lighting throughout. B.I.A. is encouraging lighting with façade grants.
7.22	Street tree lighting, was started to give impression of brightness downtown.
7.23	B.I.A. has an AGM held annually in October. Suggestion to highlight lighting & façade study. 40-60% of members attend AGM of the 126 owners. Suggest small handout be available. B.I.A. and City to coordinate a presentation by Mike Field.
7.24	B.I.A. has a bimonthly newsletter, they can publish findings if desired of study highlights.
7.25	International Village is a "traditional B.I.A.", owner occupied, small scale business, independent owners, few chain owners.
7.26	Suggestion to have City do a presentation with Hazel Milesome and Mike Field to B.I.A.'s, give the members an overview of study, work completed to date.
7.27	Façade examples, light versus dark, show examples to encourage business owners to make improvements to their facades.
7.28	A new B.I.A. Executive Director is starting mid-March 2010. Mary Pocius is phasing out/retiring and will provide transition to new Director.
7.29	By 1991, recession 3 blocks, 3 ½ blocks had 54,100 ft^2 vacant retail. At 55% vacant. Since 1991, B.I.A. has expanded 2 times. As of 2010 ± 6-7% vacancy rate only.
7.30	Some long term tenants, many have been on street a long time.
7.31	Generally, the B.I.A. is pleased to have been consulted and agrees with the preliminary recommendations.

Yours truly
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MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**8**
Client:	City of Hamilton	Date:	04/06/2010
Location:	Concession St. B.I.A, Hamilton	File No.	1160
Present:	**Lorne Lozinski**, B.I.A. Rep. **John McPherson**, B.I.A. Rep. **Devon King**, City of Hamilton **Mike Field**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with the representatives from the B.I.A. area to review any lighting issues/concerns and update on work completed to date on the study.

ITEMS	
8.1	One full-time police officer on Mountain Community Police Facility. Visibility of alleyways a concern. Lights in alleys dim, HPS, not white light, is currently used.
8.2	Fall 2009 – Mike reviewed alley lights near Concession, repairs made to Concession Alleyway lights. Concession B.I.A. has been working on problems/crime issues. Alleyways cleaned up, removed debris, trees, etc. This has been a big effort and has been successful with good results to date.
8.3	Police have assisted with cleanup, garbage, lights added in alleys. Police started a reading program, worked with schools. Area has improved.
8.4	Colour of light a concern, it is dim light along streets.
8.5	Concession Street lighting. Poorly lighted, pole lights, light levels low. 2 cameras on street – poor image quality due to colour of lights. Mike noted Concession Street is actually well lighted from a photometric standpoint. It is more of a perception issue due to colour rendition. City puts street lights on Horizon Utility poles. Intended to do streetscape upgrades in 2014 at which time the overall lighting will be reviewed.
8.6	Overhead wires an issue with respect to aesthetics. Next steps.
8.7	Suggested that Mike speak to Diago, the Concession Street police officer. Mike will meet separately from this meeting and confirm any issues.
8.8	2 cameras that are installed are 360° pan tilt type, full rotation style. Police Services

	need to identify if there's a current issue with cameras. Image quality is thought to be very poor. Cameras, 1 at Summit and 2nd by Pro Transmission. The issue is possibly due to light colour source (H.P.S.).
8.9	Light quality issue concerns. Formal request must come through the appropriate channels, Police Services must identify/request changes to lights, if required. B.I.A. will follow-up. Alleyway lighting is not patrolled, B.I.A. can report through hotline any lights that are out.
8.10	Concession B.I.A. has 43 volunteers! Concession Street is the only B.I.A. that does not have posters, etc. Stores will put signs in window. Posters not permitted on poles and are immediately removed.
8.11	Mountain Park, Sam Lawrence Park & Brow are poorly lighted. Prostitutes and drugs at Brow. Good surveillance with community police which has made a big difference to neighbourhood.
8.12	B.I.A. invited Mike to attend a B.I.A. meeting. 3rd Tuesday of month, 2nd floor of the library. When study complete, Mike can present findings to B.I.A for their information.

Yours truly
G. O'CONNOR CONSULTANTS INC.

Glenn A. O'Connor OALA CSLA

C.C. **Mike Field**, City of Hamilton
Don McLean, DMD & Associates Ltd.
Rob Fraser, DMD & Associates Ltd.

THESE MINUTES ARE CONSIDERED TO BE A TRUE AND ACCURATE RECORD OF THIS MEETING. ANY OMISSIONS OR DISCREPANCIES WITH RESPECT TO ITEMS APPEARING IN THESE MINUTES MUST BE REPORTED TO THIS OFFICE IN WRITING NO LATER THAN ONE WEEK FROM THE DATE OF RECEIPT OF THESE MINUTES

G. O'CONNOR CONSULTANTS INC.
Landscape Architecture ■ Environmental Planning ■ Resource Analysis

3310 South Service Road, Suite 205, Burlington ON L7N 3M6 Tel: 905 681-7604, Fax: 905 681-2944
E-mail: ocon@oconnor-consultants.com Website: www.oconnor-consultants.com

MINUTES OF B. I. A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**9**
Client:	City of Hamilton	Date:	04/06/2010
Location:	Dundas B.I.A., 6 Cross Street	File No.	1160
Present:	**Darlyne Mills,** B.I.A. Rep. **Phyllis Kraemer**, B.I.A. Rep. **Mike Field**, City of Hamilton **Devon King**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with the representatives from the B.I.A. area to review any lighting issues/concerns and update on work completed to date on the study.

ITEMS	
9.1	No concern with lights in Dundas. Currently, overlighted, generally satisfied with lights and maintenance. York Road to Cross Street, concern on King. King Street okay except York to Cross section.
9.2	Areas outside B.I.A. a concern with lighting.
9.3	Poles being refurbished with paint program. Mike has arranged sequential refurbishing.
9.4	Safety issue identified. Access plates are missing on pole bases. City is replacing access cover plates. Currently, cast iron. New ones being made of fiberglass to replace cast iron covers which are being stolen and sold for scrap.
9.5	6-8 poles were removed and are in storage at City. These were removed at Shoppers Drug Mart. Plan to replace/install 6 poles on King Street. In future, Albert Street or Millers Lane could use poles and lights. The poles will match as re-use.
9.6	B.I.A. generally happy with lighting levels on street.
9.7	Parking lot behind the R.B.C. near fire hall is dark.
9.8	Light level low at King Street on Cross to York, several apartments and seniors. East end of town.
9.9	West end generally okay. Alleyways and Millers Lane somewhat dark, but underused.

9.10	Alley at Shoppers Drug Mart, scary, not well lighted. No natural surveillance. Municipal maintenance an issue.
9.11	Dundas – Streetscape is planned for 2013 major streetscape upgrades.
9.12	Don't see any need to upgrade lights. Satisfied with current system. When redone, extend length of lighting in town.
9.13	Happier with Dundas than other B.I.A.'s lighting.
9.14	Wreath program good. Stored by a private sector company in Markham for annual installation.
9.15	Do not like G.F.I. plugs as they regularly trip out.

Yours truly
G. O'CONNOR CONSULTANTS INC.

Glenn A. O'Connor OALA CSLA

C.C. **Mike Field**, City of Hamilton
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MINUTES OF B.I.A. MEETING

Project:	Hamilton Outdoor Lighting Study	Meeting No.	**10**
Client:	City of Hamilton	Date:	04/06/2010
Location:	Barton Village B.I.A., 406 Barton Street	File No.	1160
Present:	**Shelly Wonch,** B.I.A. Rep. **Devon King**, City of Hamilton **Mike Field**, City of Hamilton **Glenn O'Connor**, G. O'Connor Consultants Inc.		

Purpose of the Meeting: To meet with the representative from the B.I.A. area to review any lighting issues/concerns and update on work completed to date on the study.

ITEMS	
10.1	The B.I.A. is concerned that we did not meet with police officer, Dale Neil.
10.2	Shelly has not been in area much at night. Beat officer works in daytime.
10.3	Alley lighting, basic issue. Some specific areas. Request to have some alleyways lighted. 335 Barton, 333-331 ("Studio Gallery"). West of 335 Barton; on the north side. Want lighted. Many similar issues in alleyways. West of studio gallery is alleyway. Lighting on Barton, satisfactory. Have decorative lighting. Keep maintained. Mainly decorative purposes. Agreed with recommendation of report on alleyways.
10.4	Decorative lighting installed ± 2006. Issue: can't have bike lanes due to limited space with bumpouts and median islands. Cannot have bike lanes due to spacial restrictions. EMS and emergency vehicles can't get through therefore can't have bike lanes.
10.5	B.I.A. Ferguson to Sherman – limits of B.I.A.
10.6	Business: 2-3 bakeries, 2-3 pubs, pizza, convenience stores, sign co., printers therefore very mixed uses in this B.I.A.

10.7	Looking at gateway ideas with Dave Zimmer. Poles/gateways for entrances.

Yours truly
G. O'CONNOR CONSULTANTS INC.

Glenn A. O'Connor OALA CSLA

C.C. **Mike Field**, City of Hamilton
Don McLean, DMD & Associates Ltd.
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Appendix A.3

November 26, 2009 Public Open House, Display Panels

DMD G. O'CONNOR CONSULTANTS INC.

Business Improvement Areas & Downtown

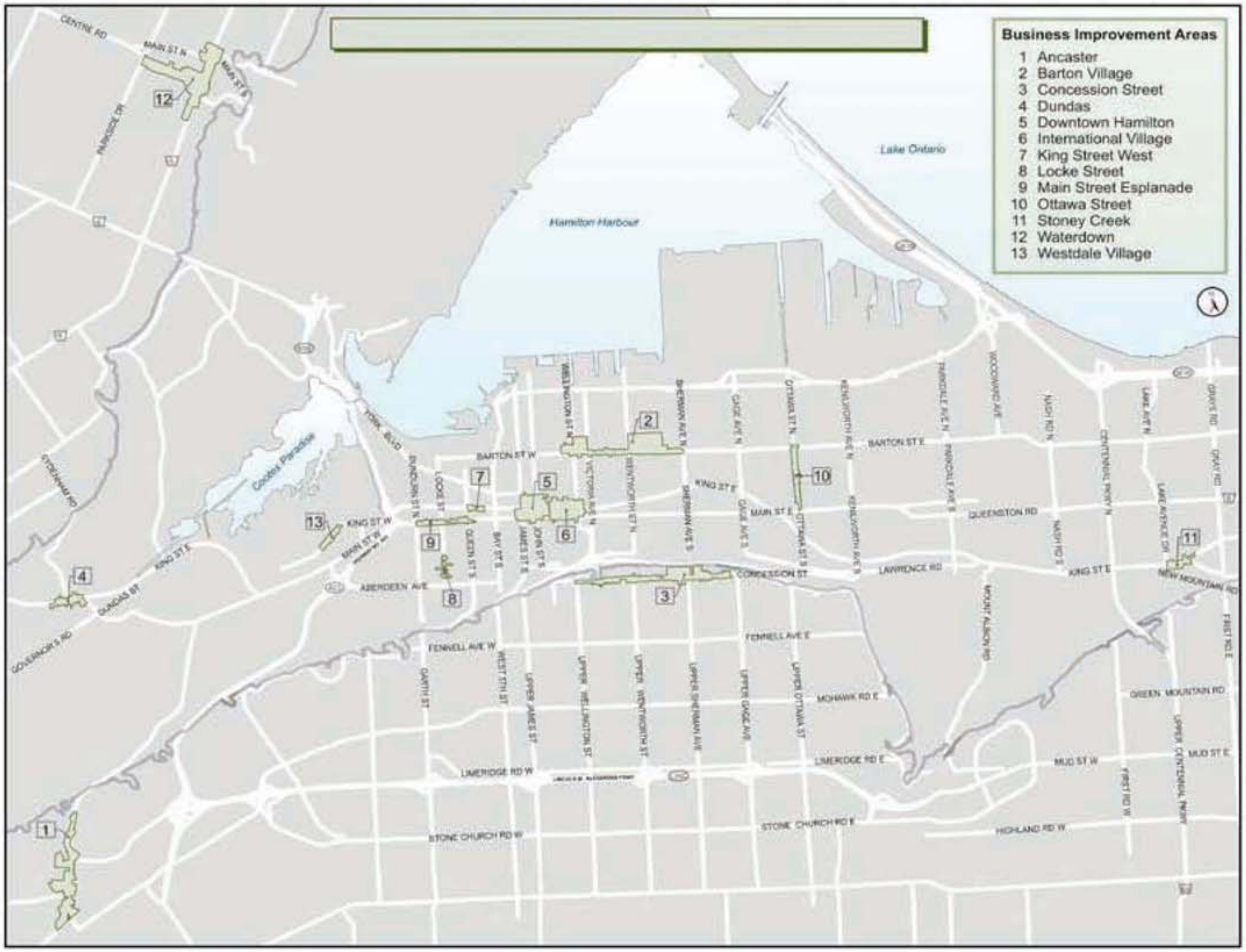
Hamilton Public Works

Lighting Is A Key Element

With the area being awarded the 2015 Pan-Am Games, lighting along with architectural enhancements can play a big part in revitalizing the City.

City of Hamilton

Hamilton Public Works



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Comprehensive Outdoor Lighting Study

Hamilton
Public Works

Project Background

In October 2008, the Task Force on Cleanliness and Security in the Downtown Core completed a study which concluded that improvements in existing streets, alleyway sidewalks, pathways and parking lots could directly contribute to improving the perception of security in the downtown core.

The City was requested by the Task Force to initiate the development of a lighting study and policy for outdoor lighting.

Project Overview

Through a competitive selection process, a specialist engineering/architect team has been retained to study outdoor lighting for the entire City. This study will provide the recommendations and a plan of action needed to meet the objectives of the Task Force and also to provide the framework for the creation of a comprehensive policy for the lighting of roadways, alleyways and pedestrian walkways.

DMD G. O'CONNOR CONSULTANTS INC.

Comprehensive Outdoor Lighting Study

Hamilton Public Works

Part I – Fundamental Lighting Standards

Investigate and validate the reasoning for the requirement of lighting and develop design and construction guidelines/standards for its application.

Part II – Downtown Hamilton Improvement Project Area

Review and analyze the existing lighting conditions in Hamilton's downtown core with an emphasis on safety, security and cleanliness related to the application of lighting; Investigate and make recommendations regarding lighting of streetscapes, parks, parking lots (public and private) and commercial areas; Provide input into how lighting can enhance the downtown core and promote re-development.

Part III – Business Improvement Areas

Review and analyze the existing lighting conditions within the thirteen (13) Business Improvement Areas (B.I.A.s); Investigate and make recommendations regarding lighting of the B.I.A.s in relation to how it can enhance each area.

Part IV – Lighting Equipment Inventory

Review and analyze the existing infrastructure and equipment standards in comparison with the guidelines and standards developed within Part I.

Part V – Infrastructure Operations & Maintenance

Review and analyze the existing operations and maintenance strategies related to streetlighting and make recommendations for improvement.

Part VI – Energy Savings Initiatives & New Technology Implementation

Advocate, through the study's recommendations, the use of energy efficient light sources and design practices in order to reduce environmental impacts; Review and determine the applicability of various energy saving initiatives and make recommendations on how outdoor lighting can contribute to the goals of the "City Corporate Energy Policy for City Facilities & Operations".

The study's project team welcomes input from all residents and local businesses with an interest in outdoor lighting such that it may be included in the final document.

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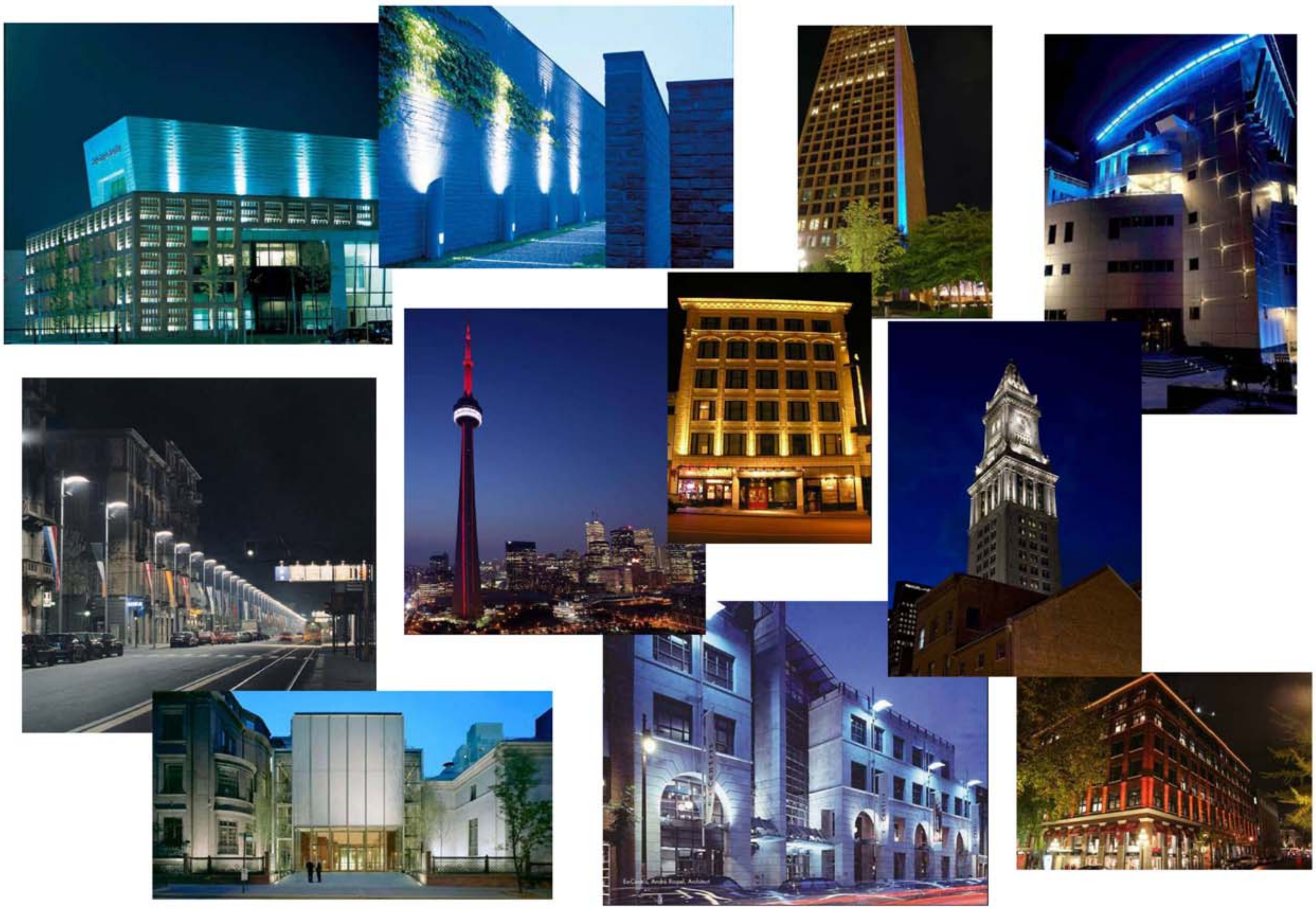
Examples of Architectural Lighting

Hamilton Public Works



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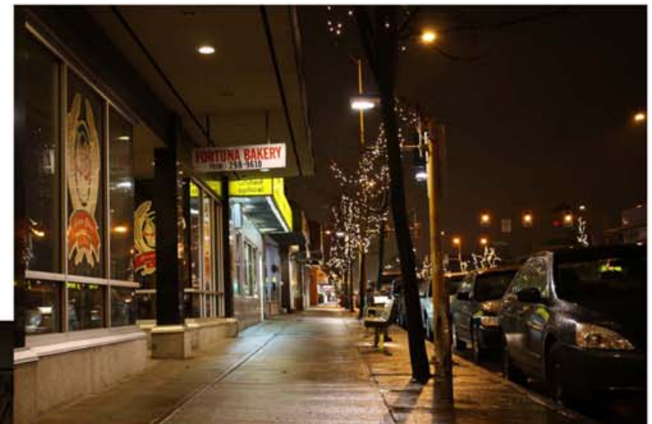
Lighting Levels

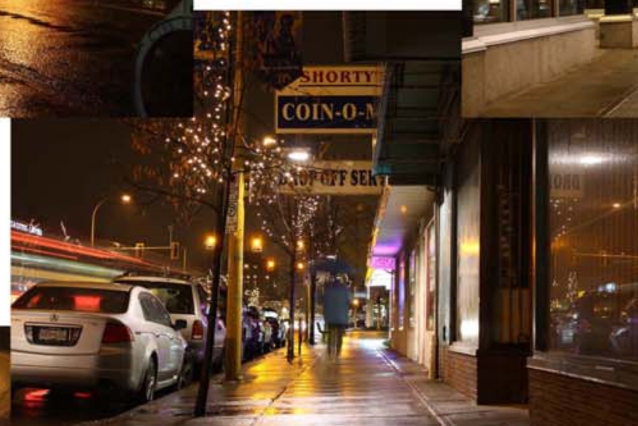
Hamilton Public Works

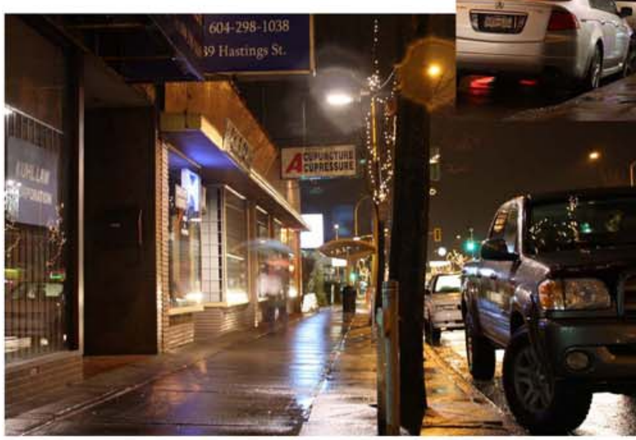
The eye adapts to different light levels making it possible to see in a wide range of illuminated conditions

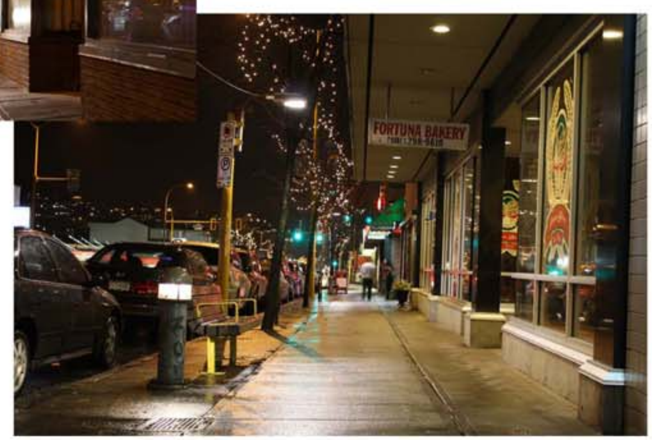
Description	Lux Levels
Daylight	10,000 lux
Overcast Day	1,000 lux
Supermarket	750 lux
Lighted Office Space	500 lux
Illuminated Local Soccer Field	300 lux
Typical Illuminated Parking Lot Lighting	20-30 lux
Typical Street Lighting	4-17 lux
Twilight	10 lux
Full Moon	0.1 lux
Overcast Night	0.0001 lux

Nighttime Lighting Examples









Obtrusive Lighting
Bothersome, Nuisance or Annoying

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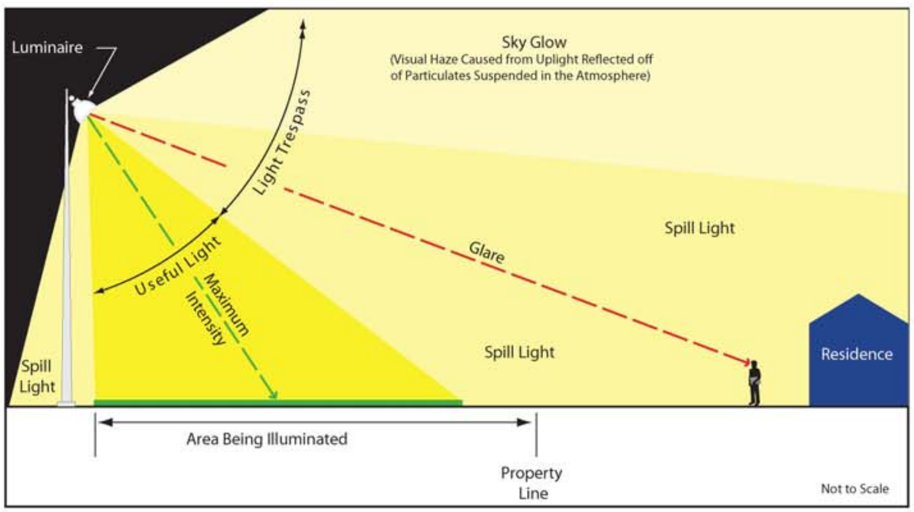
The three components of obtrusive light include glare, spill light and sky glow. In a lighting design each obtrusive light component is considered separately.



Glare. Obtrusive light that hinders or bothers the human eye. Glare is the result of light emitted from a source that is in sharp contrast to its surroundings.

Disability Glare. The presence of an amount of glare so significant as to prevent adequate vision. The presence of disability glare means that other objects in one's field of vision are obscured.

Discomfort Glare. The presence of a sufficient amount of glare to cause discomfort. While the individual may experience a sense of discomfort, this level of glare does not obscure his or her vision.

Nuisance Glare. The presence of a sufficient amount of glare as to be bothersome but does not prevent vision or lead to discomfort.

Spill Light. Illuminance falling beyond the area being illuminated. Sampling spill light with a calibrated light meter is the only accepted method of measuring and defining levels of light trespass for any community, and is quantifiable.

Sky Glow. The visible haze or glow of light seen above a lighting installation that reduces the ability to view the darkened nighttime sky. The source of sky glow is a combination of light emitted upwards from a light source and reflected light cast upwards from the surface being illuminated reflecting off particles suspended in the atmosphere.

Note: Glare, spill light and sky glow impacts are only present when an outdoor facility is illuminated at night. Once the lighting is turned off, the impacts of obtrusive light are no longer present.

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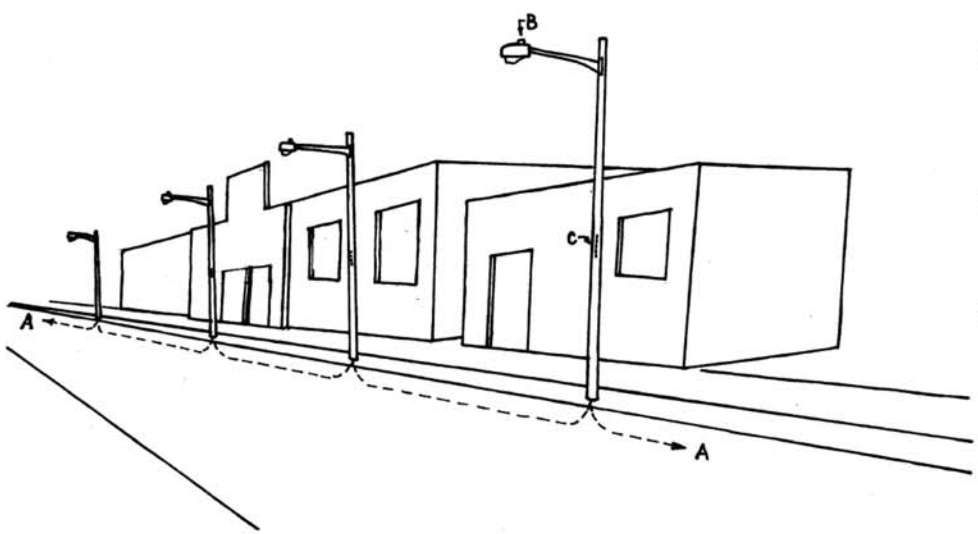
Street Lighting Operations

Hamilton Public Works

Street Lighting Infrastructure

- 44,000 light fixtures of various wattages
- 20,000 concrete light poles
- 5,000 steel and decorative pole assemblies
- 500kms of underground and overhead electrical wiring
- Costs approximately $3,800,000 in energy annually or about $10,000 per day to operate.



A. Power is supplied to the street lighting system via underground (as shown) or by overhead supply, chained from one pole to the next.
B. A 'photoelectric' sys detects the lack of natural light and signals the street light to operate.
C. Each pole is labelled with a unique identification number. This number is typically located on the pole, mid-way to the top.

Street Lighting Maintenance

On an annual basis, the City response to approximately 3600 repairs request.
These requests are generally received by two different methods:

- Public call in to the street lighting repair hotline 905-546-2098
  or 905-546-CITY (2489)
- Monthly night time City patrols

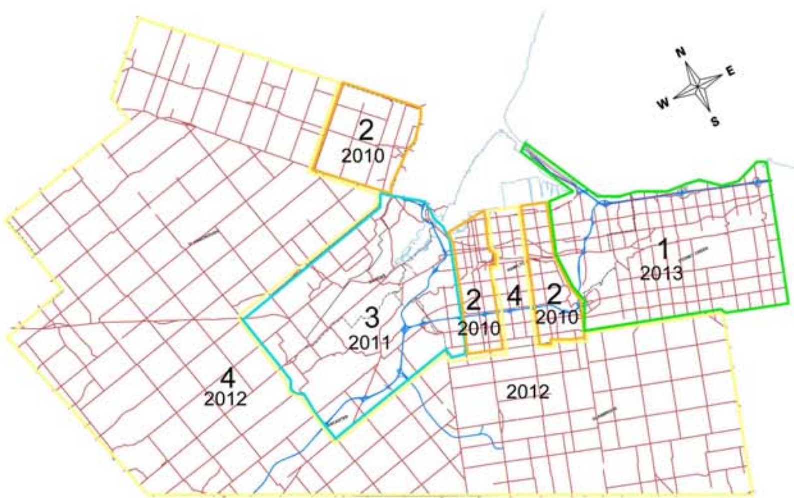
The expected turn-around time from (typical standard repairs) when a repair request is received and when it gets repaired is 5 working days or less.

In order to maintain a high service level to the public, the City proactively performs maintenance on the street lighting system. This mainly consists of annual re-lamping of light fixtures. The lamps are replaced before their expected end of life to ensure that a seamless replacement takes place with limited or no disruption to the public.

The City divided into four re-lamping zones. One zone per year is completely re-lamps. This typically takes place in the early new year and is completed prior to spring.

More complicated repairs, such as underground/aboveground wiring issues, vehicular collision damage, weather damage, etc the city evaluates each individually in order to determine how critical the repair is needed.

For the most critical issues, such as fallen poles, the city responds immediately to ensure the public's safety is maintained at all times. Other less critical issues are in need of repair are placed in a queue based upon their priority.



The City of Hamilton is responsible for the maintenance of 44,000 luminaires within the boundaries shown in this map. The City has divided up the boundaries into four zones of approximately equal quantities (11,000 street lights per zone). The City will sweep each zone once every four years to replace every light bulb within that zone. The final product is each zone will have new light bulbs once every four years. This process is called re-lamping. Re-lamping is done as a proactive approach to maintenance. Each light bulb is expected to last five years. Fixing them one by one as they burn out is a costly and time consuming effort. Large savings can be realized by purchasing the light bulbs in bulk and replacing them all together in groups prior to their expected failure date. The final result is a great cost-saving program which minimizes light failures.

Appendix A.4

July 9th, 2010 - Task Force Work Shop

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Hamilton
Public Works

Comprehensive Outdoor Lighting Study – Task Force Work Shop – July 9th

Workshop Overview

- Review the study, in particular, content related to the objectives of the Task Force
- Present and discuss the study’s recommendations
- Answer questions
- Refine recommendations
- Seek endorsement to final recommendations

The Consultant Team

DMD

Don McLean – Bio

- President of DMD and Associates Ltd – Specialist Firm
- 30+ years outdoor lighting experience
- Authored numerous national outdoor lighting publications
- Undertaken many urban streetscape and architectural projects

G. O'CONNOR CONSULTANTS INC.

Glenn O'Connor – Bio

- Landscape architect and principal - G. O'Connor Consultants Inc.
- Glenn O'Connor is a resident of the downtown
- Local firm with local knowledge and understanding

Project Status

- A final “draft” has been prepared and issued.

- To date, the study has been reviewed with:

    Hamilton Police Services
    Downtown and Community Renewal
    Hamilton Municipal Parking Systems
    Majority of the BIA’s
    Traffic Operations

- Future stake holder meetings include Parks and Cemeteries, Energy and Facilities and Forestry and Horticulture.

- The study will be finalized shortly following input from public works and the Taskforce.

Study Summary

No comprehensive lighting policy for outdoor lighting. ***Wide variation in lighting levels and types lighting equipment.***

Past industry practices focused on roadway lighting. Result: less pedestrian friendly environment. ***Doesn't meet City's walkability strategy.***

Safety and security (real and perceived): ***Poor lighting can negatively impact the image of the downtown.***

Lighting must be designed and installed to nationally recognized standards can improve safety and security. Measure and benefit difficult to quantify.

Study Summary

Secondary lighting benefits include such things as:

Enhancement of the City’s image.

Improved commerciality of the Downtown.

An enhanced feeling of comfort.

Increased public night usage/enjoyment of the Downtown

Study Summary

A set of lighting rationales were developed. The list is in priority from most important to least important:

1. ***Pedestrian Safety (off-roadway, navigating sidewalks, etc.)***
2. ***Pedestrian-Vehicular Conflict Safety (ped crossing road)***
3. ***Safety and Security (Real) – You are safer***
4. ***Safety and Security (Perceived) - Feeling of Security***
5. ***Commercial and City image enhancement***
6. ***Vehicular Road Safety (vehicle-vehicle conflicts)***

Study Structure

Section 1 – General: Introduction, theory of lighting and basic issues.

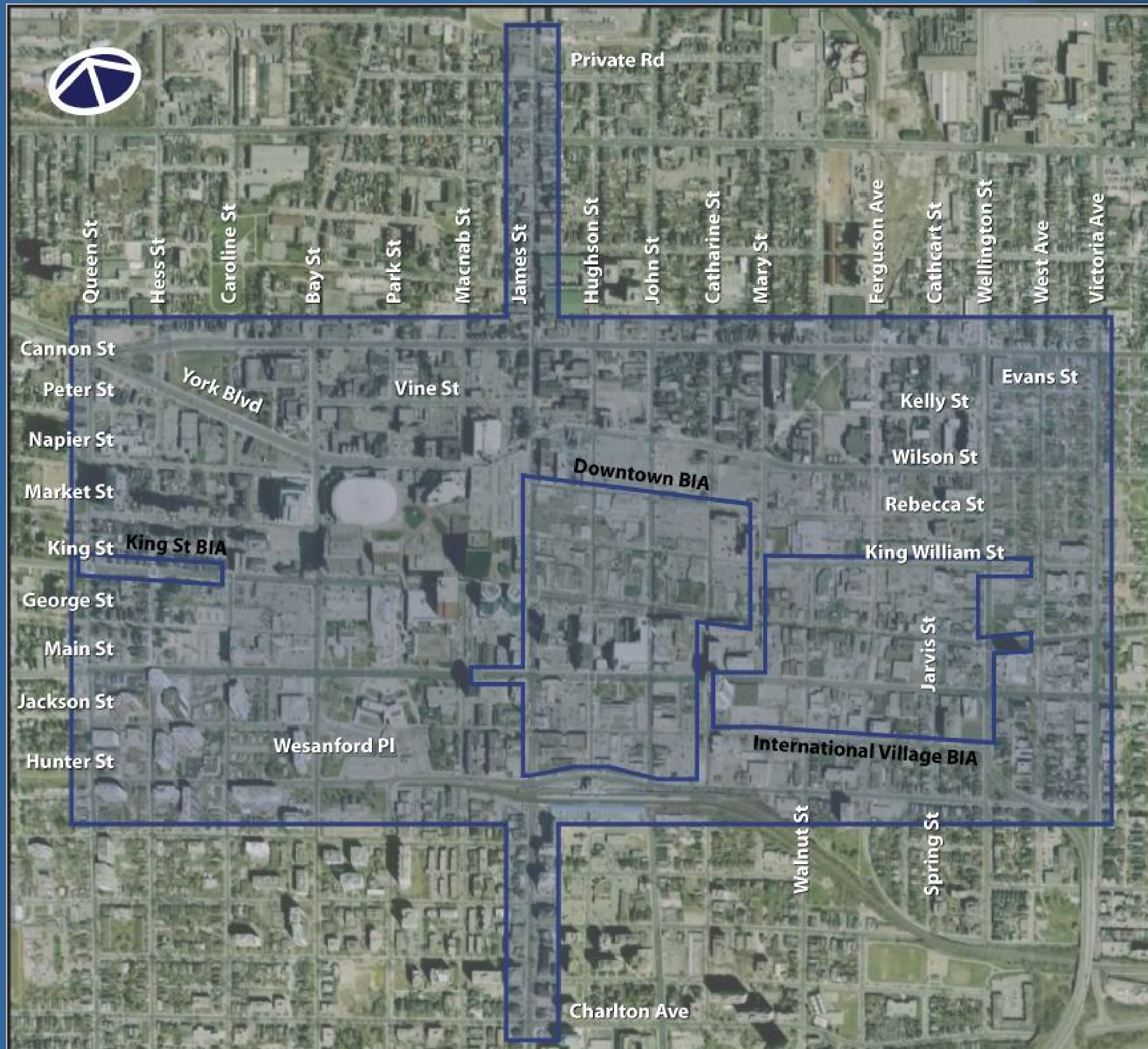
Section 2 – City-Wide Outdoor Lighting: Research, standards, existing conditions, police comments and stakeholder input and recommendations for the following applications within the City:

- ***Urban Roadway and Sidewalk Lighting***
- ***Rural Roadway Lighting***
- ***Urban Intersections***
- ***Rural Intersections***
- ***Alleyways (Commercial and residential)***

Recommendations for lighting hardware, maintenance practices and implementation strategy.

Section 3 – Downtown Area: Provides current conditions and recommendations for roadways, intersections, sidewalks, parks, plazas and parking lots in the downtown.

Section 4 – BIA Lighting: Provides a review of existing lighting within the BIA's.



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Study Findings – Existing Conditions

Lighting assessed for roadways, sidewalks, alleyways, parks and parking lots.

Results used to evaluate existing lighting were made in comparison to nationally recognized lighting standards. These standards provide comparison for evaluating existing conditions.

Based input areas that were perceived to ‘have good lighting and be most safe’, were compared to the results of the condition assessment. This assessment confirmed that lighting, when applied properly, enhances positive perception of the nighttime environment.

Study Findings – Existing Conditions

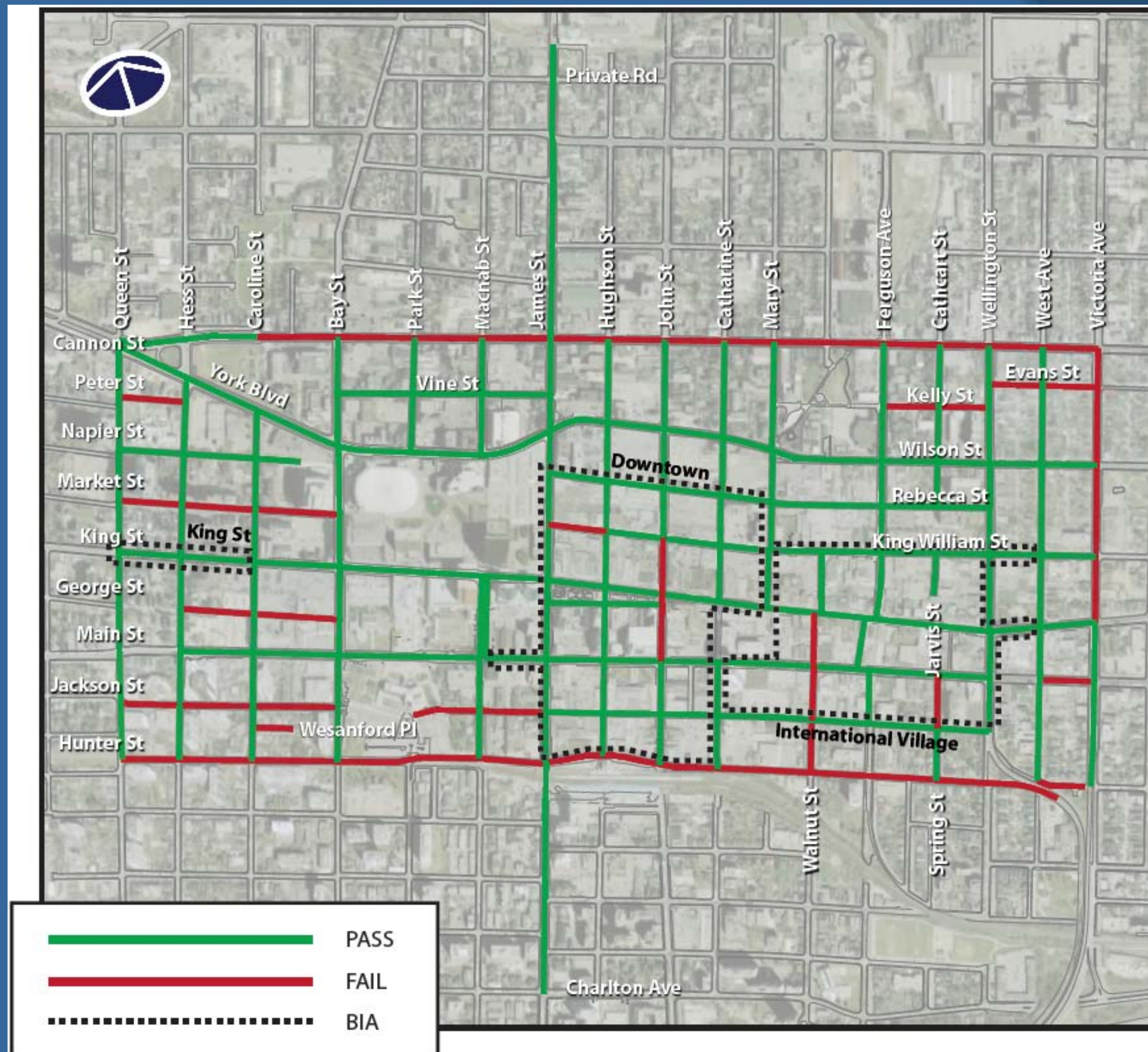
In summary, public right-of-way findings:

- ***Roadways typically meet the lighting standard requirements***
- ***Sidewalks typically fail the lighting standard requirements***
- ***Parks typically exceed (are over-lit) the lighting standard requirements***
- ***Parking lots (public and private) fail the lighting standard requirements***

Newer City lighting installations under streetscapes (example: Hughson, Bay) meet the standard requirements.

Due to the absence of a lighting policy, the lighting levels are somewhat inconsistent across the downtown.

Roadways - Results



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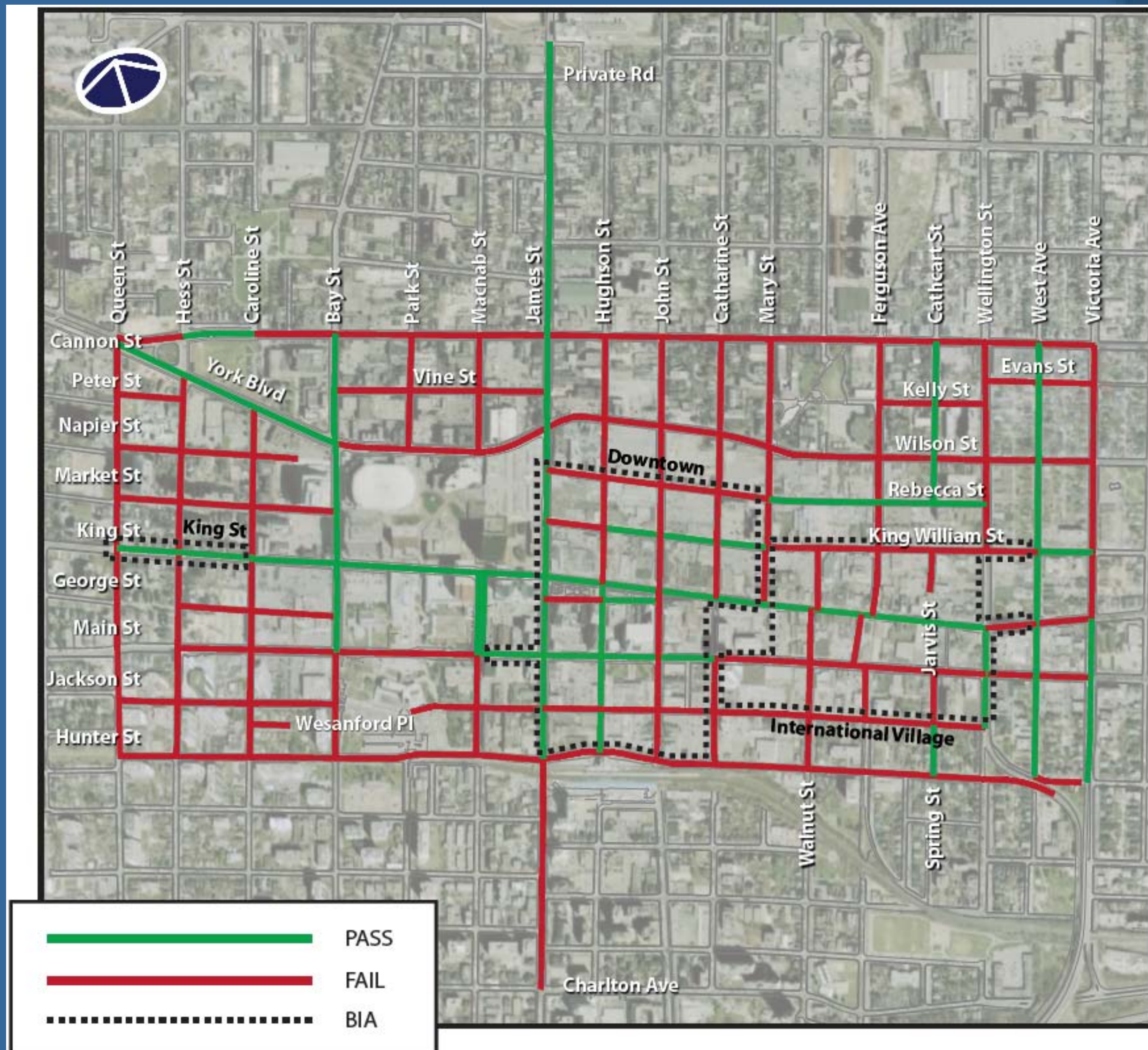
Sidewalks - Results



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DMD

Recommendations and Discussion
General

Implement and maintain a street lighting policy/guideline based on the information in this report.

Continue the existing mandate to install white light sources within the downtown. Improved colour rendition has many benefits related to safety, security and image.

Recommendations and Discussion
Roadways and Sidewalks

Utilize a lighting policy to govern the design of new lighting installations, such as streetscape projects.

Develop a long-term capital improvement/replacement program
Sidewalk lighting levels can be misleading as the reflective properties of the sidewalks and buildings can impact the overall brightness and ones visibility.
Review and develop strategies to use building materials with higher reflectivity and promote private businesses to do the same through City Urban plans.

Two scenarios – Primary and secondary Roads

Recommendations and Discussion Roadways and Sidewalks

Sidewalk lighting levels can be misleading as the reflective properties of the sidewalks and buildings can impact the overall brightness and ones visibility. Ones visibility can be improved by the very light building finishes which reflect light much better than dark finishes. We recommend new streetscape projects be designed with reflective surface to improve visibility.

Recommendations and Discussion Roadways and Sidewalks

Primary Roads - Upgrade lighting of the right-of-ways that do not meet the defined standards, more focus is needed on the lighting of sidewalks.

Upgrade Options Hamilton Light Study-Revised-2.pdf

Primary Road Estimated costs per 200m block of Streetscape Lighting:

- Pedestrian Option - $136,000.00
- Overhead Option - $149,000.00 to $209,000.00

Consider LED Lighting

Recommendations and Discussion
Roadways and Sidewalks


Traditional

Heritage

Contemporary


Transitional

Recommendations and Discussion Roadways and Sidewalks

On secondary roads that do not meet the defined standards, it is recommended existing cobra head luminaires be replaced with LED luminaires retrofitted on existing poles to improve lighting levels and reduce capital financial impacts.

Example of Vine St LED Retrofit LED.ppt

Retrofit Secondary Road to LED Lighting costs per 200m block:

- $7,000.00 per block

Recommendations and Discussion
Alleyways

Recommendations and Discussion Alleyways

Alleyway Lighting - ***Not*** recommended unless they are the ***only*** route of access/egress.

Main benefit of lighting alleyway - perceived personal safety and property standpoint. ***Lighting should be avoided where it encourages pedestrians to use an alleyway where their movement not visible from the street***.

Property security- Owners may provide lighting, for additional security. Motion sensors recommended. Businesses should enhance security and not rely on the City to provide lighting.

Personal safety – Limited Benefits:

- *Car headlamps provide adequate driver visibility in an alleyway.*
- *Pedestrians maybe less safe (safer on sidewalks).*
- *Where alley is the only access to parking or to a business, lighting may be considered on a case by case basis.*

Recommendations and Discussion
Parks and Plaza’s

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Recommendations and Discussion
Parks and Plaza's

Avoid lighting pathways in parks unless natural surveillance is available from local residences or the roadways.

Lighting an area not in view of the street may encourage criminal activity and will be difficult to provide surveillance.

Where curfew exists, consideration should be made to turning off the lighting.

Lighting of an open plaza area in view of the local streets will encourage pedestrian activity and create an inviting space. Plaza areas surrounded by trees and dense foliage that obstruct the view of the adjacent streets should ***no*** be lighted.

Where lighting is required, make it pedestrian scale with a white light source (improve facial recognition).

Provisions should be made (power and data outlets) for any seasonal lighting, stage lighting or special event lighting. Outlet boxes should be vandal resistant and lockable when not in use.

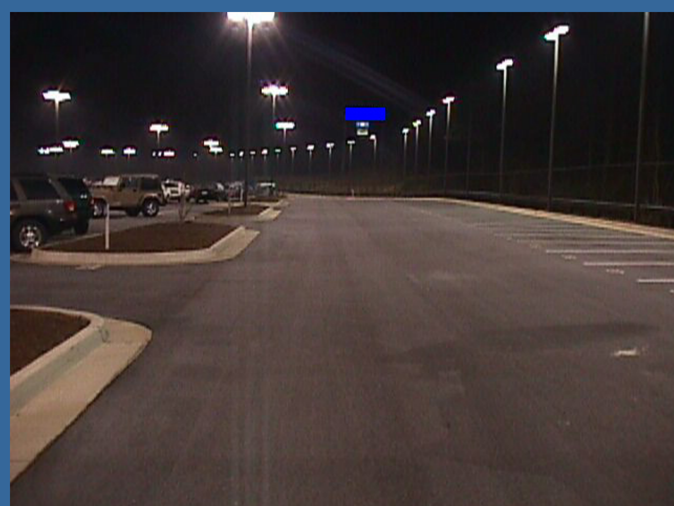
Public monuments in parks and plaza areas should be lighted to draw attention and highlight features allowing them to be viewed during hours of darkness.

Recommendations and Discussion
Parking Lots

All parking lots in the downtown should be lighted and to defined standards.

The City should light all downtown municipal parking lots. This will also encourage private businesses to upgrade private lots.

City by-laws and site plan approval review processes should be examined and updated to include the recommendations of the study related to parking lot lighting standards.



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Recommendations and Discussions Specialty / Architectural

Lighting building facades can improve aesthetics, highlight architectural features of a building and add drama.

Façade lighting can also create a more open and inviting perception of the public right-of-way.

It is recommended that the City of Hamilton provide supplemental lighting criteria and guidelines, together with examples of building lighting and distribute to downtown businesses to promote lighting improvements on facades.

The City should develop a ‘prototype’ design of a block of façade lighting as an example for B.I.A.’s and owners. The prototype can be a physical installation or a computer generated photo-realistic rendering.

The City of Hamilton should allow arterial trespass (encroachment) of fixtures over sidewalks, provided the luminaire attachments are properly engineered.

Recommendations and Discussion
Specialty / Architectural