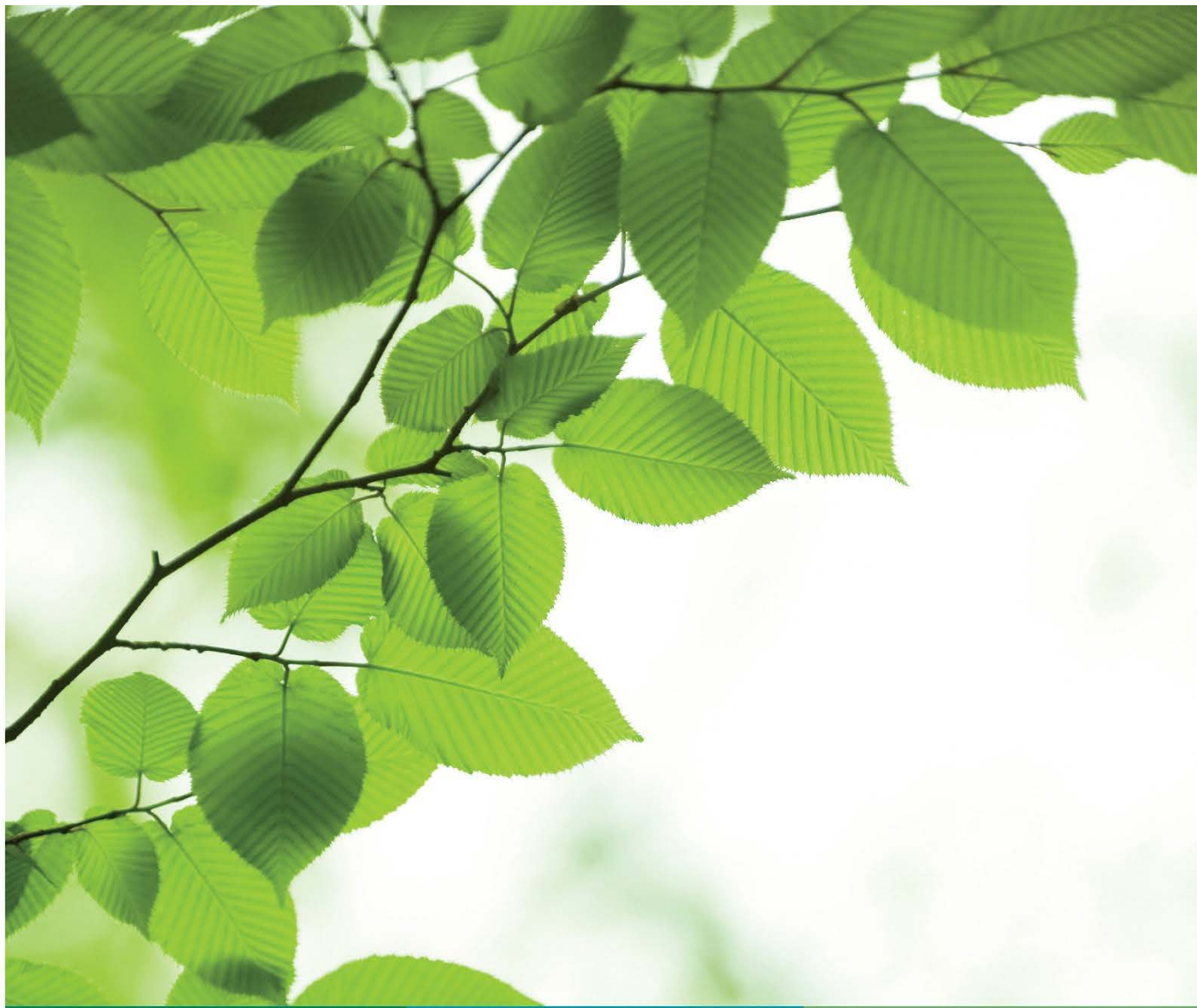




Desk Top Study Lighting Impact Assessment

Scotland Hall Road, Manchester

Presented to Manchester City F.C. City in the Community Foundation

Issued: December 2019

Delta-Simons Project No. 18-1673.01



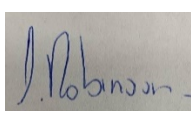
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Report Details

Client	Manchester City F.C. City in the Community Foundation
Report Title	Desk Top Study Lighting Assessment
Site Address	Scotland Hall Road, Manchester
Project No.	18-1673.01
Delta-Simons Contact	Evie Scott

Quality Assurance

Issue No.	Status	Issue Date	Comments	Author	Technical Review	Authorised
2	Final	December 2019				
				Ian Dawson Lighting Engineer	Lee Robinson Lighting Engineer	Simon Johnson Principal Consultant

About us

Delta-Simons is a trusted, multidisciplinary environmental consultancy, focused on delivering the best possible project outcomes for customers.

Specialising in Environment, Health & Safety and Sustainability, Delta-Simons provide support and advice within the property development, asset management, corporate and industrial markets. Operating from ten locations - Lincoln, Birmingham, Bristol, Dublin, Leeds, London, Manchester, Newcastle, Norwich and Nottingham - we employ over 75 environmental professionals, bringing experience from across the private consultancy and public sector markets.

Delta-Simons is proud to be a founder member of the Inogen® Environmental Alliance, a global corporation providing multinational organisations with consistent, high quality and cost effective environmental, health, safety, energy and sustainability solutions. Inogen assists multinational clients by resolving liabilities from the past, addressing today's requirements and delivering solutions for the future. With more than 200 offices located on every continent, more than 6,430 staff worldwide, and projects completed in more than 120 countries, Inogen provides a single point of contact for diverse markets as Automotive, Chemical, Consumer Products & Retail, Financial, Food & Beverage, Healthcare, Insurance, Manufacturing, Non Profit Organisations, Oil & Gas, Real Estate, Services Firms, Technology and Transportation, among others.

This report has been prepared by Stainton Lighting Design Services term framework suppliers of lighting services to and on behalf of Delta-Simons.

Executive Summary

Scope of Works	Delta-Simons Environmental Consultants Limited (“Delta-Simons”) working with our approved technical specialists Stainton Lighting Design Services instructed by Manchester City F.C. City in the Community Foundation (the “Client”) to undertake the preparation of a Desk-Top Lighting Study in respect of land at Scotland Hall Road, Manchester (the “Site”). The assessment was completed in December 2019. The desk-top lighting assessment was undertaken to inform a planning application for the Site.
Proposed Development	It is understood that the proposed development will comprise for the erection of a play zone facility.
Results	With good design and management of the lighting, the effect of the additional lighting to the environment could be kept to an acceptable level contributing very little to the existing situation in many areas.
Further recommendations	It is recommended that the proposed lighting is designed and specified in accordance with this report, taking full advantage of the tight optical control of modern luminaries, together with careful location and orientation, the potential adverse effects associated with light trespass, glare, and sky glow, experienced by surrounding receptors will be minimised to fall in line with the limits specified in the ILP Guidance Note. This document should be considered an industry-wide best-practice document with which adherence too should be mandatory for this type of development.
This is intended as a summary only. Further detail and limitations of the assessment is provided within the main body of the Report.	

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Appendices

Appendix A	Glossary and Terms of Reference
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1.0 Introduction

1.1. Appointment

- 1.1.1. Delta-Simons Environmental Consultants Limited (“Delta-Simons”) working with our approved technical specialists Stainton Lighting Design Services instructed by Manchester City F.C. City in the Community Foundation (the “Client”) to undertake the preparation of a Desk-Top Lighting Study in respect of land at Scotland Hall Road, Manchester (the “Site”).

1.2. Context & Purpose

- 1.2.1. The aim of this assessment is to consider the environmental impact of the proposed external lighting as follows:
- ▲ Lighting of the main pitch area.
 - ▲ Lighting of the football/tennis pitch area.
 - ▲ Lighting of the Panna, Passing Square and Basketball area

1.3. Scope of Works

- 1.3.1. The scope of works undertaken for this assessment was:
- ▲ Production of a detailed report using information provided a Site visit and media such as Google Earth. The report would reference existing lighting affecting the area and provide recommended mitigation actions where appropriate.
- 1.3.2. The key elements included within this section would be as follows:
- ▲ Interrogation of information provided
 - ▲ Identification of existing lighting in the vicinity and comment relating to the current likely impact of any existing lighting, this would consider lighting in the general built environment not just lighting within the Site confines.
 - ▲ Ecological and other environmental considerations
 - ▲ Comment on lighting equipment specification
 - Mounting heights
 - Appropriate lighting levels
 - Light source
 - Colour temperature
 - Maintenance
 - ▲ Comment on switching regimes, dynamic lighting levels and curfews.
 - ▲ General Mitigation – Comment on the recommended lighting proposals for the development. Any recommendations would be in line with the latest standards regarding minimising light pollution together with glare and obtrusive light.
 - ▲ General conclusion

1.4. Limitations

- 1.4.1. The standard limitations associated with this assessment are presented in Appendix C.

2.0 Methodology

2.1. Proposed Methodology

- 2.1.1. Within the report, we have considered the main three aspects for exterior lighting.
- 2.1.2. Firstly, there is the provision of lighting to the main pitch area on drawing 13034-DB3-B01-XX-DR-A-90103 Rev P3 dated 20/09/19. The primary function here is to provide a suitable level of illumination to facilitate the safe use of the play zone for the variety of sports that the area is designed for.
- 2.1.3. Secondly is the provision of lighting to the smaller adjacent football/tennis pitch area identified as area B on drawing 13034-DB3-B01-XX-DR-A-90103 Rev P3 dated 20/09/19. The primary function here is to provide a suitable level of illumination to facilitate the safe use of the play zone for the variety of sports that the area is designed for.
- 2.1.4. Thirdly is the provision of lighting to the adjacent Panna, Passing Square and Basketball area identified as area A, and C on drawing 13034-DB3-B01-XX-DR-A-90103 Rev P3 dated 20/09/19. The primary function here is to provide a suitable level of illumination to facilitate the safe use of the play zone for the variety of sports that the area is designed for.
- 2.1.5. We have endeavoured to provide a lighting outline strategy which would assist in the production of a detailed lighting solution. This would take into consideration environmental and geographical conditions and fulfil the strategy's primary function of minimizing the impact of the proposed lighting to the surrounding environment.

2.2. Survey Work

- 2.2.1. The survey work undertaken for the Desk Top Study has included Site visits during daylight and early evening on the 30/10/19. In addition, the assessment has used information provided and media such as Google Earth. The report will reference existing lighting affecting the area and provide recommended mitigation actions where appropriate.

2.3. Scope of Study

- 2.3.1. The report is to identify and where possible offer solutions to keep to a minimum any potential negative environmental effects of artificial lighting installations which may form part of the proposals for the development.
- 2.3.2. The report is also to consider appropriate lighting proposals for the three main areas identified for the scheme and to address the issues of suitable lighting levels, while minimizing the likely effect, of the scheme on road users, residents and wildlife.
- 2.3.3. The report will include proposed lighting levels for the three main areas. It will identify methods for limiting the effects of light spill or glare by recommending some limitations to any proposed lighting designs.

2.4. Surrounding Areas Considered

- 2.4.1. The proposed development is situated at Scotland Hall Road Recreation Ground, Manchester, M40 2RF.
- 2.4.2. The Site is located at the Southern tip of Scotland Hall Road, Manchester and has Amos Avenue to the North of the Site and Verona Drive to the East. To the West there are four high rise residential tower blocks overlooking the Site. There is a train/tram line South of the Park and the River Medlock passes by on the Southern side of this track. Environmental Zone examples from the Institution of Lighting Guidance Notes would indicate the area to be classified as an E3 suburban location.

- 2.4.3. The area is in what could be described as a part suburban/urban setting as there are residential areas, bus routed main roads and train lines local to the Park Area.

3.0 Existing Lighting and Baseline Conditions

3.1. Existing Lighting

The existing lighting in the vicinity of the proposed redevelopment can be described as follows:

Scotland Hall Road

- 3.1.1. From the Site visit Scotland Hall Road was identified as 6 metre mounting height road lighting columns fitted with Light Emitting Diode Luminaires (LED). It should also be noted that from the West of Scotland Hall Road the Site is overlooked by four high rise residential tower blocks.

Amos Avenue

- 3.1.2. From the Site visit Amos Avenue was identified as 6 metre mounting height road lighting columns fitted with Light Emitting Diode Luminaires (LED).

Verona Drive

- 3.1.3. From the Site visit Verona Drive was identified as 5/6 metre mounting height road lighting columns fitted with Light Emitting Diode Luminaires (LED).

General Site

- 3.1.4. The Site is located East of Manchester City Centre in a suburban area within the Miles Platting & Newton Heath District of Manchester City Council. The City Council have been undergoing LED replacement schemes with 4000K units since the Autumn of 2017 and the area around the Park have undergone these replacements. The proposed Site of the Play Zone should follow the same LED type of installation for consistency and needs to be sympathetic to the location and surrounding area that it can be viewed from.

3.2. Outdoor Lighting

Predicted Baseline Lighting Levels

- 3.2.1. To ensure that any proposed lighting solution for the areas can be achieved, whilst ensuring best-practice and guidance environmental lighting limits can also be met. Proposed lighting levels are detailed later in this report for the four areas it is proposed to utilise Light Emitting Diode luminaires. (LED)
- 3.2.2. The lighting levels have been selected from recognised recommendations for the required activities, without significantly impacting the surrounding environment.
- 3.2.3. Any future proposals at detailed design stage are to include a full set of calculations to provide evidence of the direct impact of any proposed lighting.

4.0 Proposed Lighting

4.1. Proposed Lighting, Main Pitch/Play Zone area

Lighting Design Criteria Selection

- 4.1.1. The proposed lighting design level for the main pitch/play zone will aim to achieve the Lighting Levels recommended by the FA guide to indoor and outdoor areas for small sided football.
- 4.1.2. Table 3 below is an extract from the FA guide and shows the lighting levels to be aimed for in the proposed design:

Outdoor Lighting

If an outdoor pitch is to be lit the lighting system should be designed to achieve the performance detailed in Table 3.

Table 3 Floodlighting for five, six and seven-a-side football (outdoors)	
Property	Requirement
Maintained average luminance	> 120 Lux
Uniformity (Min/Ave)	>0.6
Glare rating	≤ 50
Lamp colour temperature	Tk > 4000 K
Lamp colour rendering	≥ 65

To minimise the running costs the lighting system may be designed to provide a lower level of lighting for recreational play and training etc. This should be no lower than a maintained average luminance of 75 lux.

Light Source Selection

- 4.1.3. The selection of LED luminaires is partly dictated by current trends within the lighting industry for using energy efficient luminaires. However, using white light source is important as the ability to clearly see and distinguish colours within the area and improves the visual acuity of users' perception of safety.
- 4.1.4. Luminaires for the area are to be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night. Consideration needs to be given to the use of shields and baffles when undertaking the detailed design to assist in the alleviation of obtrusive light.

Glare Class Intensities

- 4.1.5. Upward light should be minimized in all installations by controlling the intensity of light from luminaires as installed. The design, orientation and location of luminaires should be arranged to ensure that glare is minimized. In order to limit glare, an appropriate intensity class should be selected from BS EN 13201-2:2015, Table A.1. Please see below:

Table A.1 — Luminous intensity classes

Class	Maximum luminous ^a intensity in directions below the horizontal in cd/klm of the output flux of the luminaire.			Other requirements
	at 70° and above ^b	at 80° and above ^b	at 90° and above ^b	
G*1		200	50	None
G*2		150	30	None
G*3		100	20	None
G*4	500	100	10	Luminous intensities above 95° ^b to be zero ^c
G*5	350	100	10	Luminous intensities above 95° ^b to be zero ^c
G*6	350	100	0 ^c	Luminous intensities above 90° ^b to be zero ^c
^a Luminous intensities are given for any direction forming the specified angle from the downward vertical with the luminaire installed for use.				
^b Any direction forming the specified angle from the downward vertical, with the luminaire installed for use.				
^c Luminous intensities up to 1 cd/klm can be regarded as being zero.				

- 4.1.6. The proposal for the area is to meet a minimum Glare Class of G3– This offers a balance between achieving good lighting levels on the ground and providing environmental mitigation.

4.2. Proposed Lighting of the Football/Tennis Pitch Area

Lighting Design Criteria Selection

- 4.2.1. The proposed lighting design for the Football/Tennis area will aim to achieve the Lighting Levels FA guide to indoor and outdoor areas for small sided football.
- 4.2.2. Table 3 below is an extract from the FA guide and shows the lighting levels to be aimed for in the proposed design:

Outdoor Lighting

If an outdoor pitch is to be lit the lighting system should be designed to achieve the performance detailed in Table 3.

Table 3 Floodlighting for five, six and seven-a-side football (outdoors)	
Property	Requirement
Maintained average luminance	> 120 Lux
Uniformity (Min/Ave)	>0.6
Glare rating	≤ 50
Lamp colour temperature	Tk > 4000 K
Lamp colour rendering	≥ 65

To minimise the running costs the lighting system may be designed to provide a lower level of lighting for recreational play and training etc. This should be no lower than a maintained average luminance of 75 lux.

Light Source Selection

- 4.2.3. The selection of LED luminaires is partly dictated by current trends within the lighting industry for using energy efficient luminaires. However, using white light source is important as the ability to clearly see and distinguish colours within the area and improves the visual acuity of users' perception of safety.
- 4.2.4. Luminaires for the area are to be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night. Consideration needs to be given to the use of shields and baffles when undertaking the detailed design to assist in the alleviation of obtrusive light.

Glare Class Intensities

- 4.2.5. Upward light should be minimized in all installations by controlling the intensity of light from luminaires as installed. The design, orientation and location of luminaires should be arranged to ensure that glare is minimized. In order to limit glare, an appropriate intensity class should be selected from BS EN 13201-2:2015, Table A.1. Please see below:

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	at 70° and above ^b	at 80° and above ^b	at 90° and above ^b	
G*1		200	50	None
G*2		150	30	None
G*3		100	20	None
G*4	500	100	10	Luminous intensities above 95° ^b to be zero ^c
G*5	350	100	10	Luminous intensities above 95° ^b to be zero ^c
G*6	350	100	0 ^c	Luminous intensities above 90° ^b to be zero ^c
^a Luminous intensities are given for any direction forming the specified angle from the downward vertical with the luminaire installed for use.				
^b Any direction forming the specified angle from the downward vertical, with the luminaire installed for use.				
^c Luminous intensities up to 1 cd/klm can be regarded as being zero.				

- 4.2.6. The proposal for the area is to meet a minimum Glare Class of G3– This offers a balance between achieving good lighting levels on the ground and providing environmental mitigation.

4.3. Proposed Lighting of the Panna, Passing Square and Basketball Area

Lighting Design Criteria Selection

- 4.3.1. The outline lighting design for the Panna, Passing Square and Basketball area will aim to achieve the Lighting Levels recommended in BS EN 12193:2007.

The following explanations and Table 3 assist in the selection of the lighting class.

Lighting Class I: Top level competition such as international and national competition which will generally involve large spectator capacities with long potential viewing distances. Top level training can also be included in this class.

Lighting Class II: Mid level competition such as regional or local club competition which generally involve medium size spectator capacities with medium viewing distances. High level training can also be included in this class.

Lighting Class III: Low level competition such as local or small club competition which generally do not involve spectators. General training, physical education (school sports) and recreational activities will also come into this category.

Table 3 – Selection of the lighting class

Level of competition	Lighting class		
	I	II	III
International and National	*		
Regional	*	*	
Local	*	*	*
Training		*	*
Recreational/School sports (Physical education)			*

- 4.3.2. Following the above guidelines Class III has been selected and therefore table A.21 below shows the lighting level requirements and lighting levels to be aimed for in the proposed design:

Table A.21

Outdoor			Reference Area		Number of grid points	
			Length m	Width m	Length	Width
American football PA:			110 to 117,5	55	21	9 to 11
Basketball PA:			28	15	13	7
			32	19	15	9
Class	Horizontal illuminance				GR	
	E_m lx	E_{min}/E_m				
I	500	0,7			50	60
II	200	0,6			50	60
III	75	0,5			55	20

Light Source Selection

- 4.3.3. The selection of LED luminaires is partly dictated by current trends within the lighting industry for using energy efficient luminaires. However, using white light source is important as the ability to clearly see and distinguish colours within the area and improves the visual acuity of users' perception of safety.
- 4.3.4. Luminaires for the area are to be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night. Consideration needs to be given to the use of shields and baffles when undertaking the detailed design to assist in the alleviation of obtrusive light.

5.0 Visual Impact Mitigation Considerations

5.1. Type of Equipment

- 5.1.1. Lighting Columns: The mounting height and cross-section of the columns should be kept to a minimum and consistent while achieving the lighting levels.
- 5.1.2. Column bracket arms should be kept to a minimum and, where the design criteria will allow, consideration should be given to mounting lanterns directly on the columns without the use of an outreach bracket (post-top) if possible.
- 5.1.3. Careful consideration should be given to the proposed mounting heights of lighting columns to ensure they are of an appropriate scale to blend in with the surrounding buildings and landscape areas.

5.2. Luminaires

- 5.2.1. To limit the effects of direct glare and light pollution from the luminaires, where possible they should be provided with full cut-off distribution.
- 5.2.2. Lights should be incorporated with an optic providing a distribution with a peak beam typically above 25 degrees as this will allow the luminaire to be mounted horizontally, or with a very low inclination angle, but still providing sufficient throw across the surface to achieve the required illuminance and uniformity levels whilst reducing the glare from the fitting.

5.3. Types of Light Source

- 5.3.1. To ensure good colour rendering and acceptable colour appearance is provided, it is proposed to utilise luminaires with warm/neutral white LED light sources.
- 5.3.2. Additionally, people in general intuitively prefer white light to yellow light as it is much closer to natural daylight and enables us to see colours in their true shades and achieve a good level of visual acuity.
- 5.3.3. However, good colour rendition and appearance are also useful to aid object identification, safe movement, facial recognition and perception of safety.
- 5.3.4. In the last 5 years LEDs have become a viable light source for use in outdoor lighting applications and the technology has improved efficacy (which is measured in lumens per watt) and is a direct indicator as to how much light is emitted from the luminaire for every watt of energy it consumes.

Lumen Description

- 5.3.5. This is the term used for how the output of the lamp/light source deteriorates throughout its useful life.
- 5.3.6. This minimum designed level is expressed as “L” values typically L80 to as high as L95 in real terms the number following the “L” value is the percentage of light output at this point below are some examples.
- 5.3.7. A Luminaire may have the following figures:

L70 @ 100,000 Hours	After 100,00 Hours of operation the LED will be 70% of its initial light output when new.
L80 @ 70,000 Hours	After 70,00 Hours of operation the LED will be 80% of its initial light output when new.
L90 @ 60,000 Hours	After 60,00 Hours of operation the LED will be 90% of its initial light output when new.
L95 @ 50,000 Hours.	After 50,00 Hours of operation the LED will be 95% of its initial light output when new.

- 5.3.8. As we always design to the level at end of life (maintained levels) once the operating life is known we can select the appropriate lumen depreciation figure.
- 5.3.9. The actual time to total failure is generally not stated but given the technology is solid state and has no working parts this is expected to be a significant length of time.
- 5.3.10. In terms of energy usage, LED light sources have a very high efficacy (light output measured in lumens/watt) together with a long-rated life in the order of 100,000 hours or more - this is the life of the LED chip before its light output falls to a minimum designed level and longer to complete failure.
- 5.3.11. The efficacy we can now expect to achieve is in the order of L90 at a rated life of 100,000 hours.
- 5.3.12. Given the approximate number of lamp burning hours for the lighting period dusk to dawn per annum is approx. 4,100 hours, usable lamp or chip life is around 25 years.

Lamp Colour Rendering

- 5.3.13. This refers to the light source's ability to reveal objects in their true colour as compared to a reference light source and is measured on a scale of 0 to 100 - the higher the value the better the colour rendering properties of the lamp. i.e. pure white light, that enables colours to be seen as they would appear in daylight.
- 5.3.14. The ability of a light source to render colours of objects correctly is quantified by the CIE colour rendering group and the CIE general colour rendering index (Ra) as shown in the table below:

Colour rendering groups	CIE general colour rendering index	Typical Applications
1A	$Ra \geq 90$	Critical colour matching
1B	$90 \geq Ra \geq 80$	Accurate colour judgements required for appearance
2	$80 \leq Ra \leq 60$	Moderate colour rendering required
3	$60 \leq Ra \leq 40$	True colour recognition of little significance
4	$40 \leq Ra \leq 20$	Not recommended for colour matching

- 5.3.15. This index is based on how close a set of test colours are reproduced by the lamp under evaluation - relative to how they are reproduced by a reference light source with perfect colour rendering. Perfect matching is given a value of 100.
- 5.3.16. Below are two groups of images which show the effect of Colour Rendering Index Ra on coloured surfaces:

CRI 95



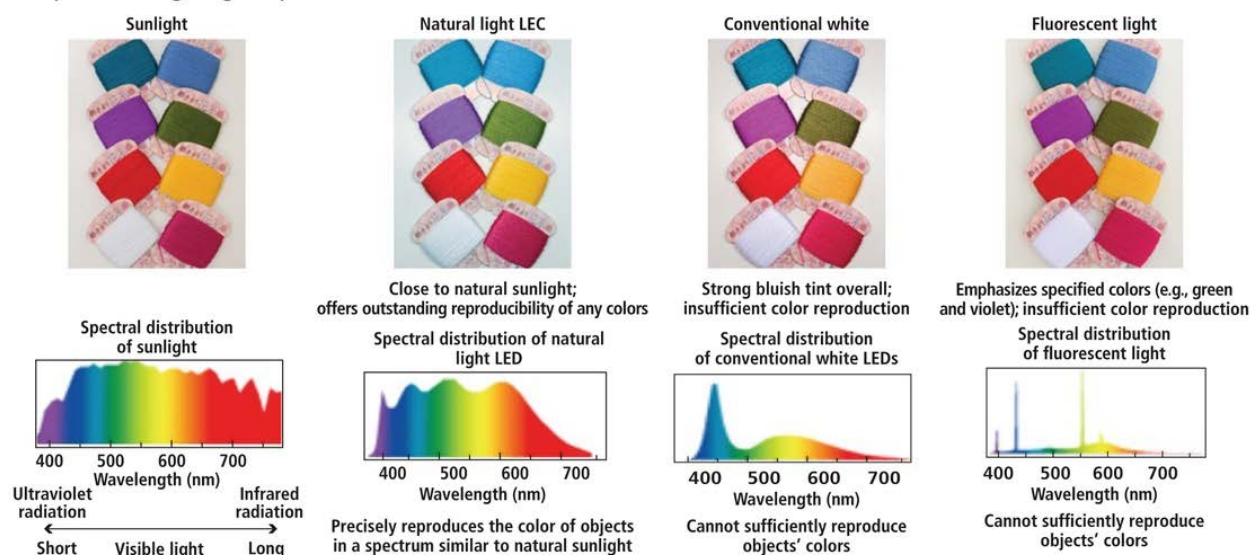
CRI 80



CRI 75



Comparison of lighting samples



Proposed Lighting

- 5.3.17. The visual task is to provide the necessary illumination level for the areas however being able to identify colour and to assist with safe movement and play in the play zone areas, is aided by good colour rendition. Also, the high colour rendering ability is better suited to widespread use of CCTV systems. Typical Values are shown in the Table below:

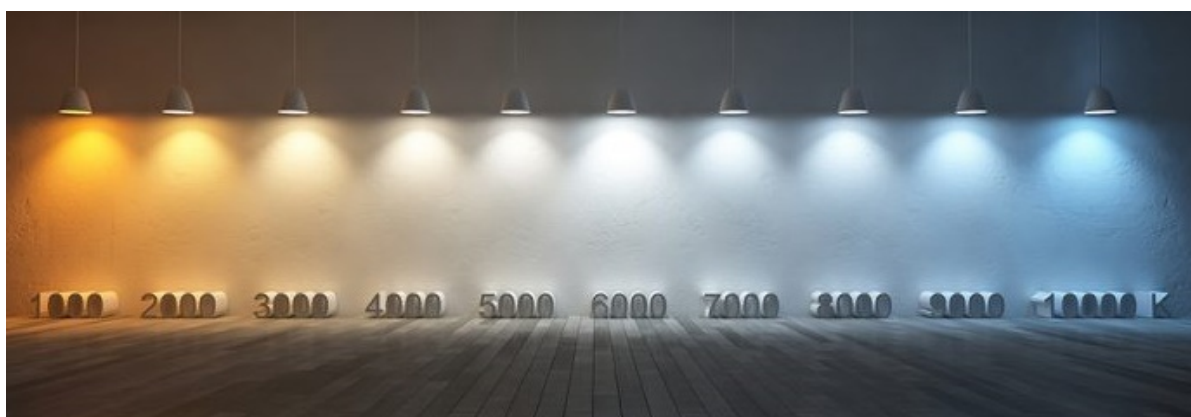
Low pressure sodium (SOX) yellow appearance	Ra = 0
High pressure sodium (SON) golden yellow appearance	Ra = 25
High pressure sodium (SON-T Comfort) golden white in appearance	Ra = 65
Light emitting diode (LED) used for amenity lighting neutral white appearance (4000K)	Ra = 70
Light emitting diode (LED) used for amenity lighting warm white appearance (3000K)	Ra = 80

- 5.3.18. A high-pressure sodium lamp has poor colour rendering for the visual task and is still a viable solution for amenity areas and access roads. However, the versatility and efficiency savings which can be

achieved using LED make this the preferred solution for the majority of amenity and highway applications.

5.4. Colour Appearance / Colour Temperature

- 5.4.1. The colour of the light emitted by a 'near white' source is indicated by its correlated colour temperature (CCT). This is a measure of the 'warmth' or 'coolness' of the light emitted by a source and is measured in Kelvin (K). The lower the Kelvin value, the 'warmer' the colour of the light and vice versa.
- 5.4.2. This becomes a more significant consideration when considering LED as the preferred light source as LED can be specified in a wide range of CCT derivatives - this was not typically the case for other light sources.
- 5.4.3. The main available CCT in outdoor lighting for LED's are around 5700K (cool white), 4000K (neutral white), 3000K (warm white). This figure must be considered along with CRI as these characteristics are not necessarily linked.
- 5.4.4. The image below illustrates the typical variation in artificial light with 1,000K very warm to the left and 10,000K very cold to the right:



- 5.4.5. The 1,000K option will have poor colour rendering properties as the light has too much red content and as such will not reproduce shades of blue and green very well the 10,000K will give a similar effect as it has too much blue content and as such will not show red colours very well typically. In exterior lighting, typically the best colour rendering is achieved with warm white (3000K) LEDs typically have a minimum Ra of 80-90. Neutral white or cool white (4000K and 5700K respectively) LEDs typically have a minimum Ra of 70.

5.5. Light, Ecology and Health

- 5.5.1. When selecting a light source for an outdoor application consideration should be given to the potential effects on the local ecology and general health.
- 5.5.2. Currently there are many studies being undertaken into the effects of different spectral wavelengths on the human body sleep pattern and ecology - with a lot of emphasis being placed on the amount of "Blue" light emitted by light sources.
- 5.5.3. Based on current generally accepted studies, effects on humans seem to be influenced by exposure time and proximity to the light source - and not just the level of blue light content.
- 5.5.4. The table below shows typical blue light from a variety of light sources and is taken from a publication produced by U.S. Department of Energy and is titled "Street Lighting and Blue Light - Frequently Asked Questions".

Light source	Luminous Flux (lm)	CCT (K)	% Blue*	Relative Scotopic Content	Relative Melanopic Content**
PC White LED	1000	2700	17% - 20%	1.77 - 2.20	1.90 - 2.68
PC White LED	1000	3000	18% - 25%	1.89 - 2.39	2.10 - 2.99
PC White LED	1000	3500	22% - 27%	2.04 - 2.73	2.34 - 3.57
PC White LED	1000	4000	27% - 32%	2.10 - 2.65	2.35 - 3.40
PC White LED	1000	4500	31% - 35%	2.35 - 2.85	2.75 - 3.81
PC White LED	1000	5000	34% - 39%	2.60 - 2.89	3.18 - 3.74
PC White LED	1000	5700	39% - 43%	2.77 - 3.31	3.44 - 4.52
PC White LED	1000	6500	43% - 48%	3.27 - 3.96	4.38 - 5.84
Narrowband Amber LED	1000	1606	0%	0.36	0.12
Low Pressure Sodium	1000	1718	0%	0.34	0.10
PC Amber LED	1000	1872	1%	0.70	0.42
High Pressure Sodium	1000	1959	9%	0.89	0.86
High Pressure Sodium	1000	2041	10%	1.00	1.00
Mercury Vapor	1000	6924	36%	2.33	2.47
Mercury Vapor	1000	3725	25%	1.82	1.95
Metal Halide	1000	3145	24%	2.16	2.56
Metal Halide	1000	4002	33%	2.53	3.16
Metal Halide	1000	4041	35%	2.84	3.75
Moonlight	1000	4681 †	29%	3.33	4.56
Incandescent	1000	2836	12%	2.23	2.73
Halogen	1000	2934	13%	2.28	2.81
F32T8/830 Fluorescent	1000	2940	20%	2.02	2.29
F32T8/835 Fluorescent	1000	3480	26%	2.37	2.87
F32T8/841 Fluorescent	1000	3969	30%	2.58	3.18

* Percent blue calculated according to LSPDD: Light Spectral Power Distribution Database,
<http://galileo.graphyics.cegepshebrooke.qc.ca/app/en/home>

** Melanopic content calculated according to CIE Irradiance Toolbox, http://files.cie.co.at/784_TN003_Toolbox.xls, 2015

- 5.5.5. We can see from this table the light sources with the coolest temperature generally are blue-rich, this is unavoidable. To achieve the high CRI, we need blue content as a light source with no blue content cannot render shades of blue.
- 5.5.6. For the proposed lighting we would propose a CCT no greater than 4000K (neutral white) is used. This is also the same CCT that is being used by Manchester City Council in its LED replacement scheme.
- 5.5.7. Blue-rich light sources can have an effect on certain insect species attracting them towards the light source. However, given we are promoting the use of a cut off lantern this will assist with reducing the environmental impact, and should mitigate against any potential increase in insect influencing factors.

5.6. Energy Usage

- 5.6.1. In terms of energy usage, high pressure sodium lighting is generally very efficient.
- 5.6.2. As an example, the tungsten filament lamp (domestic light bulb) has an output of 10 lumens/watts whilst SON-T plus lamps would be in the order of 120 lumens/watts - approximately 12 times more efficient than a domestic light bulb.
- 5.6.3. As the lumen output of the lamp is directly related to the designed lighting level, it can be seen to achieve a given lighting level with a lesser number of lighting units if a more efficient lamp type is used.
- 5.6.4. In conclusion, the LED lamp is still the first choice for functional lighting due to its high lumen efficacy, excellent lamp life, and lower whole life costs, and combined with reasonable to good colour rendering.

5.7. Lamp Control Gear

- 5.7.1. To operate any discharge lamp, it is necessary to utilise some type of electrical control equipment. This is usually in the form of an ignitor to provide a high voltage pulse to start the lamp and a magnetic ballast to control the voltage and current once the lamp is running. In addition, a power factor correction capacitor is required for efficient utilisation of power. This control gear generally wastes approximately 10%-15% in energy i.e. a 150W SON-T plus lamp would be rated at approximately 185W.
- 5.7.2. Electronic control gear is now also a viable option for wattages up to and including 250W - this combines all the control components mentioned above into one unit, which runs at near unity power factor with very low losses. The use of electronic gear would assist in reducing the sites carbon footprint and energy costs. On a LED installation, the control gear is Electronic.

5.8. Adaptive Lighting and Switching

- 5.8.1. The widening use of LED technology within the exterior lighting marketplace has created many more opportunities for adaptive lighting and switching. These can be standalone options or part of an integrated control system.
- 5.8.2. Some of the options which could be applied to scheme areas are detailed below and we made the proposed selection choices known:

Simple Switching

- 5.8.3. This is simply using time clocks/photocells (daylight sensor) or typically a mix of both to switch lighting off automatically whilst it is not in use. By using this type of approach to switch different lighting circuits independently you can create simple scenes or states such as 'full' power, 'half on' or 'security level'.
- 5.8.4. We would advise that for the main three areas of lighting detailed there is a simple switching control installed to restrict illumination from switch on at dusk to the intended closing hours of operation. The Client has informed that the lighting is to be switched off by 22:00.

Pro's

- ▲ Cheap to implement and easy to maintain and will require very little technology.
- ▲ Can provide energy savings at little capital cost.

Con's

- ▲ May require additional electrical infrastructure cost to split the circuits into a sensible grouping for the required lower levels.
- ▲ The system is not easily adapted to alternative scenes in the future.

Standalone Dimming

- 5.8.5. Most modern LED luminaires will have the built-in ability for pre-programmed, or input activated, dimming profiles.
- 5.8.6. This allows either the lighting to step dim, for example 100% at dusk, switch on then 50% after a time delay period if there is no presence detection, then 25% after a further time delay period if there remains no presence detection. This could then lead to a switch off if there is no presence detection after a further time delay period.
- 5.8.7. This can be triggered by an input from say another standalone device such as a presence sensor, or noise sensor, or could be triggered via a switch of some kind. This input would then cause the luminaire to go into a dimmed state or return to full power from a dimmed state.

Pro's

- ▲ This option is relatively cheap to incorporate and allow good uniformity, and potentially compliant levels of lighting, to be present at all times dependent on anticipated usage.
- ▲ Can provide energy savings at reasonable capital cost with very little negative effect to the visual operation of the lighting.

Con's

- ▲ Once installed it is difficult to adapt should the situation change as each individual unit would have to be reprogrammed.

Full Adaptive Lighting Management System

- 5.8.8. This would require the installation a management system to control the exterior lighting elements associated with the system. Typically, it would use either wireless, mains-borne signalling, or a separate control cable network to communicate with the individual luminaires and give specific commands based on input or instruction.
- 5.8.9. This could also incorporate some of the standalone technologies to provide an intelligent system which can be both instructed to do a specific scheme, or automatically adapt to the real worlds situation.

Pro's

- ▲ This type of install can provide an intelligent and adaptive lighting system maximising energy savings whilst only using the light when and where it is needed. Once the system is in place reacting to changing, or one off, situations is easy and requiring little human intervention.

Con's

- ▲ Can be expensive to install and requires training to use to its full potential.
- ▲ Often manufacturers have different protocols and the system needs to be carefully specified and designed to ensure it will meet the client's aspirations.

5.9. Light Trespass

- 5.9.1. The Institution of Lighting Guidance Notes gives advice on light trespass and limits on upward light (sky glow) before and after curfew for different classifications of environment zones. For example, see the Table below:

Table 1 – Environmental Zones			
Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark	UNESCO Starlight Reserves, IDA Dark Sky Parks
E1	Natural	Intrinsically dark	National Parks, Areas of Outstanding Natural Beauty etc
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Small town centres or suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

- 5.9.2. Where an area to be lit lies on the boundary of two zones the obtrusive light limitation values used should be to those applicable to the most onerous zone.

5.9.3. From our initial desk top study, we would categorize the development area as E3.

5.10. Light Pollution

5.10.1. Light pollution, or obtrusive light as it is otherwise known, is the spillage of light into areas where it is not desired. Please see the table below taken from document as issued by the Institute of Lighting Professionals 'Guidance Notes for The Reduction of Obtrusive Light – GN01:2011':

Table 2 – Obtrusive Light Limitations for Exterior Lighting Installations – General Observers						
Environment al Zone	Sky Glow ULR [Max %]⁽¹⁾	Light Intrusion (into Windows) E_v [lux]⁽²⁾		Luminaire Intensity I [candelas]⁽³⁾		Building Luminance Pre-curfew ⁽⁴⁾
		Pre- curfew	Post- curfew	Pre- curfew	Post- curfew	Average, L [cd/m²]
E0	0	0	0	0	0	0
E1	0	2	0 (1*)	2,500	0	0
E2	2.5	5	1	7,500	500	5
E3	5.0	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

ULR = **Upward Light Ratio of the Installation** is the maximum permitted percentage of luminaire flux that goes directly into the sky.

E_v = **Vertical Illuminance in Lux** - measured flat on the glazing at the centre of the window.

I = **Light Intensity in Candelas (cd)**

L = **Luminance in Candelas per Square Metre (cd/m²)**

Curfew = **the time after which stricter requirements (for the control of obtrusive light) will apply**; often a condition of use of lighting applied by the local planning authority. If not otherwise stated - 23.00hrs is suggested.

***** = **Permitted only from** Public road lighting installations

(1) Upward Light Ratio – Some lighting schemes will require the deliberate and careful use of upward light, e.g. ground recessed luminaires, ground mounted floodlights, festive lighting, to which these limits cannot apply. However, care should always be taken to minimise any upward waste light by the proper application of suitably directional luminaires and light controlling attachments.

5.11. Light Pollution Components

5.11.1. The main components of light pollution are as follows:

Sky Glow

5.11.2. Sky glow is the localised brightening of the night sky caused by upward light interacting with particles in the air. Upward light comprises light emitted by lighting above the horizontal as well as downward

light reflected upwards from illuminated surfaces. This effect is more noticeable on misty nights or when there is a low cloud base.

Light Spill

- 5.11.3. Light spill is the unwanted spillage of light onto adjacent areas that may affect sensitive receptors, particularly residential properties and ecological receptors such as bats and breeding birds.

Glare

- 5.11.4. Glare is the uncomfortable brightness of the light source against a dark background which dazzles the observer and may cause nuisance to residents and/or present hazards to road users.

Light Trespass

- 5.11.5. Light trespass is the spilling of light beyond the boundary of a property which may cause nuisance to others.

Threshold Increment (TI)

- 5.11.6. Threshold Increment is a measure of the loss of visibility caused by disability glare from an obtrusive light installation.

5.12. Mitigation of light pollution and intrusion

- 5.12.1. To mitigate against the effects of light pollution, all lighting should comply with the Guidance Notes for The Reduction of Obtrusive Light (GN01:2011) as published by the Institute of Lighting Professionals (ILP) unless the Local Planning Authority has their own specific requirements or limitations.
- 5.12.2. This document identifies four internationally recognized environmental zones and provides guidance as to the limits of overspill lighting levels required for each environmental situation.
- 5.12.3. The following design measures would assist in compliance with the above ILP Guidance Note:
- 5.12.4. To keep sky glow to an absolute minimum the proposals for lighting this development should make use of luminaires with good optical control with no light directly emitted above the horizontal (full cut-off lighting).
- 5.12.5. The other component of sky glow is from light reflected upwards from the illuminated surfaces. There is no way to control this effect, however provided the levels of illuminance proposed are limited to that required for the task, the sky glow should be at a low level. Nonetheless it could still be visible under certain atmospheric conditions (e.g. foggy nights).
- 5.12.6. Siting and aiming of the lights together with suitable mounting height in conjunction with tight optical control should ensure any problems associated with light spill, glare and light trespass are also addressed.
- 5.12.7. Should the final design incorporate some form of adaptive lighting strategy it may be possible to provide a reduced lighting option allowing the lighting level to be reduced depending on the activity. This could reduce the environmental impact as well as saving energy and carbon.

6.0 Conclusion

- 6.1.1. Providing the proposed lighting is designed and specified in accordance with this report, taking full advantage of the tight optical control of modern luminaries, together with careful location and orientation, the potential adverse effects associated with light trespass, glare, and sky glow, experienced by surrounding receptors will be minimised to fall in line with the limits specified in the ILP Guidance Note. This document should be considered an industry-wide best-practice document with which adherence too should be mandatory for this type of development.
- 6.1.2. If this is then also linked to an adaptive lighting system - be it simple switching as proposed in item 5.8 or fully adaptive - this situation could be improved upon still further.
- 6.1.3. With good design and management of the lighting, the effect of the additional lighting to the environment could be kept to an acceptable level contributing very little to the existing situation in many areas.
- 6.1.4. It can be demonstrated that there will be suitable solutions for both a discharge and LED lighting option to the proposed development - which should both offer a workable solution with improvements to the environmental impact. However, the LED solution not only provides significantly improved benefits with regard to ongoing maintenance, adaptability and energy costs, but enables maximum mitigation of environmental and ecological impacts – particularly in relation to the adjacent residential properties.
- 6.1.5. We should point out that the LED solution will come with an increased capital investment, although typically when considering whole life costs this becomes much less significant.

Appendix A - Glossary and Terms of Reference

Colour Rendering

The ability of a light source to render the colours of objects as similar to those under a reference light source, or an acceptable source such as daylight.

Glare

The discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings.

Illuminance

The luminous flux density at a surface i.e. the luminous flux incident per unit area. Unit lm-m², lux.

Light trespass

Unwanted light from an installation falling on an area.

Light pollution

Term designating the spillage of a light into areas where it is not desired.

Luminaire

Apparatus which distributes, filters or transforms the light emitted by a lamp. It includes all the parts necessary for supporting, fixing and protecting the lamp, but not the lamp itself.

Lux

The SI unit of Illuminance equal to one lumen per square metre.

Sky glow

Localized brightening of the night sky caused by upward light interacting with particles in the air. Upward light comprises light emitted by lighting above the horizontal as well as downward light reflected upwards from illuminated surfaces. This effect is more noticeable on misty nights or when there is a low cloud base.

Spill light

Stray light from a luminaire that incidentally illuminates nearby objects or surfaces in the public environment, this can be a cause of light trespass.

Appendix B - Publications

- ▲ BS 5489-1:2013 Code of Practice for the design of road lighting
- ▲ Institute of Lighting Professionals publication 'Guidance Notes for the Reduction of Obtrusive Light (GN01:2011)
- ▲ BS EN 12193:2007 – Light and Lighting – Sports Lighting
- ▲ Street Lighting and Blue Light – frequently Asked Questions
- ▲ The FA guide to indoor and outdoor areas for small sided football.

Appendix C - Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

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