Desktop Study Light Impact Assessment

Land off Low Westwood Lane, Linthwaite, Huddersfield

Presented to **Westwood Wilson Limited**

Issued: February 2020

Delta-Simons Project No.19-0438.01

Delta-Simons Environmental Consultants Limited
Head Office: 3 Henley Office Park, Doddington Road, Lincoln, LN6 3QR
Tel: 01522 882555 | www.deltasimons.com

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Report Details

Client	Westwood Wilson Limited
Report Title	Desktop Study Lighting Impact Assessment Report
Site Address	land to the West of Low Westwood Lane at Linthwaite, Huddersfield
Project No.	19-0438.01
Delta-Simons Contact	Simon Johnson

Quality Assurance

Issue No.	Status	Issue Date	Comments	Author	Technical Review	Authorised
1	**Final Issue**	**5th September 2019**		**Ian Dawson**	**Ian Dawson and Michael Robinson**	**Michael Robinson**
3	**Revised Issue**	**14th February 2020**	**Updated Figure 2**	**ID**	**ID / MR**	
				Ian Dawson	**Ian Dawson and Michael Robinson**	**Simon Johnson**

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 nine locations - Lincoln, Birmingham, Dublin, Durham, Leeds, London, Manchester, 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 Limited as term framework suppliers of Lighting Design Services to and on behalf of Delta-Simons.

Executive Summary

Appointment and Scope of Works	Delta-Simons Environmental Consultants Ltd was instructed by Westwood Wilson Limited (the 'Client') to undertake a Desktop Lighting Impact Assessment at land to the West of Low Westwood Lane at Linthwaite, Huddersfield (the 'Site'). The desktop study lighting assessment report was completed on April 2019. The assessment was undertaken to inform a planning application for the Site.
Proposed Development	It is understood that the proposed development will include the reinstatement of a listed mill building and convert in to apartments, with a new apartment building (giving between them a total of 63 apartments) and the provision of 64 new houses at the Site.
Results	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 should be minimised to fall in line with the limits specified in the Institute of Lighting Professionals (ILP) Guidance Note.
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

1.0 Introduction and Approach

1.1. Context & Purpose

1.1.1. Delta-Simons Environmental Consultants Limited ("Delta-Simons"), working with our approved technical specialists Stainton Lighting Design Limited, was instructed by Westwood Wilson Limited (the "Client") to undertake the preparation of a desktop study Lighting Impact Assessment report to support a planning application for a proposed residential development that comprises the reinstatement and conversion of the listed Westwood Mills building in to apartments, creation of a new apartment building (giving between them a total of 63 apartments) and the provision of 64 new houses at land to the West of Low Westwood Lane at Linthwaite, Huddersfield. (the "Site").

1.1.2. This report is to provide an exterior lighting impact assessment in response to a request from the Local Planning Authority. Within this report, we will be considering the environmental impact of the proposed external lighting as follows:

1.1.3. Figure 1, at the end of this report, shows an aerial image from distance of the general area around the Site.

- Lighting to the Access Road, walkways and parking areas alongside the River Colne to Blocks I.1 and I.2.
- Lighting to the Access Road, walkways and parking areas to Blocks H, J and K.
- Lighting to the two Junctions with Low Westwood Lane.

1.1.4. Figure 1 shows an aerial image from distance of the general area around the Site.

1.1.5. Figure 2 shows the proposed development layout for the Site, along with public open space and flood routes.

1.2. Scope of Works

1.2.1. The report seeks 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.

1.2.2. The report also seeks to consider appropriate lighting proposals for the scheme and to address the issues of suitable lighting levels, and the likely effect, of the scheme on road users, residents and wildlife.

1.2.3. The report includes preliminary solutions for the proposed areas, and car park/access roads, and identify methods for limiting the effects of light spill or glare by recommending some limitations to any proposed lighting designs.

1.3. Methodology

1.3.1. Within the report, we have considered the main three aspects of the exterior lighting.

1.3.2. Firstly, there is the provision of lighting to the Access Road and Public Right of Way between Low Westwood Lane and Block I.2 as detailed on Drawing No. 538.02/PLA27. The primary function here is to provide a suitable level of illumination to facilitate the safe manoeuvring and access for both vehicular and pedestrian movement.

1.3.3. Secondly, there is the provision of lighting to the Access Road to Blocks H, J and K. The primary function here is to provide a suitable level of illumination to facilitate the safe manoeuvring and access for both vehicular and pedestrian movement.

1.3.4. Thirdly is the provision of lighting at the two proposed junctions with the existing Highway, Low Westwood Lane. The primary function here is to provide a suitable level of illumination to allow the safe movement of both vehicles and pedestrians throughout and make sure the junction areas provide a suitable level of illumination to reduce any potential conflict.

1.3.5. We have endeavoured to provide a Desk Top Study of a Lighting Impact Assessment which should assist in the production of a detailed and suitable lighting solution. This would take into consideration environmental and geographical conditions and fulfil the primary function of minimizing the impact of the proposed lighting to the surrounding environment.

1.4. Surrounding Areas Considered

1.4.1. The proposed development is situated in Linthwaite, Huddersfield which is within the Kirklees Council area.

1.4.2. The Site is located to the West of Huddersfield and applying the Environmental Zone examples from the Institution of Lighting Guidance Notes would indicate the area to be classified as an E2 village/outer suburban area. The Site is also part of a Conservation area.

1.4.3. The area is in what could be described as a part-rural/part-urban setting as there are rural fields to the East, North and West of the proposed development and residential/business areas to the East and South.

1.5. Limitations

1.5.1. The standard limitations associated with this assessment are presented in Appendix A. In addition, there are the following specific limitations that apply to this assessment.

1.5.2. The survey work undertaken for the Desk Top Study has been limited to using information provided and on-line media such as Google Earth. The report will reference existing lighting affecting the area and provide recommended mitigation actions where appropriate.

2.0 Existing Lighting

2.1. Introduction

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

2.2. Low Westwood Lane

2.2.1. The highway lighting here is a mix of light sources installed on 5/6 metre Road Lighting Columns some tubular steel and some concrete with a metal over sleeve fitted.

2.2.2. From Google there appears to be Light Emitting Diode (LED), High Pressure Sodium (HPS) and Fluorescent style luminaires installed on the above Road Lighting Columns.

2.3. Bargate

2.3.1. The highway lighting here is a mix of light sources installed on 5/6 metre Road Lighting Columns some tubular steel and some concrete with a metal over sleeve fitted.

2.3.2. From Google there appear to be LED and Fluorescent style luminaires installed on the above Road Lighting Columns

2.4. Titanic Spa

2.4.1. There is Car Park Lighting installed at the Titanic Spa site located on the East side of Low Westwood Lane almost opposite one of the proposed entrances to the new development.

2.4.2. The lighting here looks to be installed on 8 metre tubular steel Lighting Columns and is provided by twin headed luminaires.

2.5. General Site

2.5.1. The Site is located in a valley between the Huddersfield Narrow Canal and the River Colne and in a conservation area, so any proposed lighting needs to be sympathetic to the location and surrounding area that it can be viewed from.

3.0 Baseline Conditions Outdoor Lighting

3.1. Predicted Baseline Lighting Levels

3.1.1. To make sure that any proposed design lighting solution for the areas, including the access road, walkways and parking areas, can be achieved whilst ensuring best-practice guidance environmental lighting limits can also be met, preliminary lighting calculations were undertaken. For all areas it is proposed to utilise Light Emitting Diodes (LED) luminaries.

3.1.2. The calculations should aim to show whether lighting levels can be achieved for the required activity, without significantly impacting the surrounding environment.

3.1.3. Any future proposals at detailed design stage should include a full set of calculations to provide evidence of the direct impact of any proposed lighting.

4.0 Proposed Lighting Design

4.1. Access Road, walkways and parking areas alongside the River Colne to Blocks I.1 and I.2

Lighting Design Criteria Selection

4.1.1. Luminaires for the area should be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary in order to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night, such as, in rural and open areas where lighting can be seen as an intrusion in an otherwise darkened environment.

4.1.2. The detailed lighting design for the proposed access road, turning head, walkways and parking areas alongside the River Colne should aim to achieve the Lighting Levels recommended in BS 5489-1:2013 Code of Practice for the design of road lighting.

4.1.3. Table A.5 below, from BS 5489-1:2013, shows the lighting level requirements and lighting levels to be aimed for in any detailed design:

Table A.5 **Lighting classes for subsidiary roads with a typical speed of main user $v \leq 30$ mph**

Traffic flow	Lighting class			
	Ambient luminance: very low (E1)	Ambient luminance: low (E2)	Ambient luminance: moderate (E3)	Ambient luminance: high (E4)
Busy [A)]	S3 or P3	S3 or P3	S2 or P2	S2 or P2
Normal [B)]	S4 or P4	S4 or P4	S3 or P3	S3 or P3
Quiet [C)]	S5 or P5	S5 or P5	S4 or P4	S4 or P4

A) Busy traffic flow refers to areas where the traffic usage is high and can be associated with local amenities such as clubs, shopping facilities, public houses, etc.
B) Normal traffic flow refers to areas where the traffic usage is of a level equivalent to a housing estate access road.
C) Quiet traffic flow refers to areas where the traffic usage is of a level equivalent to a residential road and mainly associated with the adjacent properties or properties on other equivalent roads accessed from this road.

4.1.4. The area will lend itself to the second column in the above table (E2) and is likely to fall under the guise of normal traffic therefore S4/P4 level of lighting.

4.1.5. The actual lux levels that should be provided are detailed in Table A7 below, from BS 5489-1:2013, with an adjustment in the Class of lighting allowed due to the provision of a white light source if that is to be used. As this report recommends utilising LED luminaries for the development the adjustment can be applied.

Table A.7 **Variation of maintained lighting level with S/P ratio of light source**

Values in lux

Lighting class	Benchmark (e.g. R_a < 60 or when S/P ratio of light source is not known or specified)		S/P ratio = 1.2 and $R_a \geq 60$ (e.g. some types of warm white lamp such as metal halide)		S/P ratio = 2 and $R_a \geq 60$ (e.g. some types of cool white compact fluorescent or LED)	
	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}
P1 or S1	15.0	3.0	13.4	2.7	12.3	2.5
P2 or S2	10.0	2.0	8.6	1.7	7.7	1.5
P3 or S3	7.5	1.5	6.3	1.3	5.5	1.1
P4 or S4	5.0	1.0	4.0	0.8	3.4	0.7
P5 or S5	3.0	0.6	2.2	0.4	1.8	0.4
P6 or S6	2.0	0.4	1.4	0.4	1.1	0.4

Light Source Selection

4.1.6. The recommendation of LED luminaires is partly dictated by current trends within the lighting industry for using energy efficient luminaires. However, using white light source is also important as the ability to clearly see and distinguish colours, improves the visual acuity of road users and improves users' perception of safety.

4.2. Access Road, walkways and parking areas to Blocks H, J and K

Lighting Design Criteria Selection

4.2.1. Luminaires for the area should be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary in order to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night, e.g. in rural and open areas where lighting can be seen as an intrusion in an otherwise darkened environment.

4.2.2. The detailed lighting design for the proposed access road, walkways and parking areas leading to blocks H, J and K should aim to achieve the Lighting Levels recommended in BS 5489-1:2013 Code of Practice for the design of road lighting.

4.2.3. Table A.5 below, from BS 5489-1:2013, shows the lighting level requirements and lighting levels to be aimed for in the scheme options:

Table A.5 **Lighting classes for subsidiary roads with a typical speed of main user $v \leq 30$ mph**

Traffic flow	Lighting class			
	Ambient luminance: very low (E1)	Ambient luminance: low (E2)	Ambient luminance: moderate (E3)	Ambient luminance: high (E4)
Busy [A)]	S3 or P3	S3 or P3	S2 or P2	S2 or P2
Normal [B)]	S4 or P4	S4 or P4	S3 or P3	S3 or P3
Quiet [C)]	S5 or P5	S5 or P5	S4 or P4	S4 or P4

A) Busy traffic flow refers to areas where the traffic usage is high and can be associated with local amenities such as clubs, shopping facilities, public houses, etc.
B) Normal traffic flow refers to areas where the traffic usage is of a level equivalent to a housing estate access road.
C) Quiet traffic flow refers to areas where the traffic usage is of a level equivalent to a residential road and mainly associated with the adjacent properties or properties on other equivalent roads accessed from this road.

4.2.4. The area will lend itself to the second column in the above table (E2) and is likely to fall under the guise of normal traffic therefore S4/P4 level of lighting.

4.2.5. The actual lux levels to be provided are detailed in Table A7 below, from BS 5489-1:2013, with an adjustment in the Class of lighting allowed due to the provision of a white light source if that is to be used. As this report recommends utilising LED luminaries for the development the adjustment can be applied.

Table A.7 **Variation of maintained lighting level with S/P ratio of light source**

Values in lux

Lighting class	Benchmark (e.g. R_a < 60 or when S/P ratio of light source is not known or specified)		S/P ratio = 1.2 and $R_a \geq 60$ (e.g. some types of warm white lamp such as metal halide)		S/P ratio = 2 and $R_a \geq 60$ (e.g. some types of cool white compact fluorescent or LED)	
	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}
P1 or S1	15.0	3.0	13.4	2.7	12.3	2.5
P2 or S2	10.0	2.0	8.6	1.7	7.7	1.5
P3 or S3	7.5	1.5	6.3	1.3	5.5	1.1
P4 or S4	5.0	1.0	4.0	0.8	3.4	0.7
P5 or S5	3.0	0.6	2.2	0.4	1.8	0.4
P6 or S6	2.0	0.4	1.4	0.4	1.1	0.4

Light Source Selection

4.2.6. 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 also important as the ability to clearly see and distinguish colours and improves the visual acuity of road users and improves users' perception of safety.

4.3. Two Junctions with Low Westwood Lane

Lighting Design Criteria Selection

4.3.1. Luminaires for the area should be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary in order to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night, e.g. in rural and open areas where lighting can be seen as an intrusion in an otherwise darkened environment.

4.3.2. The detailed lighting design for the proposed two junctions with Low Westwood Road should aim to achieve the Lighting Levels recommended in BS 5489-1:2013 Code of Practice for the design of road lighting.

4.3.3. Table A.5 below, from BS 5489-1:2013, shows the lighting level requirements and lighting levels to be aimed for in the scheme options.

Table A.5 **Lighting classes for subsidiary roads with a typical speed of main user $v \leq 30$ mph**

Traffic flow	Lighting class			
	Ambient luminance: very low (E1)	Ambient luminance: low (E2)	Ambient luminance: moderate (E3)	Ambient luminance: high (E4)
Busy [A)]	S3 or P3	S3 or P3	S2 or P2	S2 or P2
Normal [B)]	S4 or P4	S4 or P4	S3 or P3	S3 or P3
Quiet [C)]	S5 or P5	S5 or P5	S4 or P4	S4 or P4

A) Busy traffic flow refers to areas where the traffic usage is high and can be associated with local amenities such as clubs, shopping facilities, public houses, etc.
B) Normal traffic flow refers to areas where the traffic usage is of a level equivalent to a housing estate access road.
C) Quiet traffic flow refers to areas where the traffic usage is of a level equivalent to a residential road and mainly associated with the adjacent properties or properties on other equivalent roads accessed from this road.

4.3.4. The area will lend itself to the second column in the above table (E2) and is likely to fall under the guise of Busy traffic therefore S3/P3 level of lighting.

4.3.5. The actual lux levels to be provided are detailed in Table A7 below, from BS 5489-1:2013, with an adjustment in the Class of lighting allowed due to the provision of a white light source if that is to be used. As this report recommends utilising LED luminaries for the development the adjustment can be applied.

Table A.7 **Variation of maintained lighting level with S/P ratio of light source**

Values in lux

Lighting class	Benchmark (e.g. $R_a < 60$ or when S/P ratio of light source is not known or specified)		S/P ratio = 1.2 and $R_a \geq 60$ (e.g. some types of warm white lamp such as metal halide)		S/P ratio = 2 and $R_a \geq 60$ (e.g. some types of cool white compact fluorescent or LED)	
	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}
P1 or S1	15.0	3.0	13.4	2.7	12.3	2.5
P2 or S2	10.0	2.0	8.6	1.7	7.7	1.5
P3 or S3	7.5	1.5	6.3	1.3	5.5	1.1
P4 or S4	5.0	1.0	4.0	0.8	3.4	0.7
P5 or S5	3.0	0.6	2.2	0.4	1.8	0.4
P6 or S6	2.0	0.4	1.4	0.4	1.1	0.4

Light Source Selection

4.3.6. 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 also important as the ability to clearly see and distinguish colours and improves the visual acuity of road users and improves users' perception of safety.

4.4. Pedestrian Escape Route from to Blocks I.1 and I.2

Lighting Design Criteria Selection

4.4.1. Luminaires for the area should be selected and mounted to avoid obtrusive light. Control of the light distribution of installations is necessary in order to limit obtrusive light and sky glow. In some cases, lighting can be intrusive at night, such as, in rural and open areas where lighting can be seen as an intrusion in an otherwise darkened environment.

4.4.2. The detailed lighting design for the proposed escape route walkways leading away from blocks I.1 and I.2 should aim to achieve the lighting levels recommended in BS 5489-1:2013 Code of Practice for the design of road lighting.

4.4.3. Table A.6 below, from BS 5489-1:2013, shows the lighting level requirements and lighting levels to be aimed for in any detailed design:

Table A.6 **Lighting classes for subsidiary roads with mainly slow-moving vehicles, cyclists and pedestrians**

Traffic flow	Lighting class	
	Ambient luminance: very low (E1) or low (E2)	Ambient luminance: moderate (E3) or high (E4)
Busy [A]	S4 or P4	S4 or P4
Normal [B]	S5 or P5	S5 or P5
Quiet [C]	S6 or P6	S6 or P6

NOTE 1 If facial recognition is important then an ES lighting class from BS EN 13201-2:2003, Table 5, or an E_{sc} lighting class from CIE 115:2010 [N1], Table 7, can be selected as an additional criterion. Good colour rendering contributes to a better facial recognition. (The ES lighting class in BS EN 13201-2:2003 is expected to be replaced by SC upon publication of the revised edition.)

NOTE 2 To ensure adequate uniformity, the actual value of the maintained average illuminance is not to exceed 1.5 times the value indicated for the class.

NOTE 3 It is recommended that the actual overall uniformity of illuminance U_o be as high as reasonably practicable.

NOTE 4 Grey highlighting indicates situations that would not usually occur in the UK.

NOTE 5 The ambient luminance descriptions E1 to E4 refer to the environmental zone as defined in ILP GN01 [N5].

[A] Busy traffic flow refers to areas where the traffic usage is high and can be associated with local amenities such as clubs, shopping facilities, public houses, etc.

[B] Normal traffic flow refers to areas where the traffic usage is of a level equivalent to a housing estate access road.

[C] Quiet traffic flow refers to areas where the traffic usage is of a level equivalent to a residential road and mainly associated with the adjacent properties or properties on other equivalent roads accessed from this road.

4.4.4. The area will lend itself to the first column in the above table (E2) and is likely to fall under the guise of normal traffic, therefore S5/P5 level of lighting.

4.4.5. The actual lux levels that should be provided are detailed in Table A7 below, from BS 5489-1:2013, with an adjustment in the Class of lighting allowed due to the provision of a white light source if that is to be used. As this report recommends utilising LED luminaries for the development the adjustment can be applied.

Table A.7 **Variation of maintained lighting level with S/P ratio of light source**

Values in lux

Lighting class	Benchmark (e.g. R_a < 60 or when S/P ratio of light source is not known or specified)		S/P ratio = 1.2 and $R_a \geq 60$ (e.g. some types of warm white lamp such as metal halide)		S/P ratio = 2 and $R_a \geq 60$ (e.g. some types of cool white compact fluorescent or LED)	
	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}	$\bar{E}$	E_{min}
P1 or S1	15.0	3.0	13.4	2.7	12.3	2.5
P2 or S2	10.0	2.0	8.6	1.7	7.7	1.5
P3 or S3	7.5	1.5	6.3	1.3	5.5	1.1
P4 or S4	5.0	1.0	4.0	0.8	3.4	0.7
P5 or S5	3.0	0.6	2.2	0.4	1.8	0.4
P6 or S6	2.0	0.4	1.4	0.4	1.1	0.4

Light Source Selection

4.4.6. The recommendation of LED luminaires is partly dictated by current trends within the lighting industry for using energy efficient luminaires. However, using white light source is also important as the ability to clearly see and distinguish colours, improves the visual acuity of road users and improves users' perception of safety.

4.4.7. As part of the detailed design, consideration should be given to the escape route lighting and a Risk Assessment undertaken to assess the need of an uninterruptable power supply or battery back up unit.

5.0 Visual Impact Mitigation Considerations

5.1. Introduction

5.1.1. All items in this Section 5.0 relate to the control and restriction of lighting for the proposed development to produce a lighting design suitable for the area to the light levels recommended but keeping the negative effects associated with the development to a minimum.

5.2. Type of Equipment

5.2.1. Lighting Columns: The mounting height and cross-section of the columns should be kept to a minimum and consistent while achieving the lighting levels with reasonable spacing to avoid clutter.

5.2.2. 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.

5.2.3. 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.

5.3. Luminaires

5.3.1. To limit the effects of direct glare and light pollution from the luminaires, where possible they should be provided with full cut-off distribution.

5.3.2. 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.

5.4. Types of Light Source

5.4.1. To achieve good colour rendering and acceptable colour appearance is provided, it is proposed to utilise luminaires with neutral white LED light sources.

5.4.2. 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.

5.4.3. However, good colour rendition and appearance are also useful in car park and road environments to aid object identification, safe movement, facial recognition and perception of safety.

5.4.4. 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.

5.5. Lumen Depreciation

5.5.1. This is the term used for how the output of the lamp/light source deteriorates throughout its useful life.

5.5.2. 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.

5.5.3. 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.

5.5.4. It is recommended the detailed design is undertaken to the level at end of life (maintained levels) once the operating life is known we can select the appropriate lumen depreciation figure.

5.5.5. 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 be a significant length of time.

5.5.6. 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.

5.5.7. The efficacy we can now expect to achieve is in the order of L90 at a rated life of 100,000 hours.

5.5.8. 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.

5.6. Lamp Colour Rendering

5.6.1. 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.

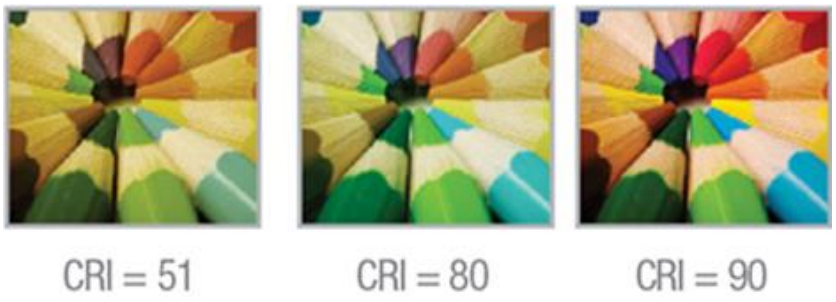
5.6.2. The ability of a light source to render colours of objects correctly is quantified by the CIE colour rendering group and the CIE general colour rendering index (Ra):

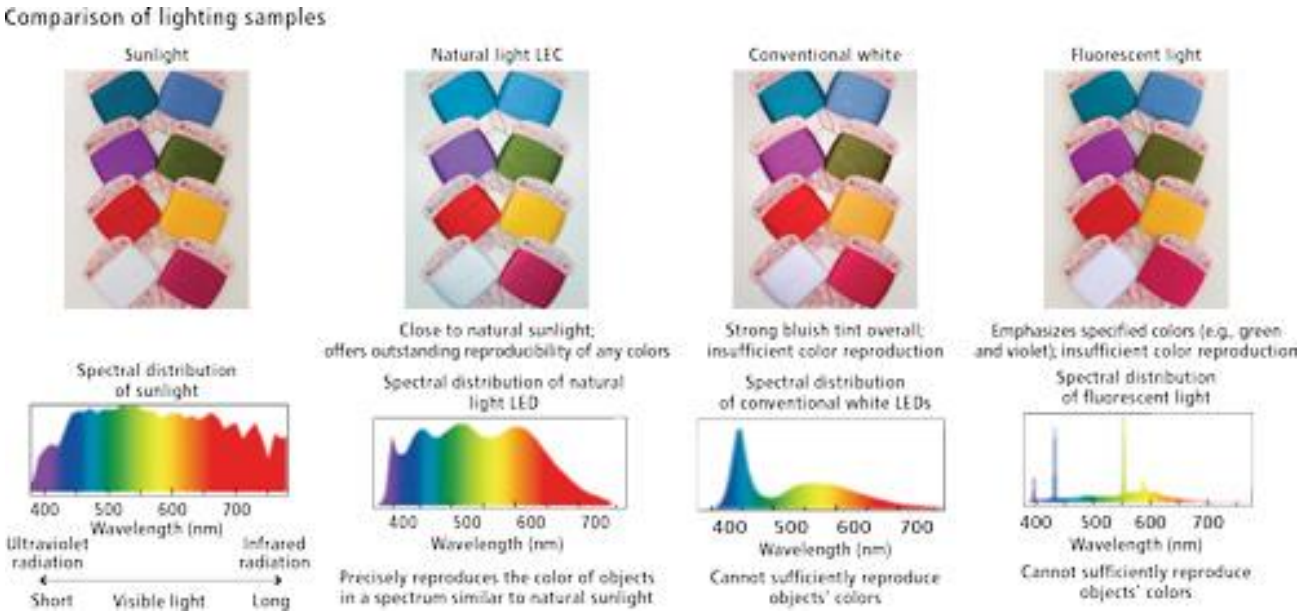
Colour rendering groups	**CIE general colour rendering index**	**Typical Applications**
1A	Ra ≥ 90	Critical colour matching
1B	90≥Ra≥80	Accurate colour judgements required for appearance
2	80≤Ra≤60	Moderate colour rendering required
3	60≤Ra≤40	True colour recognition of little significance
4	40≤Ra≤20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

CIE Colour Rendering Index Groups

5.6.3. 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.

5.6.4. Below are two groups of images which show the effect of different Colour Rendering Index Ra on coloured surfaces.





Proposed Detailed Lighting

5.6.5. The aim should be to provide the necessary illumination level for the areas however being able to identify colour and to manoeuvre through the areas as a motorist, or cross safely as a pedestrian, is aided by good colour rendition. Also, the high colour rendering ability is better suited to widespread use of CCTV systems.

Typical Values of Colour Rendering Index (Ra)

5.6.6. This is 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.

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

5.6.7. 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.

5.7. Colour Appearance / Colour Temperature

5.7.1. 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.

5.7.2. 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.

5.7.3. 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.

5.7.4. The image below Illustrated the typical variation in artificial light with 1,000K very warm to the left and 10,000K very cold to the right.

5.7.5. 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.

5.8. Light, Ecology and Health

5.8.1. When selecting a light source for an outdoor application consideration should be given to the potential effects on the local ecology and general health.

5.8.2. 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.

5.8.3. 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.

5.8.4. The example below shows the typical blue light content 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”.

Table 1. Characteristics of Various Light Sources

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.graphycs.cegepsherbrooke.qc.CA/app/en/home

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

5.8.5. We can see from the above the light sources with the coolest temperature generally are blue-rich; this is unavoidable. To achieve the high CRI, we need an element of blue content as without blue content it would not be possible to render shades of blue.

5.8.6. For the proposed lighting we would propose a CCT no greater than 4000K (neutral white) is used.

5.8.7. Blue-rich light sources can have an effect on certain insect species attracting them towards the light source. However, we would recommend the use of a cut off lantern to assist with both reducing the environmental impact and mitigate against any potential increase in insect influencing factors.

5.9. Energy Usage

5.9.1. In terms of energy usage, high pressure sodium lighting is generally very efficient.

5.9.2. 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.

5.9.3. 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 fewer lighting units if a more efficient lamp type is used.

5.9.4. 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.

5.10. Lamp Control Gear

5.10.1. 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.

5.10.2. 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.

5.11. Adaptive Lighting and Switching

5.11.1. 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.

5.11.2. Some of the options which could be applied to scheme areas are detailed below:

Simple Switching

5.11.3. 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’.

Pros

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

Cons

- 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

5.11.4. Most modern LED luminaires will have the built-in ability for pre-programmed, or input activated, dimming profiles.

5.11.5. This allows either the lighting to step dim, for example 100% at dusk, 50% output at 10PM, 25% between 12PM and 5AM returning to 100% at 7AM using a pre-set program stored within each luminaire's individual driver.

5.11.6. Also, this can be triggered by an input from another standalone device such as a presence sensor, traffic loop, 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.

Pros

- Both options are 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.

Cons

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

Full Adaptive Lighting Management Systems

5.11.7. This would require the installation of 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.

5.11.8. 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.

Pros

- This type of installation 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.

Cons

- 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.

5.12. Lighting Trespass

5.12.1. The guidance Table 1 below, taken from the Lighting Professionals publication 'Guidance Notes for the Reduction of Obtrusive Light (GN01:2011), gives advice on light trespass and limits on upward light (sky glow) before and after curfew for different classifications of environment zones.

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

5.12.2. 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.

5.12.3. From our initial desk top study, we would categorize the development area as E2.

5.13. Light Pollution

5.13.1. Light pollution, or obtrusive light as it is otherwise known, is the spillage of light into areas where it is not desired. For obtrusive exterior lighting limitations, please see Table 2, overleaf, taken from the document as issued by the Institute of Lighting Professionals 'Guidance Notes for The Reduction of Obtrusive Light – GN01:2011'.

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

Sky Glow

5.13.3. 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

5.13.4. 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

5.13.5. 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

5.13.6. Light Trespass is the spilling of light beyond the boundary of a property which may cause nuisance to others.

Threshold Increment

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

Table 2 – Obtrusive Light Limitations for Exterior Lighting Installations – General Observers

Environmental 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/m^2]
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/m^2)**

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.

5.14. Mitigation of Light Pollution and Intrusion

5.14.1. 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.

5.14.2. This document identifies four internationally recognized environmental zones and provides guidance as to the limits of overspill lighting levels required for each environmental situation.

5.14.3. The following design measures would assist in compliance with the above ILP Guidance Note:

- 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).
- 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 the minimum 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).
- Siting and aiming of the lights together with suitable mounting height in conjunction with tight optical control should mean any problems associated with light spill, glare and light trespass are also addressed.
- 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 taking place on the surface at the time such as minimal Lorry activity or low usage car park levels. This would further 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 should be minimised to fall in line with the limits specified in the ILP Guidance Note. The ILP Guidance Note 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 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.

7.0 Glossary

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.

8.0 Publications

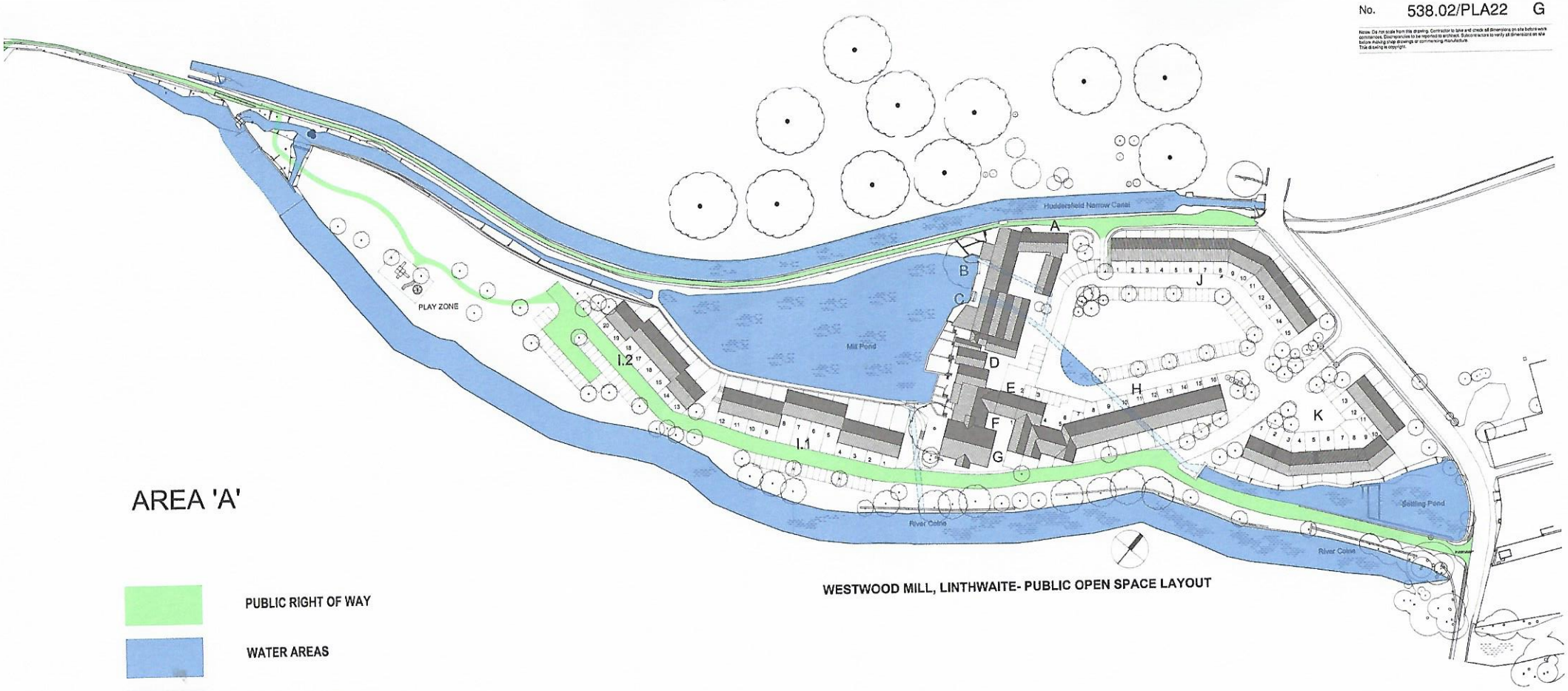
- BS 5489-1:2013 Code of Practice for the design of road lighting
- Institute of Lighting Professionals publication 'Guidance Notes for the Reduction of Obtrusive Light (GN01:2011)
- BS EN 13201-2:2015 - Road Lighting – Part 2: Performance Requirements
- Street Lighting and Blue Light – frequently Asked Questions

Figure 1 – Site Location (Aerial Image)

Distance View of Site

Figure 2 – Proposed Development Plan including Public Open Space and Flood Routes

No. 538.02/PLA22 G



AREA 'A'

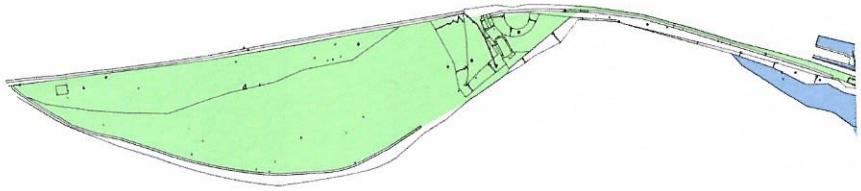
WESTWOOD MILL, LINTHWAITE- PUBLIC OPEN SPACE LAYOUT

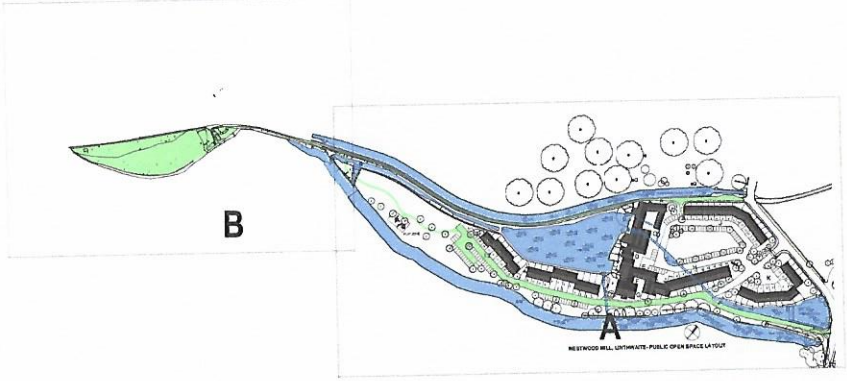
PUBLIC RIGHT OF WAY

WATER AREAS

UNDERGROUND WATER

Rev	Description	Date	Initial
G	AMENDMENTS TO ROAD	15/12/19	DP
F	AMENDMENTS TO CARPARK AND ROAD	12/12/19	DP
E	NEW PARKING LAYOUT	17/11/19	DP
D	NEW STACK ORDER	19/06/19	DP
B	NEW PAGE LAYOUT	30/01/19	DP
A	NEW COULORING AND HATCHING	29/01/19	DP





AREA 'B'

0 7.5 15 30 75m

PRIME MERIDIAN
Architects and structural engineers

Second Floor
26A Stanton Street
London W1F 7QZ
T 020 7494 3522
F 020 7494 3533
info@prime-meridian.co.uk

The Priory, Draycott Rd
Shepton Mallet
Somerset BA4 6NS
T 01749 34 66 99
F 01749 34 66 77
www.prime-meridian.co.uk

Client: WESTWOOD WILSON LTD.

Project: WESTWOOD MILL
LINTHWAITE

Title: PUBLIC OPEN SPACE LAYOUT & AREAS OF RECREATIONAL ACTIVITIES

Date: JANUARY '19
Scale: 1:500@A1
Drawn: DP

No. 538.02/PLA22 G

Appendix A 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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