Visualisation by HOK

Arena Quarter

Arena Quarter Lighting Assessment - Rev01

26 August 2021

Job Number: 281124-00

ARUP

Contents

1 Introduction

Cardiff Arena (Arena) is a 15,000-capacity entertainment centre proposed for Cardiff to enhance the city's live event infrastructure capacity. The arena aims to create a connection with Cardiff Bay and the city centre. The Arena Quarter proposal consists of the Arena, Arena Plaza and the provision of a replacement hotel.

This document sets out the lighting strategies and considerations of the external lighting for detail planning consent for the Arena Quarter (Arena, hotel and immediate landscaping) which is part of a hybrid application, applying for outline consent for the wider masterplan.

The lighting concept aims to link with the architectural and landscape intent for the Arena Quarter.

The lighting will respond to the functions of the public realm; a thriving and active night-time environment during event days and a more subdued, quieter atmosphere that is sympathetic to the surrounding residences on non-event days.

On an event day, the lighting is dynamic and guides visitors to the Arena. A warm colour palette to reflect the architectural intent, to signify the industrial history of the site.

On a non-event day, the lighting is muted and understated but activates functional routes around the masterplan.

Figure 1: Arena visualisation images by HOK

The lighting strategy aims to bring a sense of destination. To add excitement, intrigue and anticipation on an event-day, so that all visitors have a memorable time from the moment they approach the Arena. Lighting will promote routes and direct movement by varying the intensity and size of luminaires throughout the public realm.

Day-to-day, the lighting aims to blend seamlessly with the wider masterplan and provide a comfortable and safe location for visitors and locals to enjoy.

The lighting treatments are carefully chosen to reflect the predicted usage of each location at different times. While features such as the Arena and Arena Plaza take centre stage, the importance of safety and inclusivity is paramount.

Figure 2: Arena reference images by HOK

2 Context

2.1 Wider Context

Arena Quarter is located on Hemingway Road at the Cardiff County Hall site, situated between Wales Millennium Centre, Lloyd George Avenue and Bute East Dock.

Access from the city centre is via Lloyd George Avenue. Currently accessible by car, train, bicycle and foot.

Existing local residences (sensitive receptor) are adjacent to Lloyd George Avenue and Schooner Way, both back onto the proposed Arena and hotel site.

Residences to the east of the Arena are planned in future phases of the Atlantic Wharf, Butetown Masterplan (masterplan).

The masterplan includes The Vista, a public realm walkway between Roald Dahl Plas to the proposed Atlantic Square. The Vista will also be a primary route to the Arena. Details of The Vista are not included in this document as they form part of the outline application. Full details will be submitted as part of reserved matters for this application following approval of this submission.

Future phases of the masterplan currently show a multi-storey car park off Hemingway Roundabout leading to the Eastern Gateway. Although a future phase, its intended that the multi-storey car park is delivered in the same time frame as the Arena.

A considered lighting strategy emphasises the public realm design and guides people around the public realm, contributing to safety and providing visual identity.

A consistent lighting approach across the masterplan as a whole is critical to the success of the public realm design. While each location, including the scope of the Arena Quarter, has its own identity, each must have a cohesive lighting design.

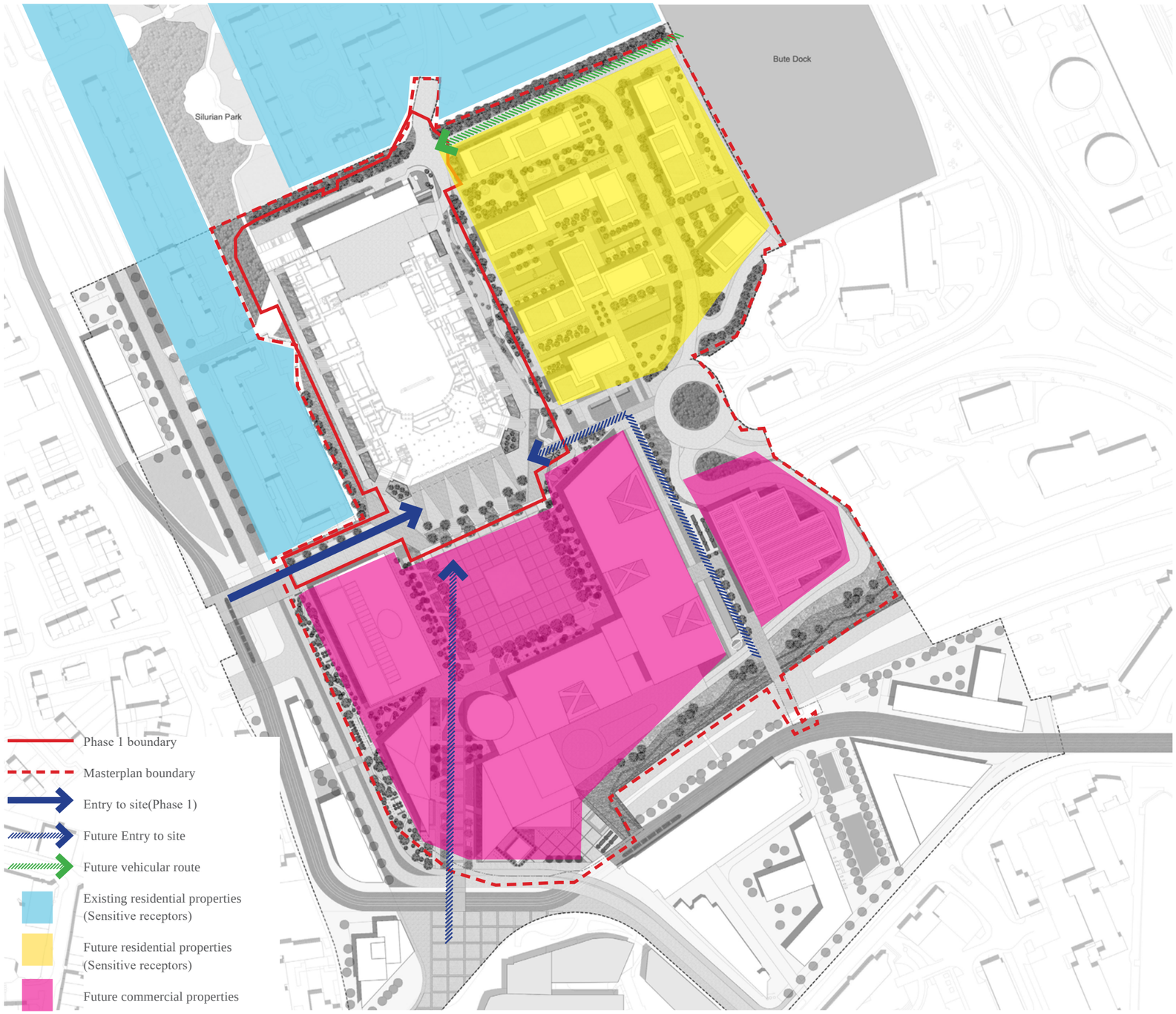


Figure 3: Wider site context (Awaiting masterplan from RIO)

2.2 Arena Context

The Arena Quarter has multiple functions as a destination. The lighting strategy aims to complement and adapt to the varying operating modes.

- **Event Mode** - High pedestrian movement using the Arena main entry points and dwelling/queuing in the Arena Plaza.

- **Non-event Mode** - Minimal pedestrian footfall related directly to the venue. However, staff movement, ticket collection and general use of the public realm are expected. The public realm becomes a more transient space.

The lighting strategy aims to provide defined lit spaces that respond to their use, encouraging the public to stop and relax. It will provide visual assistance to identify routes, allowing destination to be reached in comfort.

2.2.1 Event Mode

Lighting will play an important role in bringing the event space to life. Creating and setting the right mood and overall experience and implement a safe environment for employees and customers alike.

Public realm spaces are an extension of the venue itself, spaces where visitors can meet and orientate themselves on their journey.

During event times, large crowd volumes, both pedestrian and cyclist, would be travelling to or from a single destination. Appropriate light levels are required to enable the flow of movement around the site safely and easily.

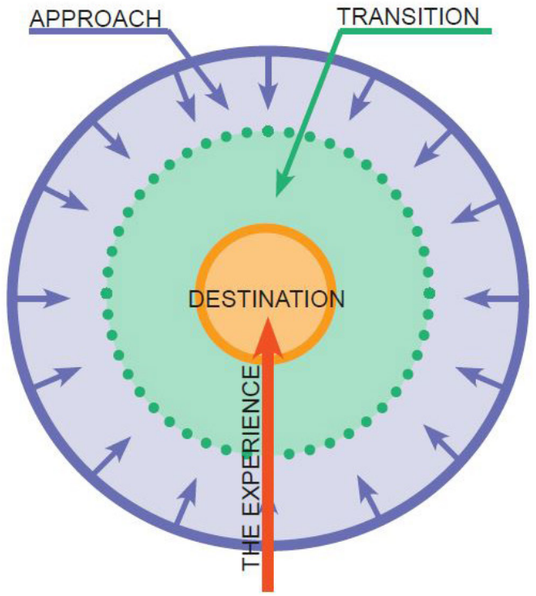
2.2.2 Non-Event Mode

During a non-event day, the area will take on a different atmosphere and personality.

A lower level of pedestrian movement will follow multiple routes throughout the area connection building entry points and ticket collection windows.

A lower, mode appropriate light level is required to maintain a safe environment whilst complement the more relaxed atmosphere of the venue. Reducing light levels during non-event modes reduces energy consumption and minimises impact to neighbours.

Good levels of ambient lighting are essential to enhance the visitors perception of safety and encouraging the use of the outdoor space after dark.



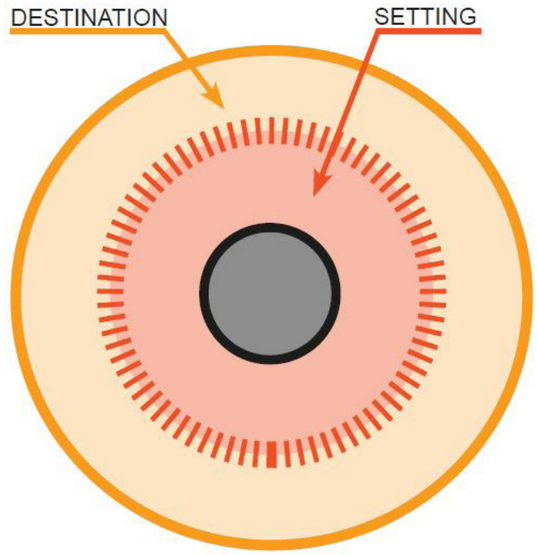


Figure 4: Event mode

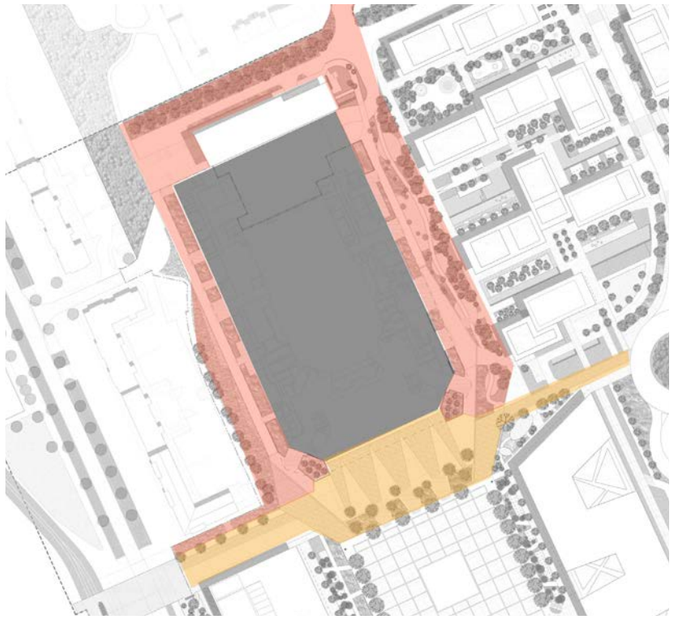


Figure 5: Non-event mode

2.3 Site Context

The Arena Plaza is the Arena Quarter hub for arrival and departure from the arena. Safe movement is required at all times across the Arena Plaza, especially on event days when queueing for the Arena is expected.

The approach to the Arena and Arena Plaza is from several directions. The primary routes are the Western Gateway and Eastern Gateway. The Western Gateway is the public realm walkway between Lloyd George Avenue and the Arena.

The Eastern Gateway is the public realm walkway between Hemingway Road roundabout and the Arena.

The Arena Quarter also includes pedestrian pathways to the east and west of the Arena, which are secondary and tertiary routes.

The east pathway is a secondary route that provides access to the proposed hotel and local residences. The Urban Arboretum linear park is adjacent to the east pathway.

The west pathway is a tertiary route providing access between local residences and the Arena Plaza.

In this phase of development the access to the Arena service yard is via the east pathway, down the side of the Arena. However, in the final masterplan the vehicular route to the Arena service yard is planned through the east development, outside the scope of this document. The east pathway is not considered a vehicular route, its use as access to the Arena service yard is temporary.

Further vehicular access is at the north of the Arena. An access road off of Schooner Way provides a route to the hotel and hotel car park.

Figure 6: Wider site context (Awaiting masterplan from RIO)

3 Lit Environment

The lighting strategy focuses on several key aspects:

1. Promoting routes using lighting intensity, equipment height and type to direct movement around the public realm.

2. Maintaining a clear and clutter-free view from Atlantic Square across the Arena Plaza.

3. Use warm white light to accentuate and complement the architecture and landscape design, particularly during event days.

4. Provide a balanced transition from inside the Arena to the Arena Plaza outside.

5. Provide a smooth and balanced transition between the Arena, Arena Plaza and the west and east pathways.

6. Highlight feature trees at the front of the Arena.

7. Functional lighting to the west and east pathways that limits light spill to sensitive receptors, emphasises a feeling of safety and is sensitive to future development e.g. The Urban Arboretum.

8. Functional lighting to illuminate the Eastern and Western Gateways and the new vehicular and pedestrian routes north of the Arena (Schooner Way).

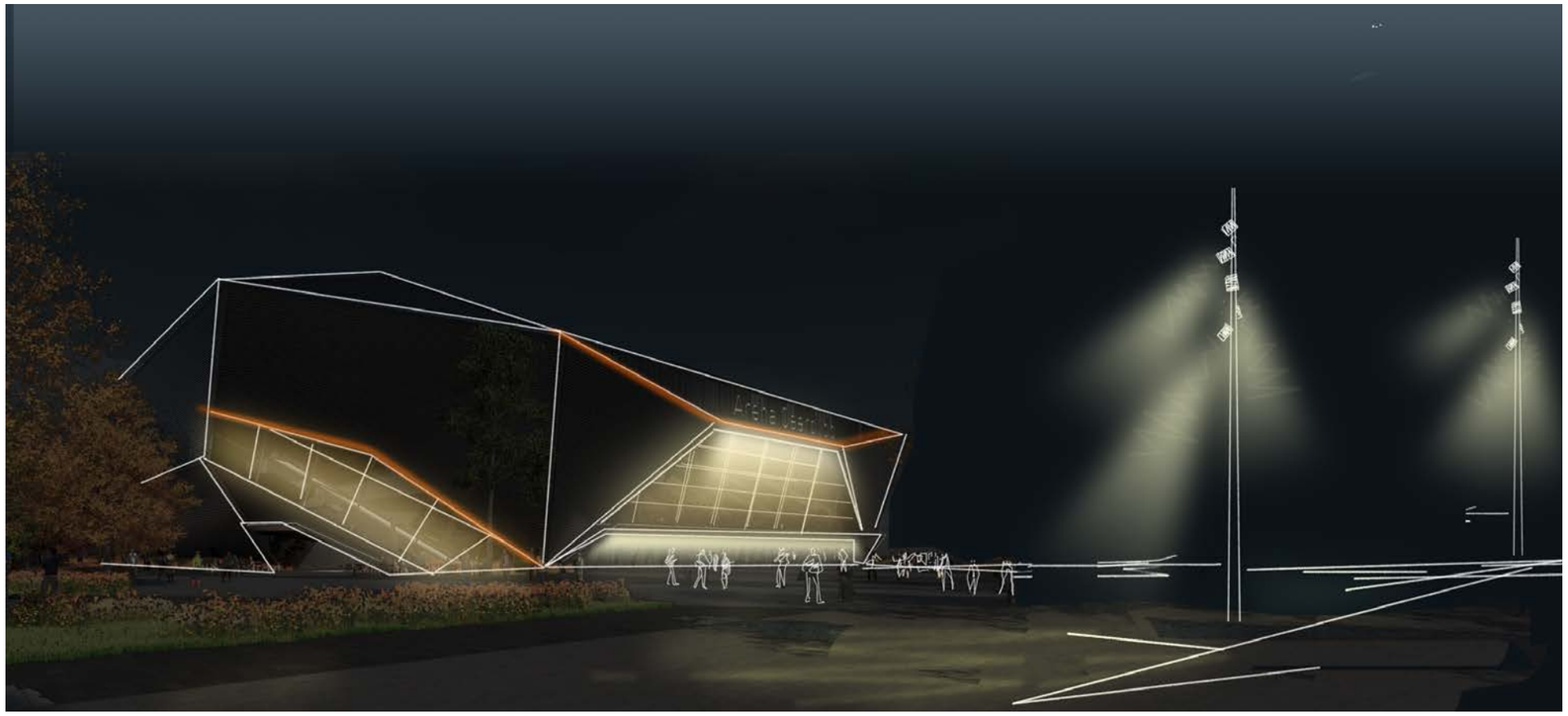


Figure 7: Indicative lit environment

4 Lighting Strategy

4.1 The Arena Plaza

The proposed lighting for the plaza will utilise the following luminaire types:

- General lighting - ≤15m high columns with multiple directional floodlights.
- Facade mounted luminaires - spotlights with deep recessed source with glare control to illuminate the area of the plaza closest to the entrance of the arena.
- Downlights - installed within arena canopy to provide enhanced illumination at the entrance to balance the transition between outdoor and internal space.
- Tree lighting - illuminate trees at the front of the Arena for visual softening of the area when the Arena is not illuminated on non-event day. Illuminate the feature Liquidambar tree for impact on event-day.

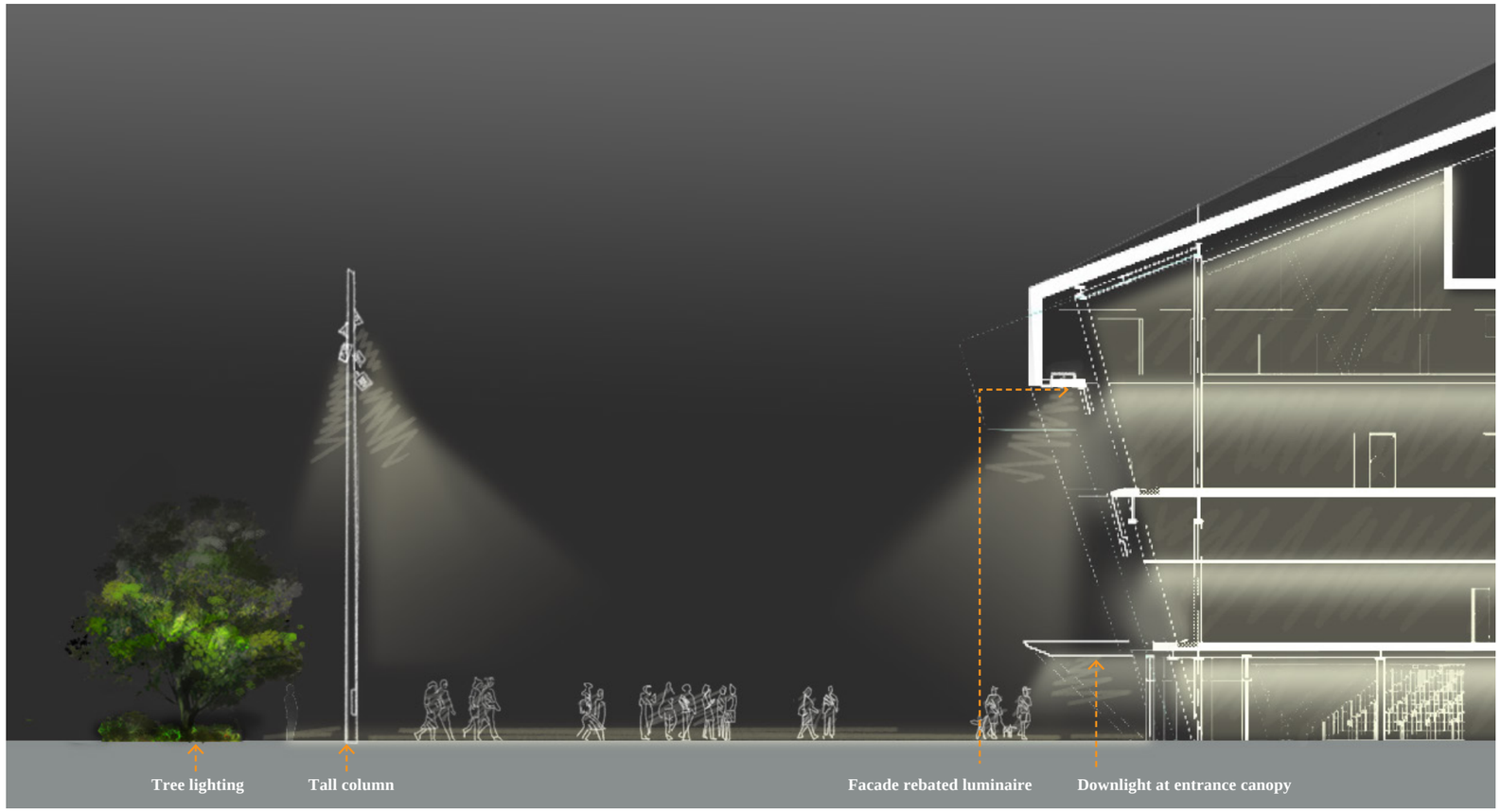


Figure 8: Arena Plaza lighting strategy

4.1.1 General Lighting

Tall columns with multiple directional floodlights will provide general lighting to the Arena Plaza.

The height of the column will be ≤15m. This scale provides enough reach for the directional floodlights to illuminate different locations within the Arena Plaza. The use of multiple floodlights helps provide smooth transitions between spaces and accentuate key areas for wayfinding.

A ≤15m high column is in keeping with the scale and mess of the Arena.

The proposed lighting approach minimised the number of lighting positions, keeping the Arena Plaza clear and clutter-free.

4.1.2 Facade Mounted Luminaires

The Arena Plaza is an open, expansive space that requires a transitional blend of light from the Arena entrance to Atlantic Square. And it's the size of the area that creates a technical lighting challenge. In particular, the zone directly in front of the Arena, outside the throw of borrowed light from the entrance canopy.

To combat this challenge, it's proposed to mount luminaires at the building facade. Spotlights with a deeply recessed source and with lighting control accessories will ensure that glare is minimised.

Illuminating the Arena Plaza from the building facade and the tall columns helps to keep the lighting consistent across the central area and keep it clutter-free.

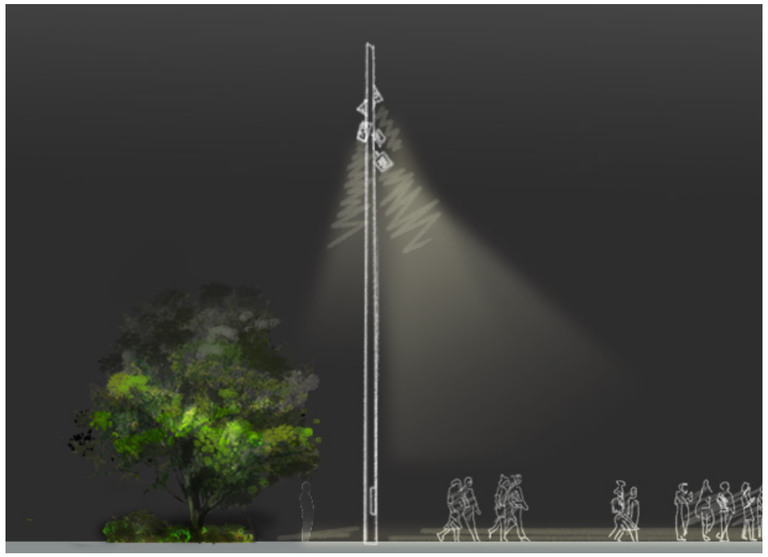


Figure 9: General lighting with column mounted luminaire

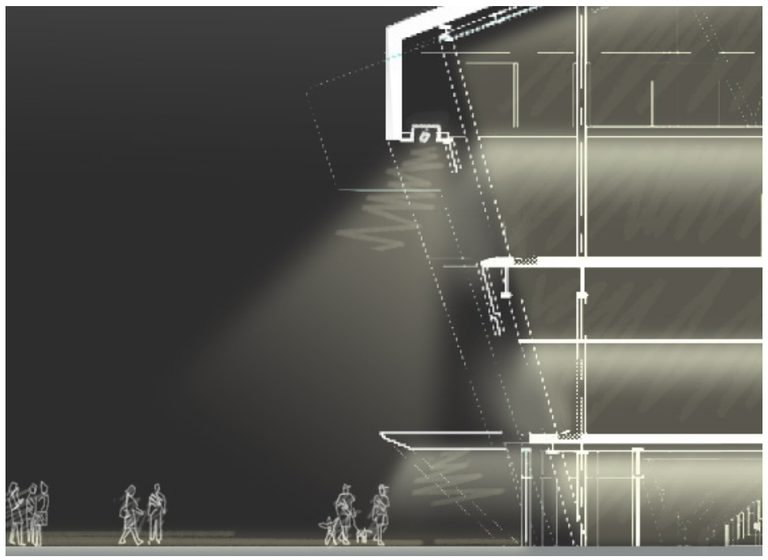


Figure 10: Facade mounted luminaire

Figure 11: Pole mounted luminaire precedent image

4.1.3 Downlights

Downlights within the Arena canopy provide increased lighting levels at the threshold between the public realm and building. A higher intensity of light in this location aids with wayfinding and visitor inclusivity.

A brighter illumination level helps Arena security during ticket check before admittance.

Recessing the lighting into the canopy keep the area clutter-free, allowing for free movement.

4.1.4 Tree lighting

Trees and soft landscaping scatter the Arena Plaza. A concentration of soft landscaping around the rain gardens at the front of the Arena. A feature Liquidambar tree is adjacent to the Arena.

Illuminating the trees at the front of the Arena and the feature Liquidambar will help create character and visual interest. Accentuating the warm, fiery colours of the Liquidambar emphasises the design concept, tying the scheme together during event and non-event days.

Lighting the planting at the front of the Arena helps soften the angular lines of the architecture, making the area feel more natural on a non-event day.

Trees within the Arena Plaza are considered for illumination. Due to the increased illuminance levels in this location, ecology is unlikely to be encouraged. A careful selection of which trees to illuminate will ensure that ecology is not negatively impacted while creating a visually interesting environment.

Please refer to section 8 for further details of the ecological requirements and criteria for Arena Quarter.

Figure 12: Canopy downlight precedent image

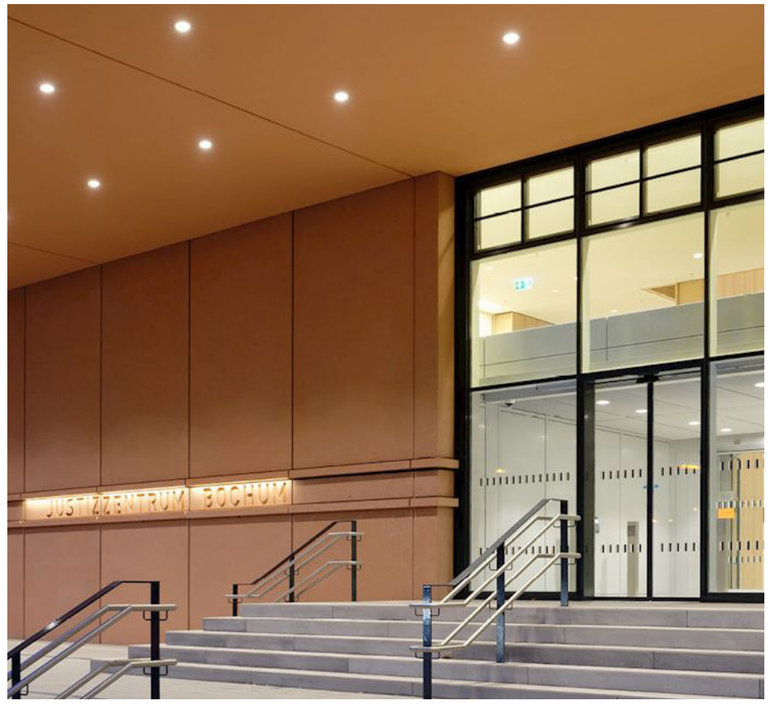


Figure 13: Canopy downlight precedent image

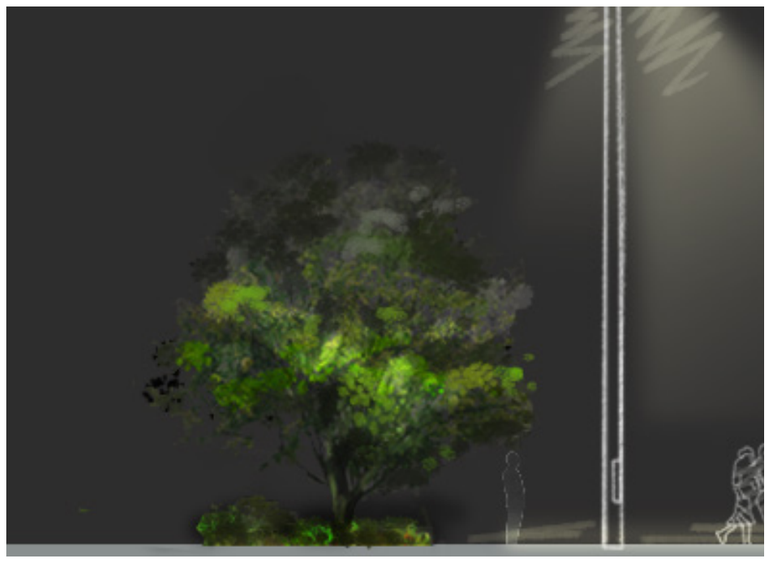


Figure 14: Tree uplight reference sketch

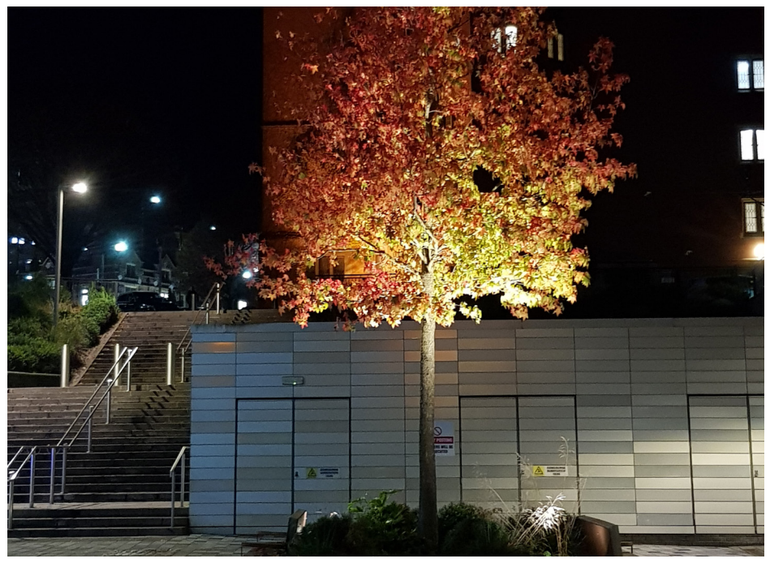


Figure 15: Tree uplight precedent image

4.2 Lighting Hierarchy

In addition to the Arena Plaza, there are the following locations that make up the Arena Quarter:

- The Eastern and Western Gateway - Primary route
- The east and west pathway (to the sides of the Arena - Secondary and tertiary route
- The north vehicular route and car park - Tertiary route

Each of these locations will have a similar lighting treatment but with subtle differences based on the classification and use of the route; primary, secondary, tertiary. Refer to Context Section 3.

A lighting hierarchy helps identify the differences between each of the areas based on the intended use. For example, the Arena Plaza is the hub location with expected high footfall and has dominant ≤15m tall columns with multiple floodlights to illuminate a vast area. But the west pathway utilises ≤6m columns with lanterns to illuminate a predominantly less-used route with a smaller area.

Figure 16 is a graphical representation of the lighting hierarchy.

The following sections of this document detail the lighting treatment for each of the areas and their relationship to the lighting hierarchy.

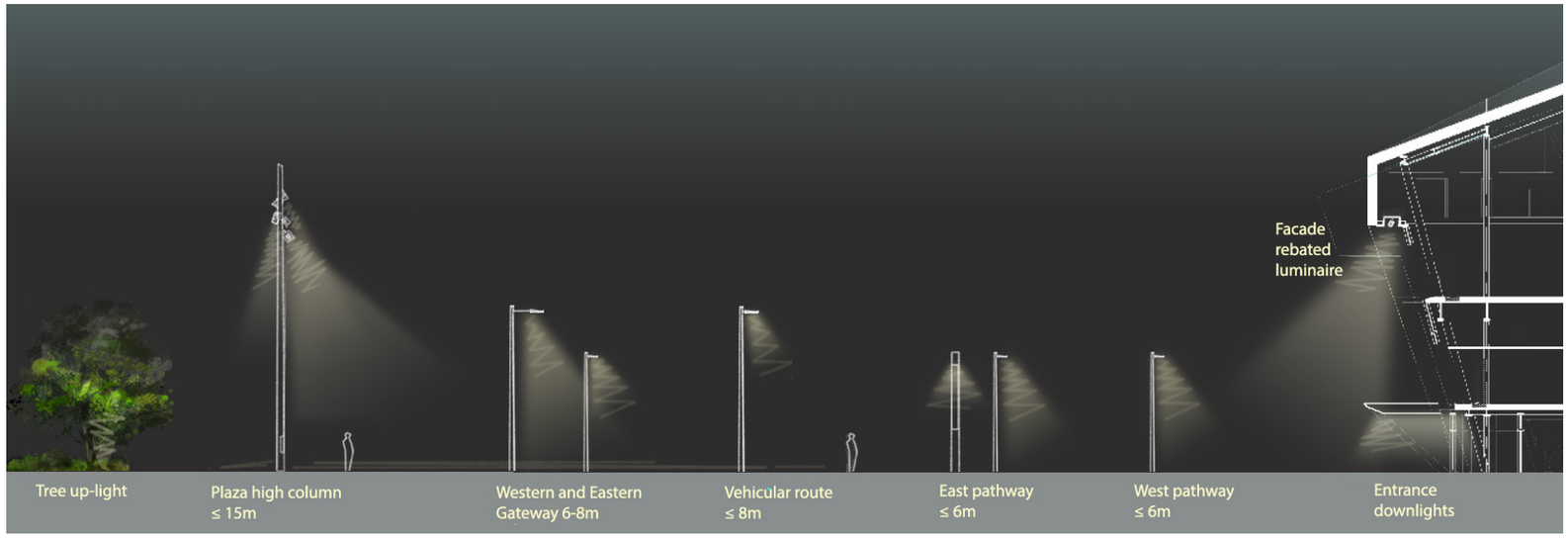


Figure 16: Hierarchy of lighting

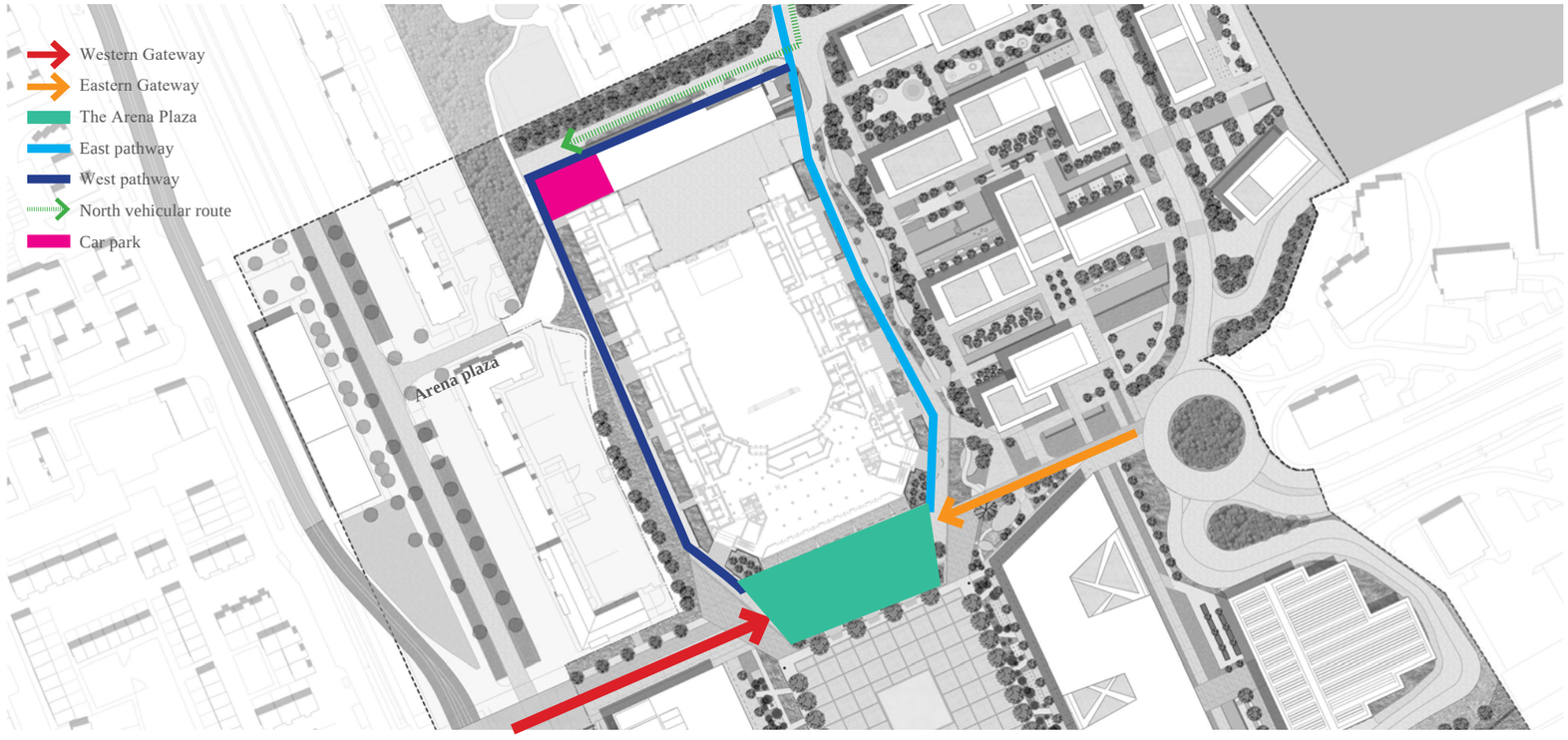


Figure 17: Movement pattern within phase 1 development

4.3 Eastern and Western Gateway

The Eastern and Western Gateway are the approaches from Lloyd George Avenue and Hemingway Road roundabout. Together they from the main approaches to the Arena and Arena Plaza.

The Eastern and Western Gateway are primary routes with high footfall volumes expected on event days. On a non-event day, the gateways are main thoroughfares to other areas of the masterplan.

The lighting at the gateways is functional and understated so as not to detract from the Arena and Arena Plaza but fits with the scale and context of the surroundings. The lighting should blend into the background, yet provide a feeling of safety on the journey.

An 6-8m high, column-mounted lantern provides illumination to the route. This height avoids potential clashes with heavy goods vehicles and tall emergency vehicles while improving lighting distribution.

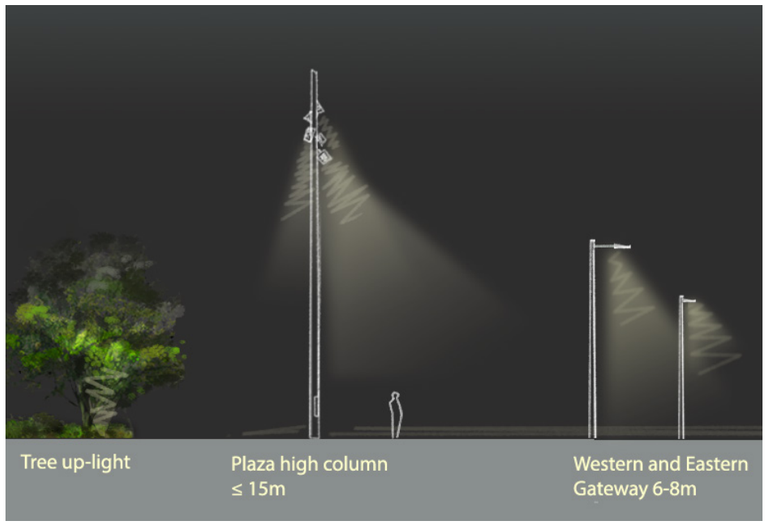


Figure 18: Eastern and Western Gateway indicative luminaire

Figure 19: Eastern and Western Gateway precedent image

4.4 East Pathway

The east pathway links local residence to the north of Schooner Way and the proposed hotel to the Arena Plaza. It's considered as a secondary route due to increased footfall during event days and access for visitors staying at the hotel.

The east pathway is next to the Urban Arboretum, a linear park, part of the proposed masterplan. The intention is for the Urban Arboretum to become a way-point for people to meet and spend time before travelling to nearby destinations or events.

The lighting along the east pathway will provide the same functionality as the west pathway while sympathetic to future proposals. The luminaires will be a combination of column/totem style. Functional to illuminate the pathway and decorative to accentuate the Arena VIP entrance and soften the aesthetic to the Urban Arboretum. A scale of 6m in height to match the west pathway.

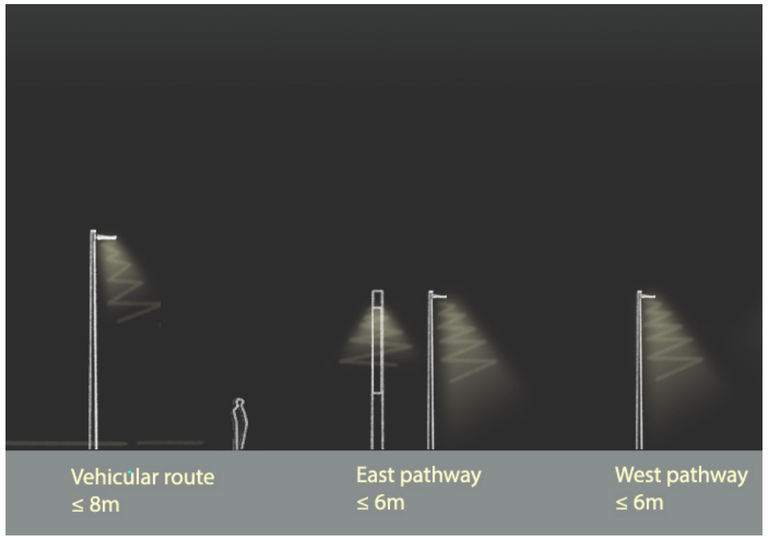


Figure 20: East pathway indicative luminaire

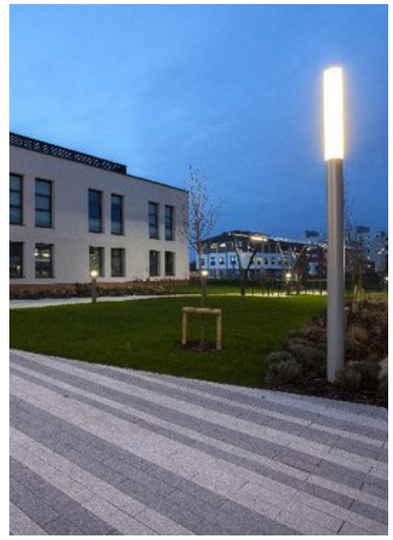


Figure 21: East pathway precedent image

4.5 West Pathway

The west pathway will provide access to and from Arena Plaza on non-event days.

Though, to minimise any potential impact on local residences this is no an encouraged route for visitors to the Arena. Lighting will be used to support this strategy, with the route being defined as "tertiary". As part of the lighting strategy, the route will be lit to a comparatively lower level to encourage visitors to use other routes.

Using a lower lighting level in this location helps to encourage ecology to use the trees and landscaping in the area.

The lighting along the route will focus on functionality, safety and minimising light spill to residences.

Column mounted street lanterns will illuminate the west pathway of the Arena. The lanterns will be a flat glass type and positioned facing away from the residential buildings, toward the mass of the Arena. This approach minimises light spill onto residential properties.

A 6m column height minimises the number of lanterns and mitigates visual impact for residents.

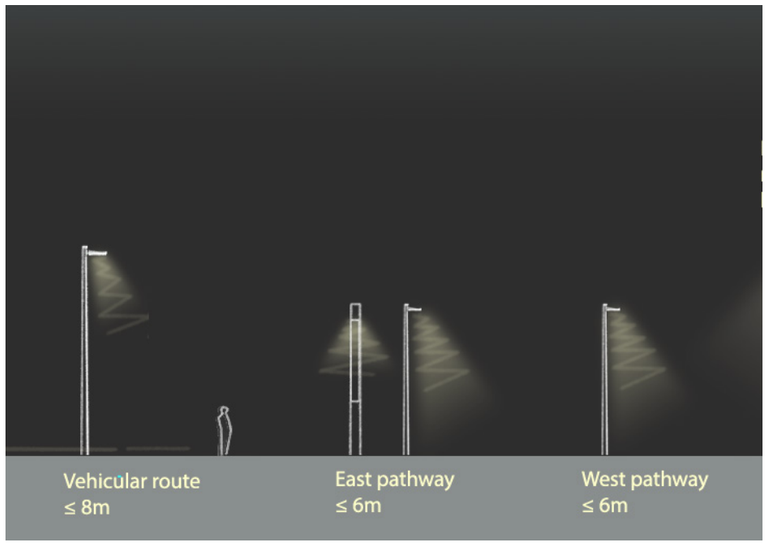


Figure 22: West pathway indicative luminaire

Figure 23: West pathway precedent image

4.6 North Vehicular Route and Car Park

The route to the north of the Arena is an extension of Schooner Way and the pedestrianised west pathway. The primary function is as a vehicular route to the proposed hotel and the Arena service entry.

The hotel car park intersects the west pathway and the vehicular route.

As this route is primarily for vehicular access, the lighting will take a practical approach.

8m high columns with lanterns illuminate the area. This height avoids potential clashed with heavy goods vehicles and tall emergency vehicles while improving lighting distribution.

The lanterns will have optical control suitable for roads with untilted flat glass to mitigate light spill into surrounding properties.

Figure 24: Vehicular route indicative luminaire

4.7 Light Source

Lighting provided throughout will utilise LED technology. This source provides benefit over conventional lamps including greater efficiency, optical and intensity control. LEDs have a low UV content, which when combined with a warmer colour temperature, reduces the impact of lighting on ecology.

4.8 Colour temperature

The colour of the lighting in the public realm must fit the surrounding architecture and landscape design. During an event day, the interior design utilises warm, fiery colours to remind us of the industrial heritage of the site. Feature Liquidambar trees as part of the landscape strategy links with the design. And the lighting should also link, supporting the concept.

Warm white colour light (colour temperature) ranging from 2,700K to 3,000K to match the architectural and landscape design.

Warm colour light works well for the Arena and Arena Plaza, complementing the architectural and landscape aspirations. However, areas of the masterplan could benefit from a cool colour light. Using different colour temperatures across locations helps define the character, function and hierarchy.

4.9 Luminaire optics and accessories

Various areas and routes in the Arena Quarter are close to residences. It's imperative luminaire optics and accessories are considered carefully to ensure that light is provided to the associated take with minimised light spill and glare.

Luminaires will have controlled cut-offs and have the ability to accommodate accessories that control and shape the light e.g. louvres, snoots and backshields.

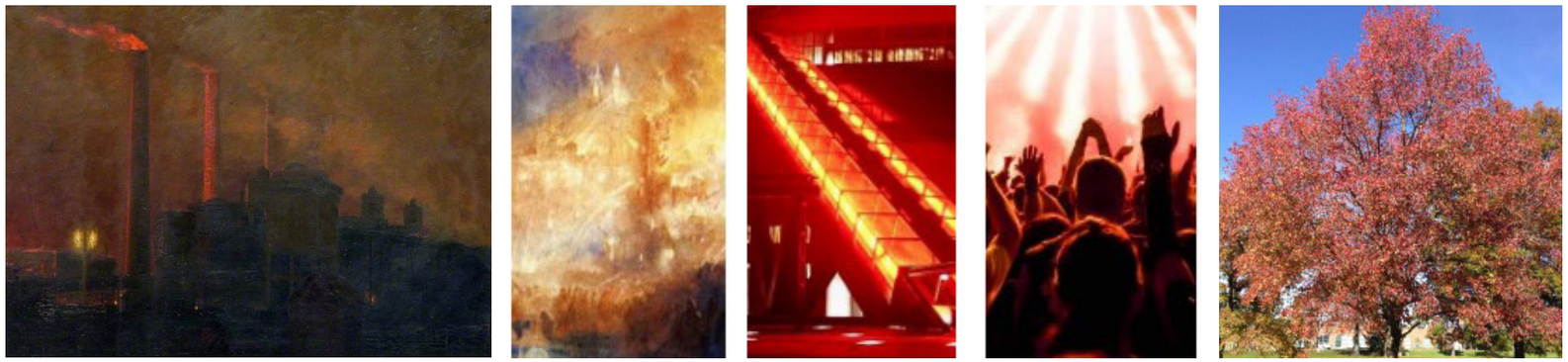


Figure 25: Reference images and visualisations by HOK. Tree reference by The Urbanists - extracts from

5 Lighting Treatment plan

The lighting criteria for the external areas with the Arena Quarter development has been carefully considered to ensure that the lighting:

- Creates a pleasant and safe, inviting public space
- Provides appropriate light levels, in accordance with approved guidelines and regulations
- Aids wayfinding around the site
- Provides good levels of ambient lighting to enhance the perception of safety to visitors
- Supports and reinforces the landscape and architectural intent
- Minimise light spill outside of the site through positioning and optic selection
- Minimise light pollution causing sky glow through the selection of appropriate equipment and minimising upwards tilt of lanterns.

Figure 26 and Table 1 details the proposed lighting criteria for the different areas of Arena Quarter.

Table 1 includes lighting criteria for Arena events and non-event day modes of operation.

Table 1 also includes vertical illuminance criteria. Vertical illuminance is light on the vertical plane, important for facial recognition, contributing to safety within the public realm and assisting with CCTV monitoring.

Figure 26 is a graphical illustration of the proposed illuminance criteria.

Lighting levels have been proposed in accordance with the following British Standards and Guides:

- BS EN 5489-1:2020 Lighting of Roads and Public Amenity Areas
- BS EN 13201-2: 2015 Road Lighting, Selection of Lighting Classes
- BS EN 13201-3:2015 Road Lighting, Performance Requirements
- CIBSE/SLL Lighting Guide 6 - Lighting of the Outdoor Environment
- BS 12464-2:2014 - Lighting of Work Places, Outdoor Work Places
- BS 8300-1:2018 Design of an accessible and inclusive built environment
- ILP GN01: Guidance Notes for the Reduction of Obtrusive Light.
- ILP PLG05: The Brightness of Illuminated Advertisements
- ILP GN08: Bats and Artificial Lighting

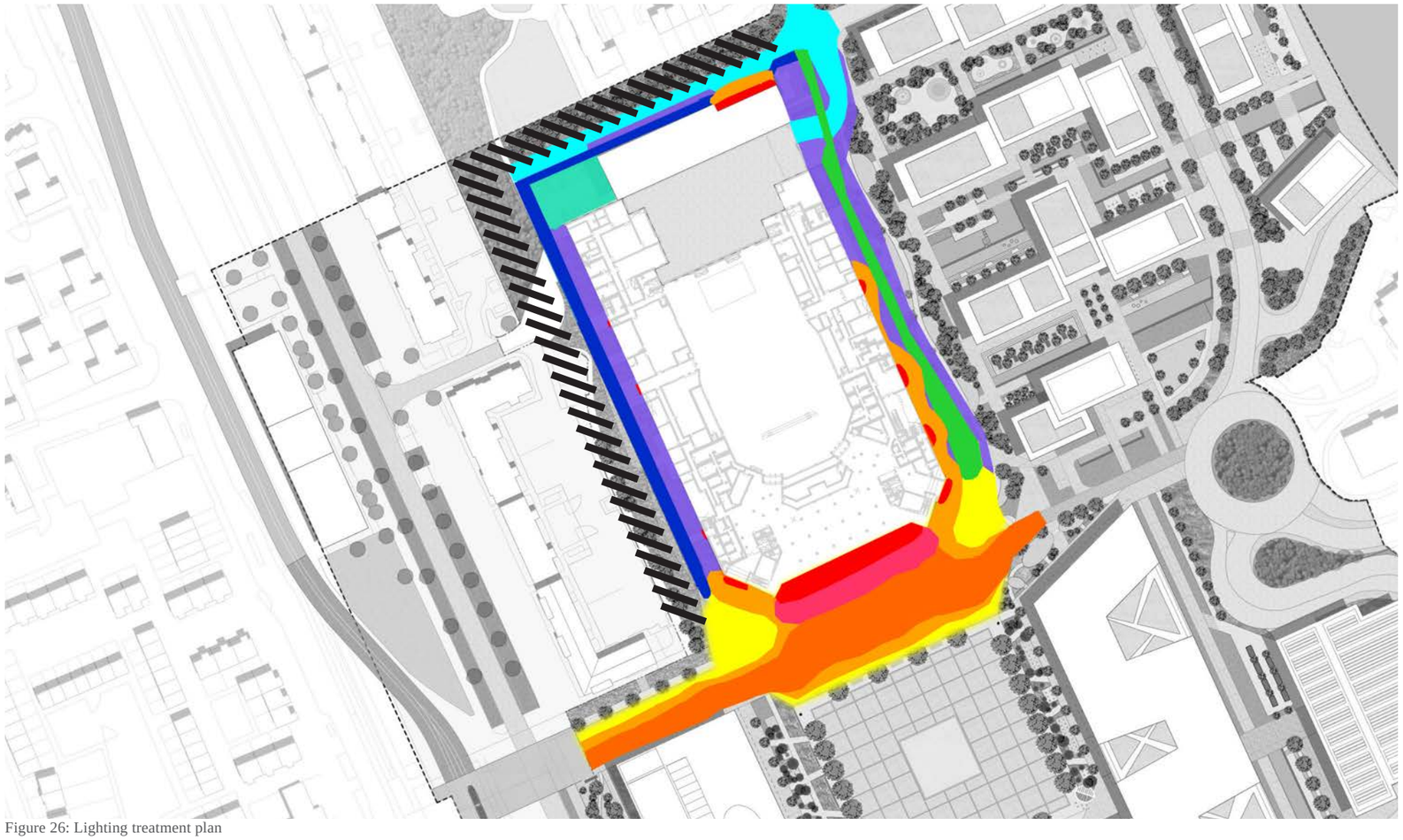


Figure 26: Lighting treatment plan

	Key	Event mode					Non-event mode					Notes
		Lighting classification	Lighting criteria			Additional Criteria	Lighting classification	Lighting criteria			Additional criteria	
			Average	Minimum	Uniformity	Ev min		Average	Minimum	Uniformity	Ev min	
	Primary route	C2	20 lux	-	0.4	5 lux	C3	15 lux	-	0.4	5 lux	BS EN 5489: event mode: Pedestrian - high traffic flow; Non-event mode: Pedestrian - normal traffic flow
	Secondary route	P2	10 lux	2 lux		3 lux	P2	10 lux	2 lux		3lux	BS EN 13201
	Tertiary rouate	P4	5 lux	1 lux		1.5 lux	P4	5 lux	1 lux		1.5lux	BS EN 13201
	Building entrance	-	100 lux	-	-	-	-	100 lux	-	-	-	BS EN 8300
	Arena plaza- transition from entrance canopy		50lux					30lux				Transitional zone within Arena plaza recieving light spill from entry canopy
	Vehicular road	P3	7.5 lux	1.5 lux	-	-	P3	7.5 lux	1.5 lux	-	-	BS EN 5489: Subsidiary road with busy traffic flow
	Car park		10 lux	-	0.25	-		10 lux	-	0.25	-	BS EN 5489: Medium traffic
	Dwell level 1	P1	15 lux	3 lux			P2	10 lux	2 lux			Illumination by light spill from adjacent areas
	Dwell level 2	P2	10 lux	2 lux			P4	5 lux	1 lux			
	Dwell level 3	P6	2 lux	0.4 lux			P6	2 ux	0.4 lux			
////												Area not lit - to encourage ecology

Table 1: Illuminance criteria

6 Environmental Zone

As the existing context of the Arena Quarter is located outside of the primary city centre, the area is considered to have relatively low district brightness in context. This document proposes that the existing area and context surrounding the site is classified as being with an E3 zone due to the size of the development and the current traffic and pedestrian flow through the site at night.

An E3 zone is defined within the Institute of Lighting Professionals (ILP) GN01: Guidance Notes for the Reduction of Obtrusive Light (GN01) as a town centre or suburban location with medium district brightness, Table 2.

But as the Arena Quarter will be developed into a major entertainment hub that connects with the city centre and has an increased pedestrian flow and night-time economy, particularly during event days, the new development of Arena Quarter would more appropriately be classified as an E4 zone.

An E4 zone is defined within the GN01 guidance as a town or city centre with high levels of night-time activity, Table 2.

It's unfair to the existing dwellings (sensitive receptor) to reclassify the existing environmental zone due to the new development. Therefore, it is proposed to have different zone classifications around the Arena Quarter.

Establishing the environmental zone helps to set the limiting lighting criteria to mitigate light obtrusion. The characteristics of light obtrusion are:

- ***Light Intrusion:*** stray light beyond the task area onto neighbouring dwellings or sensitive receptors.
- ***Source Intensity:*** how bright the light source appears to an observer.
- ***Sky Glow:*** a combination of Direct Upward Light and Indirect Upward Light. This effect is often seen as a glow in the night sky. Sky glow can be quantified in terms of upward flux and upward light output ratio which is the percentage of the luminaire output emitted above the horizontal plane.

Light obtrusion characteristics are shown graphically in Figure 27.

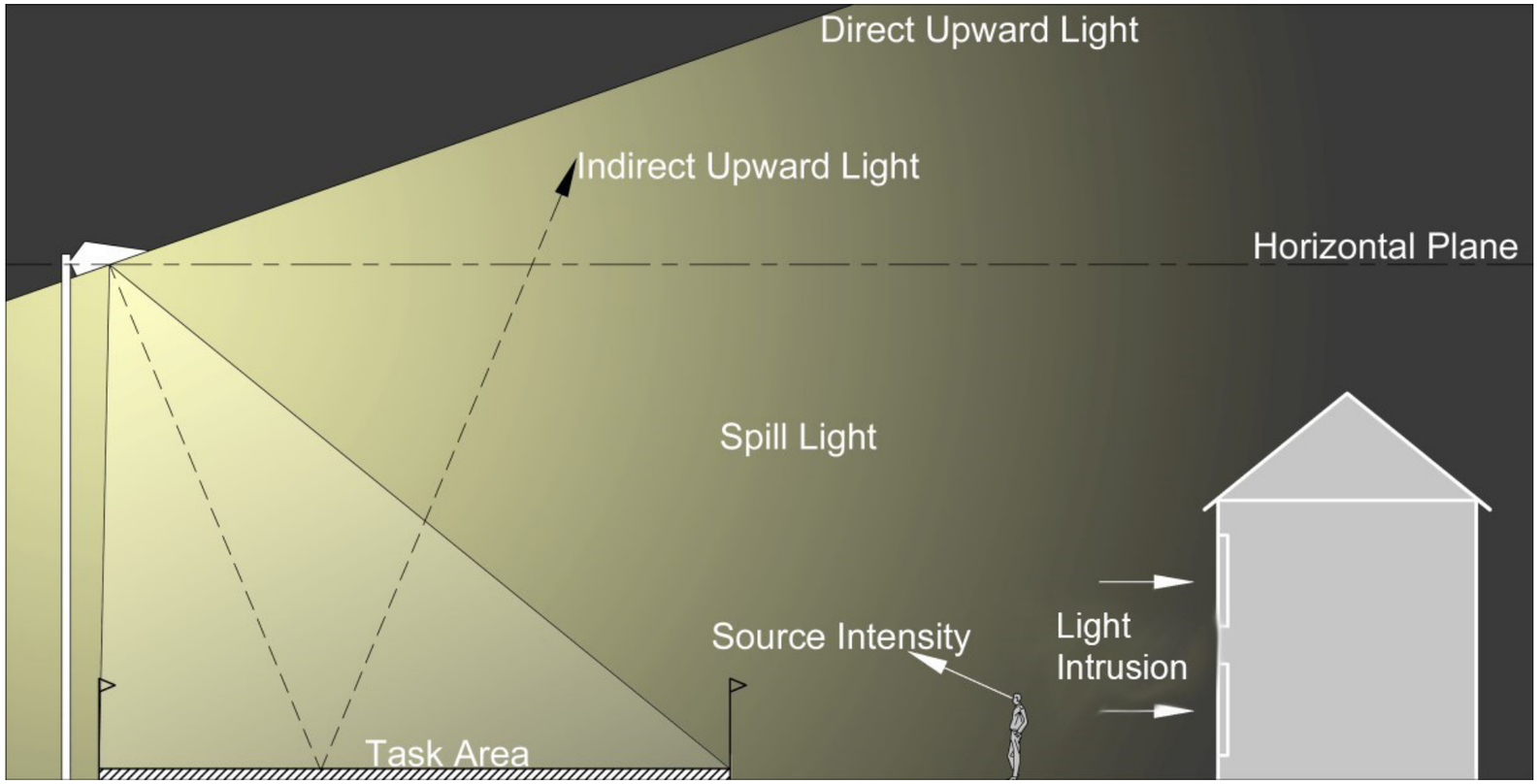


Figure 27: Light obtrusion characteristics - ILP GN01

Zone	Surrounding	Lighting environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO starlight reserves, IDA dark sky places
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.
E2	Rural	Low district brightness (SQM ~15 to 20)	Sparsely inhabited rural areas, village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, small town centres of suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

Table 2: Environmental zone classifications extract from ILP GN01

Light technical parameter	Application conditions	Luminaire group (projected area A_p in m^2)					
		$0<A_p \leq 0.002$	$0.002<A_p \leq 0.01$	$0.01<A_p \leq 0.03$	$0.03<A_p \leq 0.13$	$0.13<A_p \leq 0.50$	$A_p>0.5$
Maximum luminous intensity emitted by luminaire (I in cd)	E0 Pre-curfew	0	0	0	0	0	0
	E0 Post-curfew	0	0	0	0	0	0
	E1 Pre-curfew	0.29 d	0.63 d	1.3 d	2.5 d	5.1 d	2,500
	E1 Post-curfew	0	0	0	0	0	0
	E2 Pre-curfew	0.57 d	1.3 d	2.5 d	5.0 d	10 d	7,500
	E2 Post-curfew	0.29 d	0.63 d	1.3 d	2.5 d	5.1 d	500
	E3 Pre-curfew	0.86 d	1.9 d	3.8 d	7.5 d	15 d	10,000
	E3 Post-curfew	0.29 d	0.63 d	1.3 d	2.5 d	5.1 d	1,000
	E4 Pre-curfew	1.4 d	3.1 d	6.3 d	13 d	26 d	25,000
	E4 Post-curfew	0.29 d	0.63 d	1.3 d	2.5 d	5.1 d	2,500
Aid to gauging A_p		2 to 5cm	5 to 10cm	10 to 20cm	20 to 40cm	40 to 80cm	>80cm
Geometric mean of diameter (cm)		3.2	7.1	14.1	26.3	56.6	>80
Corresponding A_p representative area (m^2)		0.0008	0.004	0.016	0.063	0.251	>0.5

Notes:

1. d is the distance between the observer and the glare source in metres;

Table 3: Limits for the luminous intensity of bright luminaires - extract from ILP GN01

The environmental zones are proposed to be different around the arena with existing residences to the west and north of the Arena, considered sensitive receptors, in an E3 zone.

The Arena, hotel, new properties and facilities developed during the later phases of the masterplan will be in an E4 environment.

Refer to Figure 28 for a graphical representation of the environmental zoning. Refer to Figure 29 for location of the environmental zones on the masterplan.

Each environmental zone has a corresponding set of recommended limits of obtrusive light. Table 4 presents the obtrusive light criteria for each of the zones.

Existing residences, within the E3 zone, have a stricter set of limiting criteria than the proposed development. The lighting strategy and treatment proposals limit the lighting levels and potential for light spill.

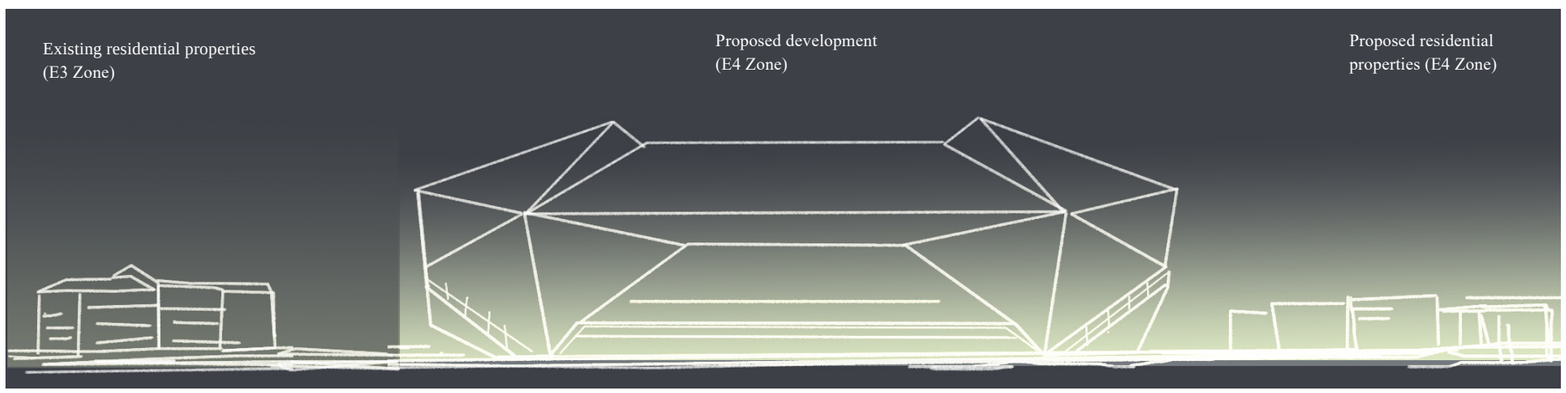


Figure 28: Sectional view showing differing environmental zones

Figure 29: Plan view showing differing environmental zones

Zone	Sky glow / ULR%	Upward flux ratio(%)	Light intrusion E_V		Maximum surface luminance(cd/m2)	
			Pre-Curfew(lux)	Post Curfew(lux)	Building facade	Sign luminance
E0	0	n/a	n/a	n/a	<0.1	<0.1
E1	0	n/a	2	<0.1	<0.1	50
E2	2.5	6	5	1	5	400
E3	5	12	10	2	10	800
E4	15	35	25	5	25	1000

Table 4: Environmental zone lighting criteria - ILP GN01

7 Brightness of Illuminated Advertisements

The final signage/advertisment on the building is still be agreed, depending upon the selected sponsor for the venue. As indicated in the architecture pack, potential options include the application of LED mesh and signage on the front elevation.

In the UK, lighting guidelines set out limiting criteria for illuminated advertisements.

The limiting criteria shown in Table 5, extracted from the ILP Professional Lighting Guide (PLG): The Brightness of Illuminated Advertisements, relate to luminance levels in Wales.

Regardless of the installation type, the Arena facade lighting strategy and any future proposals will meet and show compliance with these criteria.

Figure 30: Visualisation by HOK

Table 2: Luminance Levels for Wales and Northern Ireland	
Illuminated area	**Maximum luminance (cdm^{-2})**
More than 10 m^2	400
2 to 10 m^2	600
0.5 to 2 m^2	800
Less than 0.5 m^2	1,000

Table 5: Extract from ILP PLG05: The Brightness of Illuminated Advertisements

8 Ecological Considerations

In this document, local residences have been identifies as sensitive receptors in proximity to the Arena. Another sensitive receptor that requires lighting mitigation is ecology. Specifically, foraging bats.

In Britain, all bat species and their roosts are protected by both domestic and international legislation.

As a protected species and considering the important of biodiversity, the lighting strategy to the Arena Quarter must consider lighting guidelines associated with mitigating the impact on bats.

The lighting guideline used create an appropriate strategy for mitigation is ILP GN08: Bats and Artificial Lighting in the UK.

Based on the this guideline the following mitigation strategies will be implemented as part of this development:

- A considered set of illuminance criteria that allows for lower light levels to reduced footfall area at the perimeters of the scope line boundary. Specifically to the west and north pedestrian routes.
- Trees and landscape to the west pathway and north of the Arena, where footfall is lower, will not be illuminated to encourage ecology to occupy.
- Illuminance levels at 0 lux to bat roost locations.
- The use of an LED source.
- A warm colour temperature - 2,700K-3,000K.
- The peak wavelength of light will be >550nm.
- Carefully selected optics and accessories to illuminate the take which minimises spill into potential habitats.
- A lighting control strategy that enables the public realm lighting to be configurable based on operational hours and event/non-event modes.

9 Lighting Controls

A lighting control system will be provided to ensure lighting only on during hours of darkness and ensure the level/amount of light meets the usage and requirements of the public realm at that time. Correct commissioning and utilisation of a lighting control system will deliver the following:

- Energy saving
- Reduced carbon impact
- Reduce impact on residence and ecology (sensitive receptors)
- Reduction in obtrusive light
- Monitoring of luminaires for maintenance

As a minimum, the lighting control system will provide the following functionality:

- Switch on the electric lighting at night via a photocell of time clock control.
- The control system is capable of dimming key lighting elements.
- Capable of configuring the lighting levels for event and non-event modes.

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