



**Haweswater Aqueduct Resilience Programme
Proposed Marl Hill Section Compounds**

Lighting Management Plan Overview

RVBC-MH-APP-005

June 2021



Haweswater Aqueduct Resilience Programme

Project No: B27070CT
Document Title: Proposed Marl Hill Section Compounds - Lighting Management Plan Overview
Document No.: RVBC-MH-APP-005
Revision: Final
Date: June 2021
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Contents

1.	Introduction	1
1.1	Background	1
1.2	HARP	1
1.3	The Proposed Lighting Approach	1
1.4	Purpose of the Lighting Management Plan	2
1.5	Document Structure	2
2.	The Marl Hill Section Compounds	3
2.1	Overview	3
2.2	The Proposed Braddup Compound	3
2.3	The Proposed Bonstone Compound	4
2.4	The Proposed Clitheroe Park & Ride and HGV holding facilities	4
3.	General Approach	5
3.1	Compliance with Best Practice	5
3.2	Lighting Standards and Guidance	5
3.3	Hours of Operation	6
4.	The Marl Hill Section Compounds High Level Lighting Assessment	7
4.1	Environmental Zone and Bortle Scale	7
4.2	Proposed Site Layouts	11
4.3	Required Lighting Levels	16
4.4	Indicative Lighting Levels	16
4.5	Lighting Equipment and Controls	18
4.6	Mobile Lighting Unit Operation	20
4.7	Crane Lighting	20
4.8	Landscape Considerations at Braddup Compound	22
4.9	Ecological Considerations at Braddup Compound	23
4.10	Landscape Considerations for the Bonstone Compound	24
4.11	Ecological Considerations at the Bonstone Compound	25
4.12	Potential Mitigation Measures	25
5.	Monitoring and Verification Methods	27
5.1	Design approval fixed area lighting	27
5.2	Installation design check	27
5.3	Mobile lighting unit operation	27

Appendix A. Glossary of Terms

Appendix B. Abbreviation Table

1. Introduction

1.1 Background

- 1) The existing Haweswater Aqueduct became operational in the mid-1950s and transfers raw water from Haweswater Reservoir in the Lake District National Park to a Water Treatment Works (WTW) near Kendal for treatment. From the WTW the aqueduct conveys treated (potable) water to customers in Greater Manchester, Cumbria and Lancashire.
- 2) Inspections carried out by United Utilities uncovered areas of concern in the single line sections of the Haweswater Aqueduct. It is anticipated that the condition of these single line sections would continue to deteriorate, and therefore a solution is required to address the risks to water supply and water quality. For these reasons, it is proposed that the single line sections are replaced.

1.2 HARP

- 3) The Haweswater Aqueduct Resilience Programme (HARP), referred to as the 'Proposed Programme of Works' is broken down into five new tunnel sections and each of these sections is subject to an Environmental Impact Assessment (EIA). United Utilities is therefore submitting a series of planning applications, for these replacement sections to the corresponding LPAs and these are listed below, from north to south:
 - Proposed Docker Section: South Lakeland District Council
 - Proposed Swarther Section: South Lakeland District Council and Yorkshire Dales National Park Authority
 - Proposed Bowland Section: Lancaster City Council and Ribble Valley Borough Council
 - Proposed Marl Hill Section: Ribble Valley Borough Council
 - Proposed Haslingden and Walmersley Section: Hyndburn Borough Council, Rossendale Borough Council and Bury Metropolitan Borough Council.
- 4) Each tunnel section would have a launch shaft compound and a reception shaft compound(s) operating during the construction works. At the compounds, connections between the existing and proposed UU infrastructure would be constructed using an open cut method.
- 5) Applications for planning permission would include both the above and below ground development elements, as well as the temporary working areas and associated plant and machinery. Typical details would be used where possible with 'reasonable worst case' assumptions made where necessary. The planning application drawings incorporate limits of deviation, allowing for flexibility in the final location of proposed permanent assets.

1.3 The Proposed Lighting Approach

- 6) Where and when construction activities are taking place, particularly near the shaft locations (whether launch or reception compounds), areas would need to be lit 24 hours a day. This is particularly relevant for the tunnel launch compounds, which would have material extraction and storage activities taking place 24 hours a day within the 'main construction area' part of the overall compound in the vicinity of the shaft. Other areas around the periphery of the proposed compounds used for topsoil storage and bulk storage of materials would typically be limited to security lighting rather than higher level construction lighting. Extracted material would then be removed from site during usual working hours (07:00 to 19:00).
- 7) The temporary construction accesses, off-site highway modification works and temporary proposed haul routes would only be lit by exception where there is a specific security/safety issue e.g. at access points, next to a bridge or pedestrian route and subject to a risk assessment. Mitigation would also be used along such routes, e.g. reflectors, in the interests of safety and to avoid the need for lighting.

- 8) In summary, lighting would be required for safety reasons, when working in hours of darkness, including 24-hours a day during certain construction periods and on the areas of the site near to the shafts.

1.4 Purpose of the Lighting Management Plan

- 9) This Lighting Management Plan (LMP) is to assess the impacts of lighting generated at various compounds associated with the Proposed Marl Hill Section:
- The proposed temporary construction compounds (Braddup and Bonstone)
 - The proposed compounds for the Clitheroe Park & Ride facility and Heavy Goods Vehicle (HGV) holding facility at the Ribblesdale cement works.
- 10) The LMP also proposes good practice measures to manage the impact of this temporary lighting.
- 11) Lighting would be of the lowest lux levels necessary for safe delivery of each task based on BS EN 12464-2 (2014)¹. It would be designed, positioned and directed to reduce the intrusion into any nearby properties and wildlife habitats.
- 12) Where practicable, any activity carried out or equipment located within a construction compound that may produce a noticeable nuisance from lighting would be located away from sensitive receptors, such as residential properties or ecological sites.
- 13) Relevant guidance on mitigating the impact of artificial lighting on bats would be applied where practicable. This includes good practice measures that would:
- Limit illumination of confirmed bat roosts, or trees with moderate or high potential to support bat roosts
 - Limit times that the lights are on and consider factors such as height of lighting columns and use of light sources with minimal ultra-violet.
- 14) In summary, this LMP provides the proposed general lighting approach for the compound listed above - as applicable. The Contractor(s) would then adopt the principles contained within this LMP.

1.5 Document Structure

- 15) In addition to the background to the proposed Programme of Works and identification of likely receptors, this document contains the following elements:
- Details of the Braddup and Bonstone construction compounds and the Clitheroe Park & Ride facility and HGV holding area
 - General approach to lighting requirements and standards
 - Description of the plan, as applicable to the whole of the works covering normal work fronts, requirements associated with lighting of the temporary compound, including periods of 24 hours a day working
 - High level assessment, site considerations and modifications to the general plan as applicable to the environmentally sensitive areas
 - Monitoring and verification methods.

¹ BS EN 12464-2 (2014) Light and Lighting. Lighting of work places. Outdoor work places.

2. The Marl Hill Section Compounds

2.1 Overview

- 16) The temporary proposed Braddup and Bonstone construction compounds are within the Proposed Marl Hill Section of the Programme of Works. The Bonstone Compound would be the reception site for the tunnel boring machine (TBM) from the Braddup launch compound to the south. It is estimated that both construction compounds would be required in some form for approximately 3 years, with an estimated earliest commencement in 2024. Enabling works, such as highway modification works and the Proposed Ribble Crossing, may commence sooner in 2023.
- 17) The proposed Clitheroe Park & Ride facility and the HGV holding facility would be located at the Ribblesdale Cement Works, with the Park & Ride facility on land to the west of West Bradford Road and the HGV facility located on land to the east of West Bradford Road. The proposed temporary Clitheroe Park & Ride and HGV holding facilities are required for both the Proposed Marl Hill Section and the Proposed Bowland Section within the borough of Ribble Valley. They would be required for the duration of the associated works and thus for an approximate period of seven years commencing in 2023.

2.2 The Proposed Braddup Compound

- 18) The compound would be located, on agricultural land to the north of Waddington, off Slaidburn Road, accessed via an existing track. It is within a rural landscape with farmhouses nearby and also several sensitive wildlife habitats. For further information regarding sensitive receptors please refer to Sections 4.8 and 4.9.
- 19) The temporary compound would be based around a launch shaft. The proposed layout is shown on Figures 4 and 5 and consists of:
- Creation of site access off existing access road
 - Topsoil stripping, with storage for reinstatement
 - Earthworks to create level areas in the site and in particular the creation of platforms for working machinery and haul routes where necessary
 - The provision of compound surface run off drainage including packaged water treatment plant and attenuation lagoon
 - Site fencing, including hoarding installed around the main compound shaft working area to a height of 2.4m and, where appropriate, heras fencing would be used around any other working/storage areas
 - Plant including a transformer, a generator, fuel tanks, facilities for waste storage and 45m high crane at the main shaft
 - Temporary site cabins for offices, welfare, workshops and stores
 - Material storage areas e.g. tunnel segments and consumables that would enter the tunnels in this location
 - Areas of open cut works to connect into existing United Utilities infrastructure
 - Culverting works
 - Lighting.
- 20) Arisings from tunnel construction would be brought to the surface at the compound and may require some form of processing such as dewatering within the construction areas. While tunnel arisings may be brought to the surface on a 24 hours per day basis, surplus materials would be taken off site within agreed working hours to minimise effects on local communities. This approach is likely to require the temporary storage of material on-site.

2.3 The Proposed Bonstone Compound

- 21) The proposed compound would be located on agricultural land approximately 1.5km south of Newton-in-Bowland and approximately 600m to the west of Slaidburn Road. It is within a rural area and with farmhouses nearby and also several sensitive wildlife habitats. For further information please refer to Sections 4.10 and 4.11.

Compound Layout

- 22) The temporary compound would be based around a reception shaft. The proposed layout is shown on Figures 7 and 8 and made up of:
- The creation of site access off existing access road
 - Topsoil stripping, with storage for reinstatement
 - Earthworks to create level areas in the site and in particular the creation of platforms for working machinery and haul routes where necessary
 - The provision of compound surface run off drainage including packaged water treatment plant and attenuation lagoon
 - Site fencing, including hoarding installed around the main compound shaft working area to a height of 2.4m and, where appropriate, heras fencing would be used around any other working/storage areas
 - Plant including a transformer, a generator, fuel tanks, facilities for waste storage and 45m high crane at the main shaft
 - Temporary site cabins for offices, welfare, workshops and stores
 - Material storage areas e.g. shaft segments
 - Areas of open cut works to connect into existing United Utilities infrastructure
 - Lighting.
- 23) The preparation and use of the compound would require the clearance of vegetation, including felling of trees and hedge removal outside of seasonal ecological constraints.

2.4 The Proposed Clitheroe Park & Ride and HGV holding facilities

- 24) The proposed Park and Ride and HGV holding facilities are proposed at the Ribblesdale Cement Works in Clitheroe (see Figure 6).
- 25) The Park & Ride facility would be located on an existing works' car park to the west of West Bradford Road and welfare facilities would be provided on the site for the duration of the works.
- 26) The HGV holding facility would be located on hardstanding/car park areas within the main site, to the east of West Bradford Road. It is proposed that large construction vehicles would be held within the HGV holding area for short periods of time before being released back onto the construction traffic routes towards the Bonstone and the Braddup compounds (included in the Marl Hill Section Planning application), and the Newton-in-Bowland compound.
- 27) Both areas currently have lighting and it is not proposed to alter such lighting.

3. General Approach

3.1 Compliance with Best Practice

28) The concept of ‘Environmental Zones’, as introduced by the Commission Internationale de l’Eclairage as updated by the Institute of Lighting Professionals (ILP)(2020), has informed this LMP. The Environmental Zone classes are set out in Table 32. The existing lighting context of the area surrounding the Proposed Braddup and Bonstone Compounds has been considered against this system of lighting classification to develop appropriate levels of lighting performance set within this LMP.

3.2 Lighting Standards and Guidance

29) The following external lighting standards and guidance documents have informed the lighting strategy and minimum requirements for the construction and operation lighting for the temporary construction compounds.

Table 1: Relevant lighting standards and guidance

Category	Relevant Standards and Guidance
British Standards	<ul style="list-style-type: none"> ▪ BS 5489 – 2020 Code of practice for the design of road lighting – Part 1: Lighting of Roads and Public amenity areas³ ▪ BS EN 13201 – 2003 Road lighting- Part 2 - performance requirements⁴ ▪ BS EN 12464 – 2014 Light and lighting of workplaces- Part 2- outdoor workplaces⁵
Local Policy	<ul style="list-style-type: none"> ▪ Dark Skies Policy
Other Regulations	<ul style="list-style-type: none"> ▪ ILP. GN01: 2020 Guidance Notes for the Reduction of Obtrusive Light ▪ ILP Bats and Lighting in the UK (2019)⁶ ▪ ILP – High masts for lighting and (2013)⁷ ▪ CIBSE Building Regulations Approved Document L2B (with particular reference to metering and CIBSE TM39)⁸

30) Compliance with these requirements requires the proper design of all construction lighting, however temporary, including:

- Appropriate assessments of receptors and impact
- Monitoring
- The use of appropriate lighting fixtures, heights, hoods / cowls and louvres
- The use of timers
- The use of sensor operated systems
- The use of red bat friendly LED lighting technology.

² Institute of Lighting Professionals (2020) Guidance Note 1 for the reduction of obtrusive light 2020, ILP

³ BSI (2020) BS 5489-1:2020 Design of road lighting. Lighting of roads and public amenity areas. Code of practice, BSI

⁴ BSI (2003) BS EN 13201-2:2003 Road lighting. Performance requirements, BSI

⁵ BSI (2014) BS EN 12464-2:2014 Light and Lighting. Lighting of work places. Outdoor work places, BSI

⁶ ILP (2019) Guidance Note 08/18. Bats and artificial lighting in the UK, ILP

⁷ ILP (2013) Professional Lighting Guide 07. High masts for lighting and CCTV, ILP

⁸ CIBSE (2016) Building Regulations Approved Document L2B. Conservation of fuel and power in existing buildings other than dwellings, CIBSE

3.3 Hours of Operation

- 31) For the Proposed Braddup Compound, the launch shaft construction, tunnelling works and the connection works would require 24 hour working and therefore suitable lighting to ensure safe operations would be necessary. Whilst the requirements of ILP (2020) may not therefore be achievable during a night-time curfew period, the lighting would be the lowest average lux levels necessary for safe delivery of each task and shall be positioned, and directed to reduce the intrusion into adjacent properties and other local habitats.
- 32) For the Proposed Bonstone Compound, day working and overnight security would be required. 24 hour working for the final connection works would be required, therefore suitable lighting to ensure safe operations would be necessary. Whilst the requirements of GN01:2011 may not therefore be achievable during a night-time curfew period for a short period of time, the lighting would be the lowest average lux levels necessary for safe delivery of each task and shall be positioned, and directed to reduce the intrusion into adjacent properties and other local habitats.
- 33) For the Clitheroe Park and Ride and HGV holding facilities, daytime usage is assumed, utilising the existing site lighting during winter months.

Table 2: Description of work durations

	Approximate total duration of compound/activity	Associated Operations (where lighting may only be required at certain times)
Braddup Compound (launch)	Estimated 3 years (with ~2.5-year construction activity) Estimated earliest commencement 2024	No inactive periods during construction period Drive shaft construction and tunnelling works at the Braddup Compound would require. 24 hour working.
Bonstone Compound (reception)	Estimated 3 years (with ~2-year construction activity) Estimated earliest commencement 2024	Total indicative period of inactivity 40% Reception shaft and HA connection. Day working, overnight security and 24 hour working for final connection
The Clitheroe Park and Ride facility and HGV holding Area	Required for the duration of the Proposed Marl Hill and Bowland Sections and thus would be required for an approximate period of seven years commencing in 2023 (as the Proposed Bowland Section has a duration of 7 years).	Typically daytime usage, but utilising the existing site lighting

4. The Proposed Marl Hill Section Compounds High Level Lighting Assessment

4.1 Environmental Zone and Bortle Scale

- 34) There are various environmental considerations that need to be taken into account when considering the installation of exterior lighting. These are the direct energy usage, the visual impact of the lighting equipment during the day, the effect of light spillage on surrounding areas, the spill of light into the night sky, and the effects on human receptors, animal, plant life and surrounding landscape.
- 35) ILP (2020) establishes five Environmental Zones. Each zone has a different approach to the provision of external lighting. These zones establish 'Obtrusive Lighting Limitations for External Lighting Installations' and include the effects of 'Sky Glow' and maximum values of vertical illuminance on properties. The document also includes 'limits for the luminous intensity of bright luminaires'; the potentially obtrusive direction of light outside the area being lit. The zones are listed in Table 2 of ILP (2020), which is reproduced as Table 3 in this document.
- 36) The Braddup Compound is situated in a rural location and in an Area of Outstanding Natural Beauty (AONB) and there is still light pollution visible from the nearby town and village. The closest village is Waddington, which is located approximately 2 km south east of the Braddup Compound. The village roads are lit with 5 m post top lights. Glow from these streetlights would be visible on cloudy evenings from the proposed site. Slaidburn Road, approaching the access road from Waddington to the site, is unlit. The town of Clitheroe is located 3.5 km south east of the site. Sky glow from Clitheroe will be visible from Waddington and the Braddup Compound. The Braddup Compound is within an area identified by CPRE as an area with the least amount of 'light blight'. i.e. darkest skies. There are no dark skies visitor locations near to the Braddup Compound.
- 37) The Clitheroe Park & Ride and HGV holding facilities are proposed at the Ribblesdale Cement Works in Clitheroe. The park and ride facility would be located on an existing works car park to the west of West Bradford Road and HGV facility would be located on the main site to the east of West Bradford Road. West Bradford Road is lit with approximately 8m columns and both the Park and Ride and HGV holding facilities have existing lighting. It is assumed no additional lighting would be required for these sites and the environmental zone is E3. No landscape or ecological considerations have been presented within this report for these areas as no changes are being proposed.
- 38) The proposed Bonstone compound is situated in a rural location and in the Forest of Bowland Area of Outstanding Natural Beauty (AONB) approximately 6 km north west of Clitheroe. The proposed compound would be located on agricultural land and approximately 1.5km south of Newton-in-Bowland, and approximately 600 m to the west of Slaidburn Road. It is within a rural area and with several sensitive wildlife habitats. For further information please refer to Sections 4.10 and 4.11.
- 39) The area around the proposed Braddup and Bonstone compounds has been assessed as E1, as outlined in Table 3.

Table 3: Environmental zones

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

Zone	Surrounding	Lighting environment	Examples
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

- 40) The Bortle scale is a nine-level numeric scale that measures the night sky's brightness of a particular location. It quantifies the astronomical observability of celestial objects and the interference caused by light pollution. The Bortle Dark Sky Scale was developed by John Bortle "based on nearly 50 years of observing experience", to describe the amount of light pollution in a night sky. It was first published in a 2001.
- 41) The Bortle Dark Sky Scale classifies the Braddup Compound and the Bonstone Compound as a Bortle 4, as indicated by the dialogue box in Figures 1 and 2. The Bortle 4 is rural/suburban transition.
- 42) The Bortle Dark Sky Scale classifies Clitheroe Park & Ride and HGV Holding at the Ribblesdale Cement Works in Clitheroe as Bortle 5, as indicated by the dialogue box Figure 3.
- 43) Description of Bortle 5:
- Hints of the zodiacal light are seen on the best spring and autumn nights.
 - The Milky Way is very weak or invisible near the horizon and looks rather washed out overhead.
 - Light sources are evident in most if not all directions.
 - Clouds are quite noticeably brighter than the sky itself.
- 44) Description of Bortle 4:
- The zodiacal light is still visible, but does not extend halfway to the zenith at dusk or dawn
 - Light pollution domes visible in several directions
 - Clouds are illuminated in the directions of the light sources, dark overhead
 - Surroundings are clearly visible, even at a distance
 - The Milky Way well above the horizon is still impressive, but lacks detail
 - M33 is a difficult averted vision object, only visible when high in the sky
 - Limiting magnitude with 12.5" reflector is 15.5.

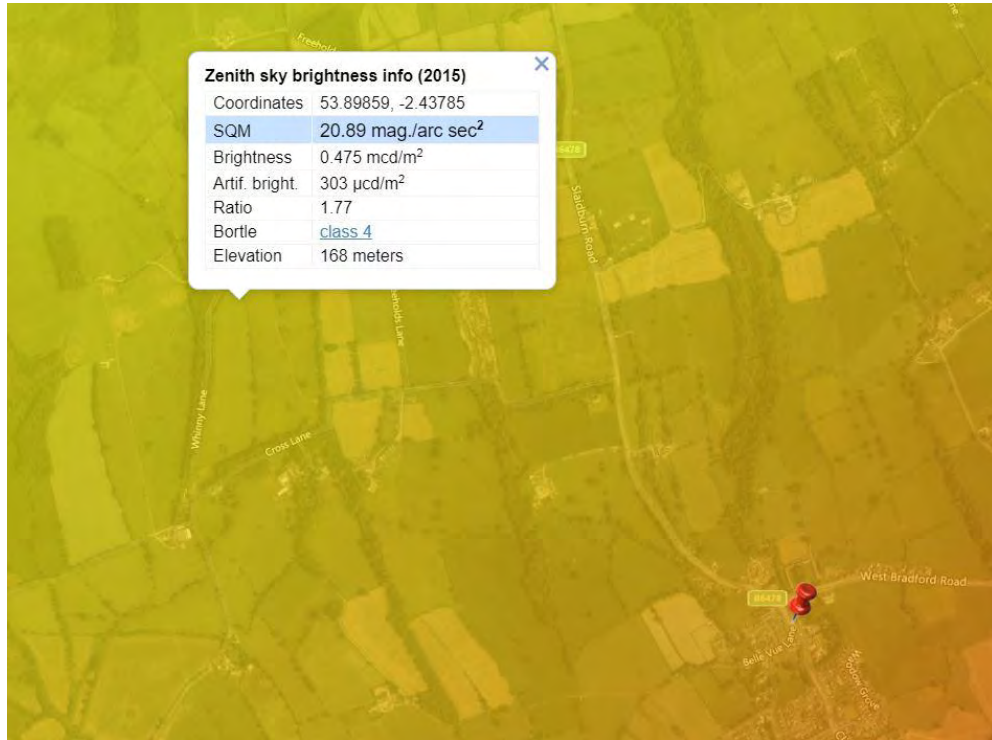


Figure 1: Zenith Sky Brightness Information Braddup Compound

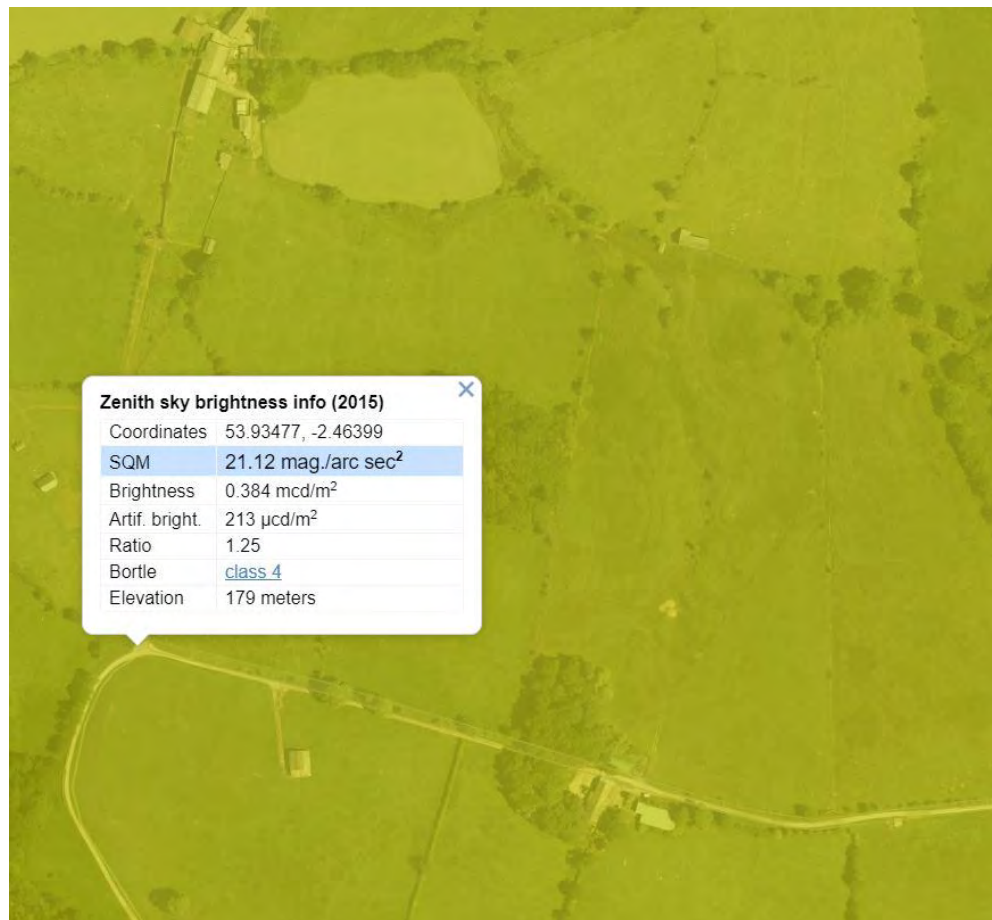


Figure 2: Zenith Sky Brightness Information Bonstone Compound

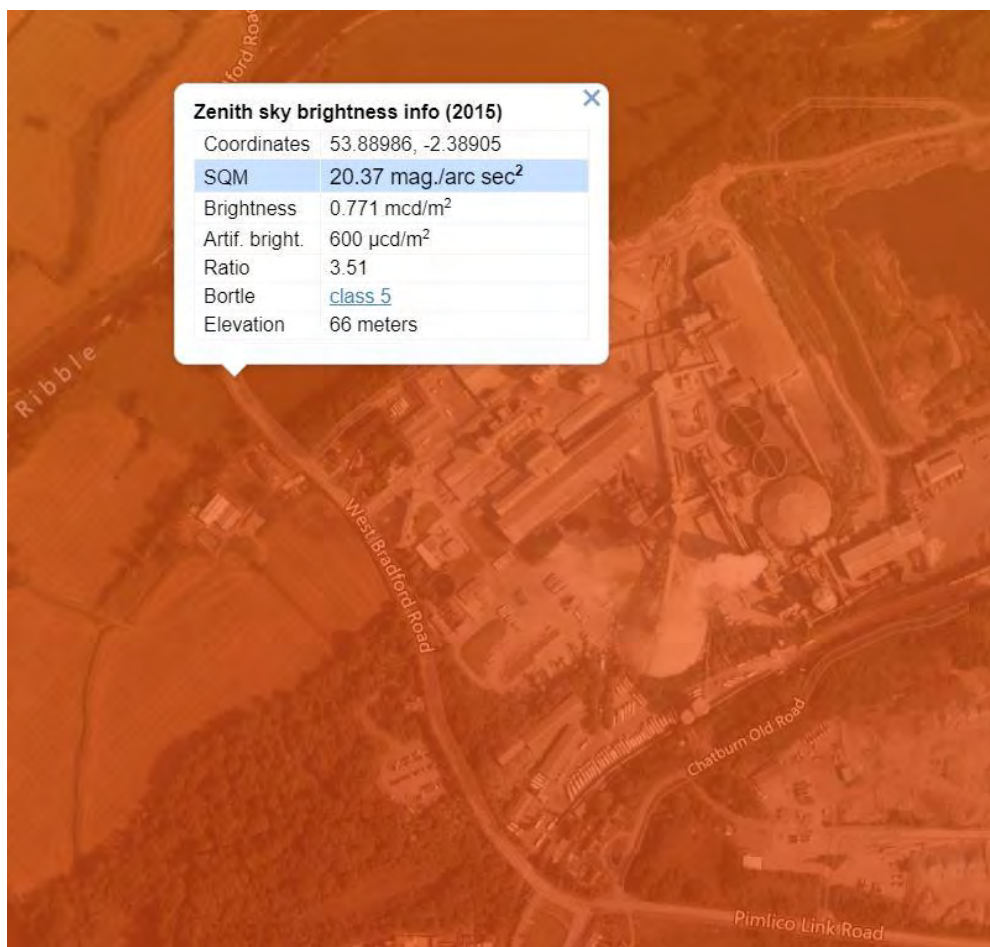
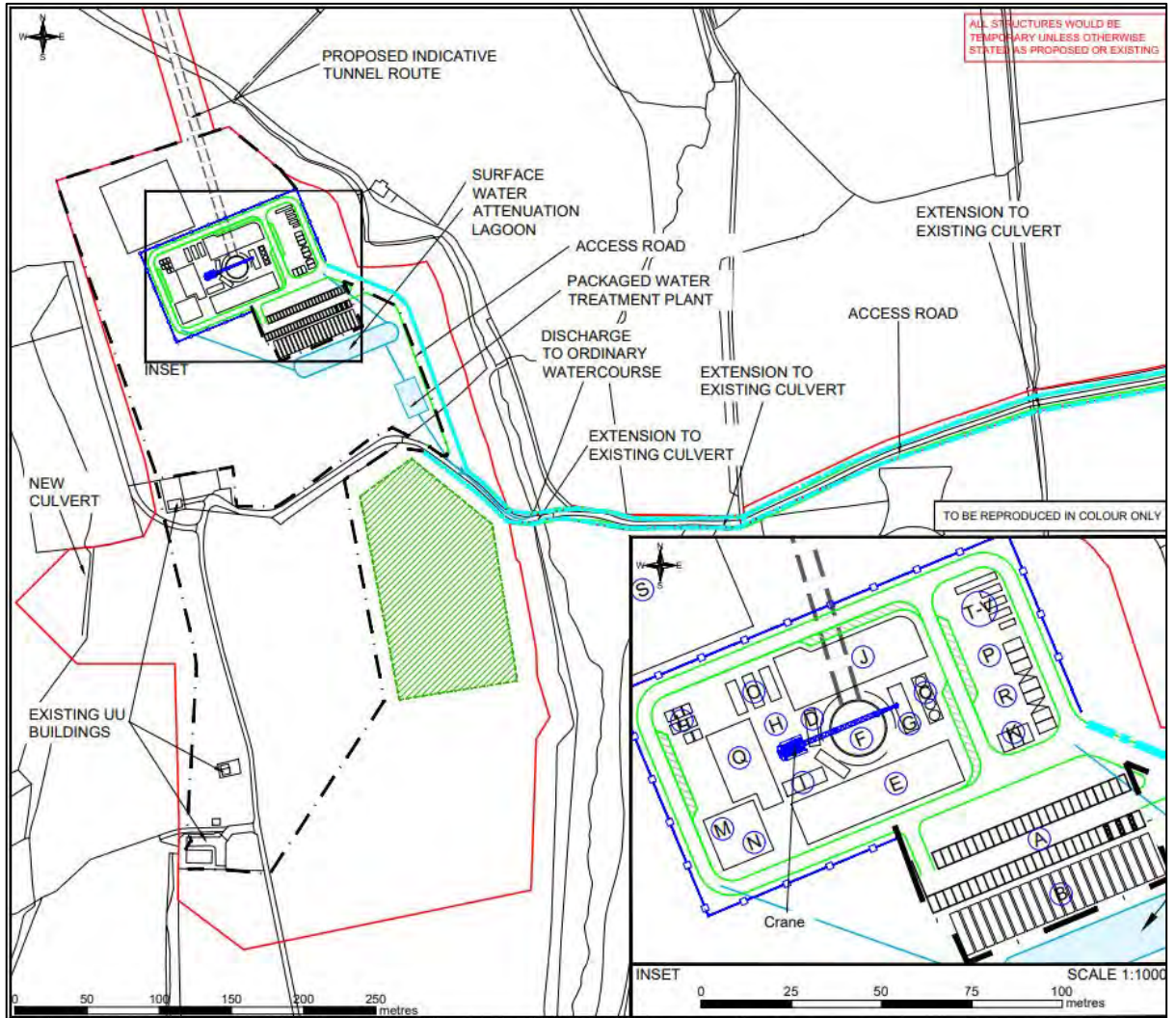


Figure 3: Zenith Sky Brightness Information Clitheroe Park & Ride and HGV Holding Facility

4.2 Proposed Site Layouts

45) Figures 4 and 5 show the Proposed Braddup Compound site layout. Figure 6 shows the Proposed Clitheroe Park & Ride and HGV Parking site and Figures 7 and 8 show the Proposed Bonstone Compound.



Legend

- Site red line boundary
- 2.4m Hoarding fence
- 2m Temporary fencing (Heras type)
- 1.3m Stock proof post and rail fence
- Initial site access / laydown / materials marshalling to facilitate site establishment. Potential temporary materials marshalling (tunnel arisings)

A	Car park	L	Skips
B	Offices + welfare	M	Oil grease
C	Bentonite & grout deliveries	N	COSHH stores
D	Vent	O	Intervention equipment
E	Area for 100 rings	P	Water cooling settlement
F	15m dia. shaft	Q	Laydown smaller crane & telehandler
G	Tally hut	R	Workshops / stores
H	Crane pad	S	Site strip earth mound
I	Rails for loco maintenance	T	Diesel fuel tank
J	Muck bin	U	Transformer
K	General stores delivery	V	Generator

Figure 4: Braddup Compound indicative site layout 1

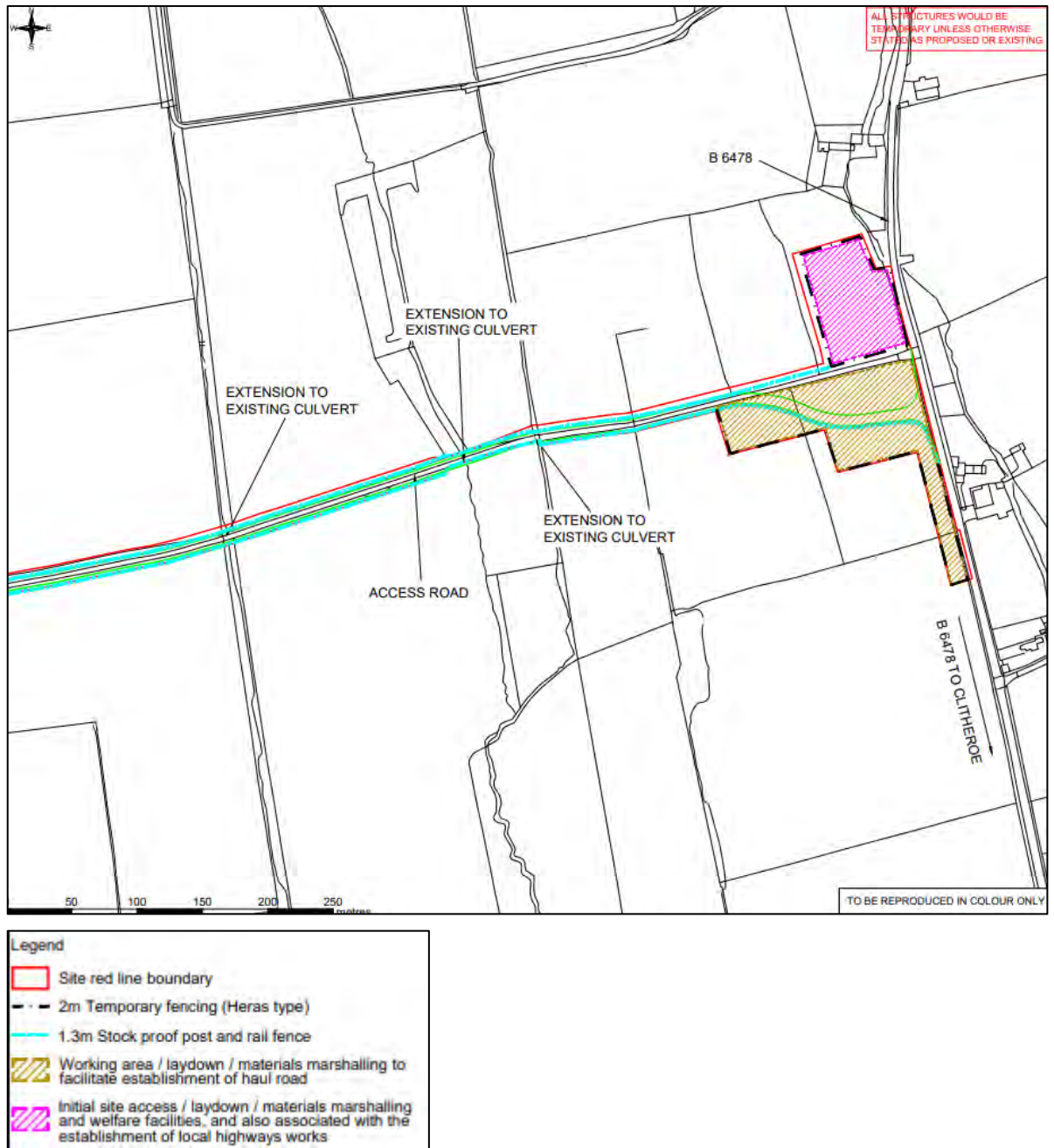


Figure 5: Braddup Compound indicative site layout 2

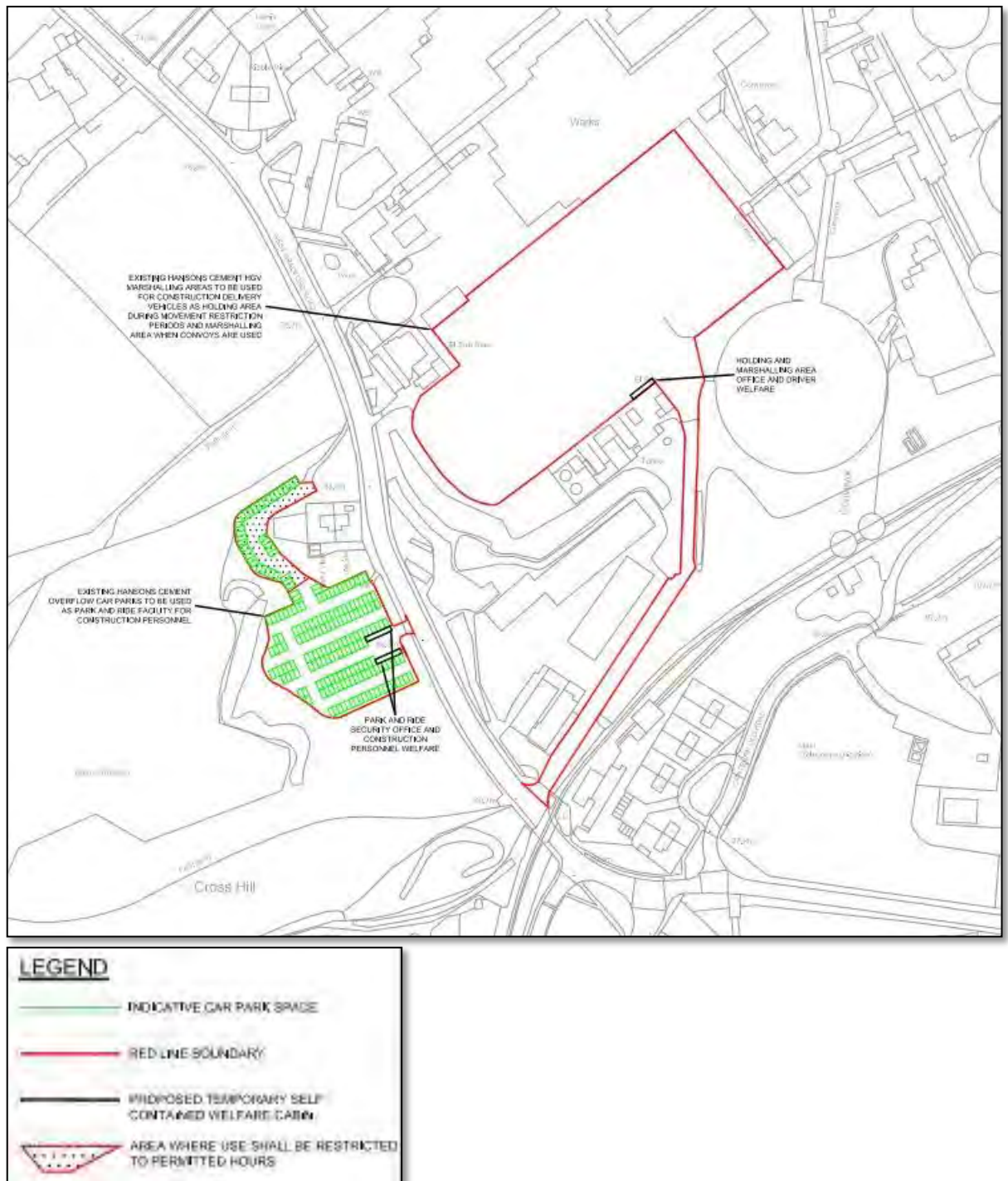
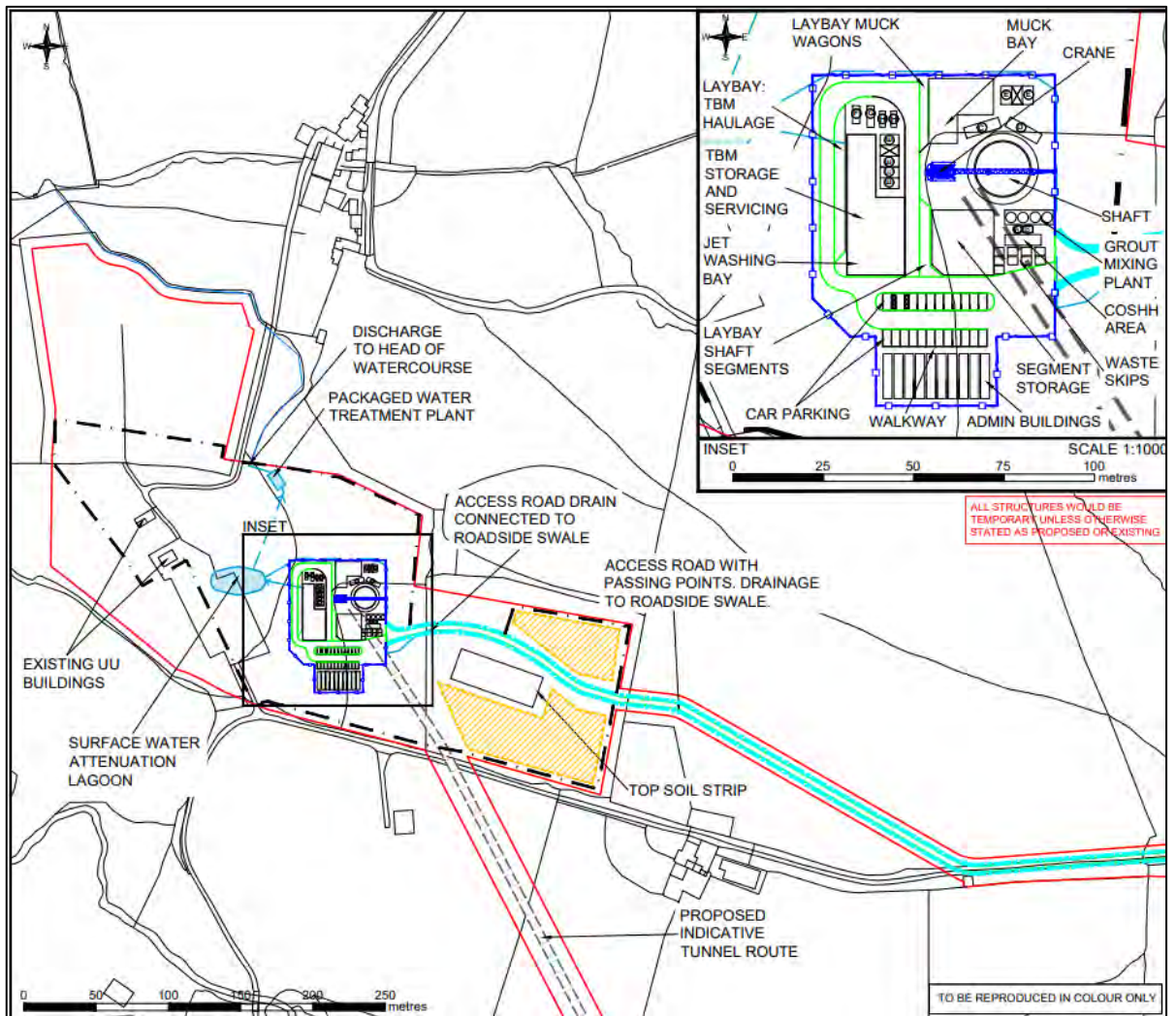


Figure 6: Clitheroe Park and Ride facility and HGV area



Legend

- Site red line boundary
- 2.4m Hoarding fence
- 2m Temporary fencing (Heras type)
- 1.3m Stock proof post and rail fence
- Potential temporary material marshalling / storage

A	Compressor	E	TBM stores & M+E workshops
B	Air receiver	F	Diesel fuel tank
C	Ventilation fan	G	Transformer
D	Air receiver	H	Generator
TBM	Tunnel boring machine		

Figure 7: Bonstone Compound indicative site layout 1

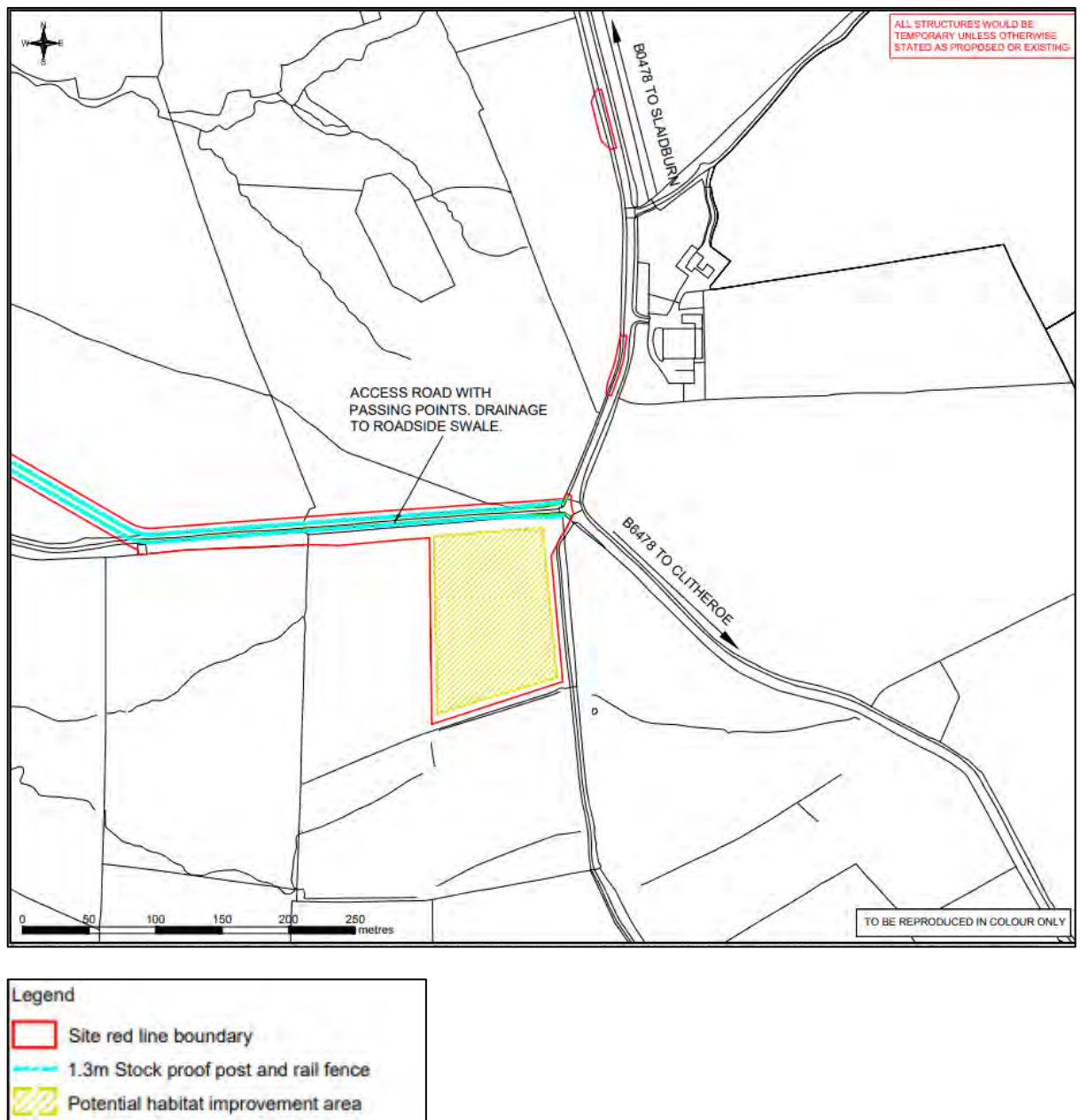


Figure 8: Bonstone Compound indicative site layout 2

- 46) The primary objectives of lighting during the construction phase are to provide illumination for construction activities and security lighting. This provides a safe working environment in the absence of natural light, allowing workers and site traffic to safely undertake various construction-related tasks.
- 47) The Braddup Compound is considered to be within an E1 Environmental Zone. The required lighting therefore needs to be designed to minimise impact on the surrounding environment.
- 48) The Clitheroe Park and Ride and HGV holding area has existing lighting and it is assumed this lighting complies with the relevant British lighting standards for parking and HGV movements. These compounds are located in a lit urban area and classed as E3.
- 49) The objectives of the construction lighting are to achieve the following:
 - Provide a safe working environment, meeting statutory requirements and standards
 - Allow 24hr working (when required)

- Provide site security lighting
- Mitigate the impact of artificial lighting on the surrounding environment as far as reasonably practicable.

4.3 Required Lighting Levels

- 50) Due to the dynamic nature of a construction site, different levels of illumination are needed for certain tasks or stages in the construction process in order to provide a safe working environment. Some areas would require suitable task lighting while other areas would require a level of ambient lighting.
- 51) Task lighting would typically be provided for construction activities and the required levels would vary depending upon the type of activity being undertaken. For example, clearance, excavation and loading typically requires an average of 20 lux, whereas undertaking fine work such as framework element mounting, light reinforcement work, piping and cabling typically require an average of 100 lux or more. There are various standards with various lighting levels which set out the required lighting levels for the various tasks that would need to be undertaken and indicative levels can be found in Section 4.4 of this document. The most appropriate standard shall be used.
- 52) Task lighting would also be required at security check points to allow the inspection of vehicles entering and exiting the site. It shall be the responsibility of the Contractor to undertake the design of any required task lighting making sure it meets with the required standards.
- 53) Ambient lighting would be constant and typically be provided to aid the safe navigation for areas such as access roads, footpaths, car parks and contractors’ compounds. Typical levels would be an average of 5 to 50 lux, depending on the area to be lit. There are various standards which set out the required lighting levels for the various tasks that would need to be undertaken and these can be found in Section 4.4 of this document. The most appropriate standard shall be used. Where ambient lighting is identified as ‘required’, it would be implemented whenever natural light levels are insufficient.

4.4 Indicative Lighting Levels

Table 4: Indicative lighting levels

Description	Assumed lux level during construction	Degree of tilt	Upward lighting	Comments
Main construction area around the shaft location	General lighting 100 lux. Localised tasks 200 lux to 500 lux average dependent on the safety standard lighting requirements for a specific task. Crane at launch shaft for duration and reception shafts for a limited period.	0° tilt, with main area lighting mounted on columns ranging from 12 m to 6m. A crane of up to 45 m for limited number of operations. Utilisation of static crane location to place luminaires to avoid the creation of dark spots.	Yes – during construction when specific types of construction are required such as rebar work. Contractor would require upward and downward light to comply with safe working requirements. This would be for limited periods of time.	Various levels for task and ambient lighting would be required in this area.

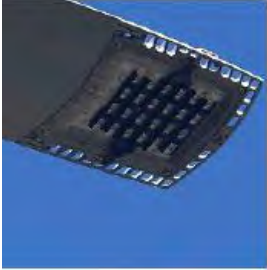






Description	Assumed lux level during construction	Degree of tilt	Upward lighting	Comments
Other more peripheral compound areas	General lighting 50 lux average with a minimum of 25 lux.	0° tilt, with main area lighting mounted on columns ranging from 12 m to 6 m	None assumed	Task and ambient lighting to specific lighting levels within the temporary construction area would be required at various periods during the construction programme. Ambient lighting would mainly be limited to the roads and car and HGV parking areas but may also include areas of contractor's compounds
Temporary construction area – Bunds and stockpiles.	50 lux average with 25 lux average. Refer to Section 4.6	0° tilt	None assumed	Task lighting would be required exceptionally when there is a requirement to carry out material movements or essential maintenance in hours of darkness. There would typically be no ambient lighting in these areas, as they are expected to be used infrequently during hours of darkness. Any fixed lighting in these areas would only operate when there is a requirement to access the area.

Description	Assumed lux level during construction	Degree of tilt	Upward lighting	Comments
Temporary construction area – Offices and Welfare	Braddup Compound various levels depending on area. Footpaths and roads around the main site but not including the access road from Slaidburn Road to the main site area would be lit to minimum safe levels. Bonstone Compound Various levels depending on area. Footpaths and roads around the main site but not including the access road from to the main site area. Security lighting in the evening from 19:00 when site is not operating a 24 hour operation and would be lit to minimum safe levels for security. The use of proximity sensors would be considered where practicable at both compounds. Clitheroe Park and ride and HGV has existing lighting and no changes are currently being proposed.	0° tilt. Lighting columns would be a maximum of 6 m and where possible attached to building structures.	None assumed	Ambient lighting would be required. Car parks and footpaths for safe walking to and from office and welfare facilities.

4.5 Lighting Equipment and Controls

54) When required, the chosen lighting equipment shall meet the requirements set out in the document. The below table gives examples of acceptable products and installations that can be used, and examples of equipment and installations that are not acceptable and would not be used. This document does not specify specific products as advancements in lighting control is ongoing and does not predict what products would be available in the future. Lighting would be controlled and upward light would be controlled where practicable. Consideration would be given to solar powered lighting products in areas away from the main site. Future new technologies would also be evaluated at the time of detail design. Lighting standards are being reviewed and updated regularly and these would also be assessed at the time of detail design.

Table 5: Luminaires and installations examples

Acceptable Products/Installations		Unacceptable Products/Installations	
	Example of a good LED flat glass full cut-off luminaire with good optical control and custom shield. For column mounting.		Example of a poorly shielded luminaire that would still produce upward light. Replacement is a better option.
	Example of a good LED flat glass full cut-off area luminaire. For column or building / surface mounting.		Example of poorly installed and aimed area luminaires.
	Example of a good LED flat glass full cut-off luminaire with good optical control. For building / surface mounting.		Example of bad building / surface mounting luminaire with no optical control.
	Example of portable site lighting unit with well positioned luminaires.		Example of bad portable balloon-type lighting with no control of upward light.

4.6 Mobile Lighting Unit Operation

- 55) The requirement for supplemental lighting in varied locations around the construction site requires careful planning and consideration to sensitive light receptors in and around the site. Good practice would be adopted and would involve:
- Close monitoring of these mobile lighting units would be required when needed to supplement lighting around the boundary
 - Knowledge of where the key sensitive receptors are in relation to night-time operations and careful placement of mobile lighting units to ensure that no extraneous light is falling onto these locations
 - Mobile units require backlight shields and need to be directed away from the key sensitive sites. There would be no tilt allowed on these units
 - The Contractor would be responsible for training the operatives in how to correctly position the mobile units and make them aware of the locations of the key sensitive receptors. The temporary lighting would be monitored by the Environmental Clerk of Works.
- 56) Figure 9 shows an example of a typical mobile lighting tower rig with four luminaires mounted at approximately 9 m and the lighting levels achieved.

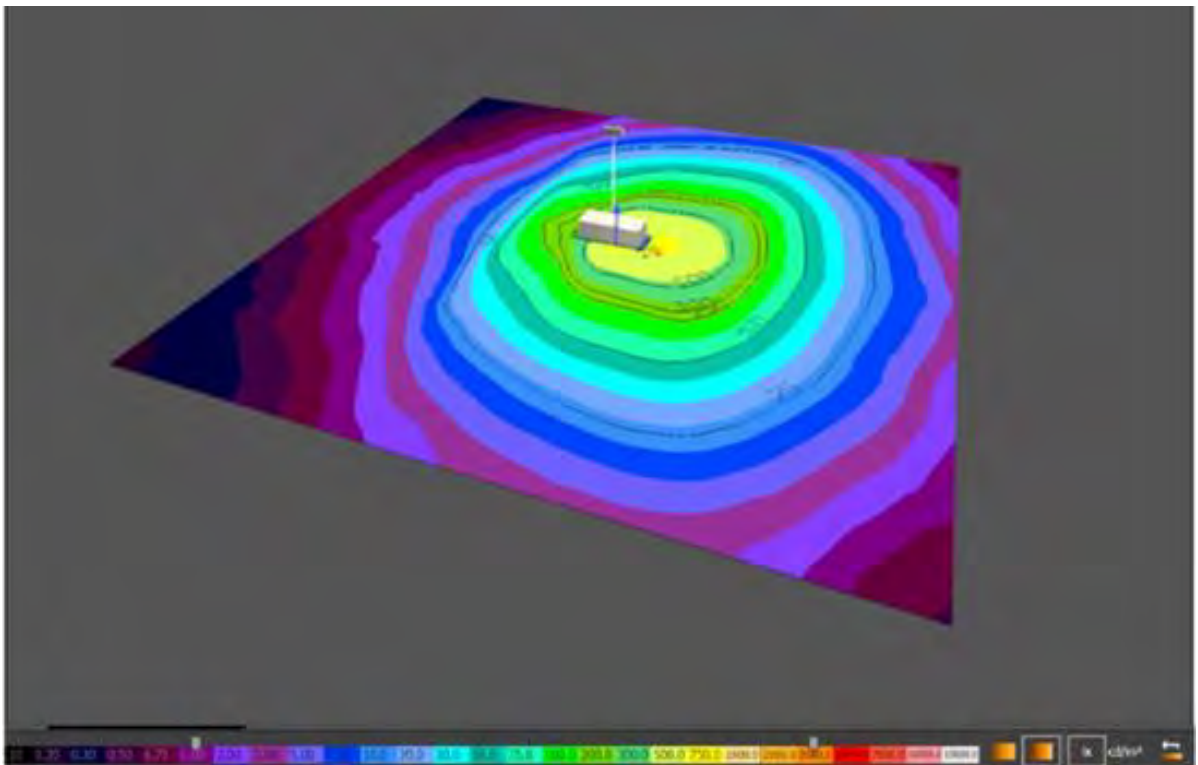


Figure 9: Example of light distribution of mobile lighting unit

4.7 Crane Lighting

- 57) It is assumed that during the tunnelling works a 45 m crane high centred above the tunnel shaft would be required for the site. This would have specific luminaires to light the crane hook when in operation (Figure 10). The lights would have a 0° tilt since their purpose is to enable the crane operator to see the hook below, hence no tilt is required.
- 58) Aircraft warning lights would also be required on the crane.

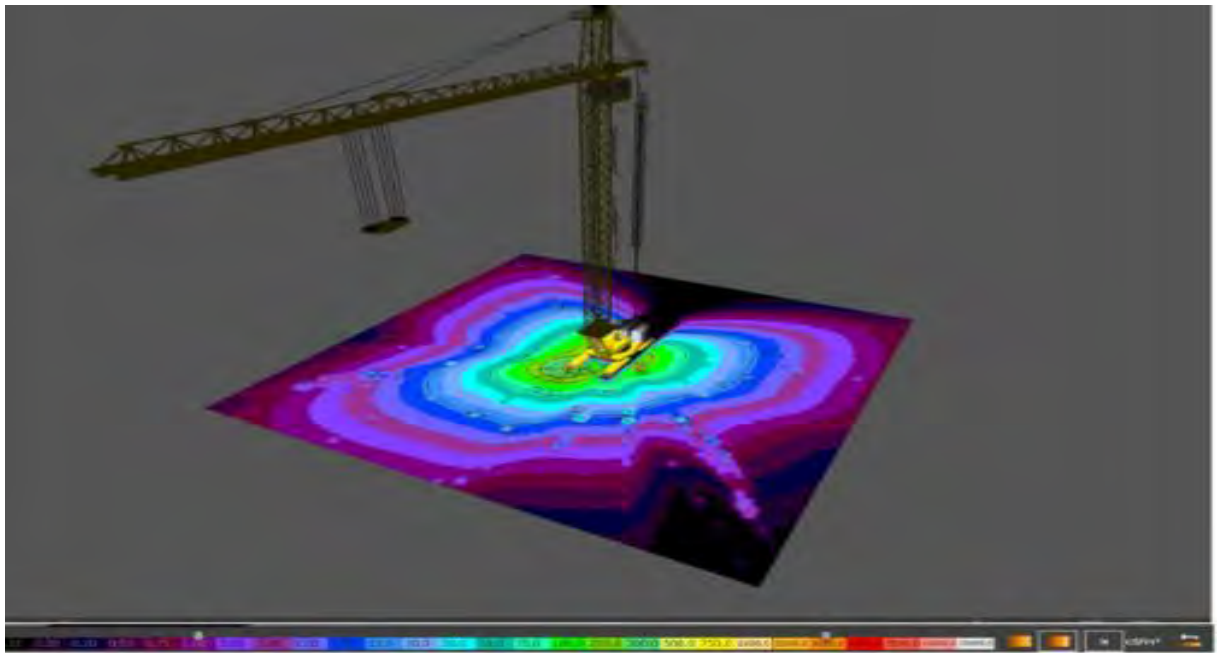


Figure 10: Example of crane lighting

4.8 Landscape Considerations at Braddup Compound

59) Figure 11 and the accompanying table show the nearby sensitive landscape receptors.



Legend		
	Residential Houses	Small collection of houses off Slaidburn Road and Cross Lane
	Rural residential property	Farm houses and outbuildings
	Public Right of Way	Unlikely to be used during hours of darkness.
	Proposed compound boundary	Indicative location of the Braddup Compound

Figure 11: Sensitive landscape receptors around the Braddup Compound

4.9 Ecological Considerations at Braddup Compound

60) Figure 12 shows the nearby sensitive ecological receptors.



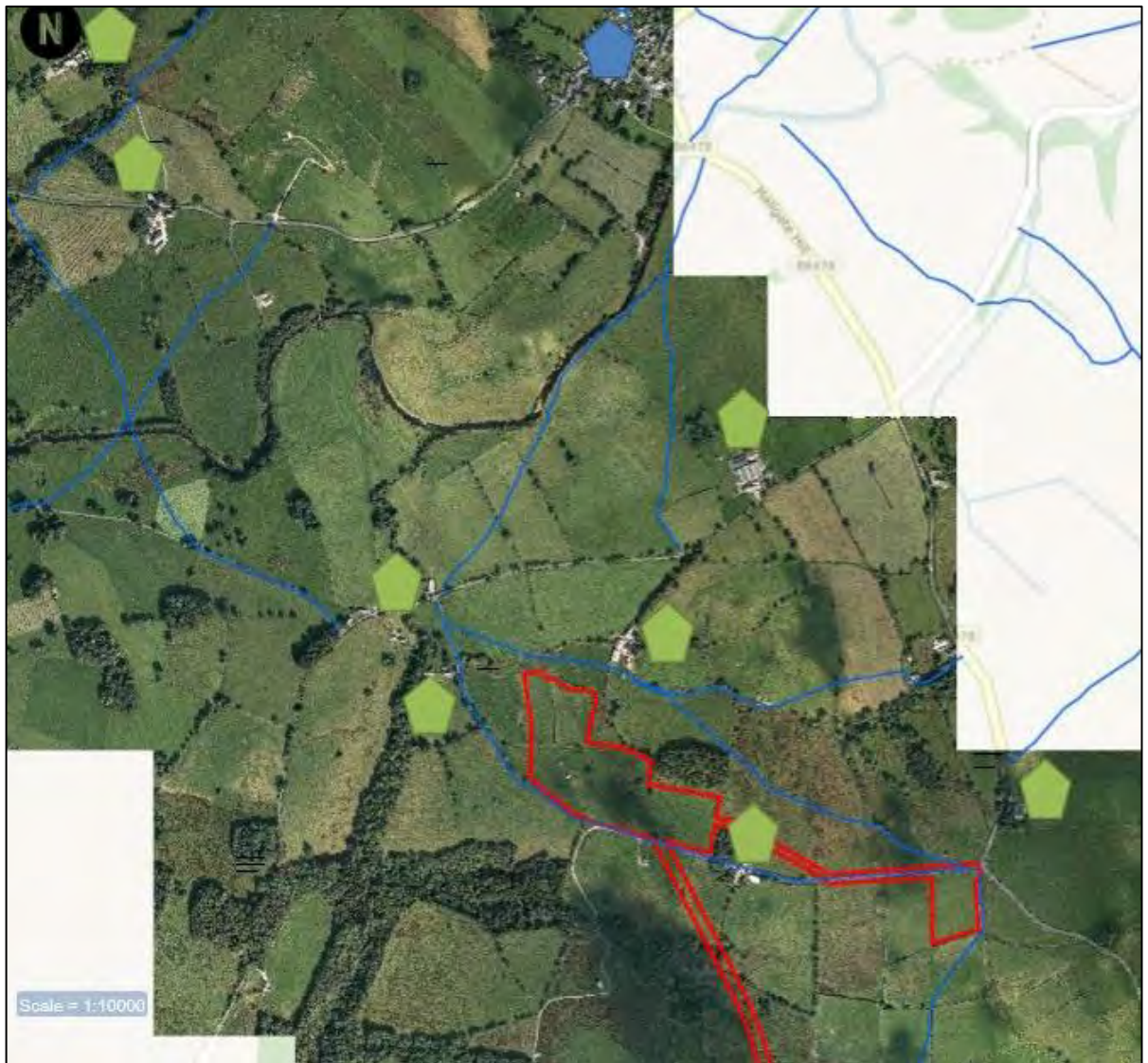
Legend	
	High bat roost potential tree
	Moderate bat roost potential tree
	Low bat roost potential tree
	Proposed compound boundary

Figure 12: Ecologically sensitive receptors around Braddup Compound

- 61) This is a rural location with a low level of artificial lighting. Braddup Compound and surrounds have some interest in relation to wintering and breeding birds. Lighting pollution outside the active working areas would generally be avoided, but an Ecological Clerk of Works would advise if additional screening is required to provide additional protection to winter foraging or spring/summer nesting birds at any locations.
- 62) Lighting should be directed away from or otherwise prevented from reaching the tree canopies of the woodland areas on the boundaries of the site and the canopies of individual trees to minimise lighting disturbance to roosting and feeding bats and nesting birds.
- 63) Particular efforts would be made to protect those trees identified as having High or Moderate potential to support roosting bats. Tree roosting is dynamic and updated bat roost assessments would be used to inform the lighting design in this respect.
- 64) The access route crosses a number of north/south aligned hedgerows that may be used at night by commuting and foraging bats. The track (and adjoining hedgerows) is currently unlit and therefore the hedgerows should be maintained as dark corridors where practicable.

4.10 Landscape Considerations for the Bonstone Compound

65) Figure 13 and the accompanying table show the nearby sensitive landscape receptors.



Legend		
	Residential Houses	Small collection of houses on cross lane
	Rural residential property	Farm houses and outbuildings
	Public Right of Way	Unlikely to be used during hours of darkness.
	Proposed compound boundary	Indicative location of the Bonstone Compound

Figure 13: Sensitive landscape receptors around the Bonstone Compound

4.11 Ecological Considerations at the Bonstone Compound

66) Figure 14 shows the nearby sensitive ecological receptors.



Figure 14 Ecologically sensitive receptors around Braddup Compound

4.12 Potential Mitigation Measures

- 67) A range of mitigation measures are available to address the potential impact from the construction phase lighting. These range from equipment choice, use of site topography and competent design and site management.
- 68) The following mitigation measures shall be adopted for both fixed and temporary lighting:
- Adopt the lowest safe lighting levels possible for task being undertaken
 - Limit the hours of lighting where practicable use a luminaire with good optical control
 - Direct luminaires into the area to be lit (light from the boundary inwards)
 - Ensure the luminaire is mounted at zero degrees to the horizontal and avoid any tilt
 - If required, make use of manufacturers supplied custom louvres
 - Provide local control for the lighting so it may be switched off when not required.
- 69) In addition to the physical equipment, lighting should be placed such that it makes use of the existing and proposed topography.
- 70) Equipment should be positioned so it is not visible to residential and ecological sensitive receptors by using natural screening.
- 71) All lighting installations would be designed by a competent lighting professional that ideally meets the ILP competency requirements, and who is at least a member of the ILP and is accredited to the Engineering Council as I.Eng or greater.
- 72) Prior to first use of any lighting on-site during the construction phase, the lighting shall be inspected and verified to ensure it has been installed as per the design and the specified equipment and optics are installed.

- 73) To ensure the correct aiming directions are maintained throughout the life of the installation, the lighting installation shall be periodically inspected during the site operations, as outlined in Section 5. If any equipment is found to be incorrectly aligned, modifications shall be made to ensure it is restored to 'as designed' and, if required, re-inspected.
- 74) This monitoring procedure shall ensure that, during the time the site is occupied, the levels of lighting are maintained in accordance with current best practice and standards whilst ensuring the potential impact associated with the introduction of temporary lighting on identified receptors is controlled and minimised as far as practicably possible.

5. Monitoring and Verification Methods

5.1 Design approval fixed area lighting

75) Lighting designs would be developed to:

- Reduce light spill onto sensitive receptors (including ecological receptors) to below thresholds where significant effects are predicted where practicable
- Maintain a uniform lighting solution to reduce dark and light spots.

5.2 Installation design check

76) Upon completion of fixed lighting column installation in the Braddup and Bonstone Compounds, a survey would be completed to check it has been completed as outlined in the detail design. Installation checks shall be in accordance with BSI (2003). This would be required once the installation is complete.

5.3 Mobile lighting unit operation

77) The requirement for supplemental lighting in varied locations around Braddup and Bonstone Compounds shall entail careful planning and the consideration of sensitive light receptors in and around the site. Up-to-date advice on the location of light sensitive receptors shall be obtained from the Contractor's Environmental Clerk of Works prior to setting up mobile lighting units.

78) Mobile units shall use backlight shields and be directed away from the key sensitive sites. There would be no tilt allowed on these units.

79) The Contractor would be responsible for training the operatives in how to correctly position the mobile units and make them aware of the locations of the key sensitive receptors. The temporary lighting would be monitored by the Environmental Clerk of Works.

Appendix A. Glossary of Terms

Term	Description
Curfew	Time during which stricter requirements (for the control of obtrusive light) would apply; often a condition of use of lighting applied by a government controlling authority, usually the local government
Colour Rendering	Colour rendering (as per BS EN 12665:2002) Effect of an illuminant on the colour appearance of objects by conscious or subconscious comparison with their colour appearance under a reference illuminant.
Diversity	Ratio of minimum illuminance (luminance) to maximum illuminance (luminance) on (of) a surface
Glare	Glare is a visual sensation caused by excessive and uncontrolled brightness. It can be disabling or simply uncomfortable.
Glare Rating Limit	Upper limit of glare by the CIE Glare Rating system
Illuminance	Quotient of the luminous flux ($d\phi$) incident on an element of the surface containing the point, by the area (dA) of that element. Equivalent definition: Integral, taken over the hemisphere visible from the given point, of the expression Unit: $L \times \cos \theta \times d\Omega$. Where L is the luminance at the given point in the various directions of the incident elementary beams of solid angle $d\Omega$; and θ is the angle between any of these beams and the normal to the surface at the given point. Unit L_x (Lux) or lumens per metre ² (lm/m^2).
Illuminance Uniformity	Ratio of minimum illuminance to average illuminance on a surface. Note: Use is also made of the ratio of minimum illuminance to maximum illuminance, in which case, this should be specified explicitly.
Lamp	Light source made in order to produce optical radiation, usually visible. Note: This term is also sometimes incorrectly used for certain types of luminaires.
LED	A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it.
Light Pollution	The spillage of light into areas where it is not desired.
Luminaire	Apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply. Note: The term 'light fitting' is deprecated.
Maintained Illuminance	Value below which the average illuminance on the specified surface is not allowed to fall. It is the average illuminance at the time during which maintenance should be carried out. Unit: L_x (Lux) or lm/m^2 .
Minimum Illuminance	Lowest illuminance at any relevant point on the specified surface. Unit: L_x or lm/m^2 Note: The relevant points at which the illuminances are determined shall be specified in the appropriate application standard.
Obtrusive/Nuisance Light	Which because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information
Spill Light	Light emitted by a lighting installation which falls outside the boundaries of the property for which the lighting installation is designed
Task Area	partial area in the workplace in which the visual task is carried out. For places where the size and/or location of the task area are unknown, the area where the task may occur is the task area

Upward Light Ratio	Proportion of the flux of the luminaire(s) that is emitted above the horizontal, when the luminaire(s) is (are) mounted in its (their) installed position and attitude
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Appendix B. Abbreviation Table

Abbreviation	Term
CRI	Colour Rendering Index
IDA	International Dark-Sky Association
I.Eng	Incorporated Engineer
ILP	Institution of Lighting professionals
GN	Guidance Note
LED	Light Emitting Diode
LMP	Lighting Management Plan
SLL	Society of Light and Lighting
SSSI	Site of Special Scientific Interest
ULR	Upward Light Ratio of the Installation