Appendix 5B

Lighting Management Plan

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Tarbert OCGT Power Plan

Lighting Assessment

SSE Generation Ireland Ltd.

Project number: 60695232

November 2023

Delivering a better world

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SSE Generation Ireland Ltd.

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1. Introduction

This lighting assessment has been undertaken on behalf of SSE Generation Ireland Ltd. (SSE) to accompany a planning application to County Kerry Council for the construction of a new section of the existing Tarbert Power Plant located on the Shannon Estuary in Tarbert.

AECOM has provided a lighting design for the proposed new section of the existing Tarbert Power Plant in County Kerry and prepared a lighting assessment to evaluate the lighting performance for all relevant adjacent external spaces which contain lighting against good practice criteria set out in Guidance Note 01 The Reduction of Obtrusive Light, 2021 by the Institute of Lighting Professionals (ILP)[1], relevant EU aligned BS EN standards such as Light and Lighting - Lighting of work places, Part 2: Outdoor work places 2014 (BS EN)[2] and good practice guidance. An indicative lighting scheme has been developed to a level that allows the lighting assessment to be undertaken.

Light modelling of the new lighting arrangement has been undertaken using DIALux software, to calculate exterior lighting scenes and evaluate the design against standard good practice guidance for the minimisation of obtrusive light. The model incorporates recognised calculation methodologies and is commonly used for exterior lighting assessments in the UK. It includes all lighting units indicated on the drawing included at Appendix A. Additional detail derived from the simulation is provided in Appendix B.

The Tarbert Power Plant in County Kerry (hereafter referred to as the 'Site' for the purpose of this assessment) requires artificial lighting for operational and security purposes during the proposed plant operating hours (see section 3 below). It is currently envisaged that lighting will mainly be required for safe passage around the Site during the wintertime when working hours extend past sunset, and at dusk / night where required. Lighting levels should be designed to ensure the safety and visual capability of Site personnel performing operational activities in and around the Site, with the knowledge that as a peaking plant the Site will not be utilised to a high frequency and as such, operational activities are assumed to primarily take place during daylight hours. As far as possible, illumination will be contained within the Site, and light spill and indirect illumination of elements beyond the boundary will be avoided as far as practicable.

[1] Institute of Lighting Professionals (2021). *Guidance Note 1 for the reduction of obtrusive light 2021*.
[2] The British Standards Institution (2014). *Light and Lighting – Lighting of work places, Part 2: Outdoor work places 2014*.

2. Standards and Guidance

2.1 British Standards / EU Standards

Legislation governing the quantity of light in workplaces is published by the Health and Safety Executive (HSE) in:

- HSG 38: Lighting at Work[3]

The lighting shall also comply with:

- BS EN 1837 Safety of Machinery: Integral lighting of machines (BSI 2020)[4] and
- BS EN 12464-2 Light and Lighting: Lighting of workplaces. Outdoor workplaces (BSI 2014)[5] and
- BS 5489-1 Code of Practice for the Design of Road Lighting part 1: Lighting of Roads and Public Amenity Areas (BSI, 2020) [6]

BS EN standards are being utilised for this Site located in the EU as they are harmonised with EU regulations. These standards state the following criteria which have been identified as applicable to the Site:

Table 2-1 Lighting Criteria

Site Type	Type of Area, Task or Activity	Light level (lux)	Uniformity	Colour rendering (min)	Glare ratio	Comments
Fuel Filling Stations	Entry and exit driveways: Dark environments	20	0.4	20	45	
General Areas at Outdoor Work Places	Traffic areas for slowly moving vehicles (max. 10 km/h), e.g. bicycles, truck and excavators	10	0.4	20	50	
General Areas at Outdoor Work Places	Regular vehicle traffic (max. 40 km/h)	20	0.4	20	45	At shipyards and in docks, RGL may be 50
Industrial Sites and Storage Areas	Short term handling of large units and raw materials, loading and unloading of solid bulk goods	20	0.25	20	55	
Power, Electricity, Gas and heat plants	Pedestrian movements within electrically safe areas	5	0.25	20	50	
Power, Electricity, Gas and heat plants	Handling of servicing tools, coal	20	0.25	20	55	
Parking Areas	Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0.25	20	50	

[3] Health and Safety Executive (1997) HSG38: Lighting at work.
[4] British Standards Institute (2020) BS EN 1837: Safety of machinery. Integral lighting of machines.
[5] British Standards Institute (2014) BS EN 12464-2: Light and Lighting – Lighting of work places; Part 2: Outdoor work places.
[6] British Standards Institute (2020) BS 5489-1: Code of Practice for the Design of Road Lighting part 1: Lighting of Roads and Public Amenity Areas

2.2 Good Practice Guidance

2.2.1 The Chartered Institution of Building Services Engineers (CIBSE) Society of Light and Lighting (SLL) lighting guidance

The SLL has produced a series of lighting guides that address various approaches and requirements for lighting. The following guidance is considered when developing new exterior lighting installations

- Lighting Guide 6 (LG6) – The Exterior Environment (CIBSE and SLL, 2016) [7]; and
- Lighting Guide 21 (LG21) – Protecting the Night-Time Environment (SLL, 2021) [8].
- The SLL Lighting Handbook (SLL 2018) [9]

2.2.2 Institution of Lighting Professionals (ILP) guidance

The ILP is the current body of the former Institute of Lighting Engineers (ILE). They have produced the following guidance documents which are considered when developing new lighting installations:

- Guidance Note 1 (GN01) - The Reduction of Obtrusive Light (ILP, 2021) [10]

  GN01: Guidance Notes for the Reduction of Obtrusive Light is a reference document published by the ILP covering how to control and reduce light pollution. It includes guidance on suggested controls for exterior lighting dependant on context and provides specification and design techniques to control and reduce light pollution.

- Guidance Note 8 (GN08) - Bats and Artificial Lighting in the UK (ILP and the Bat Conservation Trust, 2023) [11]

  GN08: Bats and Artificial Lighting in the UK is a collaboration between the ILP and the Bat Conservation Trust and offers detailed advice on protection of bats and approaches to minimising effects of exterior lighting applications.

Regarding GN08 in general, a maximum illuminance of 3 lux is advised depending on the surroundings and the species of bat which may be affected. However, currently there is a lack of evidence regarding the light levels below which there are no/reduced impacts on bats. Bat responses to light levels are likely to vary between species and between behaviours. A ‘light threshold’ below which there is little impact on bats may not exist for some species which may be light averse regardless of intensity.

To minimise disruption to bats, light sources utilised should employ lamps with minimal or zero ultraviolet (UV) emission (insects are attracted to UV) and lower quantities of blue spectral light. Lighting with a correlated colour temperature (CCT) of 3000 Kelvin (K) or lower should be used.

[7] Society of Light and Lighting (2016) Lighting Guide 6 (LG6): The Exterior Environment
[8] Society of Light and Lighting (2021) Lighting Guide 21 (LG21): Protecting the Night Time Environment
[9] Society of Light and Lighting (2018) The SLL Lighting Handbook
[10] Institute of Lighting Professionals (2021) Guidance Note 1 (GN01) - The Reduction of Obtrusive Light
[11] Institute of Lighting Professionals & Bat Conservation Trust (2023) Guidance Note 8 (GN08) - Bats and Artificial Lighting in the UK

3. Baseline Site Conditions

3.1 Baseline Conditions

Tarbert Power Plant is a peaking plant and is in operation when needed to help meet electricity grid demands. The new section of Tarbert Power Plant is located to the north east of the existing Site. It is surrounded on three sides by existing power plant infrastructure, with the fourth being near the water's edge of the Shannon Estuary opposite the path of the Killimer-Tarbert Ferry route. The Tarbert Power Plant is located on the water, with one side of it being located within an area of agricultural farmland.

The nearby existing road network consists of the N67 wrapping around the south of the Site. The N67 has a single row of street lighting installed on the opposite side of the road to the water.

Figure 3-1 provides an overview of the Site arrangements within the existing context

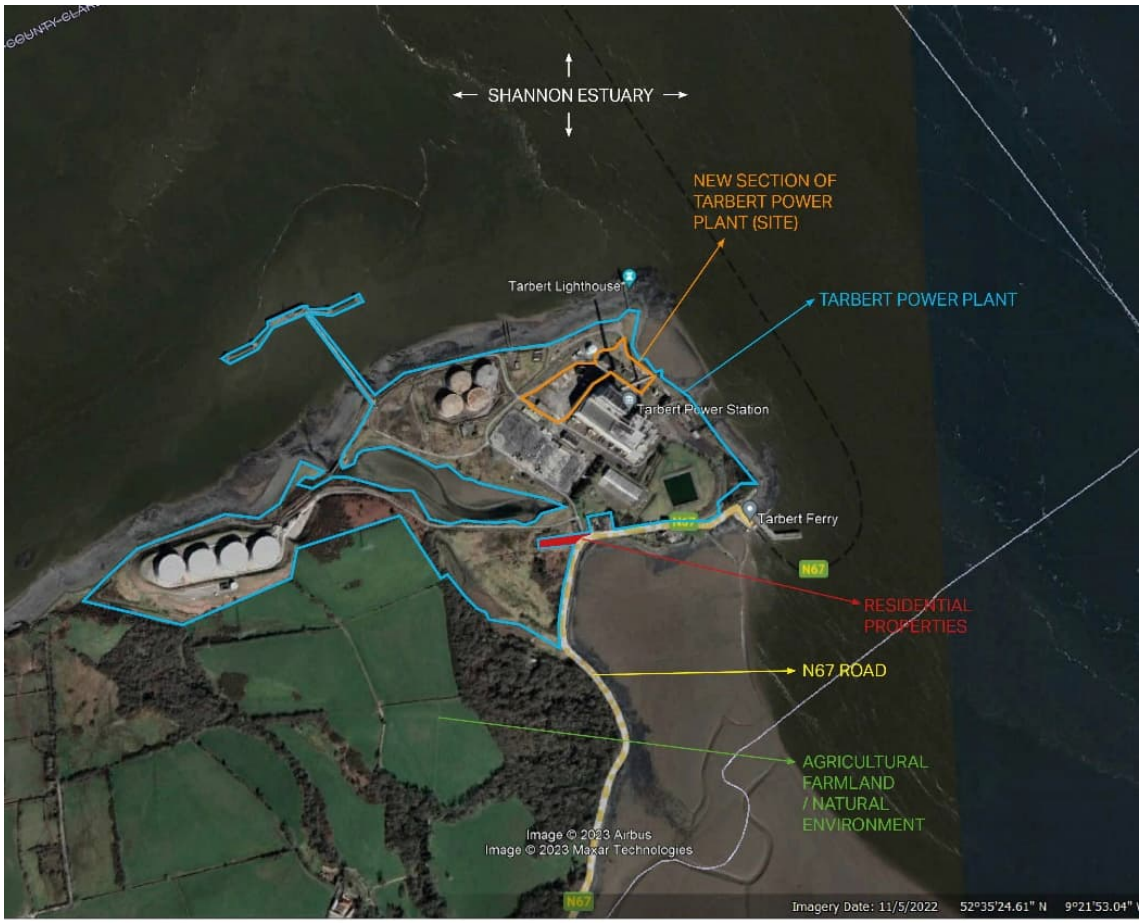

Figure 3-1 Tarbert Power Plant & Site markup (Google Earth, August 2023)

There are 2 residential properties directly bordering the Tarbert Power Plant boundaries, however, these properties are surrounded by green space and due to the natural topography of the Site they do not have a clear view to the Tarbert Power Plant nor the Site. These are shown in Figure 3-2.

Figure 3-2 View of Tarbert Power Plant from neighbouring residential properties (Google Earth, August 2023)

3.2 Site Assumptions

Key assumptions have been made about the Site and how it is used. These assumptions consider:

- As Tarbert Power Plant is a peaking plant, no standard operating hours will be utilised with this Site. As such, it is assumed that most on Site machinery operational and maintenance requirements can be met during daylight hours.
- As the Site is located within the confines of the Tarbert Power Plant, the Environmental Zone for the Site may be assumed to be higher than that of the outer edges of the plant, as the site is completely enveloped by the power plant which has lighting present throughout. Approximate SQM values of the area can be viewed in Figure 3-3 below.

Green	SQM 20 to 20.5
Yellow	SQM ~15 to 20

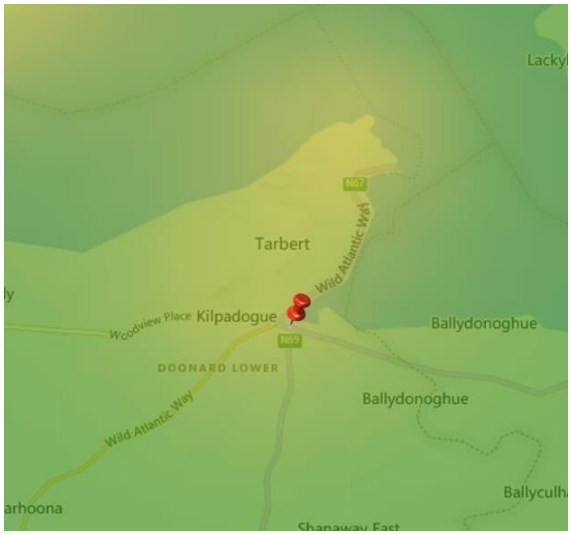

Figure 3-3 Tarbert Light Pollution Map view (Light Pollution Map World Atlas 2015, August 2023)

- From surveying Existing Site drawings, Google Earth, Google Maps and Images uploaded by the general public of the Site at dusk it has been observed that there are existing lighting poles and building mounted light fittings present on roadways/pathways and buildings to the front of the boundaries of Tarbert Power Plant. Therefore, it is assumed that lighting is associated with roadways/pathways within the Site and will be required for the new Site roadways/pathways. Figure 3-4 to Figure 3-6 show the different styles of lighting observed from off-Site.

Figure 3-4 View of Tarbert Power Station from the Kilimer-Tarbert Ferry (Google Maps, August 2023 – Photo taken by David Tough, uploaded June 2023)

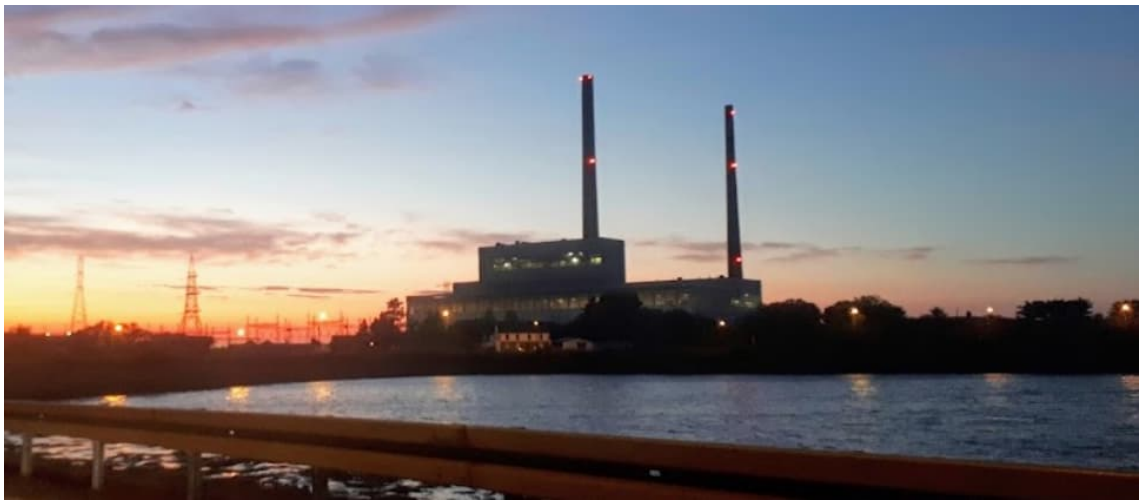

Figure 3-5 Alternative view of Tarbert Power Station from the Kilimer-Tarbert Ferry (Google Maps, August 2023 – Photo taken by David Tough, uploaded June 2019)

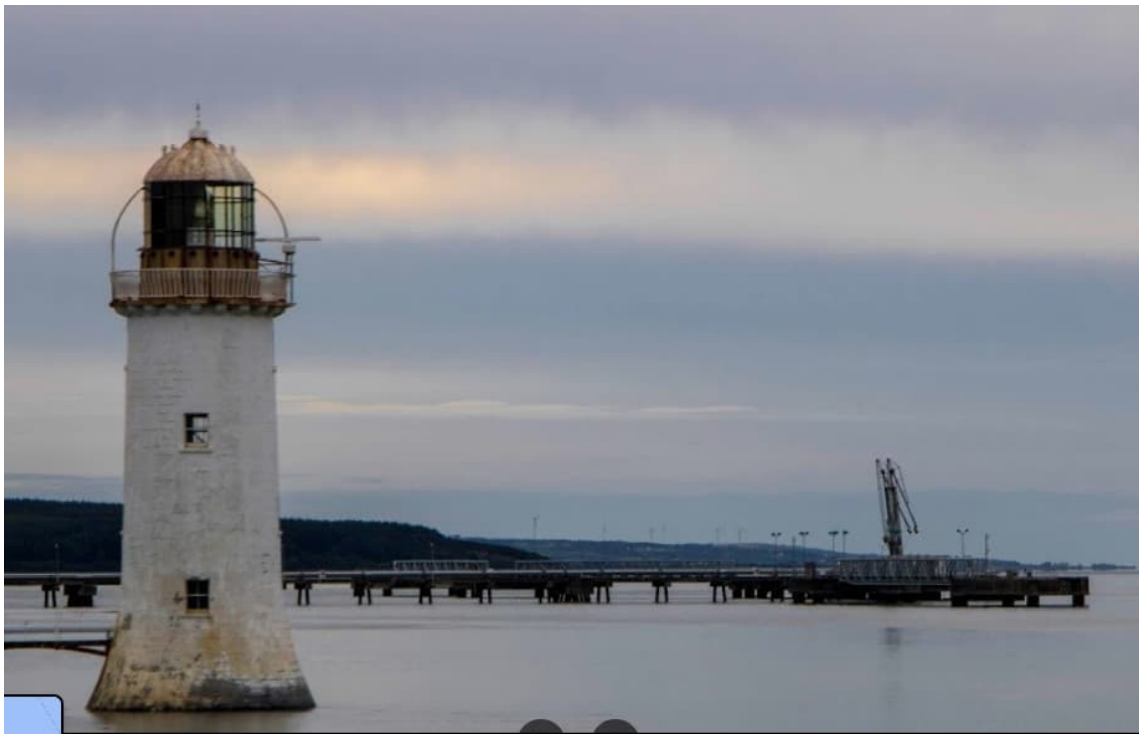

Figure 3-6 View of Tarbert Power Station Jetty streetlights from the Kilimer-Tarbert Ferry (Google Maps, August 2023 – Photo taken by Julien Heyd, uploaded August 2018)

- Existing lighting shows a mix of colour temperatures, from warm to neutral white. The lighting scheme incorporates a light colour of 3000k to be in keeping with the existing Site lighting.
- It is assumed that any existing lighting to the back of the power plant closest to and facing the residential properties has been through an assessment process and does not negatively impact them in regards to glare and lux levels, and is in keeping with appropriate curfews.
- It is assumed that any existing lighting to the power plant has been through an assessment process and does not negatively impact any water or land wildlife in regards to glare and lux levels, and does not produce inappropriate skyglow and is in keeping with appropriate curfews.

3.3 Hours of Operation

As Tarbert Power Plant is a peaking plant, no standard operating hours will be utilised with this Site. As such, it is assumed that most on Site machinery operational and maintenance requirements can be conducted during daylight hours in order to avoid any negative interference with the surrounding environment.

However, lighting is to be provided to paths and roads (marked in light blue on the site plan, Figure 3-1) to allow movement between the areas during work hours, during the winter months, and any movement at night that may be required.

In addition to the above, the Institute of Lighting Professional's Guidance Note 1 (GN01) - The Reduction of Obtrusive Light (ILP, 2021) [12] states that:

> *"For new developments there is an opportunity for LPAs to impose planning conditions related to external lighting, including curfew hours…. Curfew: The time after which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied the local planning department. Depending upon application curfew times often commence between 21:00 to 23:00 and may run until 07:00."*

[12] Institute of Lighting Professionals (2021) Guidance Note 1 (GN01) - The Reduction of Obtrusive Light

Therefore, where possible lighting shall either be dimmed or switched off after 9pm remotely (daily), or lighting switching/dimming to follow existing Tarbert Power Plant lighting controls scheme.

3.4 Receptors

3.5 Residential Receptors

Residential properties which have the potential to be impacted by obtrusive light from the new lighting installation will be limited to any housing located within 1km of the Site. The residential properties to the south of the Site, connected to the Site boundary line are the only properties within a significantly close distance. Additionally, the natural topography of the land means that these are the only properties with potential to be affected as most sight lines are blocked by the landscape. Figure 3-7 provides an overview or receptor locations in relation to the Site.

Figure 3-7 Residential Receptors within 1km radius of Site (Google Earth, 2023)

- R1 – Residential Houses – Window facing Site 1
- R2 – Residential Houses – Window facing Site 2
- R3 – Residential Houses – Window facing Site 3
- R4 – Residential Houses – Window facing Site 4

3.6 Ecological Receptors

The Shannon Estuary waters around the north, east and west of Tarbert power plant are shown to be classified as a Special Protection Area (SPA) and the same waters with the addition of some woodland to the south are classified as a Special Area of Conservation (SAC).

The waters surrounding Tarbert power plant and the bushes, trees and natural scrubby woodland to the south of Tarbert power plant are expected to support habitat, foraging and commuting routes for various species. As such, those which are nearest and with a direct line of sight are required to have a maximum of 1lux post-curfew in order to avoid disturbance and protect the ecology.

Assessment locations are representative of a worst-case, where adverse effects are most likely to occur. This is used to assess whether an extended lighting study is required for any other waters or woodlands that border the Site beyond 1500m.

There are several ecological receptors that have been identified for assessment (Points A to O), with two new additional ecological receptors (P, Q and R) added in a place where bushes and trees are located in potential view of the Site. Figure 3-8 provides an overview of ecological receptor locations.

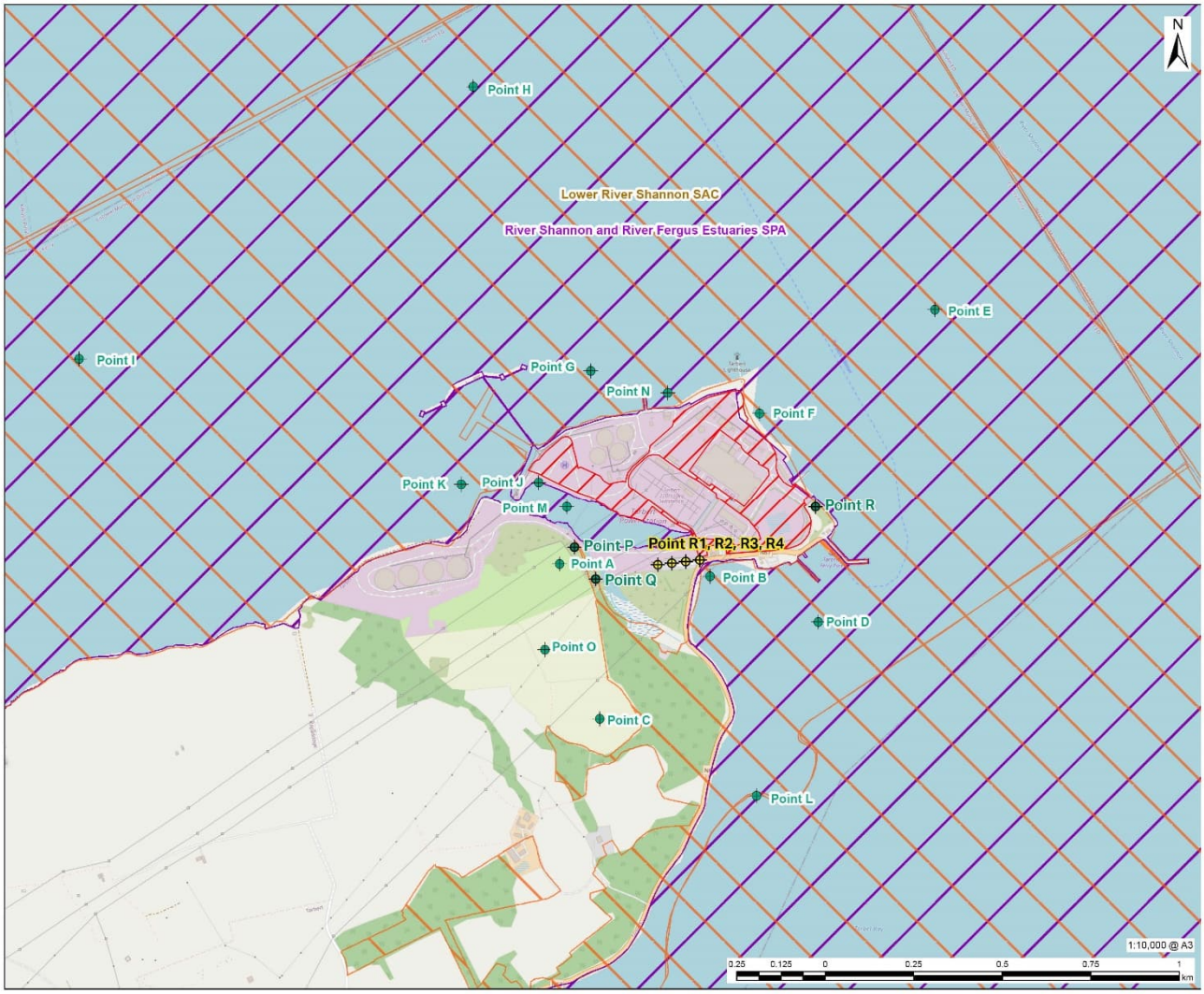

Figure 3-8 Residential & Ecological Receptors (AECOM February 2023, Modified August 2023)

- A – Open field, south west
- B – Open water close to shore, south
- C – Open field, south

- D – Open water, south east
- E – Open water, north east
- F – Open water close to shore, north east
- G – Open water near jetty, north west
- H – Open water, north
- I – Open water, west
- J – Lagoon close to shore, west
- K – Open water, west
- L – Open water, south
- M – Centre of lagoon, south west
- N – Open water, north
- O – Open field, south west
- P – Bushes, south west
- Q – Trees, south west
- R – Trees, east

4. Methodology

4.1 Assessment Criteria

The limiting criteria for receptors, primarily residential, are set out in the following tables based on recommendations from the ILP good practice guidance, Guidance Notes for the Reduction of Obtrusive Lighting, GN01, 2021. Criteria is based on the brightness context character of an area that is defined as an environmental zone. Table 4-1 sets out how the environmental zone classifications are considered, and Table 4-2 presents the applicable limiting criteria.

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 4-1 Environmental Zone Classification

Based on the criteria set out above and observations of the local area and context lighting, Zone E1 is considered to be the relevant zone of the surrounding waters, fields and woodland in which the Site is located. Industrial development is typically associated with a Zone E3, however the surrounding area would not have a similar character and a zone E2 is considered to be more appropriate.

Guidance advises that where there are two classifications, the more stringent should apply. Zone E1 should be striven for on the marine side of the Site, however it is recommended that the lower land classification be used when measuring impacts. Accordingly, the obtrusive lighting criteria associated with Environmental Zone E2 and E3 have been used within the assessment.

Obtrusive light limits for exterior lighting installations are shown below in **Error! Reference source not found.** for Zone E2 and E3.

Table 4-2 ILP Environmental Zone E2 & E3 Criteria

Environmental Zone	Upwards Flux Ratio (UFR, Amenity) [a] (%)	Max Sky Glow (ULR) [b] (%)	Light Trespass (into windows) E_v [c] (lux)		Source Intensity (kilocandelas – kcd)	
			Pre-curfew	Post-curfew	Pre-curfew	Post-curfew
E2	6	2.5	5	1	7.5	0.5
E3	12	5	10	2	10	1

(a) Upward Flux ratio (UFR) of the installation – maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky from direct and reflected light.

(b) Upward light ratio (ULR) of the installation – maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.

(c) Vertical illuminance measured flat at the glazing at the centre of the window.

Curfew hours for exterior lighting installations are enforced by CEC where 23:00 is typically applied. This means that between hours of 23:00 and 07:00 a more stringent criteria should be adhered to (per Table 4-2). If 21:00pm is a suitable / possible curfew time, this should take precedence over the later 23:00pm. For residential receptors as they are so close to the Site, E2 will be aimed for. The permitted light trespass limit at a residential receptor for Zone E2 before curfew is 5 lux, and post-curfew it is 1 lux. The permitted source intensity limit when viewed from a residential receptor before curfew is 7.5 k/candelas (kcd) and post-curfew is 0.5 kcd.

The permitted Upward Lighting Ratio (ULR) for lighting installations is (E3) 5% and Upwards Flux Ratio (UFR) (E3) 12% and this applies across pre- and post-curfew hours. E3 has been chosen for sky glow as the Site's location allows a higher Environmental Zone.

As the lighting requirements for the Site will not definitively change during the hours of darkness, only the ILP post-curfew obtrusive lighting criteria have been applied for comparison with the model results.

There is no definitive criteria to quantify the potential effects on ecological and landscape receptors, however many creatures such as owls and bats are active at night and sleep during the day, while others such as birds or moths may be attracted to light. Impacts will potentially limit feeding opportunities, may cause creatures to become confused or collide with floodlit structures, alternatively they may prompt desertion of the area altogether. Additionally, certain fish are also affected by spectral light properties, which could alter their feeding, schooling and migration.

4.2 Assessment Limitations

- Light sources used in the model are based on the basic streetlight light style luminaires with roadway optics and wattage required to achieve the required light levels for the given workplaces and the relating tasks. Photometry for luminaires was obtained from lighting manufacturer websites.
- Variation in light distribution due to luminaire design and light distribution qualities could result in different outcomes for light spill, sky glow and glare.

4.3 Lighting Model

A lighting scheme has been suggested based on the Site plan provided for the new section of the plant, and decisions have been based off studying the plant and what is currently installed on Site where possible through images and partial lighting plans. As mentioned in Site assumptions earlier in the document, roadways/pathways have been illuminated to allow for safe passage through the Site, staff security and safety, and it is assumed that major operational works to machinery will be able to be conducted during daylight hours. The lighting scheme will at the same time remain sympathetic to the relatively dark, rural nature of the area. Luminaires were chosen not only to achieve the required

lux level and uniformities for each area but also because they have the seal of approval from the International Dark Sky Association (IDA), if installed responsibly.

3D lighting models were prepared based on Figure 4-1 which is expanded to the full drawing 60695232-TBT-DR-022 in Appendix A; and Table 4-3.

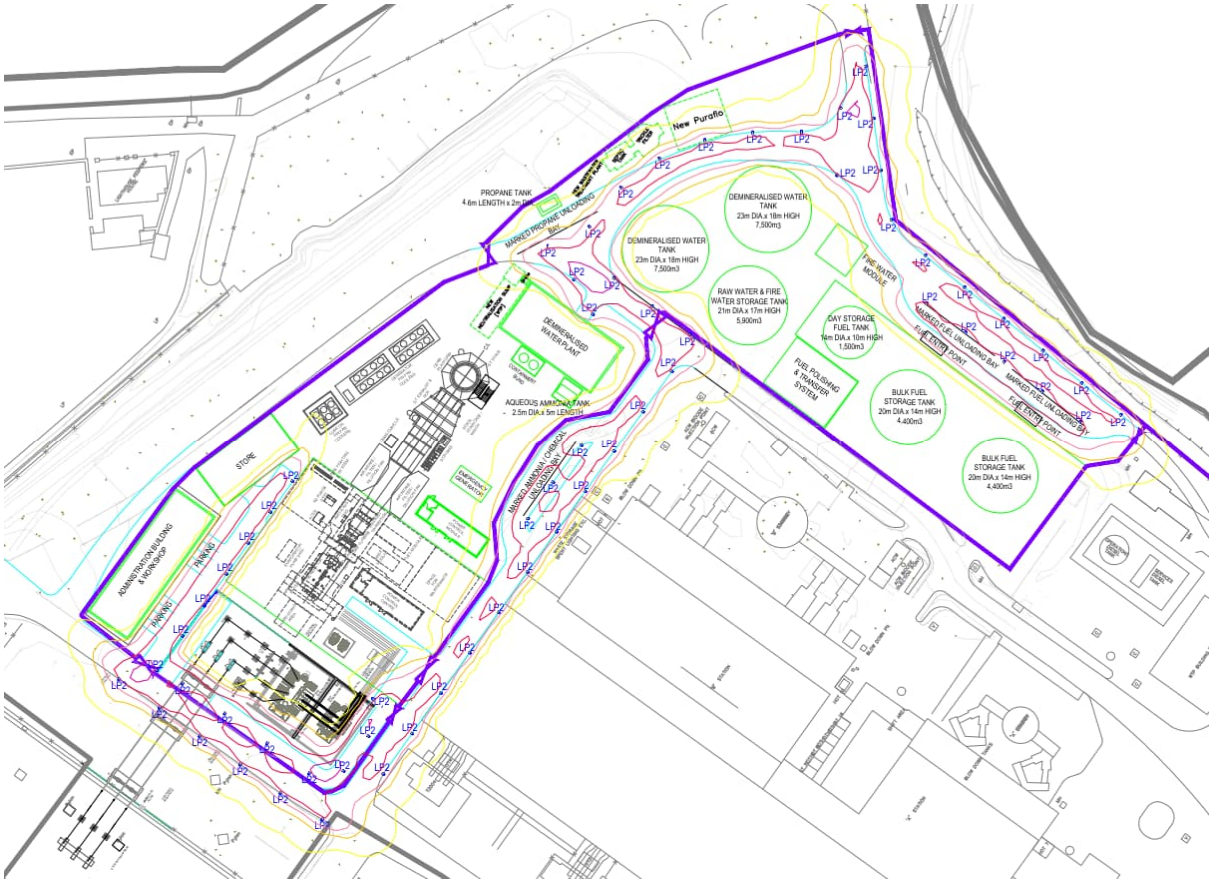

Figure 4-1 Proposed Lighting Locations at the Site

Table 4-3 Indicative Lighting Equipment

Symbol / Ref.	Photograph	Number of fixtures	Luminaire Information	Luminaire Specification*	Mounting height (m) & Tilt (degrees)
LP2		57	DW Windsor Kirium Pro 1 with D3 road optic (DW Windsor KIRIUM PRO1 32LED 3k D3 250mA UMSUG 42 0021 0000 100 KIRIUM PRO1 32LED D3)	21 W, 3292 lm 3000K	6 m 0 degrees

* Luminaire specification notes: abbreviation W is the unit for electric power consumption measured in Watts; lm is the unit for luminous flux, the total light output emitted from the luminaire.

5. Results

5.1 All Receptors

5.1.1 Sky Glow

The ULR associated with the lighting shown in Figure 4-1 has been modelled; the results are provided in Table 5-3 and Table 5-2, below.

Table 5-1 Predicted Upward Light Ratio (ULR)

Receptor	Criterion ULR (%)	Development ULR Results (%)
Wider surrounding area	E3 5	0.0

The ULR is 0.0% and is therefore within the aim of E2, and therefore within E3 guidance for potential sky glow effects.

Table 5-2 Predicted Upward Flux Ratio (UFR)

Receptor	Criterion UFR (%)	Development ULR Results (%)
Wider surrounding area	E3 12	10.22

The UFR is 10.22% and is therefore within the aim of E3 guidance for potential sky glow effects.

5.2 Residential Receptors

5.2.1 Light Spill

The level of light trespass from the Plant Site at boundary locations has been modelled and predicted at ground level. Simulation results are given in Table 5-3.

- R1 – Residential Houses – Window facing Site 1
- R2 – Residential Houses – Window facing Site 2
- R3 – Residential Houses – Window facing Site 3
- R4 – Residential Houses – Window facing Site 4

Table 5-3 Predicted Light Spill at Site Boundary Locations

Receptor Location	E2 Light Spill Criterion (pre / post-curfew) (Lux)	E2 Light Spill (max) (Lux)
R1 – Residential Houses – Window facing Site 1	5 / 1	0.00
R2 – Residential Houses – Window facing Site 2	5 / 1	0.00
R3 – Residential Houses – Window facing Site 3	5 / 1	0.00
R4 – Residential Houses – Window facing Site 4	5 / 1	0.00

Results show that light spill beyond the boundary of the Site is well controlled with respect to guidance criteria of 5 lux for pre-curfew and 1 lux for post-curfew. The maximum measured lux levels were 0.00 lux at the closest receptors (R1, R2, R3 and R4) indicate that the proposed lighting design clearly meets the criteria for light spill effects.

5.2.2 Glare

Due to the location of residential receptors being that of shielded from the Site due to the natural topography of the environment, as well as shielded by the existing buildings on the Site, no glare associated with direct line of sight to light sources was detected at residential receptor locations.

The level of light intensity associated with 57 individual light sources for the Site when viewed from the four identified residential receptor locations has been modelled. Receptors were modelled at the height of 1.7 m above the ground which is roughly the height to the middle of a ground floor window. Existing screening effects by some mature bushes and trees are not calculated within the simulation due to the variable amount of foliage available throughout the year.

A summary of results is provided in Table 5-4.

Table 5-4 Predicted Source Intensity at Residential Receptor Locations

Receptor Location	E2 Light Intensity Criterion (cd) (pre / post-curfew)	Modelled Light Intensity Results (cd)	Possible Glare Sources from the Site
R1 – Residential Houses Window 1	7500 / 500	0	n/a
R2 - Residential Houses Window 2	7500 / 500	0	n/a
R3 - Residential Houses Window 3	7500 / 500	0	n/a
R4 – Residential Houses Window 4	7500 / 500	1	n/a

All results of the measured Light Intensity values intensity at the four residential receptors meet the post-curfew requirements for a Zone E2.

While not incorporated into the simulation, this assessment acknowledges the effects of intervening structures, vegetation, or topography on intervisibility between receptors and high intensity light sources.

R1, R2, R3

The houses to the south of the Site are connected to the border of the power plant boundary. There appears to be 4 addresses at this small cluster of properties, and they are all approximately 250m from the southern most point of the Site within the power plant confines. There appears to be natural topography that means the properties sit lower than the Site, and there are sparse bushes and trees within the sight lines to the Site. Existing power plant structures obstruct and obscure sight lines from the properties to the Site.

R4

This property is further down the street at the dead end, 50m to the left of the 3 attached properties whilst facing the plant. There appears to be natural topography for this property similar to R1 – R3 that means it sits lower than the Site, and there are sparse bushes and trees within the sight lines to the Site. Existing power plant structures obstruct and obscure sight lines from the properties to the Site.

5.3 Ecological Receptors

5.3.1 Horizontal Illuminance at Ecological Receptors

Horizontal illuminance has been calculated and results shown in the form of isolux contours at ground level, to show illuminance within the working area and light spill outside of the Site. Isolux contours provide the points of equal illuminance, in lux (lx), on the ground, from a specific stated mounting position. The contours can be used to assess the distribution characteristics of the luminaire in addition to determining lighting levels. Isolux contours are presented in Appendix B, Figure B-6 for the values shown in Table 5-5.

Table 5-5 Lux Contours

Lux* (lx)
1.0
5.0
10.0
20.0
30.0

* Lux (lx) is the SI derived unit of illuminance and luminous emittance, measuring luminous flux per unit area.

Light modelling indicated that there would not be any obtrusive levels of horizontal light spill from the proposed lighting design as all illuminance has dropped below 1.0 lux before reaching sensitive ecological receptor locations that were identified in this study.

Due to the sensitive nature of the surrounding E1 Environmental Zone estuary, horizontal calculation surfaces with a tilt towards the Site were applied at the height of the surface of the water. This was to ensure no spill light was entering the water in the surrounding areas. The results showed that there is 0.00 lux readings at all calculation surfaces.

5.3.2 Vertical Illuminance at Ecological Receptors

Vertical illuminance levels (in lux) have been simulated on the bushes and trees to the south west of the power plant Site, which are approximately 380 metres away from the new Site borders. The outputs from the model are provided in the DIALux lighting calculation report in Appendix A.

Results show that light levels on a vertical calculation surface at a 2m height on the closest bush (P) on the south west of the Site boundary, 0.00 lux occurs. Toward the south west boundary of the Site beside the bushes, the neighbouring trees (Q) saw 0.00 lux. Toward the east boundary of the Site, the trees (R) also saw 0.00 lux. In all cases it shows that light spill will not be a factor in regards to any nearby bushes and trees.

Given the tight beam control of the lighting utilised in the Site design, effects of light spill have been kept well within recommended good practice guidelines.

6. Minimisation of Obtrusive Effects

The lighting design presented within this assessment maintains a low environmental impact for glare, light spill, horizontal illuminance and ULR which is well within recommended good practice guidelines for the minimisation of obtrusive effects of lighting. For the UFR, the lighting design presented maintains a medium environmental impact. If any modifications to the proposed lighting or supplementary lighting UFR results is to be considered in the future, lowering the lumen output of the fittings could be considered. However, lighting may fail to reach required lux levels and uniformities requires by the BS EN standards stated earlier in the document and presented in Table 2-1.

If any further modifications to the proposed lighting or supplementary lighting is to be considered in future, it is advised that the following strategies are observed.

To control impacts of lighting effects upon residential and ecological receptors, some careful design approaches are recommended based on the guidance and modelling results provided in this report.

The following mitigation measures are proposed as part of good lighting design practice:

- All proposed luminaires in the lighting design strategy are approved International Dark Sky Association (IDA) luminaires; any other exterior lighting should follow this principle; Figure 6-1.
- utilise backshields, glare cowls, louvres and similar to minimize / obscure source intensity towards the adjacent hedges and nearby residences (Figure 6-1); use reflector types that redirect light back downward to desired work areas;
- confine lighting to the task area (use horizontal cut-off optics and zero tilt angles, particularly for floodlights);
- give careful consideration to luminaire positioning and orientation; all floodlight luminaires to be oriented downward or at very low angles to provide lighting only to the areas directly below and adjacent to a given pole;
- ensure low colour temperature lamps (CCT) ≤ 3000 K are in use where possible; and
- observe the curfew period where lighting can be shut off or dimmed.

Figure 6-1 Examples of light Fixtures with back shields, glare cowl, hood, shield and louvres

7. Conclusions and Summary

An indicative exterior lighting scheme has been prepared for the proposed Site which will allow for safe access and use of the area by employees. New lighting has the potential to introduce new obtrusive lighting effects, and a lighting assessment was required.

Light modelling of the new lighting arrangement has been undertaken using DIALux software to calculate the exterior lighting scene and evaluate the design against standard good practice guidance. The model includes all lighting units indicated on the drawing included in Appendix A.

The indicative lighting design strategy contains light within the confines of the Power Plant. Pole lighting provides illumination to the designated areas without over-lighting, and light distribution is controlled so that light levels fall to below 1 lux within 10m of column mounting locations. This may be further reduced when using the methods highlighted in Section 6.

In summary, the assessment found that obtrusive effects relating to light spill, sky glow or glare are unlikely to occur to residential or ecological receptors as a result of the lighting scheme proposed. Should an alternate design be proposed, it is recommended that the lighting assessment be revisited.

Appendix A Site Drawing

- Lighting Layout CAD plan layout 60695232-TBT-DR-022

Appendix B Calculation Results

B.1 Ecological Receptors Diagram & Calculation Locations

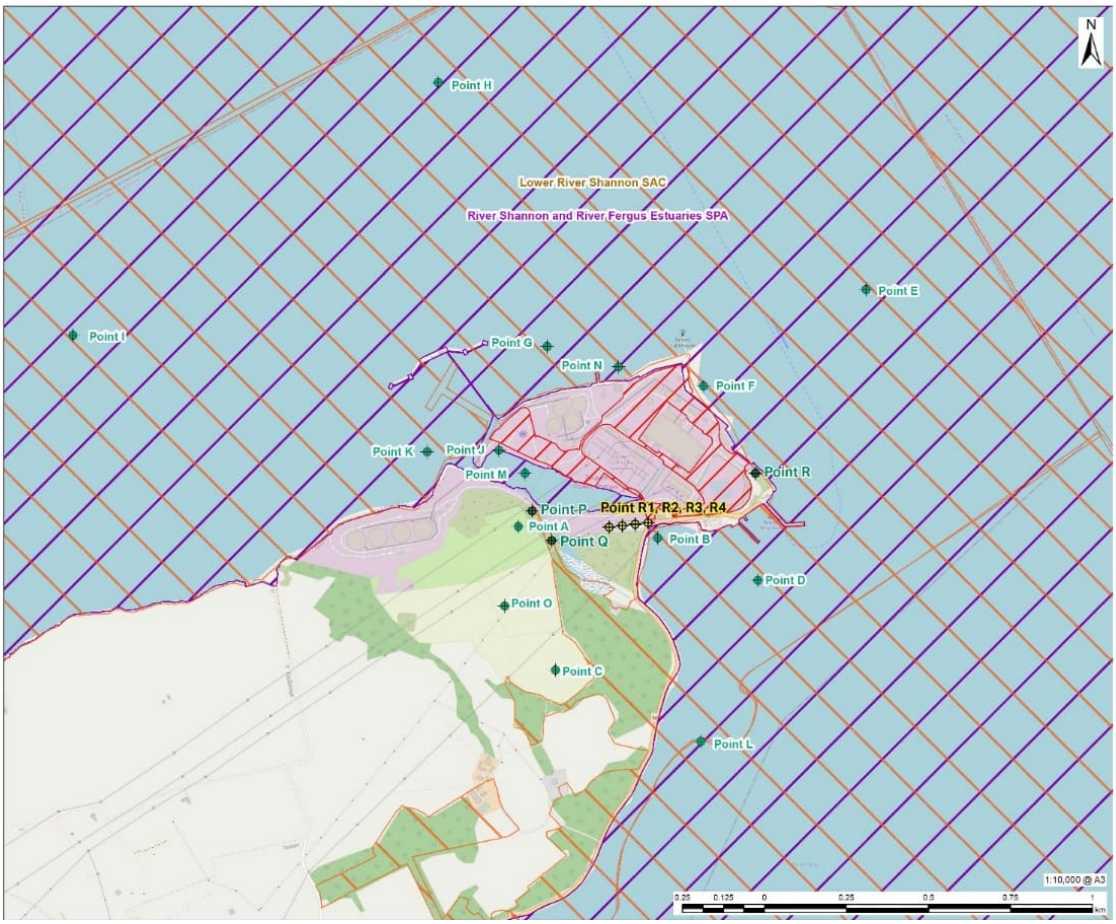

Figure B-1 Mapped locations of calculation surfaces on / near Site

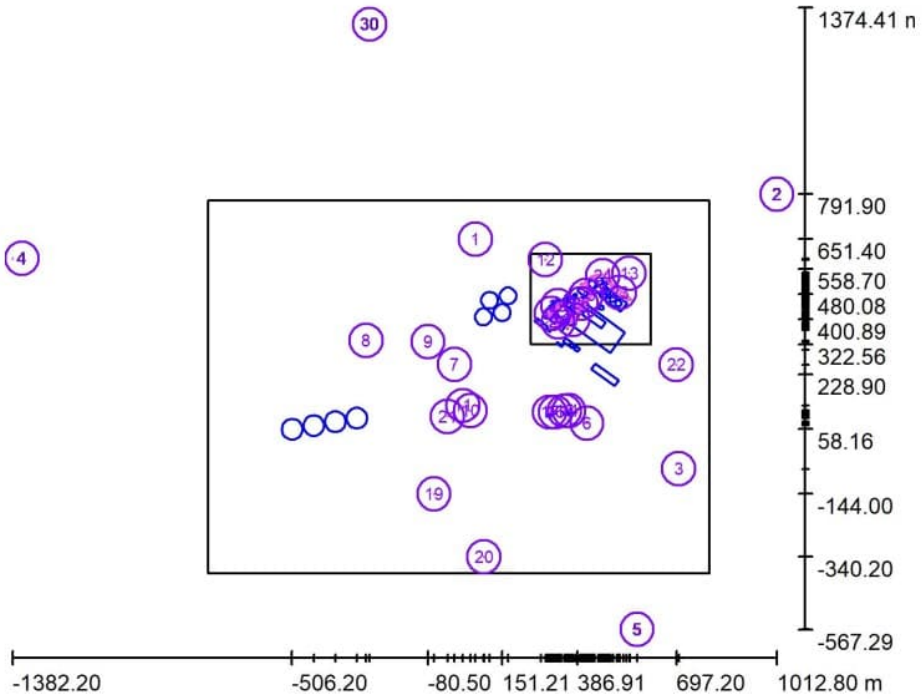

Figure B-2 Modelled locations of calculation surfaces on / near Site

Calculation Surface List

No.	Designation	Type	Grid	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
1	G	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
2	E	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
3	D	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
4	I	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
5	L	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
6	B	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
7	M	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
8	K	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
9	J	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
10	Q	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
11	P	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
12	N	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
13	F	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
14	R1	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
15	R2	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
16	R3	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
17	R4	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
18	Site - Carpark	perpendicular	64 x 16	16	8.42	26	0.533	0.324
19	O	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
20	C	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
21	A	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
22	R	perpendicular	1 x 1	0.00	0.00	0.00	1.000	1.000
23	Site Road 1	perpendicular	128 x 64	20	9.37	34	0.460	0.278
24	Site Road 2	perpendicular	128 x 128	23	9.97	35	0.432	0.286
25	Site Road 3	perpendicular	128 x 128	24	10	40	0.435	0.258
26	Site Road 4	perpendicular	128 x 32	21	11	34	0.540	0.324
27	H	perpendicular	1 x 1	0.00	0.00	0.00	0.000	0.000
28	Site Road 5	perpendicular	64 x 64	24	18	34	0.720	0.521
29	Site Road 6	perpendicular	64 x 32	27	11	33	0.427	0.346
30	Site Road 7	perpendicular	128 x 16	25	16	40	0.620	0.391
31	Site Road 8	perpendicular	128 x 32	24	14	38	0.581	0.369

Figure B-3 List of calculation surfaces and their results in lux & uniformity

B.2 Calculation Renders

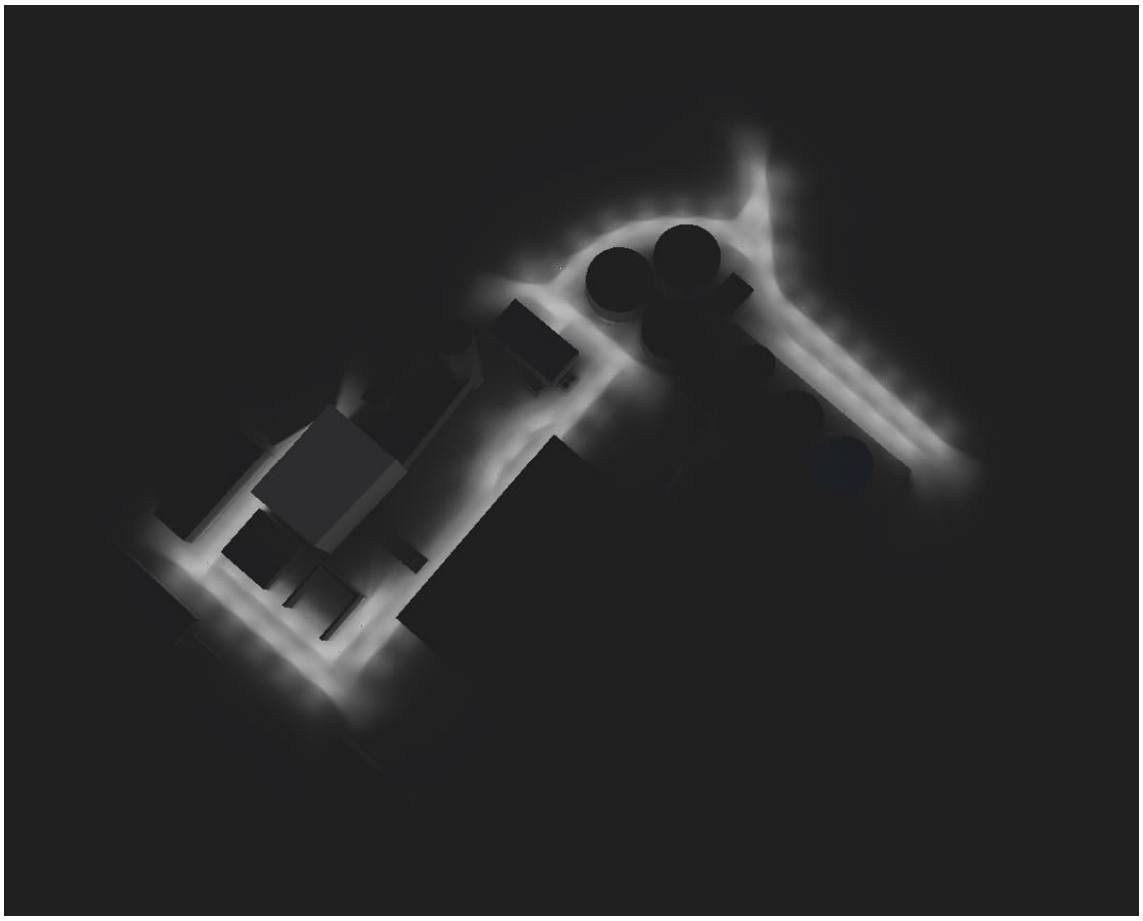

Figure B-4 White light Site render

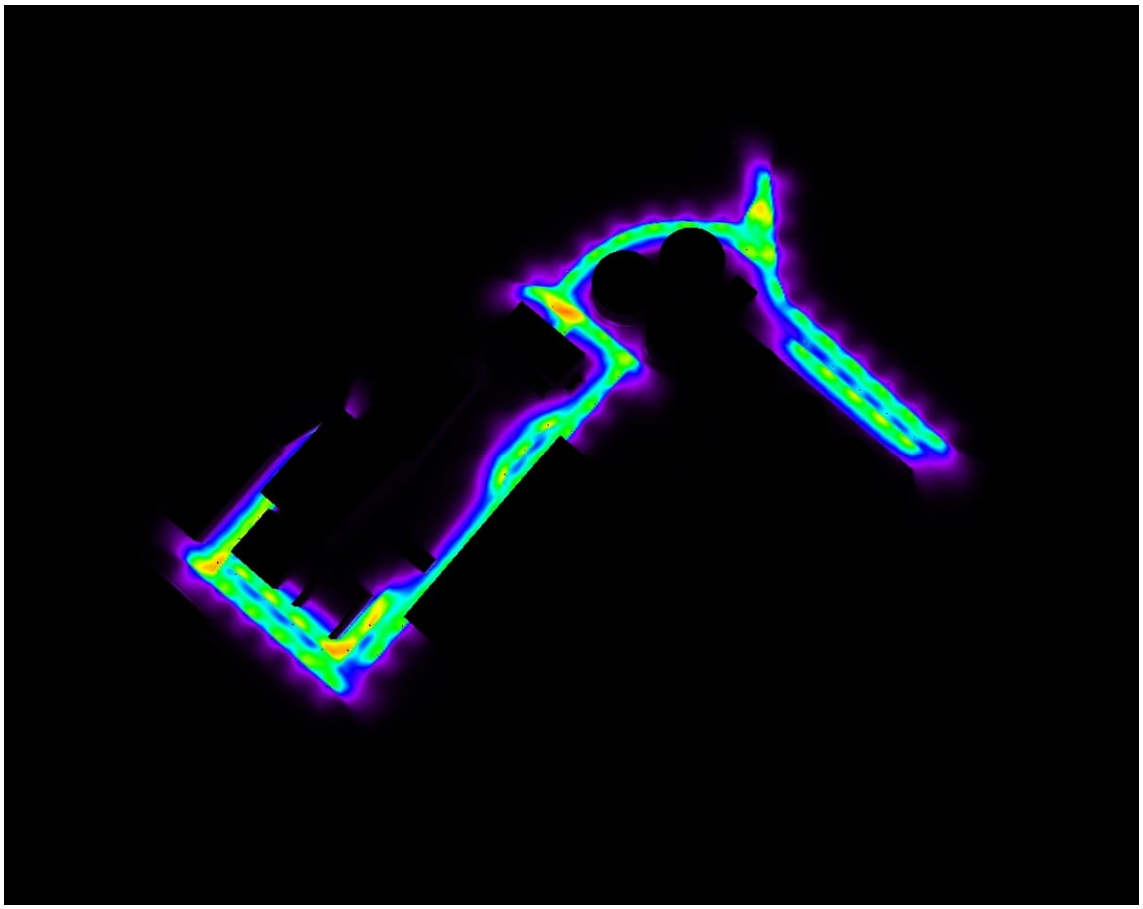

Figure B-5 False colour light Site render

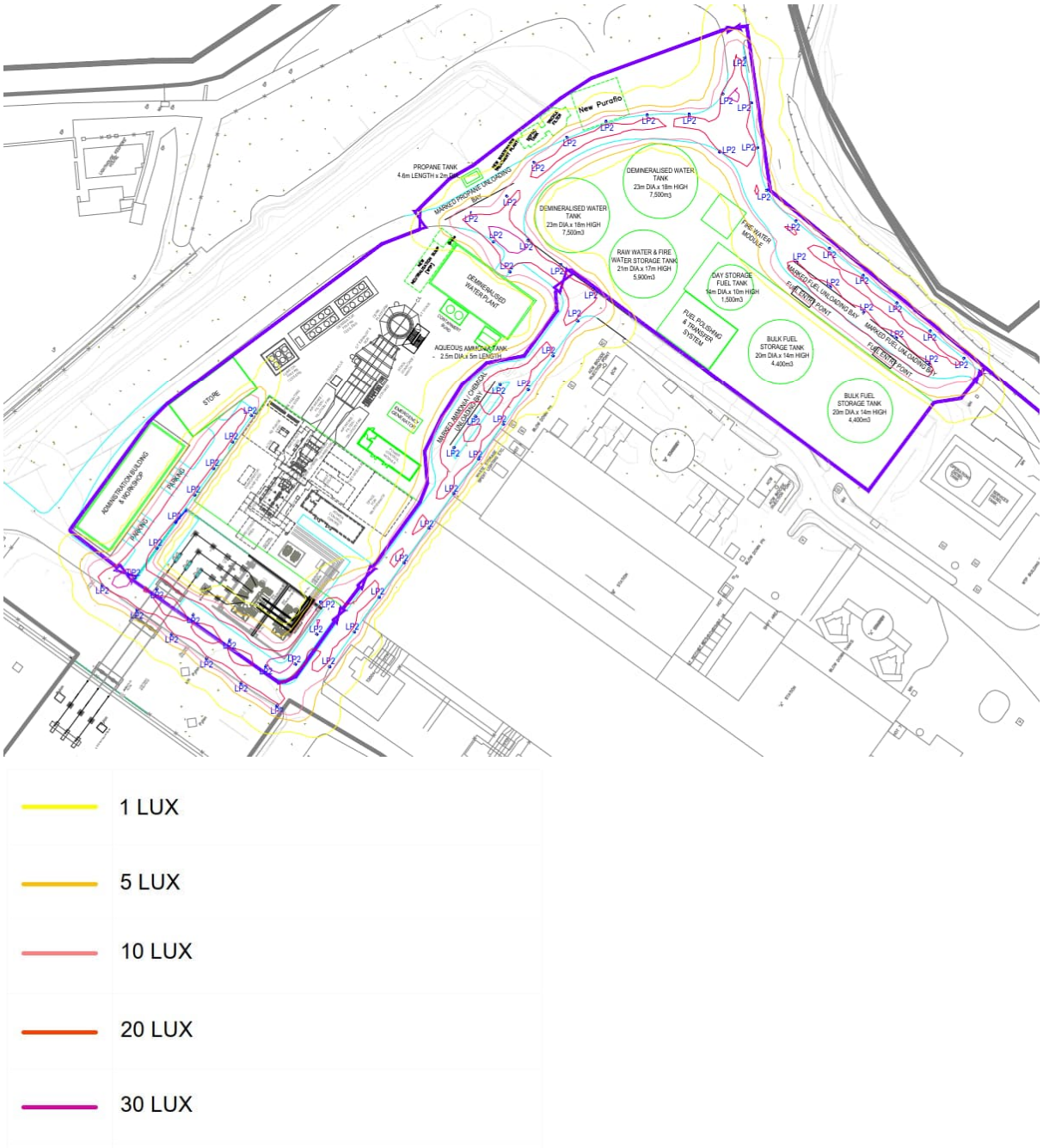

Figure B-6 Isolux light plot showing horizontal illuminance at ground level

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