Technical Appendix

Drummarnock Wind Farm

Technical Appendix 5-3: Aviation Lighting Assessment

Drummarnock Wind Farm Limited

July 2024

Tables

Figures

CBC House,
24 Canning Street,
Edinburgh,
EH3 8EG

Old Kilcoy House,
Tore,
Ross-shire,
IV6 7RZ

Linden House,
Mold Business Park,
Wrexham Road,
Mold ,
CH7 1XP

Executive Summary

In the interests of aviation safety, structures of ≥ 150m, including wind turbines, require steady red visible aviation lighting, as set out in Civil Aviation Authority (CAA) guidance.

As such, the Proposed Development will require visible aviation lighting which may be perceptible to receptors (people) from locations across the 45km LVIA Study Area.

This technical appendix sets out the background to the requirements for visible aviation lighting, followed by an assessment of landscape and visual effects arising for representative receptors across the Study Area.

A reduced lighting scheme (proposed by Straten CSL) was agreed through consultation with the CAA. This requires only four hub lights with no intermediate mid tower lights. As a result, significant landscape and visual effects associated with aviation lighting are judged to be limited.

No significant effects on landscape character or designated landscapes are anticipated. Dark sky qualities are not specifically recognised for any LCT or designated landscape considered in this assessment. However, some of the more remote and upland landscapes across the study area have naturalistic characteristics to which dark skies contribute.

Given that the Proposed Development will introduce a small number of lights, in views where other light sources are often visible (particularly in wider views which include visibility of the highly settled Carse of Stirling), no significant effects are predicted on landscape character. Equally none of the effects are judged to compromise the special qualities of designated landscapes.

In terms of visual effects, no significant visual effects are predicted for any of the three night time assessment viewpoints, under either the 2000 or 200 candela scenarios. The lights operate at a reduced intensity of 200 candela in clear weather conditions. This mitigation has been agreed with the CAA.

When visible, the Proposed Development will tend to be seen in larger scale views where four additional light sources are unlikely to result in significant effects. In views from Tomtain and Stirling Castle, numerous light sources in the surrounding lower lying landscapes (including the Carse of Stirling and the Central Belt) are also apparent.

The representative visualisations do not take account of the potential reduction in light intensity which may be perceived in relation to the relevant vertical elevation angle (refer to Figure A5-3-1).

Visibility in practice will also be influenced by weather conditions, which will vary from those experienced at the time the photography was captured. In conditions of meteorological visibility of less than 5km at the point of measurement, the perceived brightness of medium intensity lights illuminated at 2000 candela, whilst still visible, is likely to be substantially reduced.

Visibility will be affected by cloud and atmospheric dust or moisture. Both atmospheric conditions and angle intensity mitigation will influence the brightness of the lights as they are perceived in practice.

1 Aviation Lighting Assessment

1.1 Introduction

In the interests of aviation safety, structures of ≥ 150m, including wind turbines, require steady red visible aviation lighting, as set out in Civil Aviation Authority (CAA) guidance[1].

As such, Drummarnock Wind Farm (the Proposed Development) will require visible aviation lighting which may be perceptible to receptors (people) from locations across the 45km LVIA Study Area.

The requirement for visible aviation lighting is an emerging consideration for the wind energy sector, and consequently the approach to the assessment of likely landscape and visual effects which may arise, and the illustration of potential effects in the form of visualisations, is evolving.

This Technical Appendix to the EIA Report presents the background to the requirements for visible aviation lighting, followed by an assessment of landscape and visual effects arising for representative receptors across the Study Area.

Receptors considered in the assessment are identified in the Landscape and Visual Impact Assessment (LVIA) contained in Chapter 5: Landscape and Visual Amenity of this EIA Report. This technical appendix should be read with reference to the LVIA and the accompanying visualisations presented in Volume 4: Figures, along with Appendix 5.1: LVIA Methodology.

1.2 Regulatory Background and Requirements

The regulatory background to the requirements for, and specification of, visible aviation lighting on wind turbines is provided in the 'Windfarm Reduced Lighting Scheme Proposal' for Drummarnock Wind Farm (contained in Technical Appendix 14-1 Wind Farm Reduced Lighting Scheme Proposal), prepared by Straten CSL.

1.3 Lighting Design and Impacts

There are two aspects of aviation lighting design being applied at the Proposed Development: those required by the Civil Aviation Authority (CAA) Air Navigation Order (ANO) and those required by the Ministry of Defence (MOD).

With regard to lighting required by the CAA, and having applied the relevant policies and guidance, Straten CSL identified that these would support a lighting design involving illumination of four turbines at hub height (98.5m) using 2000/200 candela (cd) lights (to satisfy the CAA-ANO).

There is also a requirement for mid-mast or intermediate 32cd lights on each turbine. However, in the interests of avoiding distraction, Straten CSL has provided justification not to include mid mast or intermediate 32cd lights. Full detail of the lighting proposal, with all the rationale, is provided in Technical Appendix 14-1 Wind Farm Reduced Lighting Scheme.

The visible lighting proposals are described further below.

With regard to lighting required by the MOD, the CAA lighting described will satisfy their requirements. No additional MOD lighting is therefore required.

1.4 Potential Mitigation

Use of variable lighting intensities (e.g., 2000cd reduced to 200cd) to reflect meteorological conditions is one form of mitigation. Inbuilt shields, which reduce the intensity of the light that is seen when viewed below the horizontal, is another form. Both these mitigation options have been incorporated and are discussed further below.

Further mitigation options (such as radar activated lighting) which are currently being developed have not been considered as part of this assessment.

1.5 Proposed Aviation Lighting

Due to the height of the turbines proposed (up to 180m to turbine blade tip), visible aviation safety lighting is required. The proposed lighting scheme includes two medium intensity 'steady' red lights (2000 candela) located on the turbine hubs of all four turbines.

The secondary light is fitted for use in the event of failure of the primary light, and so will not be lit concurrently. No low intensity red lights (32 candela) located on the intermediate level on the turbine are proposed as part of this lighting scheme.

Visibility sensors, installed on the turbines, measure prevailing atmospheric conditions and visibility range. Where atmospheric conditions limit visibility to distances of less than 5km at the point of measurement (e.g., presence of low cloud cover, rain, mist, haze or fog) the lights are illuminated at the necessary peak intensity of 2000 candela.

When atmospheric conditions result in visibility at distances of 5km or greater from the turbines, the lights operate in a lower intensity mode of 200 candela (the equivalent of not less than 10% of the minimum peak intensity capable illumination). Visualisations which support this assessment have been provided to illustrate aviation lighting at both 2000 and 200 candela mode.

1.6 Approach to Assessment of Lighting Effects

The assessment of lighting effects follows the same approach detailed in Technical Appendix 5-1 LVIA Methodology.

However, it is important to note that the assessment is not a technical lighting assessment based on a quantitative measurement of light levels, but rather the assessment relies on professional judgement of what a typical naked human eye can reasonably perceive in the context of the baseline situation with regard to existing sources of artificial lighting.

Human eyes are variable, and in practice the way the lights will be seen will be influenced by this variability.

[1] Civil Aviation Authority (2016) CAA Policy and Guidelines on Wind Turbines – CAP 764

GLVIA 3 provides the following guidance on the assessment of lighting effects:

> "*For some types of development the visual effects of lighting may be an issue. In these cases, it may be important to carry out dusk/night-time 'darkness' surveys of the existing conditions in order to assess the potential effects of lighting and these effects need to be taken into account in generating the 3D model of the scheme. Quantitative assessment of illumination levels, and incorporation into models relevant to visual effects assessment, will require input from lighting engineers, but the visual effects assessment will also need to include qualitative assessments of the effects of the predicted light levels on dusk/night-time visibility*" (Paragraph 6.12, page 103).

This assessment considers the potential effects associated with two potential scenarios: When the hub lights are illuminated at 2000cd; and at 200cd. The 2000cd scenario represents the maximum illumination or lighting intensity possible. The 200cd scenario represents the lower intensity optional mode which would be activated in clear meteorological conditions.

As the baseline photography for each of the three representative dusk viewpoints was obtained in clear atmospheric conditions (whereby visibility substantially exceeds distances of 5km) the representation of 2000cd lighting in these conditions illustrates a potentially artificial 'maximum case' (worst-case) scenario.

This assessment adopts a precautionary approach, considering the potential effects that may arise when the hub light is illuminated at both 2000cd and 200cd (the latter being the optional mode during periods of clear visibility).

Although the assessment is based on effects arising in relation to the steady red light fixed to the top of each turbine hubs (as illustrated in the supporting visualisations) it is acknowledged that in some situations a potential flicker effect may be experienced by receptors as blades pass the stationary lights. It is not possible to represent this situation in static photomontages.

A reflected glow across the immediate surfaces of the turbine blades and hub may also be evident under certain conditions.

When determining the magnitude of change associated with the Proposed Development, the methodology set out in Technical Appendix 5-1 LVIA Methodology considers the duration of the change.

For operational effects this is deemed to be long term. However, and with relevance to night-time effects, the frequency of the effect should also be considered. Aviation lighting will only be apparent during hours of darkness (below 500 LUX[2]) which changes with the seasons. As such in the summer months the frequency of visibility of aviation lighting will reduce.

The night-time baseline against which the effects of the Proposed Development have be assessed, includes operational / under construction wind farms only. With regard to a theoretical future cumulative baseline, and within the more immediate vicinity around the Proposed Development Site (within 10km):

- Consented Shelloch Wind Farm (5 turbines at up to 180m to tip, with two turbines proposed with aviation lighting – Planning Ref 20/00840/FUL); and
- Proposed Earlsburn Extension (11 turbines at 180m to tip, with six turbines proposed with aviation lighting – Planning Ref ECU00004510).

will also require permanent aviation lighting, should they be constructed. Both of these schemes are located in the Southern Hills, in the Stirling Council area.

The scenario of illuminated consented and application stage wind farms is not represented in the night-time visualisations. However, these schemes are shown in the cumulative wirelines and acknowledged in the assessment text, where relevant.

At the present time the proposed manufacturer or precise model and specification of aviation light to be used is not known, therefore any further potential mitigation which may be embedded into the design of the proposed lights (i.e. the adoption of further shielding to the lights using caps and/or collars) has not been considered in the assessment.

As such, the lighting considered under this assessment is a worst-case scenario which does not take account of further mitigation opportunities.

1.6.1 Zone of Theoretical Visibility (ZTV) Mapping

A nacelle or hub height (98.5m height) ZTV, shown on Figure A5-3-1 (45km radius) has been prepared. This indicates areas from which the 2000cd lights installed on turbine nacelles may be visible. The ZTV was prepared using a 'bare ground' digital terrain model (DTM)[3], which does not take account of potential screening by buildings or vegetation.

To illustrate the potential variability in lighting intensity in relation to vertical viewing angle, the nacelle lighting intensity ZTV is also shown on Figure A5-3-1. As illustrated by the ZTV, visibility of the nacelle lights at their greatest perceived brightness would generally be limited to views experienced from locations similar to and just above the horizontal plane of the nacelle mounted aviation light.

This tends to be from more upland and less settled areas across the study area. These upland and less settled areas tend to be less frequently visited during hours of darkness. Conversely, from low lying valleys and lowland locations which are the focus of most settlement and habitation across the LVIA study area, the turbines inbuilt shields allow the aviation lights to generally be perceived at substantially reduced intensity. This includes the nearest residents at Easter Cringate and Ryecroft, discussed further in Technical Appendix 5-2 Residential Visual Amenity Assessment (RVAA).

1.6.2 Wireline and Photomontage Visualisations

Visualisations are just one source of information used to inform the LVIA. Visualisations have been produced for three representative assessment viewpoints, which have been refined from the list of night time assessment viewpoints suggested through scoping responses by consultees. The visualisations are presented in accordance with the

[2] LUX is a unit used to measure the intensity of light hitting a surface.

[3] The DTM used is based on OS Terrain® 50 height data, obtained from Ordnance Survey in October 2019.

industry standard guidance prescribed by NatureScot[4] and the Landscape Institute[5]. The methodology for the preparation of night-time photomontage visualisations is detailed in Appendix 5-1LVIA Methodology.

NatureScot guidance states:

> *"The visualisation should use photographs taken in low light conditions, preferably when other artificial lighting (such as street lights and lights on buildings) are on, to show how the wind farm lighting will look compared to the existing baseline at night… We have found that approximately 30 minutes after sunset provides a reasonable balance between visibility of the landform and the apparent brightness of artificial lights, as both should be visible in the image"* (Paras 174 – 177, Pages 35 and 36).

Capturing photography at this time represents a short window (during dusk and dawn) when the landform is visible along with existing and proposed light sources. The actual night-time view, for most of the proposed turbine lit hours, will be a darker outlook with the proposed lighting and other light sources (if visible).

The representative visualisations (Figures 5-2-1, Figure 5-2-4 and Figure 5-2-8 series of figures) are presented in Volume 4: Figures as a combination of existing baseline photography and photomontages which aim to represent the appearance of the proposed visible aviation lighting at:

- Viewpoint 1 – North Third Reservoir;
- Viewpoint 4 – Tomtain; and
- Viewpoint 8 – Stirling Castle.

Post scoping consultation also indicated the use of Bannockburn Memorial as a night time assessment viewpoint. However, design development, since scoping, has resulted in limited visibility of turbine hubs (and associated aviation lighting) from this location, with intervening forest on the horizon providing further screening.

As such, this viewpoint has not been included as a night time assessment viewpoint. However, a dusk visualisation has been provided, at Figure 5-2-7h. A night time assessment viewpoint from Ben Ledi was also considered. However, due to viewing distance and numerous intervening sources of light it was agreed with NatureScot that this was not required.

Baseline dusk photography was undertaken in accordance with NatureScot guidance. Photography was captured at dawn/ dusk in clear atmospheric conditions. This sought to capture the presence of existing baseline sources of artificial lighting (e.g. lighting associated with settlement, street lighting, motor vehicles and other sources) present in the landscape, as closely as is experienced by the human eye as is feasible.

The representative visualisations do not take account of the potential reduction in light intensity which may be perceived in relation to the relevant vertical elevation angle and distance at which they are viewed, whereby the actual light perceived at these locations is likely to be reduced from that which is illustrated in the visualisations, as shown on Figure A5-3-1.

[4] Scottish Natural Heritage (2017) Visual Representation of Wind Farms Guidance – Version 2.2

[5] Landscape Institute (2019) Technical Guidance Note 06/19 Visual Representation of Development Proposals

1.7 Effects on Landscape Character and Designated Landscapes

In terms of effects on landscape character and designated landscapes, and as noted previously, there will be a short window of time, at dawn and dusk, during which the landform is visible along with existing and new light sources.

During darkness it is harder to appreciate the key characteristics of the landscape. As such, effects associated with aviation safety lighting are principally visual effects. However, in certain landscapes, qualities such as dark skies are an important contributing factor to landscape character.

From upland landscapes, and where visible, the Proposed Development will typically be seen in more elevated and expansive views. Outside of the Touch and Gargunnock Hills, views towards the Proposed Development tend to look over settled valleys and lowland areas where light sources in more settled landscape will be visible.

When looking at the Proposed Development from the Touch and Gargunnock Hills, longer distance successive views towards highly settled landscapes (and associated light sources) to the north, east and south are often available.

Darker skies are more common in these upland landscapes, and many of the upland landscape in the more immediate context are designated at a local level (refer to Figure 5-1-4a and b). However, none of the landscape across the study area is within any recognised dark skies parks.

From the more settled lower lying landscape, the nature of night time views will be dictated by the landform, vegetation cover and presence of buildings. Light sources in the foreground of the view will also be a common feature, particularly from settlements across the Carse of Stirling, looking west towards the Proposed Development.

Actual night-time conditions, for most of the proposed hours when turbines are lit, will be darker. As such, the window for landscape effects, and effects on many of the associated key characteristics and special qualities of locally designated landscapes (most of which can only be appreciated during daytime), is limited.

None of the landscape across the study area falls within a recognised dark skies park. Given that the Proposed Development will introduce a small number of lights, in views where other light sources are often visible, no significant effects are predicted on landscape character, or are judged to compromise the special qualities of designated landscapes.

1.8 Effects on Visual Amenity

Table 1 below details the predicted visibility of the proposed turbine lighting from each LVIA assessment viewpoint (informed by Figures 5-2-1 to 5-2-17). The table also indicates the potential influence of coniferous forestry in further screening the theoretical visibility of turbine lighting from each viewpoint location, informed by the baseline photography and observations from fieldwork.

As noted above the frequency of the effect should also be considered. Aviation lighting will only be apparent during hours of darkness (below 500 LUX) which changes with the seasons. As such, in the summer months, when people are more likely to be in the hills at night, the length of time subject to visible aviation lighting will reduce.

Table 1: Summary of Turbine Lighting Visibility from Each Viewpoint

Summary of Turbine Lighting Visibility						
Table Key						
Hub lighting potentially visible (i.e. one medium intensity hub light)		•	Turbine hub lighting potentially screened by forestry			Intensity – Maximum luminous and (10% luminous) refer to Figure A5-3-1
Summary of Turbine Lighting Visibility						
Hub light		T1	T2	T3	T4	
1	North Third Reservoir	•	•	•	•	Below 200 cd (below 20cd)
2	Lewis Hill	•	•	•	•	400 to 200cd (40 to 20cd)
3	Carron Bridge at Northshields	•	•	•	•	400 to 200cd (40 to 20cd)
4	Tomtain	•	•	•	•	2000 to 2500cd (200 to 250cd)
5	M9 / A811 overpass	•	•	•	•	400 to 200cd (40 to 20cd)
6	Meikle Bin	•	•	•	•	2000 to 2500cd (200 to 250cd)
7	Bannockburn Memorial	•	•			400 to 200cd (40 to 20cd)
8	Stirling Castle	•	•	•	•	400 to 200cd (40 to 20cd)
9	M80 at Denny Drove Road overpass	•	•	•	•	1000 to 400cd (100 to 40 cd)
10	Wallace Monument	•	•	•	•	1000 to 400cd (100 to 40 cd)
11	Falkirk Wheel	•	•	•	•	1000 to 400cd (100 to 40 cd)
12	Dumyat	•	•	•	•	2000 to 1000cd (200 to 100cd)
13	Clackmannan Tower	•	•	•	•	1000 to 400cd (100 to 40 cd)
14	Ben Cleuch	•	•	•	•	2000 to 2500cd (200 to 250cd)
15	Ben Ledi	•	•	•	•	2000 to 2500cd (200 to 250cd)
16	Crow Road	No hub visibility				N/a
17	Doune Castle	Turbines screened by landform and dense woodland				N/a

1.8.1 Representative Assessment Viewpoints

Whilst the potential visibility of aviation lighting is summarised for each of the LVIA assessment viewpoints (as set out in Tables 2-4) the following assessment focuses on three representative viewpoints.

Night-time photomontage visualisations were produced for the following three assessment viewpoints:

- Viewpoint 1 – North Third Reservoir;
- Viewpoint 4: Tomtain; and
- Viewpoint 8 – Stirling Castle.

Table 2: Potential Visibility – Viewpoint 1: North Third Reservoir

Viewpoint 1: North Third Reservoir			
Grid Reference (NGR)	275155, 688977	**Figure Number**	5-2-1
LCT	Lowland Hills - Central	**Designated Landscape or Wild Land Area**	Southern Hills LLA
Direction of View	Southwest	**Distance to Nearest Turbine (km)**	2.2km
Number of Hubs Theoretically Visible	4		
Location, Description of Existing View and Potential Receptors			
This viewpoint represents views experienced by road users on the minor road network to the east of Site, as they pass North Third Reservoir. Similar views will be experienced by residents located along this minor road to the north-east of the Site. Views to the southwest (towards the Site) present a darker rural upland outlook. The north-eastern flank of Craigengelt Hill contributes to the dark horizon. In wider views, subdued lighting from upland farms, including Townhead to the northwest create some sources of artificial light. Occasional light sources from traffic moving along the minor road network also contribute to artificial light sources.			
Night-Time Sensitivity			
Road users including cyclists on this local road are considered to be of medium susceptibility to changes in the view. In terms of value the viewpoint is located within the locally designated Southern Hills LLA, but does not represent a recognised or promoted view, and is therefore considered to be of medium value. **On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be medium.**			
Assessment of Visual Effects			
Figures 5-2-1g and h illustrate the view of the Proposed Development at night with 200 and 2000 candela aviation lighting. Lighting on the hubs of all four turbines is visible, seen against the dark sky in views to the southwest at a distance of 2.2km. These lights will be seen in the context of a darker rural outlook, with occasional light sources from upland farms and traffic moving along the minor road network (from which the viewpoint is taken) visible in wider views. Overall, the scale of change associated with visible aviation lighting is judged to be small. The Proposed Development will be widely visible from this local road to the east of the Site, and the geographical extent is considered to be medium. The overall magnitude of change is considered to be low for both the 2000 candela 'maximum worst case' scenario, and the 200 candela scenario which is viewed in clear weather conditions. The intensity ZTV (refer to Figure A5-3-1) indicates that the maximum intensity of light emitted due to the viewing angle from this location is below 200 candela (and below 20 candela for the clear weather condition scenario). This further reinforces the low magnitude of change associated with visual effects at night-time. Similar levels of intensity will be experienced for the nearest residents, all of which are located on roads and tracks around the Site which sit below the hub lights. **The overall magnitude of change is judged to be low and taking account of the medium sensitivity will result in a Not Significant (Minor) visual effect.**			
Potential for Future Cumulative Effects			
In the more immediate context of the Site, aviation lighting on certain turbines in the proposed Earlsburn Extension will be apparent, seen above dark horizons in views to the northeast. Aviation lighting on the Proposed Development will be seen in successive views to the southwest. In this alternative theoretical future night time cumulative baseline, effects associated with the Proposed Development will remain similar (Not significant).			

Table 3: Potential Visibility – Viewpoint 4: Tomtain

Viewpoint 4: Tomtain			
Grid Reference (NGR)	272120, 681416	**Figure Number**	5-2-4
LCT	Rugged Moorland Hills	**Designated Landscape or Wild Land Area**	Kilsyth Hills LLA
Direction of View	North	**Distance to Nearest Turbine (km)**	5.7km
Number of Hubs Theoretically Visible	4		
Location, Description of Existing View and Potential Receptors			
This viewpoint represents views experienced by recreational receptors visiting this prominent hill summit within the Kilsyth Hills, to the south of the Site. From this elevated location the view looks north over the darker landscapes associated with the Southern Hills and towards the Carse of Stirling (to the northeast), where numerous light sources associated with settlements and major transport routes are apparent. The longer distance horizon to north and northeast, formed by the Ochil Hills and more distance hills, creates a darker backdrop to the night time view. In wider views, particularly to the south and southeast, there are also numerous light sources associated with settlement and transport corridors in the lower lying Central Belt/ southern extents of the Carse of Stirling.			
Night-Time Sensitivity			
Recreational receptors, whose attention is focused on their surroundings, are considered to be of medium-high susceptibility to changes in the view. It is recognised that this minor summit is less likely to be frequented during the hours of darkness. In terms of value, the viewpoint is located in a locally designated landscape, indicating a medium-high value. **On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be medium-high.**			
Assessment of Visual Effects			
Figures 5-2-4h and i illustrate the view of the Proposed Development at night with 200 and 2000 candela aviation lighting. Lighting on the hubs of all four turbines is visible at a distance of 5.7km, seen in front and to the west of the Carse of Striling and below darker horizons further north. Lights on the Proposed Development will be seen in the context of numerous light sources associated with settlement and major transport routes in the Carse of Stirling, to the northeast. Overall, the scale of change associated with visible aviation lighting is judged to be small. The geographical extent is judged to be small, as forestry will limit views from wider sections of the Core Path network in this area. The overall magnitude of change is considered to be low for both the 2000 candela 'maximum worst case' scenario, and the 200 candela scenario for clear weather conditions. Due to the elevation of this viewpoint, with aviation lighting seen broadly along the horizontal, the intensity ZTV (refer to Figure A5-3-1) indicates that the maximum intensity of light emitted due to the viewing angle from this location is between 2000 to 2500 candela (200 to 250 candela for the clear weather conditions scenario). **The overall magnitude of change is judged to be low and taking account of the medium-high sensitivity will result in a Not Significant (Minor) visual effect.**			
Potential for Future Cumulative Effects			
In the more immediate context of the Site, aviation lighting on certain turbines in the consented Shelloch and proposed Earlsburn Extension Wind Farms will be apparent. This will be seen in successive and combined views to the northwest and north with aviation lighting on the Proposed Development. This Proposed Development will continue to be seen in the context of numerous light sources in the Carse of Stirling and now some light sources associated with these schemes. As such, effects will reflect those as identified in the primary night time assessment from this viewpoint (Not significant).			

Table 4: Potential Visibility – Viewpoint 8: Stirling Castle

Viewpoint 8: Stirling Castle			
Grid Reference (NGR)	279009, 693969	**Figure Number**	5-2-8
LCT	Urban	**Designated Landscape or Wild Land Area**	N/A
Direction of View	Southwest	**Distance to Nearest Turbine (km)**	8.4km
Number of Hubs Theoretically Visible	4		
Location, Description of Existing View and Potential Receptors			
This viewpoint represents views experienced by recreational receptors visiting Stirling Castle, to the northeast of the Site. From the slightly elevated position of the castle, the view looks over the Carse of Striling to the west. Numerous light sources associated with settlement (housing on the western edge of Stirling and in Cambusbarron) and transport corridors are apparent. In wider views numerous light sources within the settlement of Striling are also apparent, in available views from the castle.			
Night-Time Sensitivity			
Recreational receptors at this nationally important historic site, and whose attention is focused on their surroundings, are considered to be of high susceptibility to changes in the view. The Historic Environment Scotland website states that latest entry to the castle is 5pm. As such, this will limit the availability of night time views from within the castle. In terms of value, the viewpoint is not within a designated landscape, but is considered a key public view and therefore the value is considered to be medium-high. **On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be high.**			
Assessment of Visual Effects			
Figures 5-2-8f and g illustrate the view of the Proposed Development at night with 200 and 2000 candela aviation lighting. Lighting on the hubs of all four turbines is visible, seen at a distance of 8.4km. Whilst the aviation lighting will be seen against the dark sky in views to the southwest it will be seen in the context of numerous light sources associated with the intervening settlement and transport routes situated in the lower lying carse between the viewpoint and the Site. Overall, the scale of change associated with visible aviation lighting is judged to be small. The geographical extent is considered to be small, as similar views will be gained from within the immediate surroundings of the elevated vantage point at Castle Rock. Opening hours at the castle will also limit the availability of night time views from here. The overall magnitude of change is considered to be low for both the 2000 candela 'maximum worst case' scenario, and the 200 candela scenario for clear weather conditions. The intensity ZTV (refer to Figure A5-3-1) indicates that the maximum intensity of light emitted due to the viewing angle from this location is between 400 to 200 candela (and between 40 to 20 candela for the clear weather condition scenario). This further reinforces the low magnitude of change associated with visual effects at night-time. **The overall magnitude of change is judged to be low and taking account of the high sensitivity will result in a Not Significant (Minor) visual effect.**			
Potential for Future Cumulative Effects			
In the more immediate context of the Site, aviation lighting on certain turbines in the proposed Earlsburn Extension Wind Farms will be apparent. This will be seen in combined views on dark skies to the southwest along with aviation lighting on the Proposed Development. This Proposed Development will continue to be seen in the context of numerous light sources in the Carse of Stirling and now some light sources associated with this scheme. As such, effects will reflect those as identified in the primary night time assessment from this viewpoint (Not significant).			

Drummarnock Wind Farm

wind2

Figure A5-3-1
Aviation Lighting Zone Of Theoretical Visibility - Nacelle Lighting Intensity and Viewpoint Locations

Vertical angle of lighting from nacelle (98.5m)	Maximum luminous intensity (Candela/cd)	10% Maximum luminous intensity
Above 2°	1500 to 750	150 to 75
1° to 2°	2500 to 1500	250 to 150
0° to 1°	2000 to 2500	200 to 250
-1° to 0°	2000 to 1000	200 to 100
-2° to -1°	1000 to 400	100 to 40
-3° to -2°	400 to 200	40 to 20
Below -3°	Below 200	Below 20

Key

- Turbine with nacelle lighting
- Viewpoint location
- Dusk viewpoint location
- 5km Turbine radii to 45 km

Viewpoint locations

1 - North Third Reservoir
2 - Lewis Hill
3 - Carron Bridge at Northshields
4 - Tomtain
5 - M9/A811 overpass
6 - Meikle Bin
7 - Bannockburn Memorial
8 - Stirling Castle
9 - M80 at Denny Myothill Road overpass
10 - Wallace Monument
11 - Falkirk Wheel
12 - Dumyat
13 - Clackmannan Tower
14 - Ben Cleugh
15 - Ben Ledi
16 - Crow Road
17 - Doune Castle

Generated using Ordnance Survey's Terrain 50 Dataset which does not take into account the screening effects of buildings or vegetation.

ZTV calculated using ArcGIS 10.6 Viewshed tool with observer eye height 2m above ground and corrections for earth curvature and atmospheric refraction applied.

Turbine lighting visibility calculated between +3° and -4° from a horizontal plane.

atmos CONSULTING

0 5 10 20
Kilometres

N

Scale @ A3:
1:350,000

21/05/2024	TL026	40419/ZV/113a
Drawn by: TH	Checked by: TH	Approved by: LK