Glentarken Wind Farm

LVIA Technical Appendix 5.2 - Assessment of Visible Aviation Lighting

CONTENTS

1 INTRODUCTION

1.1.1 This Technical Appendix (TA) has been prepared to accompany **Chapter 5: Landscape and Visual Impact Assessment** in Volume 1 of the Glentarken Wind Farm (Proposed Development) Environmental Impact Assessment Report (EIA Report). The Civil Aviation Authority (CAA) requires that 'en-route obstacles' at or above 150 m above ground level are lit with visible lighting to assist their detection by aircraft[1]. As such, there is potential that the Proposed Development may need to display visible red lights at night. The effect of Proposed Development at night would potentially result from visible medium intensity (2000 candela (cd)) red coloured light fittings located on the nacelles and 32cd red coloured light fittings located on the towers of proposed turbines. **TA 13.1: Glentarken Lighting Report (EIAR Volume 4)** provides details of a proposed reduced lighting scheme for the Proposed Development which would result in fewer nacelle lights and no tower lights. See also Assessment Parameters in Section 3 of this TA.

1.1.2 It should be noted that the Proposed Development would also include infra-red lighting (to satisfy MOD requirements) on the turbine hubs which would not be visible to the human eye. The focus of this TA is on the visual assessment of the visible aviation lighting of the Proposed Development (to satisfy CAA requirements).

1.1.3 For the assessment of lighting effects, the visual sensitivity and magnitude criteria described in **TA 5.1: Methodology (EIAR Volume 4**) has been applied. This TA is also supported with the following figures –

- Volume 4 - Figure 5.2.1 - Baseline Light Pollution
- Volume 4 - Figure 5.2.2 - ZTV of Turbine Hub Lighting (reduced aviation lighting scheme)
- Volume 4 - Figure 5.2.3 - Hub Lighting Intensity ZTV (reduced aviation lighting scheme)
- Volume 3 - Figures 5.23 j-k – Viewpoint 7 Nighttime Visualisations
- Volume 3 - Figures 5.26 f-h – Viewpoint 10 Nighttime Visualisations
- Volume 3 - Figures 5.35 f-h – Viewpoint 19 Nighttime Visualisations
- Volume 3 - Figures 5.37 g-i – Viewpoint 21 Nighttime Visualisations

2 REGULATIONS AND GUIDANCE

2.1 International Civil Aviation Organisation (ICAO) / CAA Regulations

2.1.1 ICAO (a United Nations (UN) body) sets international Standards; Recommendations and 'Notes' for aviation lighting in its publication *'Annex 14 to the Convention on International Civil Aviation'*[2]. ICAO Annex 14 Table 6.1 (page 6-4) identifies the international definitions of daylight; twilight and night based on measured background illuminance as follows.

- Daylight: Above 500 cd/m2

[1] Civil Aviation Authority, Safety & Airspace Regulation Group (2017). Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150m Above Ground Level. The Air Navigation Order 2016 (SI 2016 No.765).

[2] ICAO (2018). Annex 14 to the Convention on International Civil Aviation - Volume I Aerodrome Design and Operations (ICAO, Eighth Edition).

- Twilight: 50-500 cd/m2
- Night: Below 50 cd/m2

2.1.2 For 2000 cd medium intensity steady or fixed red lights, ICAO indicates a requirement for no lighting to be switched on until 'Night' has been reached, as measured at 50 cd/m2 or darker. ICAO Annex 14 Table 6.3 (page 6-5) identifies minimum requirements and recommendations for 2000 cd aviation lights on wind turbines at 150 m and above. In summary these minimum requirements are:

- 0 to +3° from horizontal: 2000 cd minimum average intensity (or 1,500 cd minimum intensity)
- -1° from horizontal: 750 cd minimum intensity

2.1.3 The European Aviation Safety Agency (EASA) implements ICAO in European airspace. In pursuit of international standards for use around the globe, a project team has been established to provide clearer direction to lighting manufacturers, as there is scope for interpretation of ICAO in different ways by manufacturers.

2.1.4 Within the United Kingdom (UK), the ICAO/ EASA requirements for lighting wind turbines are implemented through CAA publication '*CAP 764: Policy and Guidelines on Wind Turbines*'[3], and '*The Air Navigation Order*'[4]. The proposed turbines, at 180 to blade tip, would require lighting under Article 222 of CAP 393 Air Navigation Order. This requires a single, medium intensity, 'steady' red aviation light (emitting 2000cd) to be fitted at nacelle level to each turbine. In addition, the CAA requires three low intensity lights to be fitted at the intermediate level on the turbine tower (CAA, 2017), to provide 360 degree visibility around the tower. The intermediate 'tower' lights will be 32 cd.

2.1.5 CAA Policy Statement[1] (paragraph g) states that 'If the horizontal meteorological visibility in all directions from every wind turbine generator in a group is more than 5 km, the intensity for the light positioned as close as practicable to the top of the fixed structure required to be fitted to any generator in the windfarm and displayed may be reduced to not less than 10 % of the minimum peak intensity specified for a light of this type.' This reduction affords valuable mitigation of light intensity and allows the minimum intensities identified above to be dimmed to 10 % of minimum peak intensity if meteorological conditions permit (i.e. the 2000 cd minimum intensity may be dimmed to 10 %, or 200 cd, if visibility is greater than 5 km, i.e. in moderate to excellent or 'clear' visibility).

2.2 Guidelines for Landscape and Visual Impact Assessment (GLVIA3)

2.2.1 GLVIA3[5] (page 103) 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 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 night-time visibility.'*

2.2.2 GLVIA3 (page 60) also provides the following guidance with regards to mitigation of obtrusive light: *'lighting for safety or security purposes may be unavoidable and may give rise to significant adverse*

[3] Civil Aviation Authority (2016) CAP 764: Policy and Guidelines on Wind Turbines.

[4] The Air Navigation Order 2016 (SI 2016 No.765).

[5] Landscape Institute with the Institute of Environmental Management and Assessment (2013). Guidelines for Landscape and Visual Impact Assessment, Third Edition (GLVIA3).

effects; in such cases, consideration should be given to different ways of minimising light pollution and reference should be made to appropriate guidance, such as that provided by the Institution of Lighting Professionals (ILP, 2011)'.

2.3 Institute of Lighting Professional Guidance

2.3.1 Guidance produced by the Institute of Lighting Professionals (ILP) (2011) (GN01:2011)[6] is useful in setting out some key lighting terminology that relates to potential visual effects.

*2.3.2 'Obtrusive light, whether it keeps you awake through a bedroom window, impedes your view of the night sky or adversely affects the performance of an adjacent lighting installation, is a form of pollution. It may also be a nuisance in law and can be substantially mitigated without detriment to the requirements of the task. Sky glow, the brightening of the night sky, Glare, the uncomfortable brightness of a light source when viewed against a darker background, Light spill, the spilling of light beyond the boundary of the area being lit and Light intrusion, ('Nuisance'**) are all forms of obtrusive light which may cause nuisance to others, or adversely affect fauna & flora as well as waste money and energy.*

*2.3.3 **[The term light trespass has been used in the past and should no longer be referenced, trespass is to physically encroach on land and light can't do that, so the term nuisance or spill light should always be used]'*

2.3.4 The following key guidance within the ILP GN01:2011 is noted as follows:

- *'The most sensitive/critical zones for minimising sky glow are those between 90° and 100° (note that this equates to 0-10° above the horizontal).*
- *Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is not more than 70°.*
- *In rural areas the use of full horizontal cut off luminaires installed at 0° uplift will, in addition to reducing sky glow, also help to minimise visual intrusion within the open landscape.*
- *Upward Light Ratio (ULR) of the Installation is the maximum permitted percentage of luminaire flux that goes directly into the sky. A ULR of 0 (zero) Candela (cd) is suggested for Dark Sky Parks.'*

2.3.5 CPRE[7] also identifies these same broad terms as the three types of light pollution:

- *'skyglow – the pink or orange glow we see for miles around towns and cities, spreading deep into the countryside, caused by a scattering of artificial light by airborne dust and water droplets.*
- *glare – the uncomfortable brightness of a light source.*
- *light intrusion – light spilling beyond the boundary of the property on which a light is located, sometimes shining through windows and curtains'.*

2.4 NatureScot Guidance

Evolving NatureScot Approaches to Turbine Lighting

2.4.1 NatureScot workshops[8] indicate that a proportionate and pragmatic approach is required, both in terms

[6] Institute of Lighting Professionals (ILP) - Guidance Notes for the Reduction of Obtrusive Light GN01:2011

[7] CPRE – 'What is Light Pollution' found at webpage – https://www.cpre.org.uk/explainer/what-is-light-pollution-and-how-can-you-take-action-about-it/ [accessed 3.10.24].

[8] NatureScot (2019), Planning for Great Places Webinar. Wind turbine aviation lighting – considering the effects on nature and landscapes

of the need to assess likely significant effects under the EIA regulations[9] (in the context of complying with current civil aviation standards) and also in providing mitigation (on a project and site-specific basis).

2.4.2 Mitigation options to eliminate or reduce the need for, and effects of, visible lighting are evolving quickly and developers are exploring these with consultees and the CAA in relation to specific sites. NatureScot has offered a perspective on the efficacy of different mitigation options, noting that the most effective appears to be radar activated, albeit accepting the considerable cost implications inherent in this potential option.

2.4.3 Ministers and planning authorities are using planning conditions to manage effects. It is recognised that the EIA Report should not necessarily specify one mitigation option, as these are evolving rapidly, and developers need flexibility to utilise the most appropriate mitigation once they are ready to start discharging conditions. Conditions provide some flexibility for developers to identify the most appropriate mitigation option(s) post consent and prior to construction, and to agree these with the relevant decision maker.

2.4.4 In terms of visual effects, NatureScot's view (as expressed at a seminar in November 2019[8]) is that lengthy debate about the exact brightness of lights (including in visualisations) is potentially not helpful and that it is better to focus on where they will be visible, how many lights will be visible and the level of change from the baseline situation. This is recognised in the visual assessment in this Appendix. NatureScot has taken a proportionate and pragmatic view with night-time visualisations, requesting that decision makers, consultees and communities require visualisations from a small number of relevant viewpoints to understand these effects. NatureScot also recognises the challenges of capturing night-time photography and accept that some post photographic manipulation of images to provide a good representation is acceptable[8]. See also Appendix 5.1 which provides further detail on the production of visualisations. It is understood that Guidance relating to the Assessment of Aviation Lighting for Onshore Turbines is soon to be published by NatureScot, on behalf of the Scottish Government.

Visual Representation Guidance

2.4.5 In terms of how lighting is captured in visualisations, the main change in the latest version of the NatureScot Visualisation Guidance[10] is in paragraphs 174-177, which 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.'*

2.4.6 The night-time photography has therefore been captured in low light conditions, when other artificial lighting (such as streetlights and lights on buildings) is on, to show how the wind farm lighting would look compared to the existing baseline at night. Night time photography has also been captured in line with Institute of Lighting Professionals Guidance Note 10[11].

2.4.7 Existing lights shown in the photographs appear larger and more blurred than those seen to the naked eye in the field when the photographs were captured. The term used in photography to describe this

[9] The) Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. Available online from: https://www.legislation.gov.uk/ssi/2017/101/contents/made [accessed 3.10.24].

[10] NatureScot (2017). Visual Representation of Wind Farms, Version 2.2.

[11] Institute of Lighting Professionals (2019). Guidance Note 10 Night-time Photography. Available online from: https://theilp.org.uk/publication/guidance-note-10-night-time-photography/ [accessed 3.10.24].

effect is '*Bokeh'* which has been defined as *'the way the lens renders out-of-focus points of light'*. This has proved difficult to avoid when taking photographs of light at varied distances across a view. The blurred nature of the lights is also exacerbated by their movement, particularly on vehicle headlights. Where the lights of the Proposed Development have been added to the night-time views this effect has been emulated.

2.4.8 The turbine blades, when they intermittently pass in front of the aviation lights, would cause randomised flickering when the lights are switched 'on'. The turbines used in the night-time visualisations have been positioned so that their blades face away from the viewpoint so that all the lights are visible and on within the visualisations, representing a worst-case impression. The flickering effect caused by the blades interacting with the lights would be most usually apparent from a south westerly direction due to the prevailing south-westerly wind.

NatureScot Pre-application Guidance for Onshore Wind Farms

2.4.9 NatureScot has published some further guidance in relation to aviation lighting within Annex 1 of the 2024 NatureScot Pre-Application Guidance[12]. This guidance builds on other NatureScot guidance and includes a series of recommendations for the assessment of visible aviation lighting including - information to include in the assessment; proportionality and numbers of representative viewpoints (2-3 recommended); recommended study area (20 km); and health and safety concerns relating to photography. Given the location of the Proposed Development and the potential for effects on recreational receptors on surrounding hills, the recommendations in relation to photography health and safety concerns are particularly relevant to this assessment, which advocate the use of manipulated day time photography *'for remote locations where no other sources of artificial light may be present in the baseline.'*

2.4.10 The guidance also includes notes on lighting mitigation including reduced lighting schemes, dimming mitigation, directional intensity mitigation, transponder-activated lighting and seeking approval of reduced lighting schemes from CAA.

3 ASSESSMENT PARAMETERS

3.1 Proposed Reduced Aviation Lighting Scheme

3.1.1 A description of the proposed turbine lighting is found within **Chapter 2: Project Description (EIAR Volume 1)** and also within **Chapter 13: Aviation. TA 13.1: Glentarken Lighting Report (EIAR Volume 4)** provides details of the proposed lighting scheme for the Proposed Development. As set out in **Chapter 13: Aviation (EIAR Volume 1)**, this proposed lighting scheme has been approved with CAA. The assessment of night-time effects is therefore based on the following parameters:

- The CAA requires that all obstacles at or above 150 m above ground level are fitted with visible medium intensity lighting (2,000 cd) located on the turbine nacelle. The CAA also requires that a secondary light is fitted to the nacelle for use only when the primary light fails and would not be lit concurrently. The steady red lighting fixed to the top of the nacelles and to the turbine towers may

[12] NatureScot (2024). NatureScot Pre-application Guidance for Onshore Wind Farms. Available online from: https://www.nature.scot/doc/naturescot-pre-application-guidance-onshore-wind-farms [accessed 3.10.24].

appear to flicker on and off with blade movement. This would occur when the turbine blades pass between the lights and the observers.

- The proposed aviation lighting scheme reduces this requirement and as such it is agreed with the CAA that only 4 of the 12 turbines are proposed to have red, medium intensity visible lights mounted on the nacelle at 99 m (turbines 3, 6, 8 and 11).
- The 2,000 cd medium intensity lights may be dimmed to 10 %, or 200 cd, if visibility is greater than 5 km, i.e. in moderate to excellent or 'clear' visibility, as measured by a visibility sensor mounted on the wind farm.
- 2,000 cd and 200 cd intensity nacelle lights have been assessed representing two differing situations - 2,000 cd represents the maximum intensity possible, 200 cd represents the maximum intensity that would be used when visibility extending from the wind farm exceeds 5 km.
- Whilst there is an additional CAA requirement for three lights to be provided at an intermediate level of half the nacelle height, it is agreed with the CAA that none of the Proposed Development turbines would have tower lights.

3.1.2 For the extent of theoretical visibility of visible aviation lighting for the reduced aviation lighting scheme, see Figure 5.2.2 - ZTV of Turbine Hub Lighting (reduced aviation lighting scheme).

3.2 Light Intensity

3.2.1 In compliance with EIA regulations, the likely significant effects of a 'worst-case' scenario for turbine lighting are assessed and illustrated in this visual assessment. A worst-case approach is applied which considers the effects of 2000cd and 200cd scenarios during periods of clear visibility. It should be noted however, that as the required medium intensity lights are only likely to be operated at their maximum 2000cd during periods of poor visibility, and that 2000cd intensity represents an unrealistic worst-case position, as it is unlikely to ever be experienced at that maximum illumination level.

3.2.2 Visible aviation obstruction warning lights are designed to emit light horizontally in 360 degrees and offer a reduced light intensity above and below the horizontal. This in line with ICAO Annex 14[13] which requires the intensity of emitted light to be most intense at 0° (horizontal) and lower below the horizontal. Whilst aviation lighting manufacturers must meet the minimum requirements, their products may vary in relation to recommended limits set out in ICAO standards and the lighting characteristics of different light fittings may therefore vary outside the minimum requirements stipulated by ICAO. The medium intensity obstruction lights will conform to the ICAO specification as set out in Annex 14, as summarised above in the Regulations and Guidance section.

3.2.3 Following advice from the Aviation Consultant for the Proposed Development, data from the testing of a CEL medium intensity obstruction light has been used in this assessment to provide an example of the reduction in lighting intensity above and below the horizontal. Whilst the precise model of light to be used for the Proposed Development is not known at this time it is considered that such an example provides a useful understanding of the potential visual mitigation of the intensity of the lights for receptors viewing them from areas of the study area that are below the horizontal. The CEL data has been used to define the amount of light emitted at particular angles above and below the horizontal for use in the assessment, see Table 5.2.1 below.

[13] See Table 6.3 of ICAO Annex 14 to the Convention on International Civil Aviation - Volume I Aerodrome Design and Operations (ICAO, Eighth Edition). (2018).

Table 5.2.1: Intensity of Turbine Light based on the CEL Obstruction Light

Vertical angle	Turbine Lighting Intensity (Intensity of Turbine Light shown in Candelas (cd))	
	2000cd scenario	200cd scenario
0° to 2°	2200/2500 cd	220/250 cd
0° to -1	2200 to 980 cd	220 to 98 cd
-1° to -2°	980 to 420 cd	98 to 42 cd
-2° to -3°	420 to 220 cd	42 to 22 cd
-3° to -4°	220 to 170 cd	22 to 17 cd
Below -4°	<170 cd	<17 cd

3.2.4 On the basis of the CAA requirements, therefore, it is evident that the intensity of the visible lights of the Proposed Development will be dependent on the clarity of atmospheric visibility and the degree of negative / positive vertical angle of view from the light to the receptor. It should also be noted that the definitions in Table 5.2.1 do not take account of the potential for some of the emitted light spilling onto the passing blades which would be visible at all negative angles, albeit as a less intense and diffuse reflected glow. Figure 5.2.3 - Hub Lighting Intensity ZTV (reduced aviation lighting scheme) show the intensity of visible aviation lights across the extent of visibility for the nacelle lights within each scenario.

3.3 Representative Night-Time Viewpoints

3.3.1 A hub height ZTV of the scoping layout was used at an early stage, to identify where there could be direct line of sight from the surrounding area to potential turbine lights mounted on the turbine nacelle or hub. Using this analysis, four representative night-time viewpoint locations were selected from the LVIA viewpoints being consulted upon, as presented and agreed alongside the viewpoint selection consultation as – Viewpoint 5 Comrie; Viewpoint 10 A827 near Fearnan; Viewpoint 19 Lochan na Lairige pass; and Viewpoint 21 St Fillans Hill. NatureScot also requested that Viewpoint 7 Ben Vorlich be included.

3.3.2 As a result of subsequent design mitigation since this consultation, there are now no turbine hubs visible from Viewpoint 5 Comrie and therefore none of the visible aviation lights in either of the scenarios assessed would be visible. As a result, Viewpoint 5 is not included as one of the representative viewpoints.

3.3.3 Night-time visualisations have been produced for the four representative viewpoints. As described previously, whilst aviation lighting manufacturers must meet the minimum requirements, their products may vary in relation to recommended limits set out in ICAO standards[2]. This makes it difficult producing accurate visualisations, as the lighting characteristics of different light fittings, may therefore vary outside the minimum requirements stipulated by ICAO. The night-time photomontages have been produced to show both 2,000 cd and 200 cd reduced intensity lighting, to inform the assessment of worst-case effects assessed. However, it should be noted that the night-time photography has been captured in periods of good visibility that is greater than 5 km. As a result, the night-time photomontage representations of the 2,000 cd lights are therefore an unrealistic over-representation of the likely visibility of visible aviation lighting. This is because visibility on the proposed development (and likely at the viewpoint itself) is very likely to be much poorer (<5 km) when they operate at that intensity.

3.3.4 In relation to Viewpoint 5 at the summit of Ben Vorlich, a manipulated daytime photo has been used as the baseline photo for the nighttime visualisation. We consider this to be the most appropriate and

proportionate approach that avoids the serious health and safety concerns of consultants safely accessing this steep sloping mountain during the hours of darkness. This is line with the NatureScot 2024 Pre-application Guidance[12] which states in relation to manipulated daytime photography - '*there may be instances where the approach could be used for remote locations where no other sources of artificial light may be present in the baseline.'*

4 ASSESSMENT OF EFFECTS

4.1 Types of Effect

4.1.1 The visual assessment of turbine lighting is intended to determine the likely effects that the proposed development will have on the visual resource i.e. it is an assessment of the effects of visible aviation lighting on views experienced by people at night.

4.1.2 The assessment of turbine lighting in this TA does not consider effects of aviation lighting on landscape character (i.e. landscape effects). For visible medium intensity steady or fixed red aviation warning lights, ICAO[2] indicates a requirement for no lighting to be switched on until 'Night' has been reached, as measured at 50 cd/m^2 or darker. This is helpful as it does not require them to be on during 'twilight', when landscape character may be clearly discerned. It is considered that visible aviation lighting will therefore not affect the perception of landscape character, which is not readily perceived at night in darkness, particularly in rural areas. The assessment of visible lighting is solely a visual effect albeit that it may refer to the perception of special qualities present in the landscape at night. While aviation lighting will be visible and result in visual effects, as assessed in this TA, the effects of aviation lighting on the perception of landscape character are scoped out of this assessment. This decision to scope out landscape effects reflects the Scottish Ministers' recent finding in the Crystal Rig IV Wind Farm Public Inquiry.

4.2 Baseline Lighting

4.2.1 The existing baseline lighting levels have been mapped for the study area, see Figure 5.2.1 - Baseline Light Pollution. This is based on NASA mapping of light pollution which measures the radiance of the background light pollution. This data has been used to help understand and illustrate the existing baseline lighting levels of the study area. Each pixel in the mapping shows the level of radiance (night lights) shining up into the night sky, which have been categorised into colour bands to distinguish between different light levels, from low level light pollution (black / dark blue colour band) to high level light pollution (red colour band).

4.2.2 The Proposed Development and much of the surrounding area is located in the darkest colour band 0.10 – 0.25 NanoWatts/cm^2/sr. It is also clear from Figure 5.2.1 that there is very little light pollution in the wider landscape of the study area. The map identifies several small areas of night-time lights within the surrounding landscape, these tend to be small areas of a relatively low level of light pollution (blue to yellow band 0.25 – 4 NanoWatts/cm2/sr) which is isolated to smaller settled areas. Key transport routes in the area are not shown to have light pollution other than when within settled areas.

4.3 Cumulative Assessment of Visible Turbine Lights

4.3.1 Whilst there are no visible turbine lights currently operating in the 45 km study area for the Proposed

Development, it is recognised that other planned developments within the study area have proposals for visible aviation lighting and that these lights could be seen in conjunction with the proposed lighting for the Proposed Development. There are no consented or application wind farms that require turbine lighting within the close cumulative context of the Proposed Development and these scenarios are therefore not assessed. It is recognised that the nearby Glen Lednock scoping scheme may be required to be lit, however, it is not known which turbines of this scheme would be lit and a detailed assessment at this stage is therefore not possible.

4.4 Visual Receptors in the Study Area

4.4.1 Table 5.2.2: Turbine Lighting Visibility from LVIA Viewpoints below provides a summary of the potential visibility of visible turbine lights for each of the LVIA viewpoints, this is based on the nacelle light ZTV and tower light ZTV for each of the scenarios considered. The symbols used in Table 5.2.2 define the following aspects of lighting visibility –

- O = Nacelle Light Visible
- X = Nacelle Light not Visible
- XX = Nacelle not Lit

Table 5.2.2: Turbine Lighting Visibility from LVIA Viewpoints

VP name	Reduced Lighting Scheme Visibility											
	1	2	3	4	5	6	8	10	11	16	20	21
VP1 - Rob Roy Way near Meall Odhar	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP2 - Ben Chonzie	XX	XX	O	XX	XX	O	O	XX	X	XX	XX	XX
VP3 - Breadalbane Park, Killin	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX
VP4 - Minor Road near Lochearnhead	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX
VP5 - Comrie	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX
VP6 - Carn Chois	XX	XX	O	XX	XX	O	O	XX	X	XX	XX	XX
VP7 - Ben Vorlich	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP8 - Ben Lawers	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP9 - Meall na Samhna	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP10 - A827 near Fearnan	XX	XX	X	XX	XX	X	X	XX	O	XX	XX	XX
VP11 - Meall Ghaordaidh	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP12 - Sron Bealaidh	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX
VP13 - MacRosty Park Crieff	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX

VP name	Reduced Lighting Scheme Visibility											
	1	2	3	4	5	6	8	10	11	16	20	21
VP14 - A822 near Muthill	XX	XX	X	XX	XX	X	X	XX	X	XX	XX	XX
VP15 - Ben More	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP16 - Beinn Sheasgarnaich	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP17 - Schiehallion	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX
VP18 - Kinpauch Hill	XX	XX	O	XX	XX	O	O	XX	X	XX	XX	XX
VP19 - Lochan na Lairige pass	XX	XX	O	XX	XX	X	X	XX	X	XX	XX	XX
VP20 - Mor Bheinn	XX	XX	O	XX	XX	O	O	XX	X	XX	XX	XX
VP21 - St Fillans Hill	XX	XX	X	XX	XX	O	O	XX	X	XX	XX	XX
VP22 - Meall_an_t-Seallaidh	XX	XX	O	XX	XX	O	O	XX	O	XX	XX	XX

4.5 Viewpoint Lighting Intensity

4.5.1 With specific relevance to the Proposed Development, Figure 5.2.3 Lighting Intensity ZTV, illustrates where the different intensities (depending on different vertical angles from the nacelle mounted aviation light) would be visible within the surrounding landscape. Figure 5.2.3 also illustrates the corresponding intensity reductions for each of the 2,000 cd and 200 cd situations, based on an assumed model of light. Many of the viewpoints within the areas closest to the Proposed Development will have reduced intensity as a result of the negative vertical angle in which the nacelle lights would be viewed. Table 5.2.3 below provides a summary of the reduced intensity for the nacelle lights based on the light intensity data presented on Figure 5.2.3.

Table 5.2.3: Viewpoint Lighting Intensity

VP name	Distance to nearest visible turbine light (km)	Vertical Angle	Light intensity at each viewpoint allowing for vertical angle (cd)	
			2000 cd	200 cd
VP1 - Rob Roy Way near Meall Odhar	T11 @ 2.3 km	-2° to -3°	420 to 220 cd	42 to 22 cd
VP2 - Ben Chonzie	T8 @ 9.9 km	-1° to -2°	980 to 420 cd	98 to 42 cd
VP3 - Breadalbane Park, Killin	No Lights Visible			
VP4 - Minor Road near Lochearnhead	No Lights Visible			
VP5 - Comrie	No Lights Visible			

VP name	Distance to nearest visible turbine light (km)	Vertical Angle	Light intensity at each viewpoint allowing for vertical angle (cd)	
			2000 cd	200 cd
VP6 - Carn Chois	T8 @ 11.2 km	0° to 2°	2200/2500 cd	220/250 cd
VP7 - Ben Vorlich	T8 @ 10.1 km	0° to 2°	2200/2500 cd	220/250 cd
VP8 - Ben Lawers	T11 @ 11.4 km	0° to 2°	2200/2500 cd	220/250 cd
VP9 - Meall na Samhna	T11 @ 16.3 km	0° to 2°	2200/2500 cd	220/250 cd
VP10 - A827 near Fearnan	T11 @ 15.7 km	-1° to -2°	980 to 420 cd	98 to 42 cd
VP11 - Meall Ghaordaidh	T11 @ 16.8 km	0° to 2°	2200/2500 cd	220/250 cd
VP12 - Sron Bealaidh	No Lights Visible			
VP13 - MacRosty Park Crieff	No Lights Visible			
VP14 - A822 near Muthill	No Lights Visible			
VP15 - Ben More	T11 @ 22.7 km	0° to 2°	2200/2500 cd	220/250 cd
VP16 - Beinn Sheasgarnaich	T11 @ 25.2 km	0° to 2°	2200/2500 cd	220/250 cd
VP17 - Schiehallion	T11 @ 25.4 km	0° to 2°	2200/2500 cd	220/250 cd
VP18 - Kinpauch Hill	T8 @ 29.9 km	0° to -1	2200 to 980 cd	220 to 98 cd
VP19 - Lochan na Lairige pass	T3 @ 10.4 km	-1° to -2°	980 to 420 cd	98 to 42 cd
VP20 - Mor Bheinn	T8 @ 7.5 km	0° to -1	2200 to 980 cd	220 to 98 cd
VP21 - St Fillans Hill	T8 @ 5.3 km	Below -4°	<170 cd	<17 cd
VP22 - Meall_an_t-Seallaidh	T11 @ 13 km	0° to 2°	2200/2500 cd	220/250 cd

4.5.2 It is clear from Figure 5.2.3 that the full intensity of the lights would be theoretically experienced when on similar or more elevated terrain. These elevated areas are found within 5 km on some of the hills that surround the site area to the east and west. Within 5-10 km Figure 5.2.3 also shows the full intensity of the lights on the Ben Chonzie ridge of hills to the east, the Ben Lawers / Tarmachan ridge to the north and the Ben Vorlich / Meall Reamhar ridge to the south. This higher intensity would also be experienced on hills and mountains at greater distance from the Proposed Development. In distant views, over 10 km, the aviation lights are still likely to be visible, based on experience of other operational wind farm aviation lights viewed in the field, however, the proposed lighting unit to be used and reduced intensity are mitigating factors that increase with distance.

4.5.3 Much of the site area would have a vertical angle of below -4° resulting in an approximate range of

lighting intensities of below 170 cd when visibility <5 km and below 17 cd when visibility >5 km. This lower level of lighting intensity is also found in Loch Earn / Strathearn, Glen Tarken, Glen Beich, Glen Lednock and on Loch Tay. The northern shoreline of Loch Tay is shown on Figure 5.2.3 to have a vertical angle of -2° to -3° for much of the affected area resulting in a lighting intensity of 420 to 220 cd when visibility <5 km and 42 to 22 cd when visibility >5 km. Beyond the immediate Site area and immediate upland landscape context the hub visibility drops off sharply and there would be no or limited visibility of turbine lights within the settled glens and straths found in the study area. There is also a very limited amount of turbine light visibility in areas of the LLTNP away from the high summits.

4.5.4 Whilst it is noted that the actual intensity of light perceived at the majority of assessment viewpoints (and within the study area) is likely to be less intense than the maximum intensity of the light (2,000 cd in visibility <5 km and 200 cd in visibility >5 km), this Technical Appendix assesses the maximum possible intensity of light observed at each of the viewpoints considered and represents this maximum intensity in corresponding visualisations.

4.5.5 In reality, it is extremely unlikely that 2,000 cd will ever be experienced at its full intensity as it will only operate when visibility is reduced by climatic conditions. Reduced visibility will also affect perception of the intensity of the light fitting.

4.5.6 Given the majority of the viewpoints are beyond 5 km from the Proposed Development, the worst-case intensity experienced would likely be represented by the 200 cd scenario. This is because the 2000 cd intensity lights would only be in operation when visibility is less than 5 km and in this situation they would appear far less intense due to the poor visibility surrounding the Proposed Development.

4.6 Detailed Assessment of Representative Viewpoints

Viewpoint 10 A827 near Fearnan

Night-Time Baseline Condition and Sensitivity

4.6.1 This viewpoint represents the views of road users and residential receptors on the A827 near Fearnan. During the day, views to the south and southwest towards the site area are across Loch Tay, which forms a focus to views from Fearnan and the A827. Beinn Breac is a large hill that sits against the southern shores of Loch Tay and from this viewpoint appears as a broad summit that occupies much of the view south. Its forest covered slopes appearing as a patchwork of recently planted and more established forestry with more naturalised woods closer to the shoreline. The western end of Loch Tay (and Killin) is not visible due to the slight curve in the loch's shape. The slopes of the hills that contain Loch Tay gradually reduce in size with distance, leading the eye along the length of the loch towards the rocky hilltops of Stuc Mhor and Creag Gharbh.

4.6.2 Receptors in this location at night will be driving or in their residence. At night, individual landscape elements that create different landscape patterns in the view are more difficult to discern and the scenic aspects of this view are diminished in the hours of darkness. However, for both of these receptor types the contrast between loch, upland hill slopes and sky means that an appreciation of the ridgeline landform and the upland horizon would still be understood in twilight hours from this location. The baseline night photography is captured at a time where the shape of these ridgelines of surrounding hills and upland can be distinguished against the sky. Existing lights in the view include those of the passing vehicles on the A85 and also of the properties along this road and within the edges of the Fearnan settlement. It is considered that the overall baseline lighting level is moderately dark, which is supported

with the baseline lighting analysis shown on Figure 5.2.1 - Baseline Light Pollution, albeit that the view across Loch Tay is darker in nature. Taking these factors into account, the night-time sensitivity of this location is considered to be high-medium for settlement receptors and medium for road users.

Assessment of Proposed Aviation Lighting Scheme

2,000cd Light Intensity

4.6.3 1 of the 4 nacelle lights would be visible from this location at a distance of 15.7 km (light on the nacelle of turbine 11). The location of the viewpoint relative to the prevailing south-westerly wind would mean that the turbine light on the nacelle would at most times be seen in front of the rotors and would not be intermittently obscured by intervening blades. On this basis it would not usually appear to flicker as the turbine blades pass the light.

4.6.4 The vertical angle between this viewpoint and the nacelle is -1º to -2º and the intensity of the turbine 11 nacelle light in the 2,000 cd scenario is therefore between 980 to 420 cd. The turbine 11 light would be seen as an introduction of lighting to a part of the view where there are no other lights visible and would be introduced into a view that is dark in nature other than the closer proximity lights associated with the nearby properties and vehicles. Whilst the light would form a new focus in the night view to the south-west, it is considered that it would be seen as a minor feature and at distance. Taking this into account, the magnitude of change is considered to be low. As a result, and when combined with sensitivity, the effect is considered to be **Minor and Not Significant** for road users and **Moderate-Minor and Not Significant** for settlement receptors.

200cd Light Intensity

4.6.5 The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario. However, the intensity of the nacelle light on turbine 11 in the 200 cd scenario is between 98 and 42 cd. The effect differs slightly therefore in this scenario, reducing the intensity of light experienced and the magnitude of change is considered to be low-negligible. As a result, and when combined with sensitivity, the effect is considered to be **Minor and Not Significant** for both road users and settlement receptors.

Viewpoint 19 Lochan na Lairige pass

Night-Time Baseline Condition and Sensitivity

4.6.6 This viewpoint represents the views of road users on the minor road that connects Loch Tay to Glen Lyon when driving south. It is an elevated road that has steep climbs and narrow road surface with steep and rocky road verges with frequent passing places. The viewpoint is located close to a parking area, which could be visited by hill walkers in the hours of twilight before or after climbing Ben Lawers or other locations on the Tarmachan ridge. The view south during the day across Loch Tay is a key focus for views from this location. Whilst there is no view up and down the loch (to the east and west) due to intervening hill slopes, the view south across the loch to the pastoral lower slopes and shoreline attracts the eye due to its contrasting landscape pattern and texture with the surrounding large scale uplands.

4.6.7 Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are diminished in the hours of darkness. At night, individual landscape elements that create different landscape patterns in the view are more difficult to discern, however, the baseline night photography is captured at a time where the shape of the ridgelines of surrounding hills and upland can be distinguished against the sky. There is no existing lighting in the view other than from the very

occasional vehicle lights seen in close proximity to the viewpoint and the overall baseline lighting level is considered to be dark. The value and visual susceptibility of receptors at night potentially differs when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. However, due to the contrast between loch, upland hill slopes and sky it is considered that an appreciation of the ridgeline landform and the upland horizon would still be understood in twilight hours from this location. Taking these factors into account, the night-time sensitivity of this location is considered to be high-medium for road users.

Assessment of Proposed Aviation Lighting Scheme

2,000cd Light Intensity

4.6.8 1 of the 4 nacelle lights would be visible from this location at a distance of 10.4 km (light on the nacelle of turbine 3). The location of the viewpoint relative to the prevailing south-westerly wind would mean that the turbine light on the nacelle would at most times be seen in front of the rotors and would not be intermittently obscured by intervening blades. On this basis it would not usually appear to flicker as the turbine blades pass the light.

4.6.9 The vertical angle between this viewpoint and the nacelle is -1º to -2º and the intensity of the turbine 3 nacelle light in the 2,000 cd scenario is therefore between 980 to 420 cd. The turbine 3 light would be seen as an introduction of lighting to a part of the view where there are no other lights visible and would be introduced into a view that is dark in nature other than passing vehicles. Whilst the light would form a new focus in the night view to the south, it is considered that it would be seen as a minor feature and at distance. Taking this into account, the magnitude of change is considered to be low. As a result, and when combined with sensitivity, the effect is considered to be **Moderate-Minor and Not Significant.**

200cd Light Intensity

4.6.10 The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario. However, the intensity of the nacelle light on turbine 3 in the 200 cd scenario is between 98 and 42 cd. The effect differs slightly therefore in this scenario, reducing the intensity of light experienced and the magnitude of change is considered to be low-negligible. As a result, and when combined with sensitivity, the effect is considered to be **Minor and Not Significant.**

Viewpoint 21 St Fillans Hill

Night-Time Baseline Condition and Sensitivity

4.6.11 This viewpoint represents the views of recreational walkers on St Fillans Hill (Dundurn Fort) during the hours of darkness. The principal focus for views during the day from this hill, are to the east and west along the River Earn. The view north towards the site is across the lower lying areas found within the strath of the River Earn below with the surrounding steep sloping hills that enclose the strath stretching out across the backdrop and creating an undulated skyline, including Little Port Hill and Creag Odhar.

4.6.12 Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are diminished in the hours of darkness. At night, individual landscape elements that create different landscape patterns in the view are more difficult to discern, however, the baseline night photography is captured at a time where the shape of the ridgelines of surrounding hills and upland can

be distinguished against the sky. Existing lights in the view include those of the passing vehicles on the A85 and also of the properties along this road and within the edges of the St Fillans settlement. It is considered that the overall baseline lighting level is relatively dark, which is supported with the baseline lighting analysis shown on Figure 5.2.1 - Baseline Light Pollution.

4.6.13 The value and visual susceptibility of receptors at night potentially differs when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. Taking these factors into account, the night-time sensitivity of this location is considered to be high-medium.

Assessment of Proposed Aviation Lighting Scheme

2,000cd Light Intensity

4.6.14 2 of the 4 nacelle lights would be visible from this location (lights on the nacelles of turbines 6 & 8) at a distance of 5.3 km to the nearest turbine light. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the turbine light on the nacelle would at most times be seen to the side of the rotors and would not usually be intermittently obscured by intervening blades. On this basis the lights would not usually appear to flicker as the turbine blades pass them.

4.6.15 The vertical angle between this viewpoint and the nacelle is below -4° and the intensity of the turbine nacelle lights in the 2,000 cd scenario is therefore <170 cd. The turbine lights would be seen as an introduction of lighting to a part of the view where there are no other lights visible and would be introduced into a view that is relatively dark in nature other than lower elevated property and vehicle lights associated with St Fillans and the A85. Whilst the lights would form a new focus in the night view to the north, it is considered that they would be seen as minor features in the view. The lower elevation of the viewpoint in relation to the lights also means that a relatively low level of light intensity would be experienced at this location. Taking this into account, the magnitude of change is considered to be low. As a result, and when combined with sensitivity, the effect is considered to be **Moderate-Minor and Not Significant.**

200cd Light Intensity

4.6.16 The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario. However, the intensity of the nacelle lights in the 200 cd scenario is <17 cd. The effect therefore differs slightly in this scenario, reducing the intensity of light experienced and the magnitude of change is considered to be negligible. As a result, and when combined with sensitivity, the effect is considered to be **Minor and Not Significant.**

Viewpoint 7 Ben Vorlich

Night-Time Baseline Condition and Sensitivity

4.6.17 This viewpoint was selected on the request of NatureScot in order to assess effects for hill walkers within the LLTNP during the hours of darkness. Views during the day to the north and towards the site, are across Loch Earn, the upland of the site area with the northern hills and mountains of the Breadalbane range beyond, including Ben Lawers. The elevated view along Glen Vorlich provides a focus for views along the route taken to the summit but also due to the view of Loch Earn which is seen beyond. Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are

diminished in the hours of darkness.

4.6.18 The baseline photography at this location is a manipulated day time image, however, it is predicted that there is little to no existing lighting in the view other than potentially from the distant lights of a few properties or occasional passing vehicles on the northern shore of Loch Earn. Given the few sources of light in the view north and drawing on the baseline lighting analysis shown on Figure 5.2.1 - Baseline Light Pollution, the overall impression of the night time view to the north is predicted to be of an intrinsically dark upland landscape. This view will include an intermediate skyline created by the darker contrast of the uplands of the site with the more distant uplands beyond Loch Tay. A subtle contrast in the night sky to the north will also occur at dusk between the hills and the sky on the distant horizon.

4.6.19 At night, individual landscape elements that create different landscape patterns in the view are more difficult to discern, however, the manipulated baseline view has been created to replicate a time where the shape of the ridgelines of surrounding hills and upland can be distinguished against the sky.

4.6.20 The value and visual susceptibility of receptors at night potentially differs when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. However, due to the contrast between loch, upland hill slopes and sky it is considered that an appreciation of the ridgeline landforms and the upland horizon would still be understood in twilight hours from this location. The walkers and overnight campers whilst not enjoying the same degree of scenic appreciation in the views of the landscape will nevertheless have their attention on their surroundings. Taking these factors into account, the night-time sensitivity of this location is considered to be high for hill walkers at night.

Assessment of Proposed Aviation Lighting Scheme

2,000cd Light Intensity

4.6.21 4 nacelle lights would be visible from this location (lights on the nacelle of turbines 3, 6, 8 and 11) at a distance of 10.1 km to the nearest turbine light. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the turbine light on the nacelle would at most times be seen behind the rotors and would therefore be intermittently obscured by intervening blades. On this basis the lights would appear to flicker as the turbine blades pass the lights.

4.6.22 The vertical angle between this viewpoint and the nacelle is 0° to 2° and the intensity of the turbine nacelle lights in the 2,000 cd scenario is therefore between 2200/2500 cd. The turbine lights would be seen as an introduction of lighting to a part of the view where there are no other lights visible and would be introduced into a view that is dark in nature other than some lower level distant lights of properties and passing vehicles.

4.6.23 Given that only 4 turbine lights would be seen from this location they would appear as a minor feature at distance and the distance from the proposed development would also reduce the intensity of the turbine lights. The turbine lights would however form a new focus in the night view to the north and would appear as a noticeable addition to the existing baseline. Taking this into account, the magnitude of change is considered to be medium-low. As a result, and when combined with sensitivity, the effect is considered to be **Moderate and Significant.**

200cd Light Intensity

4.6.24 The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario.

However, the intensity of the nacelle lights in the 200 cd scenario is between 220/250 cd. The effect differs therefore in this scenario, further reducing the intensity of light experienced and the magnitude of change is considered to be low. As a result, and when combined with sensitivity, the effect is considered to be **Moderate-Minor and Not Significant.**

4.7 Assessment of LVIA Viewpoints

4.7.1 Whilst lighting visualisations have only been produced for 4 of the LVIA viewpoints, an assessment has been carried out for the other LVIA viewpoints within 20km[14], see **Table 5.2.4**. This assessment is based on the information provided in Tables 5.2.2 and 5.2.3 which describes the distance to the nearest light, the number of lights visible and the intensity of light potentially experienced at each viewpoint. It also draws on the detailed assessments carried out for the representative viewpoints.

Table 5.2.4: Assessment of LVIA Viewpoints within 20km

VP name	Sensitivity	2000 cd Scenario		200 cd Scenario	
		Magnitude of Change	Significance of Effect	Magnitude of Change	Significance of Effect
VP1 - Rob Roy Way near Meall Odhar	High	High	Major Significant	High-Medium	Major Significant
VP2 - Ben Chonzie	High	Medium-Low	Moderate Significant	Medium-Low	Moderate Not Significant
VP3 - Breadalbane Park, Killin	No Lights Visible – No Effect				
VP4 - Minor Road near Lochearnhead	No Lights Visible – No Effect				
VP5 - Comrie	No Lights Visible – No Effect				
VP6 - Carn Chois	High	Medium-Low	Moderate Significant	Low	Moderate-Minor Not Significant
VP7 - Ben Vorlich (see assessment in section 4.6)	High	Medium-Low	Moderate Significant	Low	Moderate-Minor Not Significant
VP8 - Ben Lawers	High	Medium-Low	Moderate Significant	Low	Moderate-Minor Not Significant
VP9 - Meall na Samhna	High	Medium-Low	Moderate Not Significant	Low	Moderate-Minor Not Significant
VP10 - A827 near Fearnan (see assessment in section 4.6)	High-Medium (settlement)	Low	Moderate-Minor Not Significant	Low-Negligible	Minor Not Significant
	Medium (road users)	Low	Minor Not Significant	Low-Negligible	Minor Not Significant
VP11 - Meall Ghaordaidh	High	Medium-Low	Moderate Not Significant	Low	Moderate-Minor Not Significant
VP12 - Sron Bealaidh	No Lights Visible – No Effect				
VP13 - MacRosty Park Crieff	No Lights Visible – No Effect				

[14] 20km based on the recommendations of study area for the assessment of turbine lighting stated in the NatureScot Pre-application Guidance for Onshore Wind Farms. Available online from: https://www.nature.scot/doc/naturescot-pre-application-guidance-onshore-wind-farms [accessed 3.10.24].

VP name	Sensitivity	2000 cd Scenario		200 cd Scenario	
		Magnitude of Change	Significance of Effect	Magnitude of Change	Significance of Effect
VP14 - A822 near Muthill	No Lights Visible – No Effect				
VP19 - Lochan na Lairige pass (see assessment in section 4.6)	High-Medium	Low	Moderate-Minor Not Significant	Low-Negligible	Minor Not Significant
VP20 - Mor Bheinn	High	Medium-Low	Moderate Significant	Low	Moderate-Minor Not Significant
VP21 - St Fillans Hill (see assessment in section 4.6)	High-Medium	Low	Moderate-Minor Not Significant	Low-Negligible	Minor Not Significant
VP22 - Meall_an_t-Seallaidh	High	Medium-Low	Moderate Not Significant	Low	Moderate-Minor Not Significant

4.8 Summary and Conclusions

4.8.1 At night the four turbines that are proposed to have visible aviation lighting would not in themselves be visible during times of darkness. Similarly, the other 8 turbines that would not be visibly lit would also not be visible during the hours of darkness. Nevertheless, the assessment of night time effects for the proposed development has predicted significant effects for some of the viewpoints. This is largely due to the appearance of lighting on an upland horizon which has a currently dark baseline characteristic and the high sensitivity of the receptors experiencing this lighting.

4.8.2 Significant effects resulting from the visible aviation lighting have been found at viewpoints 2, 6, 7, 8 and 20 for the 2000 cd scenario, however, when considered for 200cd in clear visibility for these viewpoints, the effect is considered to be not significant. Significant effects have been found for viewpoint 1 in both the 2000 and 200 cd scenarios largely due to the close proximity of this viewpoint.

4.8.3 The duration of the effect of the lights on receptors is likely to be over a relatively short period, more commonly experienced during evening and morning hours of darkness, around dusk and sunrise. The majority of receptors that experience views at night are limited to residents of settlements, rural properties and motorists using the road network. The visual effects of the Proposed Development at night would also be limited by the activity of receptors at night, e.g. the views of road users at night are more likely to be focussed on the road ahead and views from within properties are likely to be restricted by the use of window coverings, particularly in winter. The assessment has found no significant effects from these types of receptors in the affected parts of the Study Area with little or no effect found in the vast majority of lower lying parts of the study area.

4.8.4 Views from remote hills, mountains and footpaths etc. are visited infrequently at night therefore numbers of receptors affected will be low. Whilst significant effects have been found at these elevated locations for the 2000 cd scenario the assessment of night-time effects is also based on clear night time viewing conditions. In reality, it is extremely unlikely that 2,000 cd will ever be experienced at its full intensity as it will only operate when visibility is reduced by climatic conditions (poor visibility of less than 5 km).

4.8.5 Taking this into account, it is more likely that receptors at these elevated locations would experience the lights at 200 cd for which the effects have been assessed as **not significant** (with the exception of viewpoint 1 due to proximity).