

# Appendix 6.5 Visual Assessment of Turbine Lighting

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# APPENDIX 6.5 – Visual Assessment of Turbine Lighting

## Introduction

1. This Appendix presents an assessment of landscape and visual effects arising from the visible lighting of the Proposed Development. The written assessment is supported by a Zone of Theoretical Visibility (ZTV) plan of the visible turbine lighting and visualisations which illustrate the proposed turbine lighting from three viewpoints in the surrounding landscape.
2. The scope of the landscape and visual impact assessment (LVIA) was discussed during a meeting held with representatives of the Scottish Government, Scottish Natural Heritage and South Lanarkshire Council on 7<sup>th</sup> August 2018 and the scope and methodology agreed through associated correspondence (refer to Appendix 4.1). Consultation on the scope and methodology of the LVIA has also been carried out with East Ayrshire Council (refer to Appendix 4.1). Consequently, three of the 17 daytime viewpoints were selected to illustrate the night time lighting effects of the Proposed Development, as follows:
  - VP 1 – Coalburn
  - VP10 – Muirkirk
  - VP 16 - Douglas

## Description of the Proposed Turbine Lighting

3. There are 14 turbines proposed which would be greater than 150m to tip and therefore a number of the turbines would have to be lit as required by the Civil Aviation Authority (CAA). The following lighting solution is proposed to accord with CAA requirements:
  - **2000 candela steady state red aviation light on the nacelle of turbines 1, 3, 6, 9, 11, 13 and 14;**
  - **25/32 candela steady red aviation lights (likely to be 2) on the towers of the same turbines, indicating the blade length.**

## Scope of the Assessment

4. The primary source of best practice for Landscape and Visual Impact Assessment (LVIA) in the UK is *'The Guidelines for Landscape and Visual Impact Assessment', 3rd Edition (GLVIA3) (Landscape Institute and the Institute for Environmental Management and Assessment, 2013)*. The assessment criteria adopted to inform the assessment of effects arising from the visible lighting has been developed in accordance with the principles established in this best practice document. It should however be acknowledged that GLVIA3 establishes guidelines not a specific methodology. The preface to GLVIA3 states:  
***'This edition concentrates on principles and processes. It does not provide a detailed or formulaic 'recipe' that can be followed in every situation – it remains the responsibility of the professional to ensure that the approach and methodology adopted are appropriate to the task in hand.'***
5. The assessment criteria set out in Annexe 1 have therefore been developed specifically for this appraisal to ensure that the methodology is fit for purpose.
6. The purpose of an LVIA when undertaken in the context of an Environmental Impact Assessment (EIA) is to identify any likely significant landscape and visual effects arising as a result of the proposals. An LVIA should consider both:
  - ***effects on the landscape as a resource in its own right (the landscape effects); and***
  - ***effects on specific views and visual amenity more generally (the visual effects).***

7. It is recognised that in some circumstances, it may be possible for turbine lighting to result in a significant effect on the character of the surrounding landscape. For example, if the proposed wind energy development is located within, or in close proximity to, a designated dark sky area, or is remote from existing sources of visible lighting, such as residential areas, commercial or industrial sites, or major roads.
8. For wind energy developments which are not located in such areas, it is considered that there would be no potential for significant effects on landscape character to arise from visible turbine lighting of the type proposed. This is because in these areas the character of the landscape during low natural light levels is already in part characterised by the presence of artificial lighting. Therefore, the addition of turbine lighting would not have the potential bring about a fundamental change to the characteristics of the landscape.
9. The Proposed Development lies away from recognised dark sky areas, within a landscape context which already contains some sources of artificial light, particularly those located within the surrounding settlements, industrial complexes and along the highways passing through the landscape. However, notwithstanding this, an assessment of the potential for significant effects on landscape character has been undertaken, due to the location of the site itself being within an area of the local landscape which is less characterised by the presence of visible light than is evident elsewhere in the wider landscape. In order to facilitate this, a set of criteria and an appropriate methodology has been developed and this is set out in Annexe 1, allowing for the assessment of both landscape character and visual effects. The character effects are based on the extent to which there would be a change to the perceived characteristics of the landscape during low light levels. The visual effects are based on the change to the view which would be experienced by visual receptors within the landscape, particularly those people taking in the view from their properties, moving in and around residential areas and using the local road network (again during the changing periods of low light levels experienced during dusk and after sunset).
10. The assessment considers all the daily low light periods when the turbine lighting would be visible to receptors in the surrounding landscape. On any given day these may include the early morning, evening and night-time periods. On occasion this may also include periods during the day, should natural light levels be particularly low, due to adverse weather conditions. It is understood that the primary period which an assessment of visual effects should consider, is the period just before official sunset, when sufficient daylight remains for the landform of the landscape on which the wind farm is proposed, to remain partially visible. This time period is known commonly as 'dusk', and whilst it is acknowledged that the formal astronomical period of dusk actually occurs after sunset, immediately prior to night, the wider time period of low light as the sun is setting and immediately after sunset is referred to hereafter in this methodology as the 'dusk period'.
11. The timing of official sunset changes depending on the location being considered, and the date of any assessment, but is astronomically predictable. However, this does not mean that the light levels in the period just prior to official sunset are equally predictable, or consistent. In practice, these will vary due to weather conditions and also the site specific effects of surrounding topography, vegetation and built form, including existing light sources in the landscape.
12. In order to ensure consistency across the assessment work undertaken and particularly in relation to the visualisations produced, photographs were collected at regular intervals as the light levels decreased across the period prior to and shortly after sunset. In particular, photographs were gathered and assessments undertaken during the period where street lighting and other light sources of visible light in the baseline have been illuminated, but the landform remained partially visible. The ambient light conditions were recorded during each round of photography using a light meter, to seek as far as possible consistency across the visualisations prepared and assessment judgements made.
13. The starting point for determining the scope for the assessment was a consideration of the assessment viewpoints located within 10km of the wind farm which are set out within the main daytime period LVIA. Following a consideration of each of these viewpoints, and with regard to the

need to ensure a proportionate assessment was undertaken, the following viewpoints were initially selected for detailed assessment:

- VP 1 – Braehead, Coalburn
  - VP 16 - Douglas
14. During consultation on the approach to the assessment with SNH and the nearby Local Authorities, it was requested by East Ayrshire Council that a further daytime viewpoint also be included in the night-time assessment, VP10 from Muirkirk. This was agreed and this location is also considered with written assessment and a visualisation.
  15. Each of the representative viewpoints were visited several times during periods of low natural light to better understand the likely sensitivity of the viewpoint receptors and to better inform judgements on the likely visual effects arising from the turbine lighting. Furthermore, the entire extent of the 10km study area was visited to understand the extent of existing visible light sources and to appreciate the visibility of the development that would arise as receptors move through the landscape.
  16. It is also relevant to consider the ‘future-baseline’ that will be in place following the planning consent awarded to the wind farm schemes at Douglas West, Dalquandy and Cumberhead. In all cases a planning condition was set out which requires the inclusion of visible aviation lighting of 25 candela as part of the schemes, notwithstanding that they are developments with turbines of less than 150m to blade tip. Although none of these conditions have yet been discharged, specialist aviation consultants working for the Applicant have established what is likely to be put forward as a reasonable response to addressing these conditions. A plan illustrating the likely lit turbines associated with the three schemes is included as Figure 1. It has therefore been deemed appropriate to include a ‘future-baseline’ photomontage illustrating this lighting, alongside the actual night-time photography which was gathered for each viewpoint. This allows a judgement to be made as to the likely impact of the proposed Hagshaw Hill Repowering turbines when compared with the expected baseline scenario.
  17. For each viewpoint a written assessment is provided. In line with the assessment criteria set out at Annexe 1, the relative significance or level of effect on visual amenity is determined by considering in tandem the nature (sensitivity) of the visual receptor with the nature (magnitude) of change.
  18. The assessment firstly considers the current baseline lighting environment during low light periods, particularly the dusk period, and the sensitivity of the receptors represented by the viewpoint. The assessment then describes the degree to which the lighting from the Proposed Development would be visible and the magnitude of change in views in the low light period which would result from the turbine lighting. Finally, a professional judgement is made as to the level of effect which would result from the identified change and whether or not the effect is considered to be significant. The reasoning behind these judgements is set out in the assessment.
  19. It is recognised that the viewpoints only form individual representative locations from a small selection of the places within the study area from where the turbine lighting will be visible. Therefore, the viewpoints are used as the starting point to inform a wider consideration of the potential for visual effects on the key visual receptors within 10km of the site. These receptors include settlements (principally Glespin, Douglas and Coalburn) and users of the M74 and A70.
  20. The assessment of effects is supported by a Zone of Theoretical Visibility (ZTV) plan illustrating the locations from which the turbine lights would be visible during the low light period. The assessment is also supported by photomontages prepared for the three assessment viewpoints. The methodology for the production of the ZTV Plan and the Photomontages is discussed separately in Annexe 1 to this Appendix. However, it should be noted that the visual representation of light in a two dimensional printed photomontage is inherently difficult, as the manner in which light is seen and interpreted by the eye, especially in low light conditions, is a complex and varied matter.

21. The photomontages which accompany this assessment have been prepared in line with best practice guidance for the collection of photography for wind farm visualisations and using specialist software for the representation of turbine aviation lighting. However, notwithstanding this, and as with all photomontages, the images provided are simply a tool to assist in the assessment of effects and should be viewed and used in this context. It was established during the field work undertaken for this study that dusk period photographs of visible lighting do not always capture the extent to which the eye perceives light sources during the dusk period. Often photography will appear to show the lighting to be more recessive than it was perceived in the field. The photomontages therefore do not seek to replicate the manner in which a dusk period photograph would capture the aviation lighting, rather they seek to replicate the manner in which the lighting is perceived when it is viewed in the field. The assessment of visual effects does not rely solely on the photomontages however and it is ultimately professional judgement which is used to evaluate the significance of effects. In the case this judgement has been 'ground-truthed' through site work to review and appraise the effects of existing visible red aviation lighting in the landscape using a number of locations in the Scottish landscape, as close to the site as was practicable.
22. On several occasions, Pegasus have visited the Middleton Wind Farm, East Renfrewshire, an operational wind farm with aviation lighting similar to that proposed. This enabled consideration and photography of existing visible aviation lighting in comparable low light levels, during the dusk period, for use as context and an aid to the work undertaken, providing a useful control for the assessment. Part of this additional site work also sought to consider if there would be any potential for surface illumination of the turbine blades, tower or nacelle as a result of the aviation lighting to be visible in the wider landscape surrounding a wind farm. A Photographic Record of images of the Middleton Wind Farm during low light conditions is set out at Annexe 2, along with a further supporting record of images of the Emley Moor Transmitter station (a 300m concrete tower and mast lit with 2,000 candela lights close to the Pegasus Office in Leeds), which has also been used as a convenient control and test location to 'ground truth' judgements. This matter is discussed subsequently in this assessment.

#### **Analysis of Aviation Lighting at Middleton Wind Farm**

23. In order to help inform the judgements made in this assessment a site visit was undertaken to the Middleton Wind Farm, East Renfrewshire, an operational commercial scale wind farm with aviation lighting similar to that proposed. This enabled consideration of aviation lighting in comparable low light levels, during the dusk period, for use as context and an aid to the work undertaken. A Photographic Record of images of the Middleton Wind Farm during low light conditions is set out at Annexe 2, along with a further supporting record of images of the Emley Moor Transmitter mast, which has also been used as a guide.
24. Part of this additional site work also sought to consider if there would be any potential for surface illumination of the turbine blades, tower or nacelle as a result of the aviation lighting to be visible in the wider landscape surrounding a wind farm. There was no clear visibility of such phenomena in the wider landscape during the site work undertaken, however it is understood that such events may be possible in close proximity to lit turbines in locations with very low natural light. It is therefore acknowledged as part of the judgements made within this assessment that such occurrences may be possible as a worse-case scenario but that they would not be typical of the general experience of the lighting when seen from the landscape.
25. A separate phenomenon which was experienced during the site visit to Middleton was the manner in which the turbine blades passing in front of the turbine lighting serve to cause a temporary dimming and brightening of the lights. This is something which only occurs when the turbines are viewed with the blades in front of the nacelle and therefore is dependent on the prevailing wind direction on any given day. The minor dimming and brightening effect serves to increase the noticeability of the turbines within the view and to some degree increases their visual effect. It is therefore acknowledged as part of the judgements made within this assessment that such occurrences would periodically occur

in relation to the proposed turbines (the occurrence being most likely for locations to the south west of the turbines i.e. less likely for locations to the east and north-east such as Coalburn and Douglas).

#### **Assessment of Effects on Landscape Character**

26. The proposed turbines lie within the LCT 7 – Rolling Moorland and LCST 7B – Rolling Moorland Windfarm character areas as defined in the South Lanarkshire Landscape Character Assessment, 2010. The daytime period assessment work undertaken for the proposals set out in the main LVIA Chapter, identified that there would be a significant effect on the character of these areas and a number of the surrounding character areas within 10km of the site.
27. The key characteristics of the landscape character areas which lie in the area surrounding the site are set out in published landscape character assessments. However, a consideration of the potential for effects on landscape character during the low-light period requires an understanding not just of those characteristics which are apparent during the daylight, but also the degree to which artificial light sources are present in the landscape during low-light conditions.
28. Often there is a correlation between the daytime characteristics and the low-light characteristics, with primarily urban areas being identified as having a separate character from the surrounding rural landscape, both during daylight when buildings are visible and during low-light considerations when residential and street lighting is visible. However, this correlation is not always definitive as there are examples of landscapes which may appear rural and intimate during the daylight, but which may be characterised strongly by the artificial lighting of agricultural buildings during low-light. Similarly, there are landscapes which despite not being especially attractive or rural during daylight, can have very low levels of artificial lighting during low-light, giving a greater degree of intimacy and peacefulness to the landscape.
29. A review of the published character types within 10km of the site was undertaken and each was considered in the field during low-light conditions, where accessible, as well as during daylight. From this review it was apparent that the only landscape which had baseline conditions during the low-light period where artificial light was not a characteristic element of the experience from within or looking out from the area was the Plateau Moorlands of East Ayrshire, which extends to become the Southern Uplands landscape of Dumfries and Galloway. This is not to say that artificial light sources are not present within, and visible from, this landscape, rather that views of such lighting are more infrequent and often towards sources at distance. The notable exception to this being the lighting associated with the mining industry which operates in some sections of the landscape.
30. The area of the landscape in which there would be the potential for effects on landscape character to occur from the visible aviation lighting is illustrated on the Zone of Theoretical Visibility (ZTV) Plan set out at Figure 1 of this Appendix.
31. During the period in which there was sufficient daylight to clearly see the turbines any effect on landscape character would be brought about primarily by the turbines themselves, rather than the associated lighting. However, as the daylight levels decrease, the visibility of the turbines decreases and the turbine lighting becomes a more notable element. Eventually a point is reached at which it is the turbine lighting which brings about the greater degree of visual effect and indeed later in the darkest light conditions, it is only the lighting which brings about an effect as the turbine themselves are no longer visible.
32. It is accepted that within the wind farm site itself and its immediate landscape context within the Rolling Moorland the presence of the visible aviation lighting would bring about a notable change during the low-light period. This being the change from a landscape which was primarily characterised by its absence of visible artificial light, to a landscape where artificial light (i.e. the lit turbines) became a primary characteristic. However, within a relatively short distance from the turbines the overriding

characteristics of the landscape would remain those of an expansive, generally open rural and unlit landscape, with the turbine lighting forming a noticeable, but not a dominant feature.

33. In terms of an EIA judgement of significance it is considered that the Rolling Moorland landscape in the vicinity of the site is of high sensitivity to change during low-light conditions, as a consequence of its relatively low visibility of existing artificial lighting. With regard to the magnitude of the change it is considered that within the wind farm site itself and its immediate landscape context the change would be high, resulting in a major and significant effect. Beyond a distance of approximately 2km from the site the magnitude of effect would reduce to medium with the resulting level of effect being moderate, but not significant, on the basis that at this point the lighting would not be a defining characteristic of the overall experience of the landscape.

**Assessment of Visual Effects**

34. The area in which there would be the potential for visual effects to occur from the visible aviation lighting is illustrated on the Zone of Theoretical Visibility (ZTV) Plan set out at Figure 1 of this Appendix.
35. The assessment of visual effects begins with a consideration of three of the LVIA Assessment viewpoints which are located within the ZTV of the visible lighting and which are representative of key receptors within the 10km study area. Each of these assessment viewpoints are illustrated on Figure 1.

**LVIA Viewpoints**

36. It was agreed that three of the viewpoints included in the LVIA should be considered as part of the assessment of visual effects arising from the visible turbine lighting (VPs 1, 10 and 16). Each of these viewpoints is discussed in turn below. Each of these viewpoints have also been used as the locations for the production of visualisations illustrating the visible aviation lighting. Reference is given to these visualisations where appropriate within the discussion of the viewpoints.

**VP1 – Braehead, Coalburn**

<b>Viewpoint Location</b>	<b>281527, 634520</b>
<b>Distance to nearest lit turbine</b>	<b>3,778m (T14)</b>
<b>Daytime Visualisations Figure Reference</b>	<b>6.32</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Moderate (significant) [non-significant in cumulative scenario 1, once consented schemes are added to the baseline]</b>

37. This viewpoint is representative of the views of properties at Braehead, Coalburn, orientated in a south-westerly direction. The closest lit turbine within the Proposed Development is located to the south-west of the viewpoint at a distance of 3,778m.
38. The nature of the baseline daylight view is one which looks across a remediated colliery landscape which has been restored to a semi-natural state and includes areas of rough grassland and newly planted coniferous trees. In the distance, large blocks of plantation forestry and existing wind turbine development at the Hagshaw Hill Extension, Nutberry and Galawhistle can be seen along and atop of the hills, forming the skyline from this location.
39. The nature of the existing baseline dusk-period view is one where street lighting and lights within properties in Coalburn can be seen towards the west, whilst the view south towards the wind farm site is currently darker in nature. However, once the future baseline is considered this view changes, with 25 candela red aviation lighting being visible on a number of the consented Douglas West, Dalquandy and Cumberhead turbines extending across the panorama of the view.

40. The visualisations for viewpoint 1 illustrate that there would already be 5 turbine lights visible in the dusk and night time sky in the future baseline scenario and that this would increase to 9 with the addition of 4 lit Hagshaw turbines. It should be noted however that the Hagshaw turbines would be seen beyond the lit Douglas West turbines and at a considerably further distance from the viewpoint than the Dalquandy turbines. The visible Hagshaw turbine lights would be seen just above the horizon at dusk and in low light level conditions in the sky above the overall simple landform. A number of the lights would be located behind the horizon and thus would not be visible.
41. The introduction of a further four lit turbines to the dusk and night time view as seen from Viewpoint 1 would result in a medium magnitude of change in the view. The lights would be seen during periods of good, clear weather conditions where low cloud is absent from the hill formations. The lighting would be clearly notable in the view and would form an easily identifiable component in the view. The lighting would be visibly prominent but would not form a strong influence upon the wider view available relative to the existing level of lighting seen in the broader landscape as a result of the other consented wind farms.
42. It is acknowledged that it is possible that the lights could appear to go slowly off then on again under certain conditions when the turbine blades pass in front of the nacelle. However, from analysis of the wind rose for the site this set of circumstances would be fairly infrequent at this location. In the context of the existing visible turbine lighting which would be located in the view, and with regard to the distance of the lighting at more than 3.5km away, it is considered that the additional lighting would not be a dominant feature upon the experience of visual receptors in Braehead.
43. As a result of the introduction of further aviation lighting to the view to the south west of Viewpoint 1 there would be a worst case moderate visual effect which is considered to be non-significant due in part to the other existing lighting, including aviation lighting that would be visible in the landscape at this location.

VP16 – Douglas, Crabtree Street

<b>Viewpoint Location</b>	<b>283575, 631020</b>
<b>Distance to nearest lit turbine</b>	<b>3,654m (T6)</b>
<b>Daytime Visualisations Figure Reference</b>	<b>6.47</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Moderate (significant) [non-significant in cumulative scenario 1, once consented schemes are added to the baseline]</b>

44. The viewpoint is located on Crabtree Street, a minor road located on the north-western edge of Douglas. The closest lit turbine within the Proposed Development is located to the west of the viewpoint at a distance of 3,654m.
45. The nature of the baseline daylight view is one which looks across the well maintained playing fields towards the grassy banks of the Douglas Water, which can be seen cutting through the valley bottom, with the land on the other side of the bank gently rising up to Long Plantation. Long Plantation extends along most of the sky line and the existing Hagshaw Hill Extension turbines and the Hazelside Farm turbine are visible within the moorland to the west.
46. In low light periods, the existing visible aviation light on the Hazelside Farm turbine is a noticeable feature of the view in the direction of the site, with streetlighting which lines Crabtree Street also visible in the foreground. once the future baseline is considered this view changes, with 25 candela red aviation lighting being visible on the nearest of the consented Douglas West turbines to the site, as they extend across the panorama of the view behind Long Plantation.
47. The visualisations for viewpoint 16 illustrate that there would already be 2 turbine lights visible in the dusk and night time sky in the future baseline scenario and that this would increase to 6 with the

addition of 4 lit Hagshaw turbines. It should be noted however that the Hagshaw turbines would be seen in the same direction as the existing lit Hazelside Farm turbine. The visible Hagshaw turbine lights would be seen just above the horizon at dusk and in low light level conditions.

48. The introduction of a further four lit turbines to the dusk and night time view as seen from Viewpoint 16 would result in a medium magnitude of change in the view. The lighting would be clearly notable in the view and would form an easily identifiable component in the view. The lighting would be visibly prominent but would not form a strong influence upon the overall view available.
49. It is acknowledged that it is possible that the lights could appear to go slowly off then on again under certain conditions when the turbine blades pass in front of the nacelle. However, from analysis of the wind rose for the site this set of circumstances would be fairly infrequent at this location. In the context of the existing visible turbine lighting which would be located in the view, and with regard to the distance of the lighting at more than 3.5km away, it is considered that the additional lighting would not be a dominant feature upon the experience of visual receptors in this part of Douglas.
50. As a result of the introduction of further aviation lighting to the view to the west of Viewpoint 16 there would be a worst case moderate visual effect which on this occasion is considered to be non-significant due in part to the other existing lighting, including aviation lighting that would be visible in the landscape at this location.

VP10 - Victory Park, Muirkirk

<b>Viewpoint Location</b>	<b>269388, 627320</b>
<b>Distance to nearest lit turbine</b>	<b>9,625m (T1)</b>
<b>Daytime Visualisations Figure Reference</b>	<b>6.41</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Moderate (non-significant)</b>

51. This viewpoint is located on the western edge of Victory Park in Muirkirk, to allow for views beyond the immediate built form towards the site. The closest lit turbine within the Proposed Development is located to the east north-east of the viewpoint at a distance of 9,625m.
52. The nature of the baseline daylight view is one which comprises the public open space in the immediate foreground with dwellings located on Glasgow Road, Park Avenue and Burns Avenue located beyond. The existing turbines of the Galawhistle Wind Farm occupy the horizon in the direction of the view towards the site and form notable vertical features in the view. Further Galawhistle turbines are also seen slightly set down in the landscape beyond the horizon.
53. In low light periods, the existing lighting associated with residential properties and street lights is visible in the immediate context of the view, however beyond this there are currently no visible lights associated with the Galawhistle turbines close to where the Proposed Development is located.
54. The visualisations for viewpoint 10 illustrate that there would be four visible lit Hagshaw turbines. These would be seen beyond the existing lighting in Muirkirk just above the horizon at dusk and in low light level conditions.
55. The lighting would be noticeable in the view, but would appear to clearly relate to a distant part of the landscape beyond the village and would result in no greater than a low magnitude of change. It is acknowledged that it is possible that the lights could appear to go slowly off then on again under certain conditions when the turbine blades pass in front of the nacelle. From analysis of the wind rose for the site such a set of circumstances would be more common at this location than the others, however, given the distance of the lighting at more than 9.5km away, it is considered that the lighting would not be a dominant feature upon the experience of visual receptors in Muirkirk and there would be a worst case minor to moderate visual effect which is not significant.

## Settlements

56. In addition to the individual viewpoints, consideration has also been given to the potential visual effects on the nearest settlements to the site within the 10km study area. An assessment of the effects on Glespin, Douglas, Coalburn, Muirkirk, Lesmahagow and Rigside is set out below, with reference given where relevant to the individual viewpoints discussed previously where these are located within or in close proximity to the settlements.

### Glespin

<b>Distance from settlement edge to nearest lit turbine</b>	<b>1.6km (T3)</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Minor (non-significant)</b>

57. The settlement of Glespin is located to the south of the site at a distance of around 1.6km. The potential for daylight effects on the properties within the settlement is discussed in the Residential Visual Amenity Study presented at Appendix 6.4. This identifies that the potential for views of the proposed turbines from the properties within Glespin would be very limited and generally restricted to glimpsed views of the blade tips of a small number of turbines, with no significant visual effects identified. As the turbines would be lit at the nacelle and on the tower, there would therefore be very limited to no potential effects from aviation lighting.
58. In this context, it is considered that there would be a worst case **minor** effect on residential properties in Glespin.

### Douglas

<b>Distance from settlement edge to nearest lit turbine</b>	<b>3,654m (T6)</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Moderate (significant) [non-significant in cumulative scenario 1, once consented schemes are added to the baseline]</b>

59. The village of Douglas is situated to the east of the Proposed Development. Most properties are situated between 3 km and 4.5 km but with several properties scattered around the outskirts of the village. Although a significant number of the residential properties within Douglas face inwards and towards other properties, the sloping hillside that Douglas is situated on allows a number of properties to experience views towards the opposing hillside of the Douglas Water Valley.
60. The daytime assessment identified that without the Douglas West turbines considered in the baseline, the introduction of the proposed turbines would result in a worst-case high magnitude of change in the view from residential properties within Douglas, which is considered to be significant. In cumulative scenario 1, once the Douglas West turbines are included within the baseline, the effect of the addition of the Proposed Development turbines would reduce to a non-significant level, notwithstanding that the overall combined effect would be one which was significant.
61. Viewpoint 16 from Crabtree Street, described above, represents views from the north-western edge of Douglas where it was identified that there would be the potential for a worst case non-significant **moderate** visual effect during the low light period where the turbine lighting would be visible. From the southern parts of Douglas, where an open view towards the site exists, there would also be the potential for a similar effect to arise, again with the existing visible aviation light on the Hazelside Farm turbine, a feature in the current view towards the site.
62. Overall, in the context of the existing visible turbine lighting which would be located in the view, and with regard to the distance of the lighting at more than 3.5km away, it is considered that the

additional lighting would not be a dominant feature upon the experience of visual receptors as they move in and around Douglas during periods where the turbine lighting would be visible.

Coalburn

<b>Distance from settlement edge to nearest lit turbine</b>	<b>3,778m (T14)</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Moderate (significant) [non-significant in cumulative scenario 1, once consented schemes are added to the baseline]</b>

63. The linked settlements of Coalburn, Braehead, and Bellfield are situated to the north north east to north east of the site with the majority of the properties falling between 4 km and 5 km of the proposed turbines. The daytime assessment identified the potential for a moderate and significant effect to arise in the scenario whereby the consented Douglas West, Dalquhandy and Cumberhead Wind Farms are not considered as part of the baseline, reducing to a non-significant effect in cumulative scenario 1 once those turbines are considered to form part the baseline view.
64. Viewpoint 1, discussed above, represents the view from Braehead in Coalburn, where it was identified that the introduction of a further four lit turbines to the dusk and night time view would result in a medium magnitude of change and a worst case non-significant **moderate** visual effect during the low light period. From those other areas within Coalburn and its environs where the turbines were visible, such as along Coalburn Road, particularly as it travels over higher ground in the vicinity of Manse View and Dunn Crescent, there would also be the potential for views of the lit turbines in a similar manner to that of viewpoint 1.
65. Overall, in the context of the existing visible turbine lighting which would be located in the foreground of the view, and with regard to the distance of the lighting of the Proposed Development at more than 3.5km away, it is considered that the additional lighting would not be a dominant feature upon the experience of visual receptors as they move in and around Coalburn during periods where the turbine lighting would be visible.

**Rigside, Lesmahagow and Muirkirk**

The settlements between 5km and 10km of the site, which may have the potential to experience views of the aviation lighting are principally Rigside, Lesmahagow and Muirkirk.

Muirkirk lies around 9 km from the site and is represented in this appraisal by Viewpoint 10, discussed previously. This viewpoint serves as a worst-case representation of the view from the settlement which might be experienced during low light levels, as it is from an open location within Victory Park. Much of the settlement would have far less visibility due to the screening effects of built development. As such, whilst there would be a worst-case minor to moderate visual effect which is not significant, for much of the settlement any impact would be reduced.

Rigside lies around 9 km away and was identified to experience a moderate significant effect in the main assessment scenario, where other consented schemes are not considered, reducing to a non-significant effect in cumulative scenario 1, where these schemes are considered to form a part of the baseline view. This same assessment would apply equally to the night-time period, where once the turbine lighting associated with the consented Douglas West, Dalquhandy and Cumberhead schemes is considered to form a part of the baseline, the effect of the Proposed Development would reduce. However, in this instance it is not considered that the effects would be significant at this distance, once the manner in which the lighting would dissipate over this distance and form part of a much wider panorama of the view, which includes the notable lighting at the Dewars Bonded Warehouse, is considered.

Lesmahagow lies to the north of the site, again at around 9 km away. Whilst the turbines may be visible from parts of the settlement, as with the effects illustrated for Viewpoint 10 in Muirkirk, it is not considered that the effect would be a significant one. The lit turbines would not be a dominant feature upon the experience of visual receptors in Lesmahagow.

### Road Users

66. Consideration has also been given to the potential visual effects on road users across the 10km study area. An assessment of the effects on the principal roads from which the lighting would be theoretically visible (the M74 and the A70) is set out below. Where appropriate, reference is given to the individual viewpoints discussed previously and the corresponding visualisations, where these are located within or in close proximity to the roads.

#### M74

<b>Distance from road at its nearest point to the nearest lit turbine</b>	<b>6km (T14)</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Minor</b>

67. The M74 runs in a north north-west to south south-east direction to the east of the site. At its closest point between junctions 11 and 12 near Happendon Services, the route passes approximately 6km to the east of the nearest turbine (T14).
68. The daytime assessment established that travelling northwards views of the turbines would be limited to a very brief section of the motorway immediately north of Junction 12, which cars travelling at typical motorway speed would pass within a matter of seconds. It is therefore considered that there would be no greater than a very low magnitude of change in the view from the M74 travelling northwards and at most a minor effect which would not be significant. When travelling southwards there would be a number of locations where there are clear views of the proposed turbines at a distance of around 6 km, but again no greater than a minor effect.
69. During the low light period when the lit turbines would be visible, there would be the potential visibility of up to seven lit turbines from the same brief sections of the M74 as described above with regard to the daytime period. However, as with the daytime, the nature of the speed of travel on the motorway is such that sections would be passed in a very short period of time during which, at 6km away, the lit turbines would be a noticeable but minor element in the view, which would not result in any more than the same minor effect as would be experienced during the daytime period. The turbine lights would be seen in the context of the numerous elements of lighting within the landscape between the motorway and the site, but also in particular with headlights and interior lights of other vehicles using the route, which would be much more notable than the turbines.

#### A70

<b>Distance from road at its nearest point to the nearest lit turbine</b>	<b>1.1km (T1)</b>
<b>LVIA Assessment of daylight period Visual Effect</b>	<b>Major within 3-4km</b>

70. The A70 runs to the south of the site through the Douglas Valley, between Lanark and Ayr. As this road passes to the south of the site, on the western side of Glespin, it passes approximately 1.13km from the nearest proposed turbine (T1).
71. The daytime assessment identified that the Proposed Development would be visible to varying degrees along much of the route within 15km of the proposed turbines. The ZTV illustrates the extent of theoretical visibility along the route, with clear areas of no visibility between Glenbuck and Carmacoup, at Glespin, and further afield at Carbellow. Overall, the worst case visual effects were identified to occur in close proximity to the Proposed Development, within 3km to 4km of the turbines, where there would be high magnitude of change in the view resulting in a major effect which is significant.

72. From the same areas where the turbines would be visible during the day, there would be the potential for visibility of a number of the lit turbines during low light conditions. However, the existing aviation light on the Hazelside Farm turbine is already visible from many locations along the route, along with other existing lighting from properties and other vehicles. The turbine lighting would be a notable element in the view from some short sections of the route, which may result in some localised significant effects from the sections in closest proximity to the site, to the east of Glespin. However, at no point would the lighting become a dominant element of the view, nor change the overall character of travelling along the route as it is currently experienced.

### **Summary of Landscape and Visual Effects**

The assessment of landscape and visual effects of aviation lighting has identified that the visible lighting would be screened by landform and topography from much of the surrounding 10km, in particular from large sections of the M74 and A70, with views generally seen in areas where night time lighting is a familiar element of the landscape. There would be the potential for significant effects on the character of the landscape in the immediate vicinity of the site during low-light levels. Additionally, significant effects have also been identified for visual receptors who are not in the vicinity of artificial light sources (such as car headlights, dashboard lights, or bright torches) in the vicinity of the A70 within up to around 3km of the site, in particular the section to the east of Glespin. Such an effect would however only be likely to be experienced by a relatively small number of transient receptors, as it is a sparsely populated area, with few receptors being likely to take in the view in the dark conditions away from artificial lighting.

73. Overall, it is acknowledged that there are a small number of additional significant landscape and visual effects which would occur during low-light levels, over and above those which have been identified in relation to the daytime. These limited effects should be taken forward and considered within the wider planning balance when assessing the overall acceptability of the proposals.

#### **Summary Table**

<b><i>Receptor</i></b>	<b><i>Worst Case Level of Effect</i></b>	<b><i>Significant?</i></b>
<b><u>Landscape Character Areas</u></b>		
<i>Rolling Moorland</i>	<b><i>Major (up to approximately 2km from the site)</i></b>	<b><i>Yes</i></b>
<b><u>LVIA Viewpoints</u></b>		
<i>VP1 – Braehead, Coalburn</i>	<b><i>Moderate</i></b>	<b><i>No</i></b>
<i>VP16 – Crabtree Street, Douglas</i>	<b><i>Moderate</i></b>	<b><i>No</i></b>
<i>VP10 – Victory Park, Muirkirk</i>	<b><i>Moderate/Minor</i></b>	<b><i>No</i></b>
<b><u>Settlements</u></b>		
<i>Glespin</i>	<b><i>Minor</i></b>	<b><i>No</i></b>
<i>Douglas</i>	<b><i>Moderate</i></b>	<b><i>No</i></b>
<i>Coalburn</i>	<b><i>Moderate</i></b>	<b><i>No</i></b>
<i>Between 5 and 10km (Rigside Lesmahagow and Muirkirk)</i>	<b><i>Moderate/Minor</i></b>	<b><i>No</i></b>
<b><u>Road Users</u></b>		
<i>M74</i>	<b><i>Minor</i></b>	<b><i>No</i></b>
<i>A70</i>	<b><i>Major (where visible up to 3km)</i></b>	<b><i>Yes</i></b>

## **ANNEXE 1 - VISIBLE TURBINE LIGHTING ASSESSMENT: CRITERIA AND METHODOLOGY**

1. The primary source of best practice for Landscape and Visual Impact Assessment (LVIA) in the UK is *'The Guidelines for Landscape and Visual Impact Assessment', 3rd Edition (GLVIA3) (Landscape Institute and the Institute for Environmental Management and Assessment, 2013)*. The assessment criteria for the assessment of effects of visible turbine lighting has been developed in accordance with the principles established in this best practice document. It should however be acknowledged that GLVIA3 establishes guidelines not a specific methodology. The preface to GLVIA3 states:  
  
***'This edition concentrates on principles and processes. It does not provide a detailed or formulaic 'recipe' that can be followed in every situation – it remains the responsibility of the professional to ensure that the approach and methodology adopted are appropriate to the task in hand.'***
2. The assessment criteria set out below have therefore been developed specifically for this appraisal to ensure that the methodology is fit for purpose.
3. The purpose of an LVIA when undertaken in the context of an Environmental Impact Assessment (EIA) is to identify any likely significant landscape and visual effects arising as a result of the proposals. An LVIA should consider both:
  - ***effects on the landscape as a resource in its own right (the landscape effects); and***
  - ***effects on specific views and visual amenity more generally (the visual effects).***
4. It is recognised that in some circumstances, it may be possible for turbine lighting to result in a significant effect on the character of the surrounding landscape. For example, if the proposed wind energy development is located within or in close proximity to a designated dark sky area, or is remote from existing sources of visible lighting, such as residential areas, commercial or industrial sites, farms, or major roads.
5. For wind energy developments which are not located in such areas, it is considered that there would be no potential for significant effects on landscape character to arise from visible turbine lighting of the type proposed. This is because in these areas the character of the landscape during low natural light levels is already in part characterised by the presence of artificial lighting. Therefore, the addition of visible turbine lighting would not have the potential bring about a fundamental change to the characteristics of the landscape.
6. The proposed wind farm lies away from recognised dark sky areas, within a surrounding landscape context which contains some existing sources of artificial light, particularly within surrounding settlements, industrial developments and along highways. However, it is understood that an assessment of the potential for significant effects on landscape character should be undertaken, due to the location of the site itself within an area which is less characterised by the presence of visible light. Therefore, criteria are set out below for the assessment of both landscape character and visual effects.
7. For a daytime assessment, one assesses the worst case situation (i.e. clear full visibility as if a perfect day). A daytime assessment can therefore describe the full extent of that clear visibility, or lack of it, as a moment in time. For this study, it is not just the reverse. What is required is an understanding of low light level conditions which seeks to cover all the periods, both evening; dawn; gloomy winters day and after dark, in which the lights will to some degree be visible. This also seeks to cover the period just after it begins to get dark; the period just before it actually gets dark; the period in the middle as it moves from one to the other and the time after it is dark but a moonlit night affords some view of the landscape.

8. If one described a situation in detail, (e.g. just before sunset with the setting sun still illuminating part of the landscape; part going into deep shadow; a ridgeline in silhouette; the mid-ground in semi-darkness and a partially lit foreground because the street lights had just come on) this would be a snapshot in time for that viewpoint. Half an hour earlier in would have been different, as it would half an hour later, or at dawn, and that is before the matter of how it would have looked on another day earlier or later in the year is considered. Whether the description was looking east at sunset, or east at dawn would also radically change the description of what was seen and its impact. The report shall try to capture a single assessment that represents a typical judgement for the location in low light conditions, but not a specific set of conditions.
9. Such an assessment that was more specific would become very much larger, with the need to visit viewpoints at multiple times and in a range of light conditions, including dawn and dusk, to get the east - west, sunset - sunrise element. This could lead to multiple written descriptions and assessments for each location for both visual amenity and character effects. It is understood that this represents of proportional approach to the production of the low light assessment.

#### *Nature (Sensitivity) of Landscape Character*

10. The nature or sensitivity of landscape character reflects its susceptibility to change and any values associated with it. It is essentially an expression of a landscape's ability to accommodate a particular type of change. It varies depending on the physical and perceptual attributes of the landscape including but not necessarily limited to: scale; degree of openness; landform; existing land cover; landscape pattern and complexity; the extent of human influence in the landscape; the degree of remoteness/wildness; perception of change in the landscape; the importance of landmarks or skylines in the landscape; intervisibility with and influence on surrounding areas; condition; rarity and scenic quality of the landscape, and any values placed on the landscape including any designations that may apply. Additionally, for a consideration of landscape character during low light levels, a key further consideration is the extent to which existing artificial light sources are present in the landscape during low natural light levels.
11. In this assessment, the nature or sensitivity of landscape character shall be considered with reference to published landscape character areas/types. Information regarding the key characteristics of these character areas/types shall be extrapolated from relevant published studies. Together with on-site appraisal, an assessment of landscape sensitivity to visible wind turbine aviation lighting shall be undertaken, employing professional judgement.
12. The nature or sensitivity of landscape character shall be described as very high, high, medium, low or very low.

#### *Nature (Sensitivity) of Visual Receptors*

13. The nature or sensitivity of a visual receptor group reflects their susceptibility to change and any values associated with the specific view in question. It varies depending on a number of factors such as the occupation of the viewer, their viewing expectations, duration of view and the angle or direction in which they would see the site. Whilst most views are valued by someone, certain viewpoints are particularly highly valued for either their cultural or historical associations and this can increase the sensitivity of the view. The following criteria are provided for guidance only and are not exclusive:

- ***Very Low Sensitivity*** – People engaged in industrial and commercial activities, or military activities, who would be unlikely to have any particular expectation of their wider night time view.
  - ***Low Sensitivity*** - People at their place of work (e.g. offices); shoppers; users of trunk/major roads and passengers on commercial railway lines (except where these form part of a recognised and promoted scenic route). The primary interest of such receptors would not generally be on the dusk/night time view.
  - ***Medium Sensitivity*** - Users of public rights of way and minor roads which do not appear to be used primarily for recreational activities or the specific enjoyment of the landscape; recreational activities not specifically focused on the landscape (e.g. football). Such receptors may have some interest in their dusk/night time view of the wider landscape, but generally their primary concern would be their immediate landscape context;
  - ***High Sensitivity*** – Residents at home; users of caravan parks, campsites and ‘destination’ hotels; tourist attractions open after daylight hours with opportunities for views of the landscape (but not specifically focused on a particular vista); users of public rights of way or minor roads which appear to be used for recreational purposes or the specific enjoyment of the landscape during dusk/night time (often likely to be in close proximity to residential areas).
  - ***Very High Sensitivity*** - People at recognised vantage points (often with interpretation boards) which are designed to take in a dusk/ night time view, people at tourist attractions with a focus on a specific view which is available at dusk/ night time, visitors to historic features/estates where the setting is important to an appreciation and understanding of cultural value and can be visited and appreciated during dusk/night time.
14. It is important to appreciate that it is the visual receptor (i.e. the person) that has a sensitivity and not a property, public right of way or road. Therefore, a large number of people may use a motorway during dusk/ night time, for example, but this does not increase the sensitivity of the receptors using it. Conversely, a residential property may only have one person living in it but this does not reduce the sensitivity of that one receptor.
15. Where judgements are made about the sensitivity of assessment viewpoints, the sensitivity rating provided shall be an evaluation of the sensitivity of the receptor represented by the viewpoint and not a reflection of the number of people who may experience the view.
16. It is also important not to confuse the concept of visual sensitivity with the perception of wind turbines. It is acknowledged that some people consider wind turbines to be unattractive, but many people also enjoy the sight of them. This matter is therefore not a factor when determining sensitivity.

***Nature (Magnitude) of effects on Landscape Character***

17. The magnitude of effect on landscape character from visible lighting during low light periods is influenced by the resulting alteration to the physical and perceptual characteristics of the landscape. Professional judgement shall be used as appropriate to determine the magnitude using the following criteria as guidance only. In doing so, it is recognised that usually the landscape components in the immediate surroundings, including any visible lighting, have a stronger influence on the sense of landscape character than distant features whilst acknowledging the fact that more distant features can have an influence on landscape character as well.
- Very Low Magnitude of Change – No notable introduction of new visible lighting into the landscape; resulting in negligible change to the key physical and/or perceptual attributes of the landscape during the low light period.

- Low Magnitude of Change - Introduction of a minor new extent of visible lighting into the landscape; resulting in a minor alteration to the key physical and/or perceptual attributes of the landscape during the low light period.
- Medium Magnitude of Change - Introduction of some notable new visible lighting into the landscape; resulting in some notable change to the key physical and/or perceptual attributes of the landscape during the low light period.
- High Magnitude of Change - Introduction of major new visible lighting into the landscape; resulting in a major change to the key physical and/or perceptual attributes of the landscape during the low light period.
- Very High Magnitude of Change - Introduction of dominant new visible lighting into the landscape; resulting in a profound change to the key physical and/or perceptual attributes of the landscape during the low light period.

Nature (Magnitude) of effects on views and visual amenity

18. Visual effects are caused by the introduction of new elements into the views of a landscape, or the removal of elements from the existing view. In this case the effects would be brought about by the addition of visible lighting.
19. Professional judgement shall be used to determine the magnitude of impacts using the following criteria as guidance only:
  - ***Very Low Magnitude of Change - No change or negligible change in views;***
  - ***Low Magnitude of Change - Some change in the view that is not prominent but visible to some visual receptors;***
  - ***Medium Magnitude of Change - Some change in the view that is clearly notable in the view and forms an easily identifiable component in the view;***
  - ***High Magnitude of Change - A major change in the view that is highly prominent and has a strong influence on the overall view.***
  - ***Very High Magnitude of Change – A change in the view that has a dominating or overbearing influence on the overall view.***
20. Using this set of criteria, determining levels of magnitude is primarily dependant on how prominent the lighting associated with the development would be in the landscape, and what may be judged to flow from that prominence or otherwise.
21. For clarification, the use of the term ‘prominent’ relates to how noticeable the lighting associated with the development would be. This is affected by how close the viewpoint is to the development but not entirely dependent on this factor. Other modifying factors include: the focus of the view, visual screening and the nature and scale of other landscape features and visible lighting within the view. Rather than specifying crude bands of distance at which the turbines will be dominant, prominent or incidental to the view etc, the prominence of the turbines in each view is described in detail for each viewpoint or receptor group taking all the relevant variables into consideration.

Consideration of the Duration and Reversibility of effect

22. Prior to the publication of GLVIA3, LVIA practice had evolved over time in tandem with most other environmental disciplines to consider significance principally as a function of two factors, namely: the sensitivity of the receptor and the magnitude of the effect (the term ‘magnitude’ being a word most commonly used in LVIA and most other environmental disciplines to describe the size or scale of an effect).

23. The flow diagram on page 39 of GLVIA3 now suggests that the magnitude of effect is a function of three factors (the size/scale of the effect, the duration of the effect and the reversibility of the effect). This however is somewhat problematic in the context of assessing wind energy development. This is because wind energy developments are generally consented for a time limited period and are largely reversible at the end of their operational period. Whilst this is a material consideration in the planning balance it does not however reduce the scale of the effect during the period in which the scheme is operational (i.e. the 'magnitude' of the effect in the traditional and commonly understood sense of the word). In this regard, it would be incorrect to report a lesser magnitude of change to the view during the operational phase as a result of the time limited period of the effect, or the relative reversibility of the effect.
24. The approach proposed to be taken in this assessment is therefore to consider magnitude of effect solely as the scale or size of the effect in the traditional sense of the term 'magnitude'.

#### Level of effect

25. The purpose of an LVIA when produced in the context of an EIA is to identify any significant effects on landscape and visual amenity arising from the proposed development.
26. The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 do not define a threshold at which an effect may be determined to be significant. In certain other environmental disciplines there are regulatory thresholds or quantitative standards which help to determine the threshold of what constitutes a significant effect. However, in LVIA, any judgement about what constitutes a significant effect is the judgement of a competent and appropriately qualified professional assessor.
27. The level (relative significance) of the landscape and visual effects is determined by combining judgements regarding sensitivity of the landscape or the viewer, the magnitude of change, duration of effect and the reversibility of the effect. In determining the level of residual effects, all mitigation measures are taken into account.
28. The level (relative significance) of effect shall be described as Major, Major/Moderate, Moderate, Moderate/Minor, Minor, Slight/No Effect or No Effect. No Effect may also be recorded as appropriate where the effect is so negligible it is not even noteworthy.
29. In the assessment, those effects described as Major, Major/Moderate and in some cases Moderate may be regarded as significant effects as required by the EIA Regulations. These are the effects which the authors of the LVIA consider to be most material in the decision making process.

#### Production of the Zone of Theoretical Visibility (ZTV) Plan

30. A Zone of Theoretical Visibility (ZTV) illustrates the extents from which a feature (in this case the visible lighting from several wind turbines) would theoretically be visible within a defined study area.
31. ZTVs are generated assuming a 'bare ground' terrain model. This means that the ZTVs presented are generated from topographical data only and they do not take any account of vegetation or the built environment, which may screen views of the development. They are, as such, a 'worst case' zone of visual influence and considerably over-emphasises the actual visibility of the scheme. In reality trees, hedges and buildings may restrict views of the development from many of the areas rendered as within the ZTV.
32. A further assumption of ZTVs is that climatic visibility is 100% (i.e. visibility is not impeded by moisture or pollution in the air). In reality, such atmospheric conditions are relatively rare. Mist, fog, rain and snow are all common weather occurrences, which would regularly restrict visibility of the lighting

associated with the development from some of the areas within the ZTV; this being an incrementally more significant factor with distance from the site. Atmospheric pollution is not as significant as it is in other parts of the country but is still present and would also restrict actual visibility on some occasions, again more so with distance from the site.

33. A ZTV shall be generated using specialist computer software package 'WindFarm' by ReSoft Ltd. The programme uses topographical height data (OS Terrain 50) to build a terrain model. The programme then renders the model using a square grid to illustrate whether the turbine lighting would be visible in each 50m x 50m square on the grid for a specified distance in every direction from the site.
34. A digital ZTV shall be prepared to illustrate the theoretical visibility of the turbine lighting for a radius of 10km around the site. It should be noted that when light travels from its source it diminishes in intensity, limiting the area that its source can illuminate, a process known as 'light attenuation' or 'fall-off'. Therefore, whilst the ZTV would not illustrate any reduction in intensity it should be recognised that the aviation lighting would diminish in intensity with distance from the wind farm.
35. It should be noted that there are several limitations to the use of ZTVs. For a discussion of these limitations please refer to Visual Representation of Wind farms – Version 2.2 (SNH February 2017). In particular, it should be noted that the ZTV plan shall simply illustrate theoretical visibility and will not imply or assign any level of significance to those areas identified as being within the ZTV. A ZTV is a tool to assist the Landscape Architect to identify where the turbine lighting would potentially be visible from, however the assessment of landscape and visual effects shall not rely solely on the ZTV and in all cases professional judgement shall be used to evaluate the significance of effects.

### **Production of the Dusk Period Visualisations**

#### **Introduction**

36. SNH Guidance, Visual Representation of Wind Farms, Version 2.2, February 2017, considers the matter of visible turbine lighting at paragraphs 174 to 177. This highlights that '*Where an illustration of lighting is required, a basic visualisation showing the existing view alongside an approximation of how the wind farm might look at night with aviation lighting may be useful*'. It goes on to note that '*This is only likely to be required in particular situations where the wind farm is likely to be regularly viewed at night (e.g. from a settlement, transport route) or where there is a particular sensitivity to lighting (e.g. in or near a Dark Sky Park or Wild Land Area)*'. It is also clear that '***Not all viewpoints will need to be illustrated in this way***'.
37. The following section provides background information in relation to the Dusk Period Visualisations which it is proposed are prepared to illustrate the visible lighting proposed as part of the wind farm. The text explains how the photography shall be taken and how the visualisations are to be prepared and presented. It includes instructions for how it is expected that the visualisations should be viewed and explains the limitations of the visualisation material.

#### **Dusk Period Photography**

38. SNH advises that '*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. It is only necessary to illustrate visible lighting, not infrared or other alternative lighting requirements*'. It goes on to note that '*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. It is important that the photographs represent the levels of darkness as seen by the naked eye at the time and the camera exposure does not make the image appear artificially brighter than it is in*

*reality. It can also be helpful to note the intensity of other lights in the area to enable comparison (e.g. television transmitters) as this can aid the assessment process’.*

39. In this context, the following text explains how the baseline photography shall be taken for each viewpoint to be illustrated with a visualisation.
40. Each viewpoint to be illustrated with a visualisation shall be visited during the ‘dusk period’ and photographs taken at regular intervals as the light levels decrease across the dusk period. In particular, we shall seek to gather photographs during the period where street lighting and other light sources of visible light in the baseline are illuminated, but the landform remains partially visible. The ambient light conditions shall be recorded during each round of photography with a light meter to seek to ensure consistency across the visualisations prepared.
41. Baseline photographs of the existing view shall be taken using a high quality Canon 5D Mark II digital camera with a Canon EF 50mm f/1.4 USM lens. In accordance with SNH guidance, this camera shall have a full frame digital sensor.
42. As far as possible, photographs shall be taken in good weather and clear visibility conditions.
43. Neutral density graduated filters shall be used as appropriate at some viewpoints to balance the exposure within some scenes – typically where there is a contrast between bright sky and darker landform. Other than this no other filters shall be used during the photography.
44. Photographs shall be captured in high resolution JPEG format and as RAW metadata files.
45. At each viewpoint the camera shall be mounted on a levelled tripod at a height of approximately 1.5m above ground level (providing an approximation of average adult eye level).
46. The camera shall be set up on a panoramic rotating head and photographs taken at 30 degree increments of rotation from left to right.
47. In each case the camera focus shall be locked on the distant horizon (infinity). In doing so the photographs are in each case focussed on the development site whilst very close objects in the foreground may in some cases be out of focus. This approach is in line with best practice photography techniques. The exposure shall be set correctly for the centre of the development site and then locked off so that it remained constant as the camera is rotated through the panorama.

#### *Stitching of Panoramas and Post-Photographic Processing*

48. Each of the panoramic images presented for the Photographic Record and used for the Visualisations shall be comprised of three single frame photographs stitched together and then cropped down to a particular horizontal and vertical field of view.
49. The panoramic baseline photographs which illustrate a 90 degree horizontal angle of view shall be stitched in cylindrical projection as per the SNH guidance.
50. The photomontages which show a 53.5 degree horizontal field of view shall be based on the same single frame panoramic photographs but stitched in planar projection in accordance with the SNH guidance.
51. In some cases a degree of post photography processing of the raw image files may be undertaken to enhance the quality of the baseline photographs. As stated in the SNH guidance:

***‘Photographic processing involves judgements - there is no process by which a ‘pure’ photograph can be produced without the application of human decision-making, from exposure timing to the specification of the camera, and whether this is applied manually or automatically.....’***

***'In reality there is no way to avoid a photograph being enhanced as this is an integral part of photography and photomontage production.'***

52. The extent of image enhancement undertaken in the production of the any photomontages will however be limited to that which would conventionally occur in a darkroom to improve the clarity of an image, and will not in each case change the essential character of the image. Overall, a minimum of post-photography image enhancement will take place and during the stitching process none of the photographs shall be distorted in terms of scaling (other than that which is an inherent and unavoidable product of stitching photography in planar projection).

*Production of Wirelines and Photomontages*

*Wirelines*

53. A wireline visualisation (sometimes also referred to as a wireframe visualisation) is a computer generated 3D outline of a particular structure (in this case a wind farm) placed on top of a 3D ground terrain model, which again is represented by a wireline. No rendering is given to any of the surfaces.
54. The wireline images of the proposed turbines (as well as any other cumulative turbines modelled) will be generated utilising the actual dimensions of the proposed turbines and a model of the structures placed in position over a ground terrain model generated from Ordnance Survey Terrain 50 DTM data.
55. The coordinates of the viewpoints will be recorded using a Global Positioning System (GPS) in the field. Checks on these coordinates will be made with reference to Google Earth. These coordinates will be used to set up viewpoints in the model from which to view the turbines. The wirelines will be generated using specialist computer software package 'WindFarm' by ReSoft Ltd.
56. The wireline images are generated on a bare ground model and therefore do not take account of any vegetation or the built environment between the viewpoint and the development. As such, they represent a worst case view.
57. For each of the viewpoints which are illustrated with a Visualisation, a wireline will be presented to scale beneath a baseline photograph to illustrate the view. The wireline images illustrate the anticipated scale and position of the turbines in relation to the terrain.

*Dusk Period Photomontages*

58. In simple terms, a photomontage is the superimposition of a rendered, photorealistic, computer generated model of a development (in this case a wind farm with visible lighting) on to a baseline photograph to illustrate how it will appear in the surrounding landscape context.
59. The production of the photomontages shall begin with the generation of a 3D digital ground terrain model and wireline images of the turbines, using ReSoft Ltd WindFarm software (as described above). The model of the structures is then rendered, and the lighting levels set appropriate to the date, time and orientation on which the photograph was taken.
60. Using world coordinates in the computer modelling programme, the photographic viewpoints for which a photomontage is to be prepared is replicated such that a view is set up looking at the structures from exactly the same location as where the baseline photograph was taken from. The view from the model is then superimposed over the original photograph and edited as necessary in Adobe Photoshop to give a final photomontage. Several known landmarks in the far distance of the baseline photographs are recorded on site using a GPS and used to check that the positioning and scale of the structures is correct.

61. Whilst every effort shall be made to ensure the accuracy of the photomontages, it must be appreciated that no photomontage could ever claim to be 100% accurate as there are a number of technical limitations in the model relating to the accuracy of information available from Ordnance Survey and from the GPS. In particular, it should be recognised that baseline photographs on which photomontages are based can, at best, only ever be a 'flattened' 2D representation of what the eye sees in 3D on site. A photograph will never capture as much detail as the eye would see in the field, it therefore follows that a photomontage can never truly capture the sense of perspective and detail which would be possible in reality.
62. Additionally, it has been established during the field work undertaken for previous similar studies that dusk period photographs of visible lighting do not always capture the extent to which the eye perceives light sources during the dusk period. Often photography will appear to show the lighting to be more recessive than it is actually perceived in the field. The photomontages therefore do not seek to replicate the manner in which a dusk period photograph would capture the aviation lighting, rather they seek to replicate the manner in which the lighting is perceived when it is viewed in the field.
63. In some cases, the visibility of the turbines may also be slightly digitally enhanced to ensure that they are visible when printed out.
64. Each of the photomontages should be viewed from the stated viewing distance to give an accurate representation of what the development will look like. However, the photomontages are simply a tool to assist the Landscape Architect in their assessment of effects. The assessment of visual effects does not rely solely on the accuracy of the photomontages as it is ultimately professional judgement which is used to evaluate the significance of effects.

Presentation of the Visualisation Sheets

65. For each Dusk Period Viewpoint Visualisation, the following visualisation sheets shall be presented:  
  
Sheet A: Baseline Photograph of the Existing Dusk Period View and Cumulative Wireline of the Proposed Scheme and all other relevant Operational or Consented Wind Farms (including only other developments with lit turbines)
66. The baseline photograph is an unedited existing dusk period view from the viewpoint. The image illustrates a 90 degree horizontal field of view and a 25 degree vertical field of view. This image is presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 500mm when the image is curved through the same radius.
67. A cumulative wireline image of the Proposed Development, and the other neighbouring operational or consented wind farms which are required to have aviation lighting is set out directly beneath the corresponding baseline view. This image also presents a 90 degree horizontal field of view.  
  
Sheet B: Future Baseline Photograph of the Existing Dusk Period View (Showing Existing Hagshaw Hill turbines digitally removed, plus consented/under construction schemes Cumberhead, Douglas West and Dalquandy digitally added) and Cumulative Wireline of the Proposed Scheme and all other relevant Operational or Consented Wind Farms (including only other developments with lit turbines)
68. The future baseline photograph is an edited existing dusk period view from the viewpoint showing Existing Hagshaw Hill turbines digitally removed, plus consented/under construction schemes Cumberhead, Douglas West and Dalquandy digitally added. The image illustrates a 90 degree horizontal field of view and a 25 degree vertical field of view. This image is presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to

obtain a geometrically accurate impression) is 500mm when the image is curved through the same radius.

69. Again, a cumulative wireline image of the Proposed Development, and the other neighbouring operational or consented wind farms which are required to have aviation lighting is set out directly beneath the corresponding baseline view. This image also presents a 90 degree horizontal field of view.

Sheet C: Dusk Period Photomontage of the Proposed Scheme and other relevant Operational or Consented Schemes with Aviation Lighting

70. This sheet provides an enlarged and cropped dusk period photomontage of the Proposed Development, added into the future baseline image described above. The image illustrates a 53.5 degree horizontal field of view and an 18 degree vertical field of view. It is presented in planar projection. As such the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5mm. This sheet presents the information required of the 'A1 Panorama' as set out in Annex C of the SNH guidance.

Limitations of the Visualisations

71. Annex A of 'Visual Representation of Wind Farms, Version 2.2 (SNH, February 2017) sets out a summary of the key limitations of visualisations and recommends that these are set out for each windfarm application. The following text is therefore reproduced from Annex A of the aforementioned SNH guidance:

*'Visualisations of wind farms have a number of limitations which you should be aware of when using them to form a judgement on a wind farm proposal. These include:*

- *A visualisation can **never show exactly** what the wind farm will look like in reality due to factors such as: different lighting, weather and seasonal conditions which vary through time and the resolution of the image;*
- *The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but **can never be 100% accurate**;*
- *A static image cannot convey turbine movement, or flicker or reflection from the sun on the turbine blades as they move;*
- *The viewpoints illustrated are representative of views in the area, but cannot represent visibility at all locations;*
- *To form the best impression of the impacts of the wind farm proposal these images **are best viewed at the viewpoint location shown**;*
- *The images **must** be printed at the right size to be viewed properly (260mm by 820mm);*
- *You should hold the images **flat at a comfortable arm's length**. If viewing these images on a wall or board at an exhibition, you should stand at arm's length from the image presented to gain the best impression.*
- *It is preferable to view printed images rather than view images on screen. If you do view images on screen you should do so using a normal PC screen with the image enlarged to the full screen height to give a realistic impression. Do not use a tablet or other device with a smaller screen to view the visualisations described in this guidance'.*

72. It should also be noted that the quality of all printed visualisations is also dependent on the printing methods, paper and ink used.