Chapter 14
Shadow Flicker

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14 Shadow Flicker

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14 Shadow Flicker

14.1 Executive Summary

14.1.1 An assessment has been undertaken of the potential shadow flicker effects likely to be caused by the Proposed Development on sensitive receptors. Shadow flicker is the effect of the sun passing behind the moving rotors of the turbines casting a flickering shadow through the windows and doors of neighbouring properties. This occurs in certain combinations of geographical position, time of day, time of year and specific weather conditions.

14.1.2 The Study Area within which properties could potentially be affected by shadow flicker covers a distance of 10 rotor diameters from each turbine and lies 130 degrees either side of north (relative to each turbine). In the case of the Proposed Development, this area extends to 1.63 km from each turbine.

14.1.3 A shadow flicker assessment was undertaken at 26 identified receptors within the Study Area. The assessment found no significant effects were expected at any of the identified receptors.

14.1.4 Cumulative assessment identified that 24 receptors are within the relevant cumulative Study Area, with the consented Hallsburn Farm and Mill Rig developments contributing potential shadow flicker cumulatively with the Proposed Development. The assessment indicated that no significant cumulative shadow flicker effects are likely to be experienced at all receptors.

14.1.5 It is important to note that these results do not take into account existing screening features (structures and vegetation), dwelling orientation and local mitigation measures such as blinds or curtains which will reduce any potential effects further. Receptors may also be in rooms that are not generally used at the affected times, therefore, the amount of time when shadow flicker is actually 'experienced' will likely be significantly less than what has been predicted.

14.1.6 The Applicant proposes that prior to the erection of the first turbine, a 'Wind Farm Shadow Flicker Protocol' will be submitted to and approved in writing by the Local Planning Authority. This will set out mitigation measures to alleviate shadow flicker attributable to the Proposed Development as well as a protocol for addressing a complaint received from a receptor within the study area. Operation of the turbines would be required to take place in accordance with the approved Shadow Flicker Protocol and any mitigation measures that have been agreed through the protocol would require to be implemented as appropriate.

14.1.7 The residual effect of shadow flicker is, therefore, expected to be not significant for all receptors during the operational phase of the Proposed Development.

14.2 Introduction

14.2.1 This chapter describes and assesses the potential shadow flicker effects resulting from the Proposed Development on nearby residential properties. This chapter (together with its associated figures and appendices) is not intended to be read as a standalone assessment and reference should be made to **Chapter 3: Project Description**.

14.2.2 The Scottish Government Onshore wind turbines: planning advice (2014) states that shadow flicker occurs when, "*Under certain combinations of geographical position, time of day and time of year, the sun may pass behind the rotor and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as "shadow flicker". It occurs only within buildings where the flicker appears through a narrow window opening*".

14.2.3 Any receptors which may potentially be affected have been identified and the risk of shadow flicker calculated.

14.2.4 The level and significance of shadow flicker effects varies both spatially and temporally, and depends on a number of environmental conditions coinciding at a particular point in time, which include:

- time of day and year;
- wind direction;
- height of wind turbine and blade length;
- position of the sun in the sky;
- weather conditions;
- proportion of daylight hours in which the turbines operate;
- type and frequency of use of the affected space; and
- distance and direction of the wind turbine from the receptor.

14.2.5 The flickering effect caused by shadow flicker also has the potential to induce epileptic seizures in people with photosensitive epilepsy. The Epilepsy Society advises that around 1 in 100 people have epilepsy and up to 5 % of these have photosensitive epilepsy (Epilepsy Society 2024). The common rate or frequency at which photosensitive epilepsy might be triggered is between 3 and 30 hertz (Hz, flashes per second). Large commercial turbines rotate at low speeds resulting in less than 3 flashes per second and are therefore unlikely to cause epileptic seizures (Harding *et al*., 2008: Smedley *et al*., 2010). Therefore, there are not considered to be any health effects associated with the Proposed Development and this assessment will address the effects of shadow flicker related only to local amenity.

14.2.6 Turbines can also cause flashes of reflected light, which can be visible for some distance. It is possible to ameliorate the flashing but it is not possible to eliminate it. Careful choice of blade colour and surface finish can help reduce the effect and all modern turbine manufacturers use light grey semi-matt finishes to reduce this effect.

14.2.7 A wind development of more than one turbine can also result in more than one turbine affecting a specific receptor at any time, potentially increasing the overall shadow flicker intensity or frequency. This potential effect has been taken into account within this assessment as well as the cumulative effect with other operational and proposed wind turbines in the local area.

14.2.8 This chapter is supported by the following figures and technical appendices:

- Figure 14.1 Shadow Flicker Study Area
- Figure 14.2 Shadow Flicker Results (Realistic Scenario)
- Figure 14.3 Cumulative Shadow Flicker Study Area
- Figure 14.4 Cumulative Shadow Flicker Results (Realistic Scenario)
- Appendix 14.1 Shadow Flicker Meteorological Data
- Appendix 14.2 Potential Shadow Periods

14.3 Legislation, Policy and Guidelines

Legislation

14.3.1 There is no applicable legislation setting out any relevant rules or requirements for the assessment or control of shadow flicker.

Policy

14.3.2 This assessment has taken into consideration the policies contained in the National Planning Framework 4 (NPF4) (Scottish Government, 2023), South Lanarkshire Local Development Plan 2 (2021) (SLLDP2), and East Ayrshire Local Development Plan 2 (2024) (EALDP2).

14.3.3 Particularly, Policy 11 part (e)i. of NPF4 (2023) states that any potential impacts on communities from shadow flicker must be addressed by the development. This is further noted within EALDP2 policy RE1: Renewable Energy.

14.3.4 Policy RE1 of SLLDP2 specifically considers renewable energy developments and refers to an Assessment Checklist (included as Appendix 1 of LDP2 Volume 2) for Renewable Energy Proposals which in turn references the Supporting Planning Guidance (SPG) on Renewable Energy. In relation to shadow flicker the SPG states: '*In certain circumstances shadow flicker from turbines can cause a nuisance for neighbouring properties. Scottish Government guidance advises that where there is sufficient separation between wind turbines and nearby dwellings (as a general rule a distance of greater than 10 rotor diameters), shadow flicker should not be a problem. For properties within 10 rotor diameters of a turbine under the right conditions and circumstances shadow flicker could occur and as such the Council would expect an assessment to be undertake by the applicant to assess potential effects.*'

14.3.5 The standalone Planning Statement accompanying the Section 36 application for the Proposed Development sets out the full planning policy framework that is relevant to the EIA.

Guidance

14.3.6 The update of UK Shadow Flicker Evidence Base (DECC, 2011) reviews international legislation relating to the assessment of shadow flicker for wind turbine development and concludes that the area within 130 degrees either side of north from the turbine, and out to 10 rotor diameters, is considered acceptable for shadow flicker assessment. The DECC study also concluded that there have not been extensive issues with shadow flicker in the UK and, in circumstances where the potential for significant shadow flicker issues effects have been identified, these have been resolved using standard mitigation.

14.3.7 This assessment also takes into consideration the Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014) which states "*where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem*".

14.4 Assessment Methodology and Significance Criteria

Study Area

14.4.1 The shadow flicker Study Area is shown in **Figure 14.1** and the shadow flicker assessment has been carried out for the proposed 18 turbines at the locations identified in **Chapter 3**. The final turbine model has not been selected and this will be based on the most advanced technology available at the time. Therefore, as a precaution this assessment is based on the worst-case scenario model (i.e. that with the largest proposed rotor area) that is being considered for the Proposed Development, within the envelope discussed in **Chapter 3**. Dimensions of the candidate model used for the purposes of the shadow flicker assessment can be found in **Table 14.1**.

Table 14.1 - Details of the Turbine Model Used for the Shadow Flicker Assessment

Hub Height	149.5 m
Rotor Diameter	163 m

14.4.2 The Study Area within which receptors could potentially be affected by shadow flicker has been set at a distance of 10 rotor diameters from each turbine and 130 degrees either side of north (relative to each turbine), as noted within the DECC report (DECC, 2011). In this assessment, the Study Area extends to 1.63 kilometres (km) from each turbine. **Figure 14.1** shows the extent of this area and those receptors that could potentially be affected by shadow flicker.

Desk Study

14.4.3 The desk study assessment identified 26 residential receptors within the Study Area (shown in **Figure 14.1**). The majority of receptors in the Study Area (21 of the 26) are in a cluster located along

Hamilton Drive to the north-west of the Proposed Development boundary at Dungavel. The other identified receptors (5) are all located to the west of the Proposed Development's northern development area.

14.4.4 It should be noted that receptors A to G and M to O are slightly outside the Study Area but have been included in the assessment for completeness, as they are less than 50 m outside the Study Area boundary. **Table 14.2** summarises the locations of the receptors and the distance from each property to the nearest turbine. A single representative receptor location is shown in the results tables for receptors A to T along Hamilton Drive due to the proximity of the receptors to one another.

Table 14.2 – Receptor Locations

ID	Property	X-Coordinate	Y-Coordinate	Approximate Distance to Nearest Turbine (m)	Nearest Turbine(s)
A-T	Hamilton Drive	265901	637383	1576.61	1
U	Dungavel House Immigration Removal Centre	265851	637192	1429.11	1
V	Ceil Mill Cottage	264964	636134	1602.71	1
W	Templelands Cottage	265425	635999	1132.09	1
X	Laigh Plewland Farm	265434	635250	1321.85	1
Y	Glengavel House*	266421	635227	526.82	2
Z	High Plewlands Farm	265923	634597	1178.42	4

**Property with financial involvement in the Proposed Development*

14.5 Assessment of Potential Effect Significance

14.5.1 There are no UK statutory provisions setting out acceptable levels of shadow flicker. The DECC 2011 report identifies best practice guidelines across Europe and this assessment will adopt the generally accepted quantitative guidance which adopts two maximum limits to define significant effects:

- a limit of 30 hours per year; or
- more than 30 minutes per day on the worst affected day, whichever is the greater.

14.5.2 Within this assessment the sensitivity of the receptors is assumed to be high in all cases as all receptors are residential dwellings. It is noted that Receptor U is not a place of permanent or long-term residential dwelling, however it is conservatively treated as high sensitivity in any case.

14.6 Assessment Modelling

14.6.1 In assessing the effect of shadow flicker, the commercial software model WindPro 4.1 was used to calculate the expected number of hours shadow flicker that could occur at each receptor. The model takes into account the movement of the sun relative to the time of day and time of year and predicts the time and duration of expected shadow flicker at a window of an affected receptor. The input parameters used in the model are as follows:

- the turbine locations;
- the turbine dimensions;
- the location of the receptors to be assessed; and
- the size of windows on each receptor and the direction that the windows face.

14.6.2 The WindPro model is based upon a Zone of Theoretical Visibility (ZTV) analysis, which in this case was based upon a Digital Terrain Model (DTM) of 5 m resolution.

Theoretical Scenario

14.6.3 Calculations were undertaken for predicted shadow hours at each of the receptors for two scenarios: a theoretical (worst-case) and a realistic scenario. For the worst-case scenario the following assumptions were made:

- all receptors have a 1 m x 1 m window facing directly towards the turbine;
- the turbine blades were assumed to be rotating for 365 days per year;
- there is a clear sky 365 days per year;
- the turbine blades were assumed to always be positioned towards each receptor;
- more than 20 % of the sun is covered by the blade; (in practice, at a distance, the blades do not cover the sun but only partly mask it, substantially weakening the shadow);
- the receptor is occupied at all times; and
- no screening is present.

14.6.4 The effect of shadow flicker was not calculated where the sun lies less than 3 degrees above the horizon due to atmospheric diffusion, low radiation (intensity of the sun's rays is reduced) and high probability of natural screening. It is generally accepted that below 3 degrees shadow flicker is unlikely to occur to any significant extent (Nordhein-Westfalen, 2002).

14.6.5 These assumptions result in a highly conservative assessment for the following reasons:

- the receptor may not directly face the turbines;
- the turbine blades will not turn for 365 days of the year, and will turn to face into the direction of the wind, in order to maximise the energy generating potential from the wind, and therefore will not always face the receptor;
- it is unlikely that there will be clear skies 365 days a year;
- the receptor may not be occupied at the time that the shadow flicker impact is experienced; and
- screening, such as vegetation including the surrounding forestry, or curtains/blinds between the window and the turbine, is not accounted for within the and model and, in practice, such screening will prevent any shadows from being cast onto the window and therefore prevent any flickering effect.

14.6.6 In addition, the distance between the turbine and a window has an impact on the intensity of any shadow flicker that is experienced. The Study Area has been set at 10 rotor diameters as the effects of shadow flicker are shown to be greatly reduced outside this distance.

14.6.7 The assessment carried out is limited to the effects of shadows within buildings. Moving shadows will also be apparent out of doors; however, these do not result in flicker in the same manner or to the same extent, as the light entering windows. Therefore, shadow flicker effects outdoors have been scoped out of further assessment.

14.6.8 The modelling results for the theoretical scenario are typically considered to be a theoretical worst-case estimation of the actual impacts experienced, which would not arise in practice given the assumptions listed above.

Realistic Scenario

14.6.9 For much of the year weather conditions will be such that shadows will not be cast or will be weak and would therefore not give rise to shadow flicker effects. WindPro calculations most likely overestimate the duration of effects as outlined in the theoretical scenario. Other factors such as the potential for screening by vegetation or structures will also reduce or prevent flicker incidence

in practice. To create a more realistic scenario for the potential impact of shadow flicker on receptors, it was necessary to identify the expected meteorological conditions at the site and take into account any significant shielding of receptors by buildings and vegetation between the receptor and the turbines.

14.6.10 In order to estimate the impact of cloud cover, information available from the Met Office (2024) was used to consider the likelihood of sunshine at different times of the year, and therefore allow calculations of the 'expected' values for shadow flicker occurrence. As part of the WindPro calculation it is possible to upload data from a nearby climatic station to the Proposed Development. In the case of the Proposed Development this is Prestwick Airport weather station, located approximately 31 km south-west of the site. Prestwick Airport was selected as it was the nearest weather station to the Proposed Development that had long-term data for both sunshine hours and wind.

14.6.11 The realistic scenario represents a long-term average as it is based on long-term historic metrological data. The variation between individual years can be significant and may lead to future observations differing from the predicted results.

14.6.12 A 16-degree sector wind rose was calculated for 7,446 hours of wind (assuming the Proposed Development is operational for 85 % of the year) based on RenSMART data. The data was from Prestwick Airport weather station over the period 2000-2010 (ten years).

14.6.13 The WindPro model also employs a slightly simplistic assumption that sunshine probability and turbine operational probability are independent parameters. The model is therefore expected to yield slighting higher results; as there is a degree of correlation between bright and sunny weather conditions and low wind speeds.

14.6.14 There are a number of assumptions which remain in the realistic scenario model which lead to the model still predicting higher levels of shadow flicker than are likely to be experienced. These assumptions are;

- all receptors have a 1 m x 1 m window facing directly towards the turbine;
- the receptor is occupied at all times; and
- no screening is present.

14.7 Limitations to Assessment

14.7.1 All assumptions made by the WindPro 4.1 model are noted above.

14.7.2 Given the absence of UK guidance on shadow flicker, the assessment has adopted the generally accepted industry practised limit of 30 hours per year or 30 minutes per day on the worst affected day, whichever is the greatest for permanent dwellings within 10 rotor diameters of the proposed turbines.

14.7.3 The realistic scenario results represent an average as they are based on historic meteorological data from Prestwick Airport (2000-2010 for wind and 1991-2020 for sunshine). The variation between individual years can be significant and may lead to future observations differing from the predicted results.

14.7.4 As noted above, the historic meteorological data was also taken from Prestwick Airport weather station and is not site-specific. Prestwick Airport weather station is situated approximately 31 km south-west of the site and there may be slight variations in using the historical data.

14.8 Baseline Conditions

14.8.1 26 receptors have been identified within the Study Area with the potential to experience shadow flicker (refer to **Figure 14.1** and **Table 14.2**).

14.8.2 For the purpose of the assessment, it is assumed that the properties face the Proposed Development and no local screening (vegetation and blinds/curtains) are considered.

14.8.3 Within this assessment the sensitivity of receptors is assumed to be high in all cases.

14.9 Potential Effects

Construction

14.9.1 No shadow flicker will occur during construction of the Proposed Development.

14.9.2 Given that any occurrence of shadow flicker during the short commissioning period would replicate itself during operation of the Proposed Development, albeit more frequently, it is considered appropriate to consider the commissioning activities as part of the operational stage of the Proposed Development.

Operation

Theoretical Modelling of Shadow Flicker Occurrence

14.9.3 The modelling results presented in **Table 14.3** below represent the theoretical worst-case scenario discussed in the previous section. The theoretical duration of shadow flicker calculated is indicated to be potentially significant at three receptors (greater than 30 hours per year or 30 mins per day). It should be noted that this is the theoretical modelling and in reality the duration of shadow flicker at each location is likely to be considerably less than that indicated below for the reasons outlined in **Section 14.6** above.

Table 14.3 - Worst-Case Scenario Shadow Flicker Occurrence at Each Receptor

ID	Property	Shadow Flicker Hours per Year	Shadow Flicker Minutes on Worst Day	Significance
A-T	Hamilton Drive	23:23	26	Not Significant
U	Dungavel House Immigration Removal Centre	29:51	29	Not Significant
V	Ceil Mill Cottage	9:10	24	Not Significant
W	Templelands Cottage	29:27	**33**	**Significant**
X	Laigh Plewland Farm	**44:18**	27	**Significant**
Y	Glengavel House*	**133:02**	**75**	**Significant**
Z	High Plewlands Farm	**54:15**	**36**	**Significant**

**Property with financial involvement in the Proposed Development*

Realistic Modelling of Shadow Flicker Occurrence

14.9.4 The modelling results presented in **Table 14.4**, **Appendix 14.2** and **Figure 14.2** represent the realistic scenario. The inclusion of indicative wind data and average sunshine hours into the shadow flicker calculations has greatly reduced the potential of shadow flicker occurrence at all of the receptors.

14.9.5 The model still does not take into consideration any local screening from vegetation, blinds or curtains, or true window orientation relative to the turbines, which in reality will further reduce the potential time receptors are likely to experience shadow flicker over the course of the year. This model also still assumes that all receptors windows face towards the wind turbines and that receptors are occupied at all times of the day that shadow flicker is predicted.

14.9.6 The realistic scenario model does indicate potential for shadow flicker to occur for at least short periods at all receptors. The realistic duration of shadow flicker calculated is indicated to be at non-significant levels at all receptors, with a duration less than 30 hours per year or 30 mins per day.

Table 14.4 - Realistic-Case Scenario Shadow Flicker Occurrence at Each Receptor

ID	Property	Shadow Flicker Hours per Year	Shadow Flicker Minutes on Worst Day	Significance
A-T	Hamilton Drive	2:01	2	Not Significant
U	Dungavel House Immigration Removal Centre	2:36	2	Not Significant
V	Ceil Mill Cottage	1:31	5	Not Significant
W	Templelands Cottage	5:06	7	Not Significant
X	Laigh Plewland Farm	8:28	5	Not Significant
Y	Glengavel House*	21:34	14	Not Significant
Z	High Plewlands Farm	10:46	7	Not Significant

**Property with financial involvement in the Proposed Development*

14.9.7 It is important to stress the theoretical and conservative nature of the model, and the absence of any consideration of screening in the model. For these reasons it is unlikely the number of hours predicted in the 'realistic' scenario would actually occur at the sensitive receptors. In reality, the expected total shadow hours will be less than modelled. Notwithstanding these points and the financial involvement of one receptor as noted above, the Applicant is committed to providing a Shadow Flicker Mitigation Protocol to be engaged should any concerns in relation to shadow flicker effects be raised and shadow flicker subsequently be found to be causing nuisance in certain atmospheric conditions.

14.9.8 Graphs A to Z within **Appendix 14.2** summarise the modelled occurrence of shadow flicker at the identified receptors, and illustrate the times of year and times of day when shadow flicker could theoretically occur and by which turbine.

Decommissioning

14.9.9 Given that any occurrence of shadow flicker during the short decommissioning period would replicate that which would occur during operation of the Proposed Development, it is considered appropriate to consider the decommissioning activities as part of the operational stage of the Proposed Development.

14.9.10 No shadow flicker impact can occur post-decommissioning of the Proposed Development.

14.10 Cumulative Assessment

14.10.1 In order to assess the potential for cumulative impact from other wind developments in the surrounding area, any turbines within 3.3 km of the Proposed Development turbine locations were reviewed. Shadow flicker impacts are considered to extend to 10 rotor diameters from turbine locations, therefore a 3.3 km search area for cumulative developments considers any potential for overlap between the Proposed Development Study Area and a cumulative development with at least an equivalent rotor diameter (refer to **Figure 14.3**).

14.10.2 There are two developments located within 3.3 km of the Proposed Development turbine locations that have a shadow flicker study area that overlaps with, or is within very close proximity to, identified shadow flicker receptors for the Proposed Development. Shadow flicker study areas were calculated for the developments shown in **Table 14.5** based on the dimensions and locations detailed within the respective planning applications. These are shown on **Figure 14.3** and are: Hallsburn Farm which lies to the north-west of the Proposed Development; and Mill Rig Wind Farm which lies to the west of the Proposed Development.

Table 14.5 – Cumulative Developments

Cumulative Development	Number of Turbines	Max Rotor Diameter (m)	Status
Hallsburn Farm	3	126	Consented
Mill Rig	6	165	Consented

14.10.3 Receptors A to U and W lie within the area of overlap between the Study Areas of the Proposed Development and Hallsburn Farm. Receptor X lies within the area of overlap between the Study Areas of the Proposed Development and Mill Rig Wind Farm. As such, a cumulative shadow flicker assessment was undertaken.

14.10.4 Receptor V has also been included in this assessment due to cumulative effects found in the model output. In addition, Receptors V, W and X have been assumed to have windows perpendicular to all turbines for the cumulative assessment due to their position with the Proposed Development and Hallsburn Farm to the east, and Mill Rig to the west. This is because if the assumption that the receptor is facing the Proposed Development is used in the cumulative assessment, shadow flicker effects from cumulative turbines would not be considered in the model if they are not in the same direction.

14.10.5 **Table 14.6** details the expected total realistic hours of shadow flicker per year on these receptors as a result of the three developments being operational.

Table 14.6 – Cumulative Shadow Hours (Realistic Scenario) at Receptors

ID	Property	Shadow Flicker Hours per Year	Shadow Flicker Minutes on Worst Day	Significance
A-T	Hamilton Drive	11:16	10	Not Significant
U	Dungavel House Immigration Removal Centre	13:16	8	Not Significant
V	Ceil Mill Cottage	7:37	5	Not Significant
W	Templelands Cottage	8:55	7	Not Significant
X	Laigh Plewland Farm	10:08	6	Not Significant

14.10.6 The total number of cumulative shadow hours per year is indicated to be not significant levels at all receptor locations (refer to **Figure 14.4**). This total figure is likely to be conservative for the reasons noted in **Paragraph 14.6.5**.

14.10.7 It is noted that the predicted shadow flicker hours attributable to the Proposed Development are very low (all less than 2:36 and mostly less than 2:00) at Receptors A to U. It is therefore evident that the majority of flicker hours contributing to the cumulative total at these receptors are expected to arise from the other consented developments.

14.11 Mitigation

Construction

14.11.1 No mitigation measures are required during the construction phase of the Proposed Development.

Operation

14.11.2 Although the realistic scenario takes into consideration expected operational time for the turbines and average sunshine hours for the region, the results are likely to still be conservative due to local vegetation, dwelling orientation and internal screening from blinds, curtains or furniture that are not included in the model. Additionally, while shadow flicker may potentially occur at these locations it is possible that flicker will not be 'experienced' at all locations due to the time of day during which it may potentially occur and use of the properties.

14.11.3 Nevertheless, in the event of consent being granted, in order to ensure that potential shadow flicker effects do not exceed acceptable limits at any property, the Applicant proposes that prior to the erection of the first turbine a written scheme (known as the 'Wind Farm Shadow Flicker Protocol') will be submitted to and approved in writing by the Local Planning Authority. This will set out mitigation measures to alleviate shadow flicker attributable to the Proposed Development as well as a protocol for addressing a complaint received from a receptor within the Study Area.

14.11.4 Operation of the turbines would be required to take place in accordance with the approved Shadow Flicker Protocol and any mitigation measures that have been agreed through the protocol would require to be implemented as appropriate.

14.11.5 Mitigation measures could include the provision of local screening to reduce or block shadow flicker affecting a receptor. Should screening provision not be possible, the most effective mitigation measure to mitigate shadow flicker is by selective automatic turbine shutdown during the times of year when shadow flicker is predicted if the weather conditions are correct. The relevant technology which will allow for the automatic shutdown of the turbine will be fitted to the Proposed Development turbines and details included within the 'Wind Farm Shadow Flicker Protocol'.

14.11.6 Engagement with the operators of the other cumulative developments is likely to be appropriate in investigating any complaints and identifying the most suitable and effective mitigation measures, given that the majority of potential flicker hours impacting many of the receptors is expected to arise from other developments.

14.11.7 It is proposed that the provision and agreement of a Wind Farm Shadow Flicker Protocol is secured through a condition attached to the permission.

Decommissioning

14.11.8 No mitigation measures are required during the decommissioning phase of the Proposed Development.

14.12 Residual Effects

14.12.1 On the basis that potential shadow flicker effects can be mitigated through matters secured through the agreement of the Wind Farm Shadow Flicker Protocol, no significant residual effects are predicted during the operational, construction or decommissioning phases of the Proposed Development.

14.13 Summary

14.13.1 A shadow flicker assessment was undertaken at 26 identified receptors within the Study Area. Calculations have shown that there are no expected significant effects from shadow flicker at all receptors.

14.13.2 Cumulative assessment identified that 24 receptors are within the relevant cumulative Study Area, with the consented Hallsburn Farm and Mill Rig developments contributing potential shadow flicker cumulatively with the Proposed Development. The assessment indicated no significant cumulative shadow flicker effects at all receptors.

14.13.3 The 'realistic scenario' results are considered to be conservative, as they do not take into account existing screening features, dwelling orientation, local mitigation measures such as blinds or curtains, and actual use of rooms within affected receptor properties. Therefore, the amount of time when shadow flicker is actually 'experienced' will likely be significantly less than what has been predicted.

14.13.4 The Applicant proposes that prior to the erection of the first turbine, a 'Wind Farm Shadow Flicker Protocol' will be submitted to and approved in writing by the Local Planning Authority. This will set out mitigation measures to alleviate shadow flicker attributable to the Proposed Development as well as a protocol for addressing a complaint received from a receptor within the Study Area. Operation of the turbines would be required to take place in accordance with the approved Shadow Flicker Protocol. The residual effect of shadow flicker is, therefore, expected to be not significant for all receptors during the operational phase of the Proposed Development.

Table 14.7 – Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
During Construction & Decommissioning					
No shadow flicker effects during construction or decommissioning.					
During Operation					
Shadow flicker nuisance at all receptors.	Not Significant	Adverse	Shadow Flicker Mitigation Protocol (if required)	Not Significant	Adverse
Cumulative Effects					
Shadow flicker nuisance at receptors A to U, V, W and X.	Not Significant	Adverse	Shadow Flicker Mitigation Protocol (if required)	Not Significant	Adverse

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