# Shadow Flicker Assessment

## Highfield Turbine Repowering

18 September 2024

Revision version 2, 31 January 2024

# Contents

# 1. INTRODUCTION

1.1. This Shadow Flicker Assessment has been produced in in support of a planning application submitted to Copeland Borough Council ("the Council") for the removal of the existing wind turbine and the erection of a single replacement wind turbine up to a maximum of 76m to blade tip height ("the Proposed Development") and revised hardstanding arrangements on land at Highfield Farm, Egremont, Cumbria CA22 2TY ("the Application Site").

1.2. The Proposed Development is centred on National Grid Reference E298945 N512795 at an elevation of approximately 121m AOD.

## THE PROPOSED DEVELOPMENT

1.3. The Proposed Development would consist of a single turbine, with an output capacity matched to the 225kW of the existing maximum grid capacity. Constantine Wind Energy ("the Applicant") proposes to use a Vestas V-52 as the candidate turbine, with the potential to replace with a similar model such as a Vestas V-47 or Enercon E-48, with a maximum tip height of 76m. The Proposed Development will be located at approximate Grid Reference E298945 N512795.

## SITE DESCRIPTION

1.4. The Application Site is located in a rural setting on land approximately 1km west of the edge of Bigrigg. The proposed turbine is planned to utilise the existing infrastructure of the wind turbine site and be sited adjacent to the existing wind turbine.

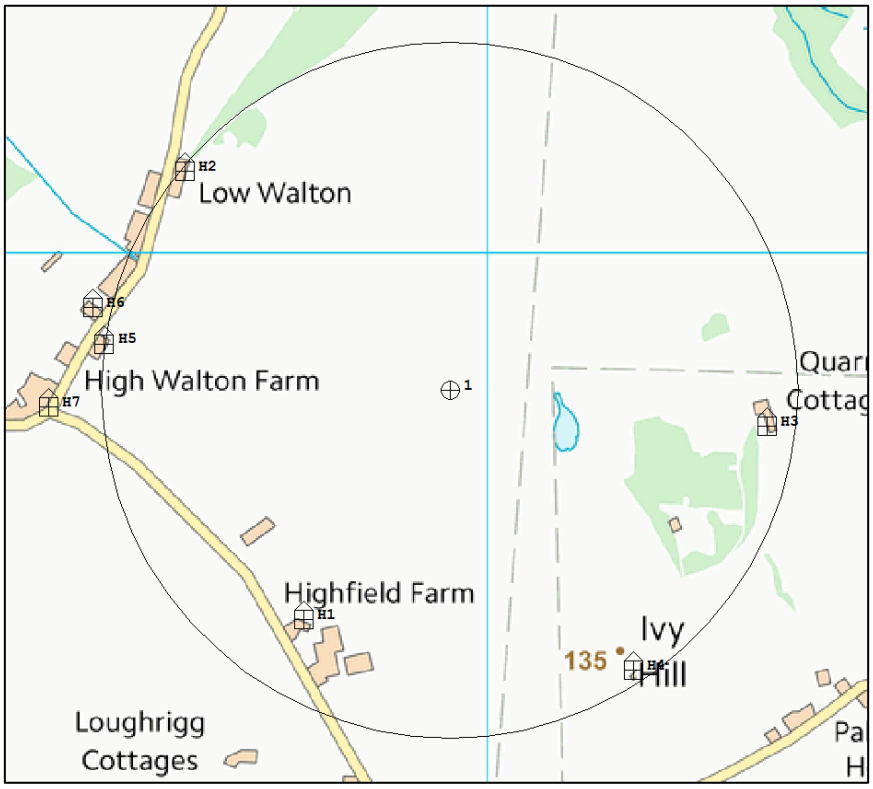
1.5. The existing wind energy site currently comprises one wind turbine which has a hub height of 32m, a rotor diameter of 27m and overall tip height of 45.5m. The turbine has a rated output capacity of 225kW.

1.6. There are three dwellings, or receptors, within 520m (10 times the rotor diameter of the proposed turbine) of the Proposed Development. These are detailed in **Table 1** and **Figure 1** below.

**Table 1: Receptors within 520m**

| ID | Receptor Name | Grid Easting | Grid Northing | Proximity to Turbine (m) | Bearing from Turbine | Financially Involved (Y/N) |
|---|---|---|---|---|---|---|
| **1** | Highfield Farm | 298727 | 512452 | 400 | 212 | Yes |
| **2** | Low Walton | 298549 | 513121 | 510 | 309 | No |
| **3** | Quarry Cottages | 299419 | 512741 | 480 | 96 | No |
| **4** | Wireless Station | 299219 | 512377 | 500 | 327 | No |
| **5** | Coronation Terrace | 298429 | 512864 | 520 | 98 | No |
| **6** | Springbank | 298412 | 512918 | 550 | 103 | No |
| **7** | High Walton | 298345 | 512770 | 600 | 88 | No |

**Figure 1: Application Site and Receptors**



# 2. EXECUTIVE SUMMARY

2.1. The Proposed Development consists of a wind turbine of 50m hub height, a rotor diameter of 52m and a maximum tip height of 76m.

2.2. Within a study area of 520m – equivalent to 10 times the rotor diameter of the proposed turbine – being examined, exist four residential dwellings or receptors. A further three dwellings have been examined just outside of this study area.

2.3. Five receptors are found to have no possibility of receiving shadow flicker effects. Two receptors are found to have a small amount of possible shadow flicker hours per year, which after realistic amendment is found to be de minimis.

2.4. It is recommended that due to the marginal number of hours – well under reference guidelines – no immediate mitigation is conditioned. Instead it is recommended that if a flicker event is evidenced, that the timing of the occurrence be subject to a shadow flicker protocol which ensures that the same time in future years cannot feature a similar event.

# 3. ASSESSMENT CRITERIA

3.1. ‘Shadow Flicker’ is the strobe effect caused when a wind turbine’s rotating blades intermittently cast shadows over enclosed apertures as they turn. This is most prevalent in dwellings with small windows, where the blades can cause a flicking light effect as their shadows momentarily disrupt the emergence of sunlight into an interior.

3.2. The duration, significance, and likelihood of shadow flicker is influenced by a number of factors:

- Sun height and position (and, correspondingly, time of year and day);
- Prevalence of clouds;
- Direction of turbine relative to receptor;
- Distance from turbine to receptor;
- Prevalence of objects between the turbine and receptor which may act as a screen;
- Turbine rotor diameter and height;
- Window size at the receptor;
- Wind speed;
- Wind direction;

3.3. Only properties within 130 degrees either side of north can be affected at UK latitudes and at distance the effects of shadow flicker are reduced – being proven to occur only within ten rotor diameters of the turbine.[1]

3.4. The assessment area for this turbine will reach 10 times the proposed rotor diameter encompassing all the dwellings provided in **Table 1**. For completeness, dwellings outside of 130 degrees either side of north from the turbine will be included for assessment.

3.5. There is no formal threshold defined by local or national Government for the amount of shadow flicker effect that can be considered acceptable. However other European countries

[1] Office of the Deputy Prime Minister, Planning for Renewable Energy A Companion Guide to PPS22 (2004)

do provide guidance and there is a typically agreed limit as practiced by various nearby countries including Northern Ireland. This recommends that shadow flicker effects should not exceed '30 hours per year or 30 minutes per day', quoting a previous survey undertaken by Predac, an organisation sponsored by the European Union to promote best practice. This recommendation will be used as a reference guide ("PPS18").[2]

3.6. Modification of the total theoretical hours of shadow flicker to reach a realistic understanding is important due to the number of limiting factors that can and will occur. Two factors are brought to bear on the theoretical hours:

3.6.1. An industry standard expectation of 95% availability which would allow for spinning;

3.6.2. Average annual sunlight hours in the region of NW England as recorded by the Met Office[3] reveal that the turbine is to be subject to sunlight conditions 1,320 hours per year. Therefore sunlight conditions that would allow for shadow flicker occur take place 30.1% of the time (1,320 / (8760/2).

Adjusted realistic hours of flicker can thus be estimated to be 28.6% of the theoretical maximum (1 * 95% * 30.1%).

[2] Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy' (2009)
[3] https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-and-regional-series

# 4. ASSESSMENT RESULTS

4.1. An assessment of the potential for shadow flicker effects has been carried out in accordance with the above. This assessment has taken a conservative approach, assuming windows facing from the nearest side of the receptor towards the proposed turbine and open ground between turbine and receptor with no screening of the receptor by intermediary objects. Only distance and landform (utilising OS digital terrain model elevation mapping) may screen a receptor.

4.2. Windfarm 4.2.1.7 has been used as the software modelling the results of shadow flicker. The assessment has been carried out utilising the model of a Vestas V-52, with a 50m hub height and 52m rotor diameter. A study area of 520m radius regardless of bearing from turbine has been examined.

4.3. **Table 2** provides the summary of modelled, theoretical maximum shadow flicker effects at each property, in decimalised time where 0.5 hours = 30 minutes.

**Table 2: Shadow Flicker Assessment, Theoretical Maximum Results**

| ID | Receptor Name | Number of Days in a Year with Flicker Event (Days) | Longest time of any one Flicker Event in the Year (Hours) | Average Event Length on any one Day (Hours) | Theoretical Sum of all Hours of Flicker Events in one Year (Hours) | Months in Year with Shadow Flicker Events |
|---|---|---|---|---|---|---|
| **1** | Highfield Farm | n/a | n/a | n/a | n/a | n/a |
| **2** | Low Walton | n/a | n/a | n/a | n/a | n/a |
| **3** | Quarry Cottages | 14 | 0.3 | 0.2 | 2.7 | Apr, Aug |
| **4** | Wireless Station | n/a | n/a | n/a | n/a | n/a |
| **5** | Coronation Terrace | 26 | 0.42 | 0.36 | 9.25 | Apr, Sep |
| **6** | Springbank | n/a | n/a | n/a | n/a | n/a |
| **7** | High Walton | n/a | n/a | n/a | n/a | n/a |

4.4. **Table 3** provides the summary of realistic shadow flicker effects at each property, in decimalised time where 0.5 hours = 30 minutes.

**Table 3: Shadow Flicker Assessment, Adjusted Results**

| ID | Receptor Name | Adjusted Sum of all Hours of Flicker Events in one Year (Hours) |
|---|---|---|
| **1** | Highfield Farm | n/a |
| **2** | Low Walton | n/a |
| **3** | Quarry Cottages | 0.8 |
| **4** | Wireless Station | n/a |
| **5** | Coronation Terrace | 2.64 |
| **6** | Springbank | n/a |
| **7** | High Walton | n/a |

4.5. The one property with possible times of shadow flicker is Quarry Cottages, with a theoretical maximum of 14 days of effect, within which the maximum length of one event is under 19 minutes **(see Part 7: Appendix – Data)** and the average is 11 minutes. A more realistic, adjusted view takes the total number of shadow flicker hours per year to 0.8. Each of these calculated potentials is well below the recommended reference guidelines in PPS18.

# 5. MITIGATION

5.1. In accordance with PPS18, the two properties with potential for shadow flicker sit well under the acceptable guideline annual threshold to flicker effects upon dwellings.

5.2. As a consequence of the extremely minor hours of potential impact it is recommended that no mitigation measures be taken.

5.3. If shadow flicker were to occur, there are several forms of mitigation available, including:

5.3.1. Control at Receptor: The provision of blinds, shutters or curtains to affected properties;

5.3.2. Control on Pathway: Screening planting close to an affected property; and

5.3.3. Control at Source: Shutdown of the turbine at times when effects occur.

5.4. It is recommended that in the event of a shadow flicker occurrence, a shadow flicker protocol be agreed in order to remove the possibility of future occurrences at the same time that flicker was previously evidenced.

# 6. CONCLUSION

6.1. Of seven receptors assessed within proximity of the turbine of the Proposed Development, two are predicted to be affected by shadow flicker with a combined adjusted number of shadow flicker hours per year between them under 4.

6.2. It is recommended that no mitigation is required as the hours of impact, length of individual events, and chance of real events are minor and under reference guideline thresholds, but that a condition is set wherein in the event of a flicker event, the Applicant ensure that no such event can occur in the same period in future years.

# 7. APPENDIX – DATA

| Turbine | Easting | Northing | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 298945 | 512795 | | | | | |
| | | | | | | | |
| **House** | **Easting** | **Northing** | **Date** | **Start Time** | **End Time** | **Duration** | **% Cover** |
| 1 | 298727 | 512452 | n/a | n/a | n/a | 0 | n/a |
| 2 | 298549 | 513121 | n/a | n/a | n/a | 0 | n/a |
| 3 | 299419 | 512741 | 20-Apr | 18:26:17 | 18:28:20 | 00:02:04 | 100 |
| 3 | 299419 | 512741 | 21-Apr | 18:19:21 | 18:27:27 | 00:08:07 | 100 |
| 3 | 299419 | 512741 | 22-Apr | 18:12:52 | 18:26:22 | 00:13:30 | 100 |
| 3 | 299419 | 512741 | 23-Apr | 18:06:49 | 18:25:07 | 00:18:18 | 100 |
| 3 | 299419 | 512741 | 24-Apr | 18:06:32 | 18:23:32 | 00:17:00 | 100 |
| 3 | 299419 | 512741 | 25-Apr | 18:08:29 | 18:21:29 | 00:12:59 | 86.53 |
| 3 | 299419 | 512741 | 26-Apr | 18:10:22 | 18:18:16 | 00:07:55 | 26.33 |
| 3 | 299419 | 512741 | 16-Aug | 18:17:22 | 18:24:18 | 00:06:56 | 19.93 |
| 3 | 299419 | 512741 | 17-Aug | 18:14:56 | 18:27:21 | 00:12:25 | 78.91 |
| 3 | 299419 | 512741 | 18-Aug | 18:12:32 | 18:29:05 | 00:16:33 | 100 |
| 3 | 299419 | 512741 | 19-Aug | 18:11:20 | 18:30:16 | 00:18:56 | 100 |
| 3 | 299419 | 512741 | 20-Aug | 18:16:48 | 18:31:07 | 00:14:20 | 100 |
| 3 | 299419 | 512741 | 21-Aug | 18:22:39 | 18:31:48 | 00:09:09 | 100 |
| 3 | 299419 | 512741 | 22-Aug | 18:28:55 | 18:32:15 | 00:03:20 | 100 |
| 4 | 299219 | 512377 | n/a | n/a | n/a | 00:00:00 | n/a |
| 5 | 298429 | 512864 | 27-Mar | 06:58:03 | 07:19:31 | 00:21:28 | 100 |
| 5 | 298429 | 512864 | 28-Mar | 06:56:55 | 07:20:05 | 00:23:09 | 100 |
| 5 | 298429 | 512864 | 29-Mar | 06:56:04 | 07:20:21 | 00:24:18 | 100 |
| 5 | 298429 | 512864 | 30-Mar | 06:55:25 | 07:20:25 | 00:24:59 | 100 |
| 5 | 298429 | 512864 | 31-Mar | 06:54:59 | 07:20:15 | 00:25:16 | 100 |
| 5 | 298429 | 512864 | 01-Apr | 06:54:45 | 07:19:54 | 00:25:10 | 100 |
| 5 | 298429 | 512864 | 02-Apr | 06:54:42 | 07:19:22 | 00:24:39 | 100 |
| 5 | 298429 | 512864 | 03-Apr | 06:54:53 | 07:18:37 | 00:23:44 | 100 |
| 5 | 298429 | 512864 | 04-Apr | 06:55:17 | 07:17:38 | 00:22:21 | 100 |
| 5 | 298429 | 512864 | 05-Apr | 06:55:59 | 07:16:22 | 00:20:23 | 100 |
| 5 | 298429 | 512864 | 06-Apr | 06:57:03 | 07:14:45 | 00:17:42 | 100 |
| 5 | 298429 | 512864 | 07-Apr | 06:58:44 | 07:12:33 | 00:13:49 | 91.17 |
| 5 | 298429 | 512864 | 08-Apr | 07:02:04 | 07:08:53 | 00:06:50 | 20.85 |
| 5 | 298429 | 512864 | 05-Sep | 06:56:12 | 07:08:22 | 00:12:10 | 68.56 |
| 5 | 298429 | 512864 | 06-Sep | 06:53:37 | 07:10:12 | 00:16:35 | 100 |
| 5 | 298429 | 512864 | 07-Sep | 06:51:46 | 07:11:20 | 00:19:34 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 298429 | 512864 | 08-Sep | 06:50:20 | 07:12:04 | 00:21:43 | 100 |
| 5 | 298429 | 512864 | 09-Sep | 06:49:12 | 07:12:29 | 00:23:17 | 100 |
| 5 | 298429 | 512864 | 10-Sep | 06:48:18 | 07:12:40 | 00:24:22 | 100 |
| 5 | 298429 | 512864 | 11-Sep | 06:47:37 | 07:12:38 | 00:25:01 | 100 |
| 5 | 298429 | 512864 | 12-Sep | 06:47:07 | 07:12:25 | 00:25:17 | 100 |
| 5 | 298429 | 512864 | 13-Sep | 06:46:49 | 07:11:59 | 00:25:11 | 100 |
| 5 | 298429 | 512864 | 14-Sep | 06:46:42 | 07:11:23 | 00:24:41 | 100 |
| 5 | 298429 | 512864 | 15-Sep | 06:46:48 | 07:10:34 | 00:23:46 | 100 |
| 5 | 298429 | 512864 | 16-Sep | 06:47:07 | 07:09:30 | 00:22:23 | 100 |
| 5 | 298429 | 512864 | 17-Sep | 06:47:44 | 07:04:43 | 00:16:59 | 100 |
| 6 | 298412 | 512918 | n/a | n/a | n/a | 00:00:00 | n/a |
| 7 | 298345 | 512770 | n/a | n/a | n/a | 00:00:00 | n/a |