Galileo 03 Ltd.

Mynydd Ty-talwyn Energy Park - Environmental Statement Volume III

Appendix 4.7: Shadow Flicker Impact Assessment

Project Reference: 663870

APRIL 2026

PAGERPOWER
Urban & Renewables

Shadow Flicker Impact Assessment

Mynydd Ty-talwyn Energy Park

Galileo 03 Limited

April 2026





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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	March 2025	Initial issue
2	March 2025	Assessment considering weather data and administrative revisions
3	October 2025	Updated layout and administrative revisions
4	November 2025	Final for submission
5	April 2026	Updated layout plan (change to ecological mitigation only)

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been commissioned to assess the potential shadow flicker impact of a wind turbine development, located in Bridgend County Borough and Neath Port Talbot, south Wales, upon residential amenity in the surrounding area.

Assessment Methodology

All assessed dwelling receptors[1] are within 3 km of a turbine. The model has assumed that each dwelling receptor has a single window with a size of 1 metre by 1 metre with a centre that is 1.5 metres above ground directed towards the closest turbine. A minimum Sun elevation of 2 degrees has been considered. All results are with respect to the threshold limits of 30 minutes per day and/or 30 hours per year (Section 4.2 for further details).

Shadow flicker effects can occur only on clear sunny days. Additionally, other factors could also diminish effects, including:

- Visibility from the receptor;
- Window position;
- Cloud cover;
- Varying wind direction; and
- Low wind speed – which could result in the turbine not operating for a period of time.

Overall Conclusions

- In total, 28 dwellings would experience shadow flicker effects for more than the threshold limits of 30 minutes per day and/or 30 hours per year as per an initial worst-case assessment;
- When considering a realistic weather scenario and proportion of sunlight to daylight hours, four dwellings would experience shadow flicker effects for more than the threshold limit of 30 hours per year. Therefore, a potential significant shadow flicker impact is predicted pre-mitigation;
- The dates and times of when shadow flicker occurs for each dwelling initially exceeding the threshold limits are presented in Section 4.

[1] Source: RSK, January 2025

Mitigation

It is envisaged that a Shadow Flicker mitigation protocol will be conditioned as part of any forthcoming permission, detailing stepped procedures in the event of shadow flicker occurrence at a property. In the event of a substantiated complaint from residents of impacted dwellings, should screening mitigation not be deemed appropriate in the first instance, mitigation in the form of a shutdown scheme to mitigate all impacts to below the threshold limits can be implemented. With this measure in place, no significant shadow flicker effects would arise from the Proposed Development.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 63 countries internationally.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems.

Pager Power have expanded into numerous fields including:

- Renewable energy projects;
- Building developments;
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been commissioned to assess the potential shadow flicker impact of a wind turbine development, located in Bridgend County Borough and Neath Port Talbot, south Wales, upon residential amenity in the surrounding area.

This report contains the following:

- Proposed wind development details;
- Details of technical analysis;
- Shadow flicker explanation;
- Receptor details;
- Assessment of receptors;
- Shadow Flicker Hours Chart (per receptor);
- Assessment of hours per year/day.

Following this, a summary of findings and overall conclusions and recommendations from the desk-based analysis is presented. No site survey has taken place at this stage.

A Scoping Direction was received by PEDW, as provided at **Environmental Statement (ES) Volume III, Appendix 1.2: Scoping Direction**. The following comments were made in relation to the shadow flicker assessment, Table 1 details how these comments have been addressed.

Scoping Direction	Response
Shadow Flicker: PEDW notes that in 'Review of Light and Shadow Effects from Wind Turbines in Scotland' (L.U.C. for climateXchange, 2017) it was found that "there is a lack of evidence to support the use of ten rotor diameters as a cut off, and this is entirely down to misinterpretation of the original reference to this distance." The ES should provide a clear rationale as to the methodology adopted, and why it is considered appropriate given the scale of turbines proposed and the requirement for more nuanced assessment suggested by the concerns raised in the above document.	As detailed in Table 2 below, there is no specific Welsh guidance relating to the study area for a shadow flicker assessment, however, it is generally accepted in the industry, and referenced within Scottish guidance, that effects could occur up to 10 rotor diameters distance from the proposed wind turbines. However, given the concerns raised by PEDW, the study area has been increased to a 3 km radius (c.18 rotor diameters) to ensure a conservative approach to the assessment has been taken.

NPTCBC and BCBC state that inadequate information has been provided at this stage to justify shadow flicker being scoped out. Whilst the methodology for assessing receptors to be impacted is acknowledged, the results of this assessment would be required in order to determine whether it is appropriate to scope out this matter. BCBC also disagree with the proposed approach to limit shadow flicker impact as set out in the SR (a maximum of 30 hours per year and not exceeding 30 mins per day). **PEDW concurs with comments from the LPAs and advises that shadow flicker is scoped in to the ES.** A full assessment on receptors including residential dwellings, highways, PRoWs etc. should be undertaken to determine the impact on receptors, and the results used to inform the design and, if necessary, any mitigation measures. The applicant should consult with LPAs on the receptors to be included in the shadow flicker assessment. The applicant should note the comments regarding Shadow Flicker assessment in Section 5 of this Direction. The ES should provide a robust rationale for the methodology adopted.	A full shadow flicker assessment has been undertaken on residential dwellings.. Shadow flicker only occurs inside buildings where the flicker appears through a narrow window opening, and therefore highways and PRoWs have not been included as receptors within the assessment. As detailed within Section 3.3 below, there is no formal guidance on the limit of shadow flicker that is considered acceptable within the UK. Thus, limits used in other countries (30 minutes per day or 30 hours per year) are used as a guide. Consultation was undertaken with PEDW for an alternative wind farm development, to determine if there was an alternative criteria that PEDW wish to be used, specifically to the assessment area of 10-rotor diameters. PEDW confirmed '*the assessment area should be determined on a case-by-case basis with the site context informing the assessment*'. As such, the assessment had considered a study area of 3 km from each turbine (greater than 10-rotor diameters). Based on the use of these limits as a guide, no significant effects have been concluded and therefore an ES Chapter is considered not to be required. Irrespective of the above, planning conditions can be imposed to ensure that any level of shadow flicker deemed to be a nuisance can be corroborated and effectively mitigated.

Table 1 *Scoping direction and response*

2 DEVELOPMENT AND RECEPTOR DETAILS

2.1 Development Layout

The Site layout[2] is shown in **Figure 1** below. The locations of the wind turbines are indicated by blue circles.

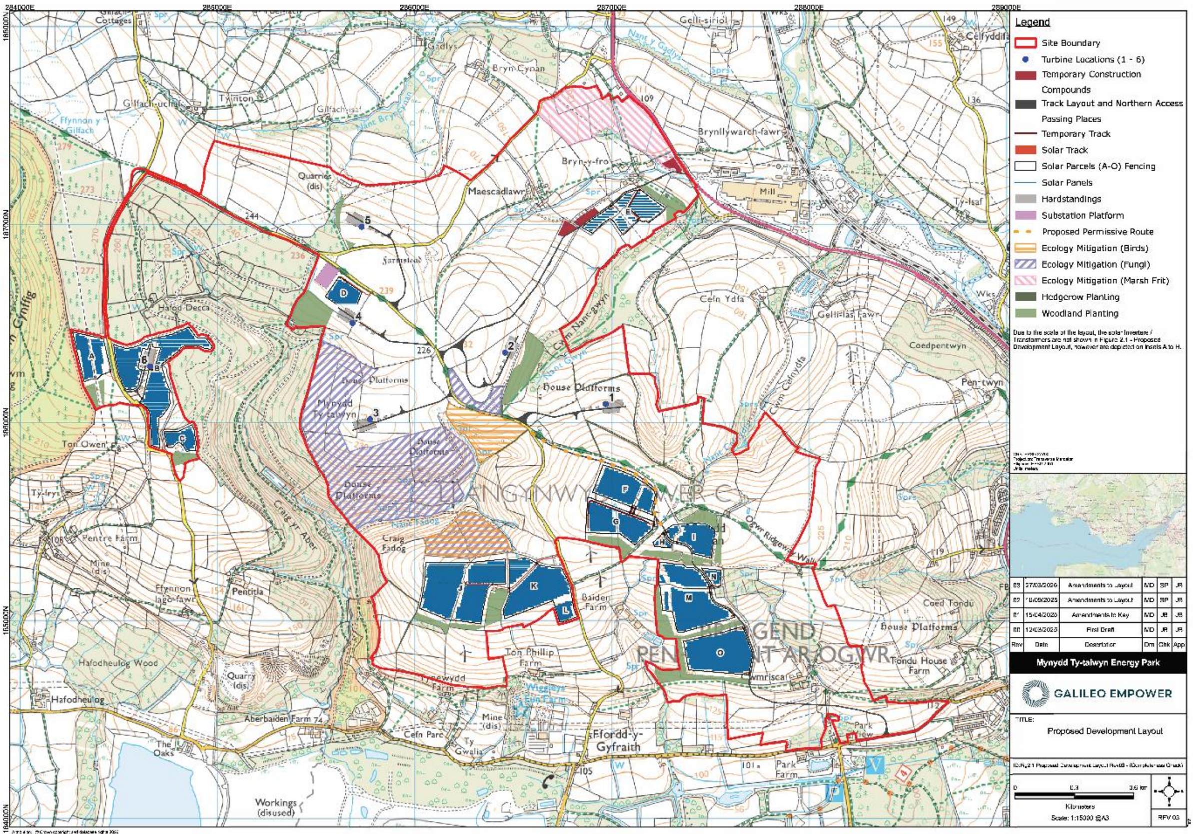

Figure 1 *Site layout*

The turbines have been modelled with the following specifications:

- 119 m hub height;
- 200 m tip height;
- 162 m rotor diameter.

Full coordinates of the modelled turbines are presented in Annex A.

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[2] Source: RSK, September 2025, 'Fig2.1 Proposed Development Layout (Post PAC Changes) rev1'

2.2 Dwelling Receptors

Dwelling receptors have been identified[3] within 3 km[4] of each turbine location. A total of 469 dwelling receptors have been assessed, the details of which are presented in Annex A. In some cases, a single receptor has been used to model a group of dwellings as a representative receptor, modelled at the outer edge of the group. This has adopted to consider all dwellings within the 3 km assessment area, due to these properties being beyond the industry-standard study area of 10 rotor diameters (in accordance with the guidance outlined in Section 3.2). These dwellings have been included as part of a conservative assessment. **Figure 2** below shows the dwelling receptors (yellow house icons) relative to the turbine locations (white icons).

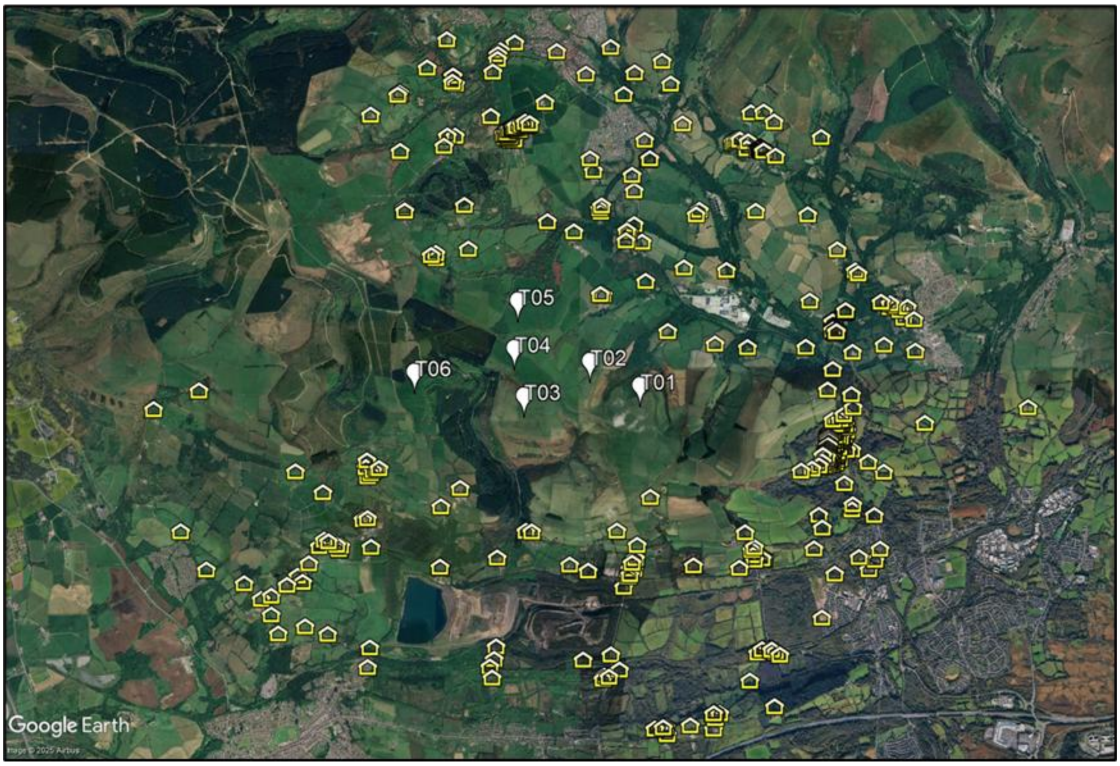


Figure 2 *Dwelling receptors relative to turbines*

[3] Source: RSK, January 2025

[4] The study area had been informed from the Scoping Response and is conservatively larger than the standard practice of 10 rotor diameters.

3 SHADOW FLICKER

3.1 Overview

Rotating wind turbine blades can cause brightness levels to vary periodically at locations where they obstruct the Sun's rays. This can result in a nuisance when the shadow is cast over the windows of residential properties. This intermittent shadow is described by the term 'shadow flicker' and it can be a cause of annoyance at residences near onshore wind turbines if it occurs for a significant period of time during the year[5].

3.2 Guidance Overview

There are various sources of guidance with regard to shadow flicker impacts caused by wind turbines. The most relevant extracts have been presented and summarised[6] in Table 2 on the following page. It is noted that guidance and standards referred to are published for use in countries outside Wales, and are considered as basis for industry best practice. In the absence of specific Welsh planning advice for shadow flicker, they are considered to be a reasonable basis for informing this assessment.

[5] No significant negative health effects are anticipated. See Table 1.

[6] The material regarding shadow flicker is quite extensive and not all aspects have been summarised here.

Source	Extract	Remarks
Scottish Government Onshore wind turbines: Planning Advice	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. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the potential site. Where this could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem. However, there is scope to vary the layout/reduce the height of turbines in extreme cases.	This has been considered for technical context and accepted by the industry in the absence of Welsh guidance.
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	This report presents an update of the evidence base which has been produced by carrying out a thorough review of international guidance on shadow flicker, an academic literature review and by investigating current assessment methodologies employed by developers and case study evidence. Consultation (by means of a questionnaire) was carried out with stakeholders in the UK onshore wind farm industry including developers, consultants and Local Planning Authorities (LPAs). This exercise was used to gauge their opinion and operational experience with shadow flicker, current guidance and the mitigation strategies that can and have been implemented.	The report was read and understood by Pager Power and provides context for flicker reports.
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	The three key computer models used by the industry are WindPro, WindFarm and Windfarmer. It has been shown that the outputs of these packages do not have significant differences between them. All computer model assessment methods use a “worst case scenario” approach and don’t consider “realistic” factors such as wind speed and cloud cover which can reduce the duration of the shadow flicker impact.	Pager Power uses WindFarm software for its analysis.

Source	Extract	Remarks
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	Mitigation measures which have been employed to operational wind farms such as turbine shut down strategies, have proved very successful, to the extent that shadow flicker cannot be considered to be a major issue in the UK	-
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	Companion Guide to PPS22 makes the following statements: • Shadow flicker only occurs inside buildings where the flicker appears through a narrow window opening; • Only properties within 130 degrees either side of north of the turbines can be affected at UK latitudes; Shadow flicker has been proven to occur only within ten rotor diameters of a turbine position.	Note that this guidance relates to England and was officially withdrawn as of March 2014 however the technical context pertaining to shadow flicker is still relevant for the purpose of this report.
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	On health: *'On health effects and nuisance of the shadow flicker effect, it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health. Mitigation measures which have been employed to operational wind farms such as turbine shut down strategies, have proved very successful, to the extent that shadow flicker can not be considered to be a major issue in the UK.'*	-

Source	Extract	Remarks
Parsons Brinckerhoff, 2011 – *Update of UK Shadow Flicker Evidence Base*	[Onshore Wind Energy Planning Conditions Guidance Note, Renewables Advisory Board and BERR (2007)] states that only dwellings within 130 degrees either side of north relative to a turbine can be affected and the shadow can be experienced only within 10 rotor diameters of the wind farm.	Secondary source presented within the Parson Brinckerhoff report.
Department for Communities & Local Government (July 2013): Planning practice guidance for renewable and low carbon energy.	Under certain combinations of geographical position and time of day, the Sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the impact is known as 'shadow flicker'. Only properties within 130 degrees either side of north, relative to the turbines.	This document relates to England and replaced 'Planning for renewable energy: a companion guide to PPS22'..

Source	Extract	Remarks
Department of Environment Northern Ireland (2009) Best Practice Guidance for Planning Policy Statement 18 (PPS18)	It is stated that 'shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day'	This has been considered in determining the threshold limits further discussed in Section 3.3.

Table 2 *Summary of guidance pertaining to shadow flicker*

3.3 Acceptable Limits

There is no formal limit on the amount of shadow flicker that is considered acceptable within the UK. Potentially significant effects are based on the available guidance, and other features of the modelling are highly conservative[7] as set out in Table 2. The results and conclusions made within this assessment consider the threshold limits of **30 minutes per day or 30 hours per year**.

Other European countries do have limits, and these vary from one country to another[8]. A typical limit, which has been utilised in Northern Ireland, Germany and Belgium, is 30 hours per year with a maximum of 30 minutes per day. Since there is no formal guidance on this subject in the UK, the discussion of the results relative to these limits is for reference purposes only.

If shadow flicker effects are predicted beyond this limit, mitigation may be required to eradicate the occurrence of shadow flicker. This is typically controlled by remote automatic wind turbine shutdown so that, in effect, no neighbouring property will experience the occurrence of shadow flicker beyond the limits specified above. There are there two approaches to mitigation:

- Complete removal of effects;
- Reduction of any effects to the acceptable limit specified above.

Shadow flicker effects can only occur under specific conditions so, in reality, turbine shutdown may not be required to eliminate effects i.e. shadow flicker cannot occur if the weather at the time of predicted effects is not clear and sunny or if the rotor is not face on to the receptor.

[7] For example the assumption that all properties have a single window facing the nearest wind turbine and ignoring potential cloud cover or low wind speeds that could reduce the effects.

[8] Parsons Brinckerhoff (2011): *Update of UK Shadow Flicker Evidence Base*.

4 TECHNICAL ASSESSMENT

4.1 Overview

The following sections present an overview of the methodology, assumptions and modelling results.

4.2 Methodology and Assumptions

The assessment has considered a 'view height' of 1.5 metres above ground level with each window having dimensions of 1 m by 1 m which directly facing the nearest wind turbine's position. The model considers terrain, the relative geometry of the turbine to the receptor, the dimensions of the wind turbine and the path of the Sun across the sky throughout a single year. The minimum Sun elevation at which shadow flicker effects could be deemed to materialise is 2 degrees above the horizon. The dimensions of the turbine have been set in accordance with Section 2.1 of this report.

The main parameters of this assessment are presented in Table 3 below.

Criteria	Parameters
Terrain Model	OS Panorama 50m DTM
Software	Windfarm R4
Turbines	6
Assessment area	3 km from each turbine 469 dwelling receptors
Minimum sun height over horizon	2 degrees
Meteorological assessment	Assessment considered clear skies
Windows	1 window per dwelling 1 metre by 1 metre with a centre that is 1.5 metres above ground level The orientation of windows is based on the conservative assumption that windows face the nearest proposed wind turbine with full visibility of the wind turbine and unobstructed by curtains/blinds
Eye height	1.5 m above ground level

Table 3 *Shadow flicker assessment parameters*

The initial assessment also considers the following assumptions:

- The wind turbine blades are assumed to be rotating for 365 days per year, not taking into account changes in wind speed or shut down periods;
- No account is taken of the potential shielding effects of trees, vegetation, or neighbouring buildings;
- No account is taken for weather conditions (such as hours of sunshine, cloud coverage or periods of low visibility). A realistic weather assessment considering average sunshine hours is further presented in Section 4.5;
- Modelled dwelling receptors are assumed occupied at all times.

4.3 Shadow Flicker Results

A summary of results is presented in Tables 4 and 5 below and on the following pages respectively. Time results are given as a decimal value, where 0.5 hours = 30 minutes. Dwelling receptors exceeding the threshold limits of 30 minutes per day or 30 hours per year are highlighted in red for ease of reference.

4.3.1 Shadow Flicker Results – Per Dwelling

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
1	0	0	0	0
2	17	0.15	0.12	2.1
3	9	0.07	0.06	0.5
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	7	0.07	0.06	0.4
14	56	0.41	0.26	14.7
15	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	54	0.38	0.23	12.7
21	44	0.4	0.27	11.8
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	113	0.57	0.32	35.8
26	114	0.59	0.34	38.6
27	0	0	0	0
28	14	0.26	0.17	2.4
29	8	0.14	0.1	0.8
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
41	0	0	0	0
42	124	0.53	0.36	44.5
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	28	0.26	0.2	5.6
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	31	0.27	0.21	6.5
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	6	0.23	0.14	0.8
61	0	0	0	0
62	0	0	0	0
63	124	0.69	0.41	50.5
64	105	0.68	0.38	39.6
65	162	0.98	0.51	82.7

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
66	128	0.8	0.4	50.6
67	138	0.57	0.36	49.6
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	132	0.67	0.49	65.1
75	129	0.64	0.48	61.6
76	90	0.81	0.52	47
77	69	0.97	0.77	53.4
78	0	0	0	0
79	0	0	0	0
80	77	0.49	0.42	32.4
81	79	0.48	0.41	32.3
82	32	0.64	0.5	16.1
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
91	0	0	0	0
92	0	0	0	0
93	0	0	0	0
94	0	0	0	0
95	0	0	0	0
96	0	0	0	0
97	0	0	0	0
98	0	0	0	0
99	0	0	0	0
100	0	0	0	0
101	0	0	0	0
102	0	0	0	0
103	0	0	0	0
104	0	0	0	0
105	0	0	0	0
106	94	0.98	0.68	63.9
107	119	0.52	0.34	40.1
108	134	0.5	0.33	43.9
109	182	1.51	0.74	135.1
110	179	1.51	0.76	136.4
111	126	0.5	0.34	43
112	0	0	0	0
113	0	0	0	0
114	0	0	0	0
115	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
116	23	0.07	0.05	1.1
117	14	0.03	0.02	0.3
118	14	0.03	0.02	0.3
119	0	0	0	0
120	0	0	0	0
121	0	0	0	0
122	0	0	0	0
123	0	0	0	0
124	0	0	0	0
125	0	0	0	0
126	0	0	0	0
127	103	1.43	1.03	105.9
128	0	0	0	0
129	0	0	0	0
130	0	0	0	0
131	0	0	0	0
132	0	0	0	0
133	0	0	0	0
134	0	0	0	0
135	0	0	0	0
136	0	0	0	0
137	0	0	0	0
138	0	0	0	0
139	0	0	0	0
140	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
141	0	0	0	0
142	0	0	0	0
143	0	0	0	0
144	0	0	0	0
145	0	0	0	0
146	0	0	0	0
147	0	0	0	0
148	0	0	0	0
149	0	0	0	0
150	0	0	0	0
151	0	0	0	0
152	0	0	0	0
153	31	0.27	0.21	6.5
154	31	0.26	0.21	6.4
155	31	0.26	0.2	6.2
156	29	0.26	0.2	5.8
157	0	0	0	0
158	0	0	0	0
159	0	0	0	0
160	0	0	0	0
161	0	0	0	0
162	137	0.53	0.33	45.6
163	0	0	0	0
164	123	0.66	0.49	60.3
165	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
166	0	0	0	0
167	79	0.48	0.41	32.3
168	0	0	0	0
169	0	0	0	0
170	0	0	0	0
171	0	0	0	0
172	0	0	0	0
173	0	0	0	0
174	0	0	0	0
175	0	0	0	0
176	0	0	0	0
177	0	0	0	0
178	0	0	0	0
179	0	0	0	0
180	0	0	0	0
181	0	0	0	0
182	44	0.33	0.23	10.3
183	44	0.33	0.24	10.4
184	44	0.33	0.24	10.4
185	43	0.32	0.24	10.4
186	42	0.32	0.25	10.4
187	44	0.32	0.24	10.5
188	46	0.32	0.23	10.6
189	46	0.32	0.23	10.6
190	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
191	0	0	0	0
192	0	0	0	0
193	0	0	0	0
194	0	0	0	0
195	0	0	0	0
196	0	0	0	0
197	0	0	0	0
198	0	0	0	0
199	0	0	0	0
200	0	0	0	0
201	0	0	0	0
202	0	0	0	0
203	0	0	0	0
204	0	0	0	0
205	0	0	0	0
206	0	0	0	0
207	0	0	0	0
208	0	0	0	0
209	0	0	0	0
210	0	0	0	0
211	0	0	0	0
212	0	0	0	0
213	0	0	0	0
214	0	0	0	0
215	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
216	0	0	0	0
217	0	0	0	0
218	0	0	0	0
219	0	0	0	0
220	0	0	0	0
221	0	0	0	0
222	0	0	0	0
223	0	0	0	0
224	0	0	0	0
225	0	0	0	0
226	0	0	0	0
227	0	0	0	0
228	0	0	0	0
229	0	0	0	0
230	0	0	0	0
231	0	0	0	0
232	0	0	0	0
233	0	0	0	0
234	0	0	0	0
235	0	0	0	0
236	0	0	0	0
237	0	0	0	0
238	0	0	0	0
239	0	0	0	0
240	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
241	0	0	0	0
242	0	0	0	0
243	0	0	0	0
244	0	0	0	0
245	0	0	0	0
246	0	0	0	0
247	0	0	0	0
248	0	0	0	0
249	0	0	0	0
250	0	0	0	0
251	0	0	0	0
252	0	0	0	0
253	0	0	0	0
254	0	0	0	0
255	0	0	0	0
256	0	0	0	0
257	0	0	0	0
258	0	0	0	0
259	0	0	0	0
260	0	0	0	0
261	0	0	0	0
262	0	0	0	0
263	0	0	0	0
264	0	0	0	0
265	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
266	0	0	0	0
267	0	0	0	0
268	0	0	0	0
269	0	0	0	0
270	0	0	0	0
271	0	0	0	0
272	0	0	0	0
273	0	0	0	0
274	0	0	0	0
275	0	0	0	0
276	0	0	0	0
277	0	0	0	0
278	0	0	0	0
279	0	0	0	0
280	0	0	0	0
281	0	0	0	0
282	0	0	0	0
283	0	0	0	0
284	0	0	0	0
285	0	0	0	0
286	0	0	0	0
287	13	0.03	0.02	0.3
288	0	0	0	0
289	0	0	0	0
290	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
291	0	0	0	0
292	0	0	0	0
293	0	0	0	0
294	0	0	0	0
295	0	0	0	0
296	0	0	0	0
297	0	0	0	0
298	0	0	0	0
299	0	0	0	0
300	0	0	0	0
301	0	0	0	0
302	0	0	0	0
303	0	0	0	0
304	0	0	0	0
305	0	0	0	0
306	0	0	0	0
307	0	0	0	0
308	0	0	0	0
309	0	0	0	0
310	0	0	0	0
311	0	0	0	0
312	0	0	0	0
313	0	0	0	0
314	40	0.32	0.24	9.5
315	43	0.32	0.23	9.8

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
316	41	0.32	0.24	9.8
317	43	0.32	0.23	9.9
318	45	0.31	0.22	10.1
319	44	0.31	0.23	10
320	45	0.31	0.22	10.1
321	46	0.31	0.22	10.1
322	44	0.3	0.23	10
323	44	0.3	0.23	10
324	0	0	0	0
325	0	0	0	0
326	0	0	0	0
327	0	0	0	0
328	0	0	0	0
329	0	0	0	0
330	0	0	0	0
331	0	0	0	0
332	0	0	0	0
333	0	0	0	0
334	0	0	0	0
335	0	0	0	0
336	0	0	0	0
337	0	0	0	0
338	0	0	0	0
339	40	0.32	0.23	9.2
340	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
341	0	0	0	0
342	0	0	0	0
343	0	0	0	0
344	0	0	0	0
345	0	0	0	0
346	0	0	0	0
347	0	0	0	0
348	0	0	0	0
349	0	0	0	0
350	0	0	0	0
351	0	0	0	0
352	0	0	0	0
353	0	0	0	0
354	0	0	0	0
355	0	0	0	0
356	0	0	0	0
357	0	0	0	0
358	0	0	0	0
359	0	0	0	0
360	0	0	0	0
361	0	0	0	0
362	0	0	0	0
363	0	0	0	0
364	0	0	0	0
365	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
366	11	0.02	0.02	0.2
367	0	0	0	0
368	113	0.32	0.23	25.5
369	0	0	0	0
370	0	0	0	0
371	25	0.3	0.22	5.4
372	52	0.35	0.26	13.4
373	72	0.3	0.24	17
374	47	0.32	0.24	11.1
375	46	0.32	0.24	10.9
376	47	0.32	0.24	11.1
377	25	0.2	0.17	4.2
378	54	0.29	0.22	11.9
379	63	0.41	0.25	15.6
380	5	0.19	0.13	0.7
381	22	0.27	0.21	4.6
382	20	0.26	0.21	4.3
383	0	0	0	0
384	0	0	0	0
385	22	0.27	0.21	4.6
386	0	0	0	0
387	59	0.36	0.32	19
388	20	0.27	0.22	4.5
389	0	0	0	0
390	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
391	31	0.15	0.1	3.1
392	0	0	0	0
393	20	0.26	0.21	4.2
394	0	0	0	0
395	40	0.41	0.31	12.3
396	21	0.26	0.19	4.1
397	0	0	0	0
398	0	0	0	0
399	82	0.79	0.56	45.9
400	0	0	0	0
401	0	0	0	0
402	27	0.12	0.08	2.2
403	0	0	0	0
404	16	0.04	0.03	0.5
405	55	0.3	0.22	12
406	0	0	0	0
407	0	0	0	0
408	0	0	0	0
409	0	0	0	0
410	0	0	0	0
411	59	0.36	0.32	19
412	34	0.25	0.21	7
413	0	0	0	0
414	0	0	0	0
415	0	0	0	0

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
416	0	0	0	0
417	42	0.33	0.26	10.8
418	0	0	0	0
419	0	0	0	0
420	0	0	0	0
421	37	0.25	0.2	7.5
422	85	0.8	0.57	48
423	43	0.23	0.14	5.9
424	20	0.25	0.2	4
425	0	0	0	0
426	31	0.21	0.13	4
427	0	0	0	0
428	0	0	0	0
429	0	0	0	0
430	14	0.27	0.17	2.4
431	0	0	0	0
432	0	0	0	0
433	0	0	0	0
434	0	0	0	0
435	0	0	0	0
436	20	0.25	0.19	3.8
437	82	0.41	0.34	27.7
438	0	0	0	0
439	0	0	0	0
440	18	0.25	0.15	2.8

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
441	21	0.25	0.18	3.9
442	5	0.04	0.03	0.2
443	0	0	0	0
444	0	0	0	0
445	0	0	0	0
446	0	0	0	0
447	18	0.25	0.21	3.7
448	62	0.33	0.2	12.7
449	0	0	0	0
450	47	0.3	0.26	12.1
451	54	0.36	0.27	14.7
452	0	0	0	0
453	0	0	0	0
454	32	0.16	0.11	3.5
455	60	0.36	0.32	19
456	17	0.25	0.2	3.3
457	37	0.31	0.25	9.4
458	20	0.26	0.21	4.2
459	0	0	0	0
460	0	0	0	0
461	0	0	0	0
462	66	0.3	0.22	14.2
463	0	0	0	0
464	0	0	0	0
465	64	0.4	0.36	22.7

Dwelling	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
466	0	0	0	0
467	29	0.13	0.09	2.5
468	222	0.84	0.6	132.9
469	0	0	0	0

Table 4 *Shadow flicker result per dwelling*

4.3.2 Shadow Flicker Results – Per Turbine

Turbine	Days per year of shadow flicker	Maximum hours per day	Mean hours per day	Total hours per year
1	293	2.18	0.93	271.9
2	213	2.88	1.35	287.1
3	285	0.89	0.5	141.2
4	215	1.74	0.8	171
5	249	3.31	1.6	399
6	178	0.57	0.31	55.8

Table 5 *Shadow flicker result per turbine*

4.3.3 Date-Time Graph

Figure 3 below illustrates the combined shadow flicker times for all dwelling receptors from the wind development (red hatched areas). The red lines illustrate the sunrise and sunset times.

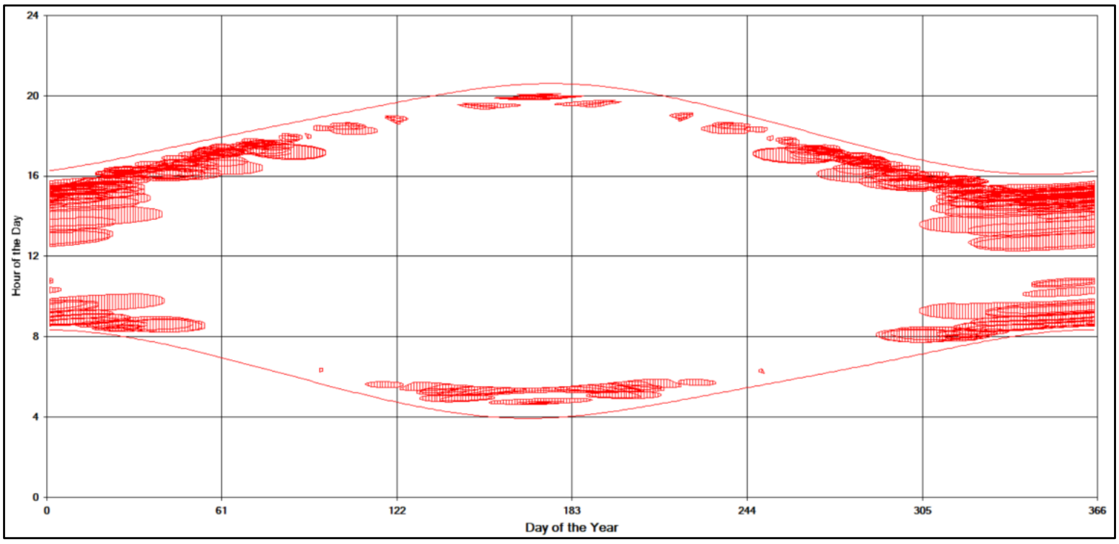


Figure 3 *Shadow flicker times – all receptors*

The geometric results suggest that shadow flicker effects are most prominent when the Sun is low in the sky[9], which is to be expected since this equates to the longest shadows.

Further detailed breakdowns are presented in Annex B, including a contour map.

[9] This includes during the winter months where the Sun's maximum elevation is around 12 degrees.

4.4 Shadow Flicker Results Discussion

Shadow flicker impacts for 28 dwelling receptors are theoretically predicted to exceed the threshold limits of 30 minutes per day and/or 30 hours per year.

An initial review of aerial imagery indicates the presence of intervening vegetation and buildings that may provide screening; however, their height and density cannot be reliably assessed to rule out shadow flicker impacts entirely. A more detailed investigation of screening effectiveness could be conducted to determine whether turbine visibility from windows at each dwelling is possible.

4.5 Realistic Scenario Shadow Flicker Assessment

This section considers the predicted shadow flicker effects under a realistic weather scenario; taking into account the proportion of sunlight to daylight hours during each month at the location of the Proposed Development.

Weather data has been collated from the St Athan weather station, approximately 22km southeast of the Proposed Development.

4.5.1 Sunshine Hours

The proportion of sunshine to daylight hours is calculated and presented in Table 6 below and on the following page.

Month	Average Daylight Hours (per Month)	Average Sunshine Hours (per Month)	Proportion of Sunshine to Daylight (per Month)
January	262.55	55.98	21.32%
February	280.55	85.03	30.31%
March	369.53	127.98	34.63%
April	416.98	181.83	43.61%
May	484.55	226.29	46.70%
June	496.22	217.13	43.76%
July	498.03	220.19	44.21%
August	450.17	189.75	42.15%
September	378.38	160.49	42.41%
October	330.07	108.77	32.95%
November	266.55	66.29	24.87%

Month	Average Daylight Hours (per Month)	Average Sunshine Hours (per Month)	Proportion of Sunshine to Daylight (per Month)
December	246.17	52.07	21.15%

Table 6 *Proportion of sunshine hours to daylight hours in each month*

4.5.2 Realistic Scenario Assessment

The assessment results, considering the realistic scenario for the dwellings which were predicted a significant impact as per the worst-case assessment, are presented in Table 7. For the realistic scenario assessment, a significant impact is considered possible if shadow flicker impacts are predicted for more than **30 hours per year**. The reasoned scenario has not been applied to the predicted minutes per day, because if the sun shines continually on any one day, the occurrence of shadow flicker on that day would theoretically be the same as previously concluded.

The realistic scenario assessment also considers the following assumptions:

- The wind turbine blades are assumed to be rotating for 365 days per year, not taking into account changes in wind speed or shut down periods;
- No account is taken of the potential shielding effects of trees, vegetation, or neighbouring buildings;
- Modelled dwelling receptors are assumed occupied at all times.

The effects of shadow flicker which occur under the reasoned scenario are therefore likely to be lower, however it is not practicable or proportionate to model every scenario and therefore the reasoned scenario is considered a reasonable approach.

Dwelling	Total Hours Per Year	Significant Impact?
25	12.77	No
26	13.77	No
42	15.87	No
63	18.01	No
64	14.13	No
65	29.50	No
66	18.05	No
67	17.69	No
74	23.22	No

Dwelling	Total Hours Per Year	Significant Impact?
75	21.97	No
76	16.77	No
77	19.05	No
80	11.56	No
81	11.52	No
82	5.74	No
106	22.79	No
107	14.30	No
108	15.66	No
109	48.19	Yes
110	48.66	Yes
111	15.34	No
127	37.78	Yes
162	16.27	No
164	21.51	No
167	11.52	No
399	16.37	No
422	17.12	No
468	47.41	Yes

Table 7 *Realistic scenario shadow flicker results*

4.5.3 Realistic Scenario Conclusions

The average sunshine hours are approximately 35.67% (for each month) over the course of the year. Dwellings may experience shadow flicker effects at different times of the year due to their location in relation to specific turbines.

Properties identified as experiencing more potential shadow flicker in the winter months will, on average, have less occurrence than properties identified as experiencing more potential shadow flicker in the summer months. This has been factored into the assessment in the realistic scenario.

Considering the realistic weather conditions and proportion of sunlight to daylight hours at the location of the Proposed Development, four dwellings are predicted to experience shadow flicker impacts for more than the threshold limit of **30 hours per year**. Therefore, a significant pre-mitigation shadow flicker impact is predicted, and mitigation by way of a shutdown scheme is recommended.

4.6 Shadow Flicker Overall Conclusions

Shadow flicker effects can only occur if there is a clear, unobstructed path between the turbine and the affected window(s). If the turbine is not visible from a receptor, no shadow flicker effects will be experienced, as the turbine's shadow will not pass over the window.

An initial assessment considering the worst-case (dwellings orientated directly towards the nearest turbine and no realistic weather scenario considered), 28 dwellings would theoretically receive shadow flicker effects for more than the threshold limits of 30 minutes per day and/or 30 hours per year, When considering the proportion of sunlight to daylight hours during each month four dwellings are predicted to remain experiencing shadow flicker impacts for more than the threshold limit of 30 hours per year. Therefore, a pre-mitigation significant shadow flicker impact is predicted

If views from windows towards the turbines are not available, or removed, via screening, or are confirmed to not exist under baseline conditions, then shadow flicker effects from the turbine are entirely eliminated.

4.7 Mitigation

It is envisaged that a Shadow Flicker mitigation protocol will be conditioned as part of any forthcoming permission, detailing stepped procedures in the event of shadow flicker occurrence at a property.

Once final micrositing of turbines is agreed and turbine selected, an updated shadow flicker assessment would be undertaken and results would inform the mitigation protocol.

In the event of a substantiated complaint from residents of impacted dwellings, should screening mitigation not be deemed appropriate in the first instance, mitigation in the form of a shutdown scheme to mitigate all impacts to below the threshold limits can be implemented.

A shutdown scheme to mitigate potential shadow flicker effects requires the appropriate shadow module / sunshine sensors to be installed on the turbine and programmed into the turbine Supervisory Control and Data Acquisition (SCADA). As such, it is recommended that this equipment is installed on turbines which have been predicted to cause an impact.

With the protocol and SCADA equipment in place, no significant shadow flicker effects would arise from the Proposed Development.

ANNEX A – COORDINATE DATA

Coordinates are presented as in British National Grid.

Turbines

Turbine	Easting	Northing	Turbine	Easting	Northing
1	286968	186094	4	285686	186503
2	286459	186354	5	285732	186989
3	285774	186016	6	284660	186283

The proposed turbine locations are consistent with the locations proposed and consulted on during the Pre-Application Consultation period (between April 2025 and June 2025), with the exception of a small change to the location of T06. Any differences in the proposed coordinates of the other turbines is associated with rounding.

Dwellings

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
1	284066	184885	1518.96	23.02
2	283659	184683	1887.33	32.03
3	283672	184673	1888.98	31.54
4	283787	184627	1872.02	27.80
5	283703	184665	1879.83	30.60
6	283828	184617	1862.20	26.54
7	283817	184578	1902.02	26.31
8	283808	184582	1902.45	26.61
9	283491	184440	2182.48	32.39
10	283082	183915	2845.61	33.68
11	283422	184249	2381.13	31.33

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
12	283091	184112	2678.62	35.86
13	283606	184618	1970.57	32.34
14	284233	185414	968.24	26.17
15	283259	184222	2492.09	34.21
16	282983	184081	2767.88	37.29
17	283373	184315	2351.47	33.18
18	284857	184376	1878.09	29.23
19	284863	184374	1876.91	29.04
20	284192	185397	1002.01	27.84
21	284117	185428	1012.85	32.42
22	288183	188993	3143.31	202.74
23	288252	188621	2834.50	206.94
24	289246	187350	2601.31	241.13
25	287635	188010	2028.78	199.19
26	287601	187964	1974.23	198.70
27	289121	185491	2235.85	285.65
28	289337	185363	2479.22	287.15
29	289176	185491	2288.86	285.27
30	289044	185403	2187.98	288.41
31	289037	185403	2181.34	288.47
32	288298	183431	2976.65	333.46

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
33	288198	183441	2924.26	335.13
34	288193	183438	2924.89	335.24
35	288189	183437	2924.12	335.32
36	288283	183434	2967.29	333.69
37	288288	183433	2970.41	333.62
38	288293	183432	2973.53	333.54
39	288278	183435	2964.18	333.77
40	289047	185532	2153.62	285.13
41	289040	185520	2150.04	285.48
42	286877	187812	1410.09	234.29
43	287678	182758	3410.72	347.99
44	287659	182647	3515.58	348.66
45	288052	183125	3160.70	339.94
46	289108	185757	2166.37	278.95
47	289106	185751	2165.34	279.11
48	289104	185730	2166.79	279.67
49	289067	185761	2125.25	279.01
50	289125	185693	2193.96	280.53
51	288140	188633	2796.45	204.78
52	287725	182806	3374.02	347.03
53	285108	189372	2463.34	165.33

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
54	288146	183405	2935.71	336.34
55	288021	188722	2831.11	201.84
56	289178	186068	2210.15	270.67
57	289018	185478	2140.55	286.72
58	289019	185484	2139.79	286.56
59	288295	182865	3491.04	337.66
60	288913	186122	1945.20	269.18
61	288984	186333	2030.12	263.24
62	288710	186569	1805.60	254.75
63	287760	186622	951.87	236.31
64	288099	186579	1230.60	246.79
65	287060	187287	1110.36	212.83
66	287461	187418	1412.81	200.42
67	287906	187384	1594.97	216.02
68	289025	185644	2105.65	282.34
69	289097	185650	2174.81	281.78
70	288906	188726	3268.53	216.37
71	288310	188992	3193.64	204.85
72	288414	188886	3144.23	207.38
73	288744	185307	1942.56	293.90
74	284903	187560	1006.62	124.56

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
75	284856	187590	1062.35	124.45
76	286612	188015	1351.69	220.62
77	286055	187925	990.16	199.04
78	285044	188820	1955.99	159.41
79	285007	188714	1871.16	157.20
80	284591	188075	1575.21	133.59
81	284596	188048	1553.05	132.99
82	285203	188102	1232.32	154.58
83	285124	188817	1926.46	161.60
84	284559	188664	2044.88	145.00
85	285116	189435	2522.37	165.86
86	284569	189253	2545.24	152.81
87	284569	189253	2545.24	152.81
88	285139	189354	2438.21	165.92
89	284271	189032	2511.65	144.43
90	289046	185600	2135.91	283.37
91	289047	185605	2135.73	283.24
92	289050	185611	2137.29	283.06
93	289052	185619	2137.45	282.84
94	289055	185625	2139.05	282.67
95	289057	185632	2139.48	282.47

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
96	289060	185639	2140.91	282.27
97	289062	185646	2141.39	282.08
98	289063	185653	2140.91	281.89
99	289067	185660	2143.40	281.68
100	289069	185667	2143.95	281.49
101	289069	185674	2142.57	281.30
102	289073	185681	2145.13	281.10
103	287968	184298	2055.63	330.89
104	289000	185366	2158.47	289.71
105	289001	185371	2157.73	289.58
106	286327	187812	1015.56	215.87
107	286956	187879	1513.37	233.98
108	286865	187710	1342.96	237.53
109	286586	187158	814.13	189.05
110	286612	187154	814.69	190.90
111	286895	187801	1418.42	235.08
112	289095	185854	2140.50	276.44
113	289097	185860	2141.82	276.27
114	288028	184670	1775.21	323.34
115	288100	184484	1968.13	324.89
116	288125	184512	1959.94	323.82

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
117	288109	184434	2014.32	325.50
118	288112	184427	2021.79	325.54
119	286823	184262	1837.73	4.53
120	286814	184237	1863.37	4.74
121	286762	184129	1975.77	5.98
122	286396	184306	1818.67	340.00
123	285760	184730	1285.08	0.62
124	285820	184724	1291.82	357.96
125	286831	184318	1781.28	4.41
126	286206	184372	1698.84	345.27
127	285235	187650	827.00	143.06
128	284854	189518	2677.07	160.85
129	285701	188758	1769.27	179.00
130	285777	188852	1863.54	181.38
131	285680	188866	1877.72	178.41
132	285698	188872	1883.31	178.97
133	285720	188881	1892.04	179.64
134	285668	188833	1845.11	178.01
135	285672	188779	1791.01	178.08
136	285784	188883	1894.71	181.57
137	285814	188911	1923.75	182.44

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
138	285850	188901	1915.64	183.53
139	285866	188904	1919.68	184.00
140	285844	188933	1947.22	183.30
141	285851	188933	1947.64	183.50
142	285741	188887	1898.02	180.27
143	285737	188886	1897.01	180.15
144	285733	188885	1896.00	180.03
145	285727	188884	1895.01	179.85
146	285629	188825	1838.89	176.79
147	285758	188894	1905.18	180.78
148	285652	188833	1845.73	177.52
149	285652	188816	1828.75	177.49
150	285665	188814	1826.23	177.90
151	285640	188792	1805.35	177.08
152	285789	188857	1868.87	181.75
153	288000	188707	2809.41	201.55
154	288047	188727	2845.51	202.28
155	288069	188724	2851.16	202.72
156	288153	188703	2865.50	204.43
157	289096	185815	2146.21	277.47
158	285685	188794	1805.61	178.51

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
159	285730	188761	1772.00	179.94
160	289198	185932	2235.88	274.15
161	285109	189432	2521.19	165.69
162	287033	187693	1457.24	203.24
163	288983	185758	2042.82	279.47
164	284903	187609	1035.20	126.79
165	287670	182809	3359.17	347.94
166	287670	182809	3359.17	347.94
167	284595	188055	1558.57	133.15
168	288257	183438	2952.26	334.11
169	284551	189233	2535.80	152.24
170	283422	184249	2381.13	31.33
171	288332	183411	3009.81	333.05
172	287656	182805	3360.19	348.19
173	287663	182806	3360.65	348.06
174	287141	182675	3423.37	357.10
175	287146	182676	3422.63	357.02
176	287151	182676	3422.90	356.94
177	287157	182677	3422.22	356.83
178	287161	182680	3419.45	356.76
179	287050	182663	3431.98	358.63

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
180	287057	182663	3432.15	358.51
181	286829	184259	1840.26	4.33
182	289001	186740	2133.17	252.37
183	289003	186744	2136.29	252.29
184	289006	186748	2140.36	252.21
185	289008	186752	2143.49	252.12
186	289010	186756	2146.63	252.04
187	289013	186760	2150.72	251.96
188	289015	186764	2153.86	251.88
189	289017	186770	2157.63	251.74
190	289013	185455	2142.51	287.35
191	289012	185449	2143.35	287.51
192	289011	185444	2143.91	287.65
193	289010	185439	2144.48	287.78
194	289009	185433	2145.37	287.95
195	289008	185428	2145.96	288.08
196	289008	185400	2154.82	288.79
197	289008	185392	2157.41	288.99
198	289007	185386	2158.42	289.15
199	288961	185354	2125.95	290.37
200	288856	185376	2019.92	290.82

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
201	288860	185338	2037.45	291.78
202	288996	185608	2085.42	283.48
203	288997	185683	2070.21	281.45
204	288998	185614	2085.98	283.30
205	288990	185685	2062.95	281.44
206	288999	185628	2083.77	282.92
207	288978	185686	2050.99	281.47
208	288997	185635	2080.27	282.75
209	288972	185686	2045.11	281.51
210	288994	185643	2075.59	282.55
211	288961	185684	2034.74	281.62
212	288991	185651	2070.94	282.35
213	288956	185681	2030.45	281.74
214	288962	185643	2044.37	282.74
215	288947	185674	2023.08	281.98
216	288964	185637	2047.65	282.90
217	288943	185670	2020.00	282.12
218	288963	185626	2049.16	283.20
219	288936	185659	2015.50	282.46
220	288965	185620	2052.48	283.35
221	288934	185653	2014.85	282.64

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
222	288963	185609	2053.11	283.66
223	288931	185642	2014.37	282.97
224	288965	185603	2056.48	283.81
225	288930	185634	2015.20	283.19
226	288930	185626	2017.04	283.42
227	288929	185618	2017.94	283.64
228	288932	185607	2023.48	283.93
229	288931	185601	2023.96	284.10
230	288935	185591	2030.30	284.34
231	288934	185583	2031.32	284.57
232	288966	185563	2067.36	284.88
233	288934	185575	2033.35	284.79
234	288964	185557	2066.97	285.06
235	288934	185567	2035.41	285.01
236	288959	185548	2064.51	285.34
237	288929	185556	2033.46	285.34
238	288957	185542	2064.18	285.51
239	288929	185550	2035.06	285.50
240	288953	185532	2063.02	285.81
241	288924	185541	2032.67	285.79
242	288950	185524	2062.33	286.04

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
243	288924	185535	2034.31	285.95
244	288947	185517	2061.40	286.25
245	288914	185503	2033.76	286.89
246	288945	185509	2061.74	286.48
247	288912	185495	2034.19	287.13
248	288940	185498	2060.10	286.82
249	288909	185483	2034.90	287.47
250	288938	185490	2060.51	287.05
251	288908	185476	2036.06	287.67
252	288936	185479	2061.86	287.35
253	288906	185465	2037.52	287.98
254	288935	185472	2063.00	287.55
255	288905	185457	2039.05	288.20
256	288933	185464	2063.52	287.78
257	288904	185446	2041.57	288.51
258	288932	185452	2066.27	288.10
259	288904	185439	2043.80	288.69
260	288932	185445	2068.45	288.29
261	288904	185427	2047.68	289.01
262	288904	185419	2050.30	289.22
263	288922	185405	2071.92	289.42

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
264	288922	185396	2074.93	289.66
265	288931	185383	2087.80	289.91
266	288931	185386	2086.78	289.83
267	288932	185376	2091.13	290.08
268	288932	185372	2092.51	290.18
269	288998	185572	2096.04	284.42
270	288996	185566	2095.61	284.59
271	288992	185557	2094.03	284.86
272	288990	185551	2093.64	285.03
273	288985	185541	2091.43	285.33
274	288983	185535	2091.10	285.51
275	288976	185526	2086.79	285.79
276	288973	185518	2086.10	286.03
277	288970	185511	2085.16	286.24
278	288968	185504	2085.21	286.44
279	288968	185492	2088.64	286.75
280	288966	185485	2088.75	286.95
281	288963	185475	2088.82	287.24
282	288960	185467	2088.35	287.47
283	288957	185456	2088.82	287.78
284	288955	185449	2089.07	287.98

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
285	288951	185438	2088.69	288.30
286	288949	185431	2089.00	288.50
287	288126	184379	2069.35	325.97
288	289035	185768	2092.55	278.96
289	289030	185802	2082.57	278.06
290	288981	185808	2033.22	278.09
291	289005	185761	2064.04	279.28
292	289065	185777	2120.82	278.60
293	289021	185764	2079.35	279.13
294	289049	185771	2105.92	278.82
295	289068	185584	2161.04	283.65
296	289070	185589	2161.81	283.51
297	289071	185594	2161.62	283.37
298	289073	185599	2162.42	283.23
299	289075	185604	2163.23	283.09
300	289077	185608	2164.27	282.98
301	289078	185613	2164.13	282.84
302	289080	185619	2164.76	282.68
303	289084	185627	2166.92	282.45
304	289086	185633	2167.59	282.28
305	289087	185638	2167.51	282.14

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
306	289089	185643	2168.42	282.00
307	288376	183379	3058.38	332.59
308	285420	183532	2508.11	8.11
309	286857	184388	1709.61	3.72
310	286889	184425	1670.87	2.71
311	288820	185338	2000.36	292.21
312	289073	185810	2124.07	277.68
313	289099	185675	2171.80	281.12
314	289034	186716	2157.60	253.24
315	289038	186724	2163.75	253.07
316	289041	186729	2168.08	252.97
317	289045	186735	2173.66	252.85
318	289127	186920	2311.61	249.06
319	289129	186925	2315.27	248.97
320	289131	186929	2318.58	248.89
321	289134	186933	2322.82	248.83
322	289136	186937	2326.13	248.75
323	289138	186941	2329.44	248.68
324	288268	188633	2852.46	207.11
325	288305	188604	2843.88	208.04
326	288309	188600	2842.24	208.15

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
327	288272	188630	2851.62	207.21
328	288277	188626	2850.35	207.34
329	288281	188623	2849.53	207.44
330	288285	188620	2848.71	207.54
331	288289	188616	2847.02	207.65
332	288293	188614	2847.11	207.74
333	288297	188611	2846.32	207.83
334	288301	188608	2845.54	207.93
335	285896	188918	1935.96	184.86
336	285885	188917	1934.06	184.54
337	285878	188915	1931.53	184.34
338	287418	182688	3435.60	352.47
339	289028	186710	2150.13	253.35
340	289095	185663	2170.23	281.45
341	287136	182674	3424.12	357.19
342	286701	184720	1399.70	11.00
343	286889	184419	1676.86	2.70
344	286854	184377	1720.78	3.80
345	288946	185346	2114.71	290.71
346	289036	185803	2088.37	278.01
347	286909	184564	1531.14	2.21

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
348	288625	185291	1841.32	295.86
349	286614	183425	2692.37	7.56
350	286871	184314	1782.64	3.12
351	287176	182601	3499.19	356.59
352	287052	185062	1035.41	355.35
353	288912	185345	2083.30	291.07
354	288932	185347	2101.26	290.82
355	288865	185444	2005.27	288.91
356	288877	185338	2053.25	291.60
357	288830	185337	2010.00	292.12
358	289058	185813	2108.81	277.66
359	289047	185804	2099.13	277.94
360	289013	185799	2066.17	278.21
361	290993	185892	4030.07	272.87
362	289015	185463	2142.05	287.13
363	289016	185468	2141.54	287.00
364	288892	185328	2070.88	291.71
365	287484	184334	1834.08	343.66
366	288121	184377	2068.21	326.12
367	288306	183423	2987.39	333.39
368	288214	187982	2262.09	213.42

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
369	288924	185346	2094.14	290.93
370	287491	184335	1835.10	343.44
371	289204	186507	2273.82	259.54
372	288764	187046	2032.71	242.07
373	288746	187930	2555.81	224.08
374	289001	186825	2160.43	250.22
375	289009	186838	2172.38	249.97
376	289005	186832	2166.57	250.08
377	288431	188544	2853.57	210.84
378	289050	187566	2549.81	234.74
379	284255	185416	956.93	25.04
380	282436	186259	2224.13	89.38
381	289503	187018	2698.15	249.97
382	289593	186999	2776.63	250.98
383	289223	184375	2835.49	307.32
384	283148	183713	2981.79	30.47
385	289495.29	187017.45	2690.72	249.93
386	285372.66	183214.98	2828.64	8.16
387	287118.81	188548.53	2086.95	221.65
388	289526.93	186574.31	2603.62	259.37
389	285582.64	189652.84	2668.02	176.79

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
390	288796.73	184832.13	2221.84	304.61
391	288216.99	184393.65	2109.78	323.70
392	289395.95	184338.31	2996.23	305.87
393	289657.17	186972.03	2828.88	251.92
394	286700.04	183269.13	2837.55	5.42
395	284131.3	185498.7	945.86	33.98
396	289686	186927	2842.78	252.96
397	285453	184457	1590.72	11.64
398	285578.38	189601.04	2616.55	176.63
399	286622.12	188078.29	1406.72	219.25
400	287365.44	189320.15	2846.47	215.02
401	289591.01	186959.46	2762.10	251.74
402	288202.74	184391.42	2103.18	324.05
403	289325.98	184243.29	2997.53	308.13
404	288829	184700	2325.20	306.84
405	284131.5	185332.5	1087.55	29.08
406	285759.53	189773.9	2785.04	180.57
407	285059	189814	2904.06	166.60
408	284102	183548	2791.34	11.53
409	285526.21	189470.77	2490.29	175.26
410	286994	189442	2758.60	207.22

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
411	287125.17	188551.78	2093.61	221.72
412	286543.46	188438.39	1661.08	209.24
413	286877.21	189227.04	2514.03	207.10
414	283430	183781	2787.99	26.18
415	285397.2	183404.32	2637.73	8.21
416	288746.51	184481.27	2400.83	312.20
417	283657	185176	1493.81	42.18
418	289391.12	184340.43	2991.07	305.89
419	289327.87	184248.71	2995.68	308.02
420	286324	183381	2690.81	348.21
421	282157	184800	2909.35	59.35
422	286601.12	188051.12	1372.40	219.29
423	289153	184875	2502.04	299.16
424	289723.78	186846.13	2856.58	254.73
425	289448.86	184453.99	2973.94	303.47
426	289165.25	184926.67	2488.08	297.98
427	288964.15	184208.81	2745.64	313.36
428	285583.88	189657.97	2673.08	176.82
429	282810	184247	2750.96	42.26
430	289278	187318	2614.24	242.08
431	286539	183211	2906.48	344.74

Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
432	284142	184596	1764.74	17.07
433	286588.95	183198.98	2919.73	7.46
434	286058.38	189132.43	2168.14	188.66
435	285609	189693	2706.80	177.40
436	289824.64	186827.64	2949.34	255.60
437	286962.22	188225.59	1744.30	224.85
438	289393.38	184807.02	2745.68	297.95
439	287278.91	189547.72	2989.98	211.16
440	289499	185255	2666.44	288.34
441	289761.35	186956.01	2923.33	252.85
442	286510.15	188560.6	1753.69	206.34
443	283664	183696	2772.11	21.06
444	286525.6	183181.16	2931.82	345.15
445	286488.78	189440.65	2565.79	197.15
446	282417	184397	2930.54	49.94
447	289839.92	186503.09	2900.91	261.89
448	284164	185366	1042.55	28.41
449	281922	186076	2745.81	85.68
450	287481	188908	2596.45	222.35
451	285092	185195	1066.55	39.75
452	284075.88	183346.48	2994.05	11.25

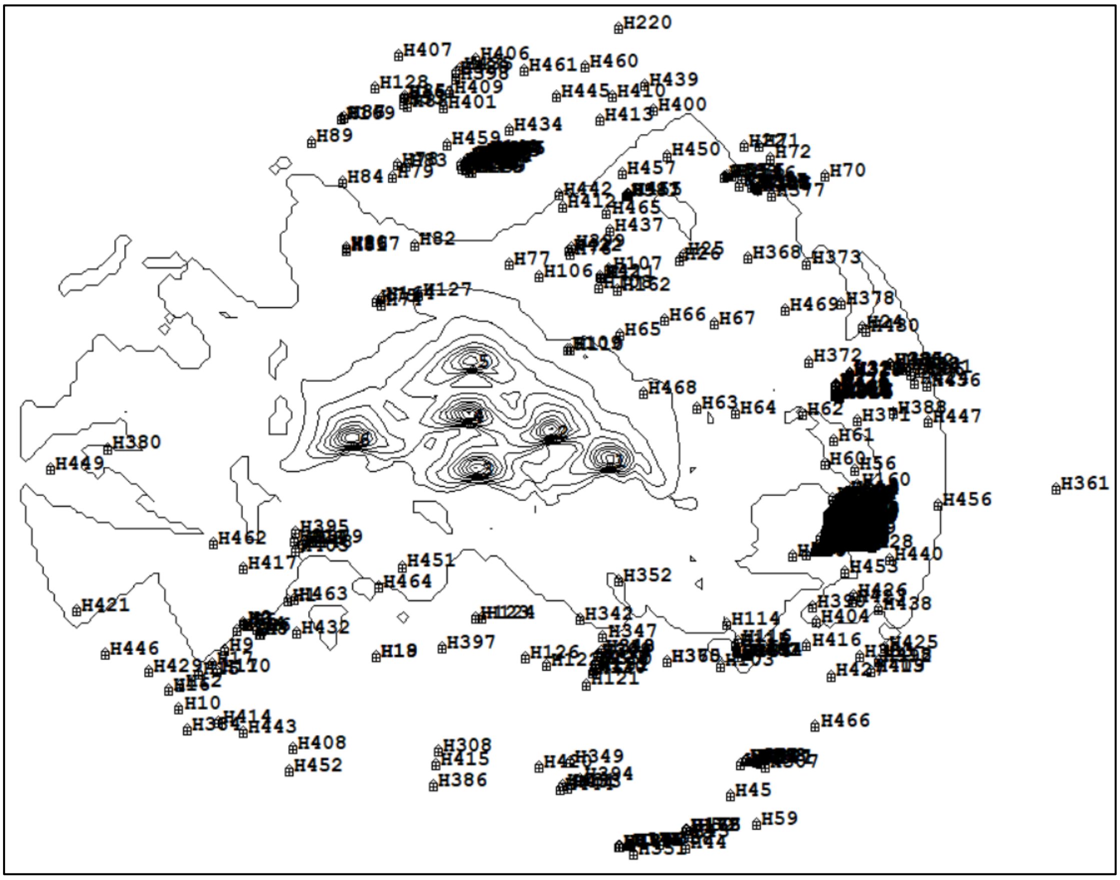
Receptor	Easting	Northing	Distance to nearest turbine (m)	Bearing to nearest turbine (°)
453	289088.88	185144.77	2323.61	294.11
454	288222.18	184393.88	2112.67	323.58
455	287133.34	188553.67	2100.46	221.85
456	289925.87	185753.91	2977.36	276.56
457	287084.12	188749.57	2219.87	217.52
458	289644.36	186975.66	2817.84	251.77
459	285497.55	189007.28	2031.85	173.37
460	286751	189709	2904.61	200.54
461	286191.09	189679.9	2729.78	189.68
462	283384	185401	1551.16	55.35
463	284113	184895	1491.90	21.51
464	284886	185007	1295.86	349.96
465	286943.3	188385.1	1848.34	220.95
466	288825.09	183752.61	2988.46	321.58
467	288208.32	184392.56	2105.54	323.91
468	287276	186763	736.50	204.72
469	285352.14	183328.29	2719.63	8.92

Assessed dwelling receptor details

ANNEX B – CONTOUR MAP

Overview

The figures below show the shadow flicker contours associated with the proposed wind development relative to the receptor locations. The contour spacing is 50 hours per year.



Contour map

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