17.0 MATERIAL ASSETS – SHADOW FLICKER

17.1 INTRODUCTION

This chapter assesses the potential for shadow flicker from the proposed Wind Farm to impact on sensitive receptors in the surrounding area. The objectives of this chapter are to describe what shadow flicker is, describe the assessment methodology and guidance, describe the potential effects, mitigation measures, if required and any residual effects. This chapter deals only with the proposed turbines, as there is no potential for shadow flicker effects from any other elements of the proposed development, such as the grid connection, met mast, substation, and works associated with the turbine delivery route, etc.

17.1.1 Background

Wind turbines can cast long shadows when the sun is low in the sky. 'Shadow flicker' is an effect that occurs when the rotating blades of a wind turbine cast a moving shadow over a building. The effect is experienced indoors where a moving shadow passes over a window in a nearby property and results in a rapid change or flicker in the incoming sunlight.

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 a building, primarily concerned with residential properties. This intermittent shadow flicker can be a cause of annoyance at residences near wind turbines. Shadow flicker is largely dictated by the relative position of the turbine(s) and the window, in combination with weather conditions (i.e., presence of direct sunlight, wind speed and wind direction) and the time of day and year (i.e., affecting the position of the sun). Shadow flicker will occur if the turbine rotors are located between an observer within a dwelling and the sun. The frequency of the flicker effect is related to the frequency of the rotating turbine blades. It can also be dependent on the number of individual turbine rotors that are casting shadows on a window.

The occurrence of shadow flicker effects are determined by a number of criteria as follows:

- **The presence of screening**: Screening can occur from a variety of sources including vegetation, terrain, and buildings. If screening is present between the property and the wind turbine/sun, then shadow flicker would not occur at that property.
- **The orientation of the property**: The windows of the sensitive property must have windows that face the proposed turbines in order to be able to receive shadow flicker.
- **The distance of the property from turbines:** The potential effect of shadow flicker diminishes as distance from the turbine increases. An industry standard approach is to use a distance of ten rotor diameters as a maximum limit within which significant shadow flicker effects can occur.
- **The presence of direct sunlight**: Cloud cover can remove the presence of direct sunlight so that it is diffused and does not cast a shadow. If direct sunlight is present, the turbine blades must be located in the direct path between the sun and the property.
- **The time of year and day:** The path of the sun varies over the seasons resulting in a changing potential for a shadow to be cast throughout the year. Similarly, the sun's position in the sky over the course of a day is changing such that the shadow cast by a turbine is constantly changing.
- **Wind speed**: In order for shadow flicker to occur, the turbine must be rotating. This requires a wind speed high enough to cause the turbine to turn on.

- **Direction of Wind**: The width of a shadow at any given property is dependent on the direction of the wind. This will be different on any given day at every property. The worst-case shadow occurs when the turbine faces directly towards or away from a property, while minimum flicker occurs when it faces perpendicular to the property.
- **The presence of people**: If the property is empty at the time of a shadow flicker event, then it would not cause a nuisance.

Given the above requirements for the presence of a shadow flicker impact, it is likely for the vast majority of the time at any given property, the probability of shadow flicker occurring is low. Nevertheless, this chapter will assess the potential occurrence of shadow flicker on any sensitive properties.

17.1.2 Proposed Development

The proposed development will comprise 22 no. wind turbines and associated infrastructure at the site as described in Chapter 3 of this EIAR (Description of Proposed Development). For the purpose of this assessment, the proposed wind turbines are the only infrastructure that have the potential to cause shadow flicker, so other elements of the proposed development are not considered in this Chapter. The locations of the proposed turbines are shown in Figure 17-1 below, and all coordinates referred to in this chapter are in Irish Transverse Mercator (ITM).

A full description of the proposed development is provided in Chapter 3 (Description of the Proposed Development).

7°54'0"W

53°36'40"N

606000

612000

768000

Legend

- Proposed wind farm site boundary
- Turbine Layout

0 1 2
Kilometres

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING\
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE\
3. ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES\
4. ALL LEVELS RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Rev	Date	Description	By	Chkd.
A	03/12/2024	First issue	S.P	I.H

Client: Bord na Móna

Project: Derryadd Wind Farm

Title: Figure 17-1 Site layout overview

Scale @ A3:	1:35,000	
Prepared by:	Checked by:	Date:
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Map Ref: 11399-114-Shw.FI-LAY.INFR-TOB-A

Draft: A

17.1.3 Statement of Authority

This assessment has been carried out by TOBIN Consulting Engineers. The shadow flicker modelling and assessment was carried out by Michael Nolan who has more than 20 years' experience in building and environmental consulting and environmental impact assessment including the preparation of shadow flicker impact assessments. Michael has a City & Guilds Certificate in Computer Aided Design (2001) and 20 years' professional experience. He has worked on a number of wind farms with various roles (which included carrying out scoping exercises with telecoms providers and other stakeholders and providing content for reports). Michael completed training with EMD International, a global consultancy providing software for wind energy projects including WindPRO, which has been used to model the shadow effects at this wind farm.

This Chapter has been reviewed by Ian Heanue, a Project Manager in TOBIN. Ian holds a BEng in Energy Engineering and has considerable experience in project managing commercial developments. He has worked on a number of wind farms with various roles (which included delivery of EIARs and other reports on a range of projects including SID wind farms.).

17.2 METHODOLOGY AND GUIDANCE

17.2.1 Guidance

There are various sources of guidance with regard to the assessment and management of shadow flicker effects caused by wind turbines. Irish guidance relevant to the proposed development is summarised below. Additional guidance from the UK is also presented to provide technical context.

Wind Energy Development Guidelines (2006):

The 2006 Guidelines state that:

"Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. It is recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day".

The Guidelines also state that:

"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. Where shadow flicker could be a problem, developers should provide calculations to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times".

The shadow flicker modelling approach in this assessment is consistent with this recommendation.

Draft Revised Wind Energy Development Guidelines (2019):

Draft WEDGs were published in December 2019 and are subject to a consultation process. It is noted that at the time of writing (January 2025) the Draft 2019 WEDGs have not yet been adopted and the 2006 Guidelines referred to above remain in place. Nonetheless, this EIAR is cognisant of the content and proposed measures set out in the Draft 2019 WEDGs. The Draft 2019 WEDGs note that:

"Generally only properties within 130 degrees either side of north, relative to the turbines, can be affected at these latitudes in the UK and Ireland – turbines do not cast long shadows on their southern side."

The Draft 2019 WEDGs also outline that the time period in which a neighbouring property may be affected by shadow flicker is completely predictable from the relative locations of the wind turbine(s) and the property. To support this, *"A Shadow Flicker Study detailing the outcome of computational modelling for the potential for shadow flicker from the development should accompany all planning applications for wind energy development."*

The Draft 2019 WEDGs advise that if shadow flicker prediction modelling indicates that there is potential for shadow flicker to occur at any particular dwelling or other potentially affected property, that a design review should be carried out to consider if one or more of the turbines can be relocated to eliminate the occurrence of shadow flicker. If this cannot be accommodated, then measures which provide for automated turbine shutdown to eliminate shadow flicker would be required.

The Draft 2019 WEDGs also state that *"The planning authority or An Bord Pleanála should impose condition(s) to ensure that no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application".*

This approach in the current draft of the Guidelines provides for the prevention of shadow flicker by automatic shutdown of the turbines. This means that turbines will need be programmed to shut down when shadow flicker effects occur, i.e., no amount of shadow flicker per day or per year would be acceptable. The nature of the automatic shutdown process in modern turbine technology requires a very short period of shadow flicker to occur as the blades are moved into the idle position and the blade movement safely comes to a halt.

A Working Group from Wind Energy Ireland (WEI) (formerly Irish Wind Energy Association (IWEA)) have expressed concern at the proposed shadow flicker response requirements noting that, if implemented, they will be strictest in Europe[1]. The Working Group notes that the proposed requirements can be complied with subject to incorporation of some essential clarifications:

- A slowing-down period of a few minutes (technology dependent) permitted to allow safe and efficient shutdown once flicker is detected;
- The study area to be limited to 10 times rotor diameter or a maximum distance of 1.5 km; and,
- Financially involved properties should be exempt from zero shadow flicker requirements.

Parsons Brinckerhoff – Update of UK Shadow Flicker Evidence Base (2011)

[1] http://www.iwea.com/latest-news/3180-blog-draft-revised-wind-energy-development-guidelines (Accessed on 28 March 2025)

Parsons Brinckerhoff were commissioned by the Department of Energy and Climate Change in the UK to carry out a study to advance the understanding of the shadow flicker effect. The 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".*

The report sets out that *"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 summarised that *"The current recommendation in Companion Guide to PPS22 (2004) to assess shadow flicker impacts within 130 degrees either side of north is considered acceptable, as is the 10 rotor diameter distance from the nearest property"*, though it is mentioned that this approach may not be suitable at all latitudes.

The Companion Guide to PPS22 was a planning policy statement produced by the UK Government in 2004 and, in addition to the above, states that *"Shadow flicker only occurs inside buildings where the flicker appears through a narrow window opening"*.

In terms of shadow flicker modelling, the report states that *"The three key computer models used by the industry*[at that time] *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."*It is noted that the WindPRO modelling software has been used in the assessment of shadow flicker for the proposed development.

The report states, *"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".* Further discussion on shadow flicker and human health risks is contained in Chapter 6 (Population & Human Health) of this EIAR.

In summarising measures to minimise shadow flicker effects, *"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."*

<u>Onshore Wind Energy Planning Conditions Guidance Note – A Report for the Renewables Advisory Board and BERR (2007)</u>

This Wind Energy Guidance Note was prepared in the UK for the Renewables Advisory Board and Department for Business, Enterprise and Regulatory Reform (BERR) in 2007 and states that shadow flicker *"occurs only within buildings where the shadow appears through a narrow window opening"*and 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".*

The Guidance Note advises in terms of planning control that *"a local planning authority may consider it appropriate to impose a planning condition to provide that wind turbines should operate in accordance with a shadow flicker mitigation scheme…….unless a survey carried out on behalf of the developer in accordance with a methodology approved in advance by the local planning authority confirms that shadow flicker effects would not be experienced within habitable rooms within any dwelling".*

Irish Wind Energy Association (IWEA) (now WEI) – Best Practice Guidelines for the Irish Wind Energy Industry (2012)

The IWEA Best Practice Guidelines note that, *"At certain times of the year, the moving shadows of the turbine blades could periodically reduce light to a room causing the light to appear to flicker. This would not generally have any effect on health or safety but could on limited occasions present a brief nuisance effect for some neighbours."*

The Guidelines identify that modifications to predicted worst-case shadow flicker effects to account for sunshine probability and wind direction are reasonable and refers to mitigation measures such as wind turbine operation controls and screening where shadow flicker is anticipated to lead to potential problems.

17.2.2 10x Rotor Diameter Assessment Zone

As per the guideline documents set out in Section 17.2.1, it is common practice to use a distance of ten rotor diameters as a maximum limit within which significant shadow flicker effects can occur. The validity of this limit is discussed at length within the relevant literature, and guidance varies in different documents and countries, with some stating that effects can only occur within this distance and others stating that the risk beyond this distance is low. The Parsons Brinckerhoff Report referenced in Section 17.2.1 acknowledges that the latitude of the site will determine the distance from a wind turbine where shadow flicker can occur.

The Onshore Wind Energy Planning Conditions Guidance Note published in the UK in 2007 stated that *"shadow flicker has been proven to occur only within ten rotor diameters of a turbine position".* The Scottish Government *Onshore Wind Turbines: Planning Advice* (2014) states that *"where separation is provided between wind turbines and nearby dwellings (as a general rule 10 rotor diameters), "shadow flicker" should not be a problem".* The Northern Ireland (NI) Department of the Environment *Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy'* (2009) states that *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low".*

The IWEA Guidelines referred previously state that *"The assessment of potentially sensitive locations or receptors within a distance of ten rotor diameters from proposed turbine locations will normally be suitable for EIA purposes"* and refers to the 2006 WEDGs recommended threshold limits of 30 hours per year or 30 minutes per day for receptors within 500m.

Ireland's 2006 Wind Energy Development Guidelines use the exact same wording as the NI Guidance above and, in addition, state that *"It is recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day".* It is noted that the Draft 2019 WEDGs do not specify a maximum distance for assessing shadow flicker. In reality, there is no fixed cut off distance at which effects can occur,

as this is sensitive to many parameters including the exact latitude of the site and the terrain around the proposed wind farm site location.

Given the recommendations in the above Guidance documents, it is considered that an assessment of potential shadow flicker at properties within ten rotor diameters of the turbine locations is appropriate to provide a robust assessment of shadow flicker from the proposed development.

The rotor diameter for the turbines for the proposed development is 165 m, therefore all sensitive receptors within 1.65 km of the proposed turbine locations have been included in the shadow flicker assessment. For the purpose of this assessment, the 2006 WEDGs recommended maximum thresholds of 30 hours per year or 30 minutes per day have been applied to all sensitive receptor locations within 1.65 km of a proposed turbine location. Sensitive receptors for the purpose of this assessment are defined in Section 17.3.1.

For dwellings where shadow flicker is likely to exceed threshold limit values there are a range of measures that can be implemented to ameliorate shadow flicker effects such as the planting or screening vegetation or the turbine in question can be programmed to shut down during periods when shadow flicker is predicted to occur. This strategy has been successfully employed at other wind farms. Shadow flicker control modules (SFCM), which operate by standing the turbine down based on times of day and the relative angle of the sun and turbine, will be installed on the appropriate turbines which can be programmed to shut down turbines if shadow flicker is anticipated to exceed nuisance levels (these potential measures are discussed further in Section 17.5).

17.2.3 Shadow Flicker Modelling

The analysis has been undertaken using WindPRO: Shadow – Version 3.6.366 (by EMD International) which is one of the leading industry software packages for carrying out a shadow flicker simulation. It is a specialist modelling software package that incorporates:

- Wind turbine configuration;
- Terrain mapping;
- Sun path throughout the year at the development latitude; and,
- Defined receptors.

The wind turbine dimensions inputted to the model are consistent with those discussed in Chapter 3 (Description of the Proposed Development). The proposed wind turbine tip height is 190 m with a rotor diameter of 165 m and a hub height of 107.5 m.

The ground level on which the wind turbines and surrounding properties are situated has been incorporated into the model using Digital Terrain Modelling. This terrain mapping ensures that the realistic elevation variations between the turbines and properties are accounted for. This includes a Zone of Visual Influence (ZVI) calculation that checks whether the terrain provides screening for a given property from each turbine and from the sun.

The model allows for user defined receptor locations (i.e. size, position, and orientation of windows at a receptor/property location). The location of properties in the model has been defined using address data from the Geodirectory database which is used to populate Eircode's. As discussed in Chapter 6 (Population & Human Health), this data has been used to define the sensitive receptor properties in the vicinity of the site and specifically in relation to this shadow

flicker assessment, within 1.65 km of a proposed turbine location (i.e., 10 m x 165 m (rotor diameter) = 1.65 km). A ground truthing exercise was carried out on this data in the area surrounding the proposed wind farm site to ensure accuracy of the identified sensitive receptors. This exercise is further detailed in Section 6.4 of Chapter 6 (Population & Human Health).

The model can be set up to incorporate windows (typically with a size of 1 m x 1 m and an elevation of 1 m above ground level) directed towards the centre of the wind farm. This feature can be used to provide specific detailed analysis on the locations of windows and allow for modelling multiple windows on properties facing different groups of turbines. However, to ensure consideration of a worst-case scenario, these features are over-ridden in the model by the 'greenhouse mode' which assumes that shadows can be seen from 360 degrees at a property/receptor as opposed to only through windows facing the wind turbines.

The model default assumes that the turbine rotor is turning at all times. However, in practice, calm conditions, low wind speeds and maintenance shut-down will reduce the duration of operation of the turbines throughout the year and accordingly the potential flicker effect. The model default also assumes that the wind direction is such that the turbine rotor is always perpendicular to the direction to the property so that it casts the maximum shadow possible for each wind turbine. Again, in practice, the wind direction will change periodically over the course of the year and the wind turbines are programmed to rotate around, or 'yaw', in order to face the wind direction.

The modelling software has built-in long-term solar statistics that accurately replicate the suns path throughout the year at the development latitude. The model considers a minimum sun elevation of 3 degrees over the horizon which is a typical value at this latitude to accommodate terrain obstruction at the horizon for low solar elevation angles.

There are a number of features of the software that can produce highly conservative or 'worst-case' results in terms of modelling the potential shadow flicker effect. For example, there are a range of factors that could diminish shadow flicker effects namely cloud cover, varying wind direction and low wind speed. In relation to cloud cover, the default annual shadow flicker calculated by the model for each property assumes 100% sunshine during daytime hours. However, Met Éireann data for this region shows that the sun shines on average for 30% of the daylight hours per year[2] thus, the total hours per year of shadow flicker is likely to be significantly less than the theoretical worst-case durations produced by the model. The modelled results, therefore, overestimate the likely effects based on sunshine probability.

Similarly, the worst-case model inputs assume that the wind direction is such that all turbines are orientated to cast the maximum shadow over the identified receptors. However, Met Éireann identify that the prevailing wind direction across the country is between south and west[3]. Therefore, the direction that the blades of the turbine face (the turbine blades automatically orientate to face into the wind) will vary and, as such, will not always be perpendicular to the position of the receptors. The modelled results, therefore, overestimate the likely effects based on wind direction.

[2] 30 Year Average Data (1979-2008) – Mullingar Weather Station (no long term sunshine probability statistics available for the nearest weather station to the site located in Mountdillon)
[3] https://www.met.ie/climate/what-we-measure/wind (Accessed on 28 March 2025)

The worst-case modelled shadow flicker outputs assume unobstructed (from vegetation or other obstacles) visibility between a receptor and the turbine rotors, bright weather conditions, use of 'greenhouse mode' (i.e. the windows face the turbines) and rotor alignment with maximum potential to cast a shadow. These are worst-case conditions used to predict the maximum possible shadow flicker effect. In practice, over the course of any year, the actual weather conditions and any screening will reduce the worst-case modelled effects.

17.2.4 Cumulative Assessment

The only developments that have the potential for cumulative shadow flicker effects are other wind farms.

The shadow flicker assessment considers the 22 no. proposed wind turbines that make up the proposed wind farm and quantifies the worst-case potential shadow flicker effects that may arise from the 22 no. turbines .

Other wind farms have also been considered to assess any potential cumulative effects with regard to shadow flicker. A planning search was conducted using the Longford County Council (LCC) website, An Bord Pleanála (ABP) website and the EIA portal to identify any existing, consented or proposed wind farm developments in proximity to the proposed wind farm site.

The nearest wind farm (existing, consented or proposed) to the proposed wind farm is the existing Sliabh Bawn wind farm, located approximately 8 km to the northwest of the proposed wind farm site. Sliabh Bawn Wind Farm is not located close enough to have the potential to cause cumulative shadow flicker effects (i.e., no sensitive receptor properties are located within 10 rotor diameters (1.65 km) of the proposed wind farm site and Sliabh Bawn wind farm).

17.2.5 Acceptable Limits

In accordance with the current WEDGs (2006), the acceptable limit for shadow flicker in Ireland is a maximum of 30 hours per year or 30 minutes per day at any one property. The assessment carried out in this Chapter is based on these current guidelines.

Furthermore, as per the Draft WEDGs 2019, the proposed wind farm design used the 4 times tip height setback distance from turbines, should these guidelines come into force while this proposed development is in the application process.

In the interests of developing best practice, Bord na Móna is proposing to use the currently available technology to minimise any adverse effects from the proposed development on the local community.

This is subject to the technical capabilities of turbine technology where a controlled and safe slow-down of blade rotation is required in the event that shadow flicker on a receptor is predicted to occur.

17.3 EXISTING ENVIRONMENT

17.3.1 Shadow Flicker Receptors

The shadow flicker receptors identified for the purpose of this assessment are shown on Figure 17-2. The locations of the proposed turbines are also shown as well as the shadow flicker study area which extends to 1.65 km from the proposed turbine locations. The design of the wind farm layout incorporates a minimum set-back distance from the proposed turbine locations to dwellings and potential sensitive receptors, such that there are no sensitive receptors located within 760 m of a proposed turbine location (i.e., allowing for 4 times tip height (190 m)).

The shadow flicker receptors have been identified from a combination of publicly available mapping, aerial imagery, street-level imagery and Geodirectory address data[4] as well as verification of properties by the Project Team from a number of drive-around ground truthing surveys (most recently carried out in September 2024). In addition, a search of planning applications within 1.65 km of the turbine locations was carried out to identify proposed developments and consented, but as yet not built, developments (most recently carried out in November 2024).

During the verification process, any properties/buildings identified that would not be considered sensitive receptors (i.e. farm sheds, garages, etc.) were omitted. Only habitable dwellings and planning consented habitable dwellings were included as shadow flicker receptors. Unconstructed dwellings where the planning permission expiry period for development had elapsed were also excluded.

This verification process identified a total of 204 no. shadow flicker receptors within 1.65 km of the proposed turbines, which were each issued a unique identification number and are shown below in Figure 17-2 and listed in Table 17-1. The co-ordinates (ITM) of each of the receptors were compiled and their locations added to the WindPRO model.

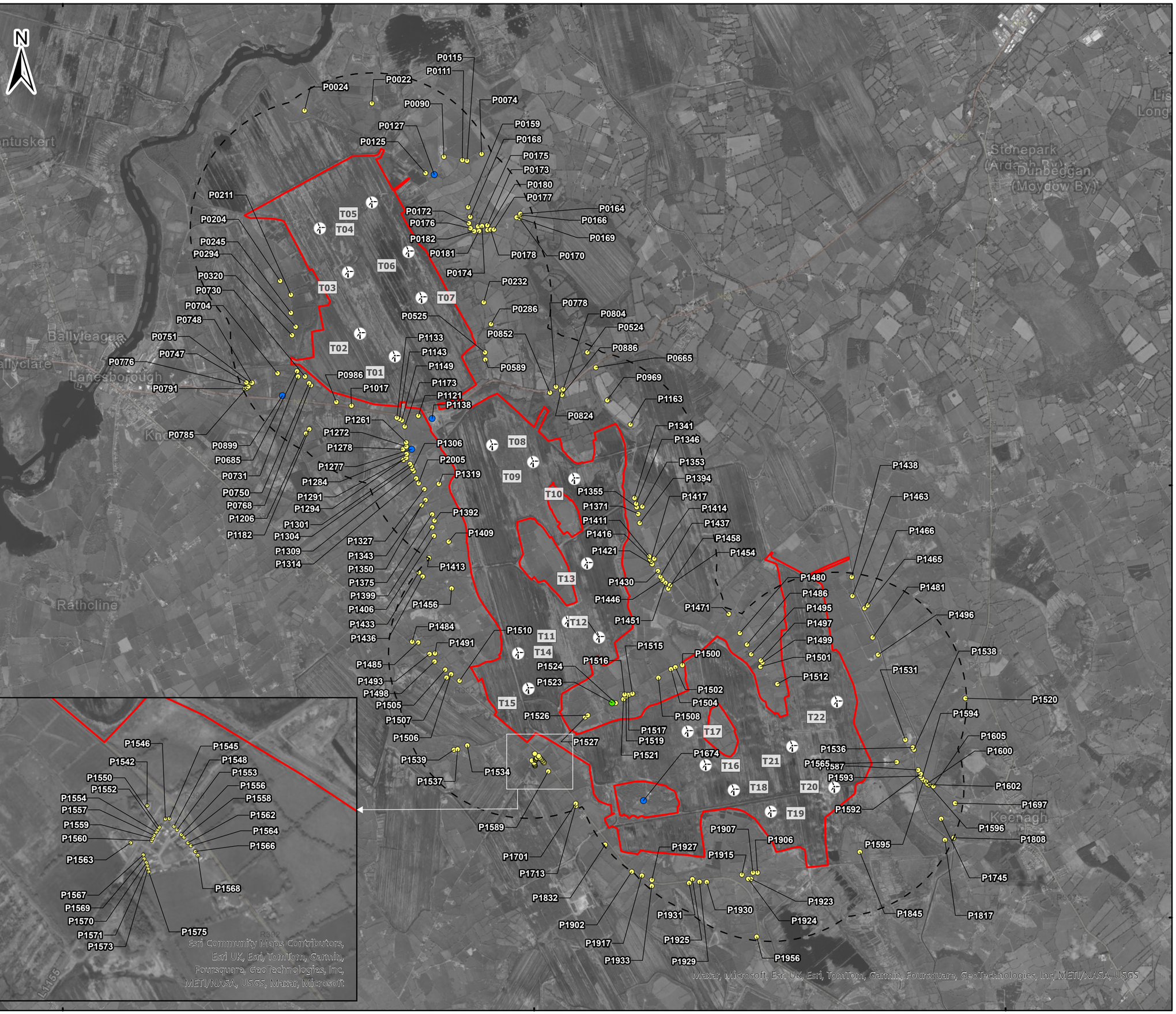
[4] Geodirectory address data captured in December 2022

8°0'0"W 7°54'0"W 7°48'0"W

53°42'50"N 53°39'40"N

773500 768000 762500

600000 606000 612000



Legend

- Proposed wind farm site boundary
- Turbine Layout
- Shadow flicker study area - 1.65km from turbine locations

Receptors

- Residential
- Commercial
- Other

0 1 2
Kilometres

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING\
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE\
3. ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES\
4. ALL LEVELS RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

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Client: Bord na Móna

Project: Derryadd Wind Farm

Title: Figure 17-2 Shadow Flicker Assessment Area

Scale @ A3: 1:45,000

Prepared by:	Checked by:	Date:
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Map Ref: 11399-115-Shw.FI-SENS.R-TOB-A

Draft: A

17.4 POTENTIAL EFFECTS

17.4.1 Do-nothing Scenario

The shadow flicker effects examined in this Chapter are entirely dependent on the installation and operation of wind turbines at the proposed wind farm site. In the event that the proposed development does not proceed, there will be no shadow flicker effects.

17.4.2 Construction Phase

There are no potential effects relating to shadow flicker during the construction phase of the proposed development as shadow flicker can only occur when the turbine blades are installed and rotating.

17.4.3 Operation Phase

The shadow flicker model provides a detailed report and illustration of the potential shadow effects on the identified shadow flicker receptors. The full report is provided in Appendix 17.1.

Table 17-1 details the predicted maximum daily shadow flicker representing the maximum number of hours in any one day when shadow flicker will be experienced at a receptor in the worst-case conditions. The number of days where the predicted daily shadow flicker exceeds the 30 minutes per day threshold is also detailed. Based on the worst-case conditions, it is predicted that 115 no. shadow flicker receptors will experience daily shadow flicker in excess of the 2006 WEDGs threshold of 30 minutes per day.

The model inputs used to predict the daily shadow flicker levels have assumed worst-case conditions, including direct sunshine for the full duration of daylight hours throughout the year, that the turbine blades are always turning, that the turbine blades are always facing the receptors, the property has windows facing each turbine (i.e. 360 degree windows in 'greenhouse mode'), the property is always occupied and that there is no screening (vegetation or other obstacles). In reality, the actual occurrence and incidence of shadow flicker over the course of a day is likely to be significantly less than that the maximum predicted in Table 17-1.

Table 17-1 also details the total shadow flicker hours per year for comparison against the 2006 WEDG threshold of 30 hours per year. The *'Worst Case Annual Shadow Flicker'* column in Table 17-1 represents the worst-case scenario which assumes 100% sunshine on every day during daylight hours as well as worst-case wind conditions resulting in maximum shadow cast in the direction of a receptor for the entire year.

As noted in Section 17.2.3, the Met Éireann data for this region shows that the sun shines on average for only 30% of the daylight hours per year. Accordingly, a sunshine reduction factor can be applied to account for the more realistic sunshine probability at the site. Additionally, as it is not possible for all turbines to face directly towards sensitive receptors at all times and wind direction is subject to change, a wind direction reduction factor can also be applied to the worst-case annual shadow flicker results. The WindPRO modelling software has built-in options to specify statistical weather data to produce more realistic (referred to as 'Expected' in the modelling software) predictions of annual shadow flicker effects. These predicted results are presented in the column titled *'Expected Annual Shadow Flicker'* in Table 17-1.

The technical assessment below (Table 17.1) shows that the guideline threshold limit of 30 hrs per year is predicted to be exceeded at 95 no. receptors in the worst-case scenario but is not exceeded at any receptors when the statistical sunshine probability and wind reduction factors are taken into account. Therefore, the realistic 'Expected Values' for shadow flicker at the identified receptors are significantly reduced from the worst-case scenario.

For the operational phase of the proposed wind farm, the potential effect from shadow flicker in the worst-case scenario and before mitigation measures are applied at a defined number of receptors as set out in Table 17-1 will be likely, significant and long-term, with any individual occurrences of shadow flicker being momentary to brief in duration.

As per Table 17-1, there are some identified receptors where no shadow flicker effect will occur and therefore there will be no impact.

Section 17.5 below details the mitigation measures which will be employed at the potentially affected properties to ensure that the current adopted 2006 DoEHLG guidelines are complied with at any sensitive receptors within the study area. The same mitigation measures also demonstrate that the proposed Derryadd Wind Farm can be operated in accordance with the shadow flicker requirements of the Draft Revised Wind Energy Development Guidelines (2019), i.e. zero shadow flicker occurrences, should they be adopted while the planning application is being determined.

Table 17-1 - Predicted daily and annual shadow flicker effects

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P0022	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P0024	Sensitive Receptor (Dwelling)	00:27	0	16:22	02:17
P0074	Sensitive Receptor (Dwelling)	00:24	0	24:33	03:42
P0090	Sensitive Receptor (Dwelling)	00:41	21	33:04	05:14
P0111	Sensitive Receptor (Dwelling)	00:30	4	21:49	03:31

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P0115	Sensitive Receptor (Dwelling)	00:29	0	25:35	04:00
P0125	Sensitive Receptor (Dwelling)	00:50	55	56:50	09:22
P0159	Sensitive Receptor (Dwelling)	00:53	44	61:12	10:19
P0164	Sensitive Receptor (Dwelling)	00:24	0	25:58	04:10
P0166	Sensitive Receptor (Dwelling)	00:24	0	26:21	04:13
P0168	Sensitive Receptor (Dwelling)	00:54	37	70:57	11:57
P0169	Sensitive Receptor (Dwelling)	00:29	0	30:02	04:49
P0170	Sensitive Receptor (Dwelling)	00:24	0	27:01	04:20
P0172	Sensitive Receptor (Dwelling)	00:51	71	81:04	13:33
P0173	Sensitive Receptor (Dwelling)	00:39	38	64:10	10:21
P0174	Sensitive Receptor (Dwelling)	00:39	62	73:32	11:52
P0175	Sensitive Receptor (Dwelling)	00:40	61	78:53	12:47

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P0176	Sensitive Receptor (Dwelling)	00:45	86	88:50	14:38
P0177	Sensitive Receptor (Dwelling)	00:41	27	54:15	08:48
P0178	Sensitive Receptor (Dwelling)	00:42	34	58:27	09:28
P0180	Sensitive Receptor (Dwelling)	00:42	42	64:07	10:22
P0181	Sensitive Receptor (Dwelling)	00:44	74	81:42	13:11
P0182	Sensitive Receptor (Dwelling)	00:45	93	90:53	14:46
P0204	Sensitive Receptor (Dwelling)	00:57	48	55:04	10:28
P0211	Sensitive Receptor (Dwelling)	00:51	110	100:17	19:01
P0232	Sensitive Receptor (Dwelling)	00:59	66	85:28	16:21
P0245	Sensitive Receptor (Dwelling)	00:42	59	69:12	12:39
P0286	Sensitive Receptor (Dwelling)	00:44	44	56:22	10:54
P0294	Sensitive Receptor (Dwelling)	00:46	38	63:45	11:41

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P0320	Sensitive Receptor (Dwelling)	00:44	34	54:27	10:23
P0524	Sensitive Receptor (Dwelling)	00:23	0	15:06	02:21
P0525	Sensitive Receptor (Dwelling)	00:32	10	26:04	05:00
P0589	Sensitive Receptor (Dwelling)	00:33	10	31:23	05:58
P0665	Sensitive Receptor (Dwelling)	00:23	0	19:21	02:57
P0685	Sensitive Receptor (Dwelling)	00:44	63	60:24	11:36
P0704	Sensitive Receptor (Dwelling)	00:36	24	37:53	07:32
P0730	Sensitive Receptor (Dwelling)	00:33	12	32:16	06:12
P0731	Sensitive Receptor (Dwelling)	00:36	34	41:05	07:50
P0747	Sensitive Receptor (Dwelling)	00:27	0	14:34	02:58
P0748	Sensitive Receptor (Dwelling)	00:28	0	16:51	03:25
P0750	Sensitive Receptor (Dwelling)	00:34	16	26:47	05:16

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P0751	Sensitive Receptor (Dwelling)	00:27	0	16:35	03:22
P0768	Sensitive Receptor (Dwelling)	00:35	20	25:42	05:07
P0776	Sensitive Receptor (Dwelling)	00:25	0	15:29	03:07
P0778	Sensitive Receptor (Dwelling)	00:37	29	41:40	06:48
P0785	Sensitive Receptor (Dwelling)	00:24	0	14:46	02:59
P0791	Sensitive Receptor (Dwelling)	00:23	0	13:55	02:48
P0804	Sensitive Receptor (Dwelling)	00:35	20	38:33	06:16
P0824	Sensitive Receptor (Dwelling)	00:35	24	42:32	06:57
P0852	Sensitive Receptor (Dwelling)	00:40	38	42:14	06:45
P0886	Sensitive Receptor (Dwelling)	00:36	44	51:42	08:19
P0969	Sensitive Receptor (Dwelling)	00:32	13	24:47	03:55
P0986	Sensitive Receptor (Dwelling)	00:21	0	13:38	02:27

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1017	Sensitive Receptor (Dwelling)	00:18	0	04:19	00:44
P1121	Sensitive Receptor (Dwelling)	00:38	24	21:24	03:43
P1133	Sensitive Receptor (Dwelling)	00:30	3	12:52	02:11
P1143	Sensitive Receptor (Dwelling)	00:31	6	13:47	02:21
P1149	Sensitive Receptor (Dwelling)	00:31	9	14:43	02:31
P1163	Sensitive Receptor (Dwelling)	00:41	42	51:44	08:02
P1173	Sensitive Receptor (Dwelling)	00:34	12	17:46	03:04
P1182	Sensitive Receptor (Dwelling)	00:12	0	01:52	00:19
P1206	Sensitive Receptor (Dwelling)	00:11	0	01:42	00:18
P1261	Sensitive Receptor (Dwelling)	00:35	17	24:53	04:35
P1272	Sensitive Receptor (Dwelling)	00:34	18	25:24	04:48
P1278	Sensitive Receptor (Dwelling)	00:33	14	23:55	04:34

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1284	Sensitive Receptor (Dwelling)	00:35	18	26:59	05:13
P1291	Sensitive Receptor (Dwelling)	00:34	18	27:12	05:16
P1294	Sensitive Receptor (Dwelling)	00:34	14	25:40	04:58
P1301	Sensitive Receptor (Dwelling)	00:36	22	31:10	06:04
P1304	Sensitive Receptor (Dwelling)	00:37	24	33:05	06:28
P1306	Sensitive Receptor (Dwelling)	00:37	27	34:48	06:54
P1309	Sensitive Receptor (Dwelling)	00:38	29	36:54	07:22
P1314	Sensitive Receptor (Dwelling)	00:38	37	48:33	09:36
P1319	Sensitive Receptor (Dwelling)	00:35	31	51:09	09:24
P1327	Sensitive Receptor (Dwelling)	00:40	42	53:05	09:58
P1341	Sensitive Receptor (Dwelling)	00:52	101	92:18	16:14
P1343	Sensitive Receptor (Dwelling)	00:27	0	23:05	04:25

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1346	Sensitive Receptor (Dwelling)	00:48	133	113:06	19:35
P1350	Sensitive Receptor (Dwelling)	00:25	0	19:31	03:46
P1353	Sensitive Receptor (Dwelling)	00:43	91	84:55	14:44
P1355	Sensitive Receptor (Dwelling)	00:46	149	114:46	19:47
P1371	Sensitive Receptor (Dwelling)	00:45	119	102:11	17:29
P1375	Sensitive Receptor (Dwelling)	00:27	0	29:03	05:32
P1392	Sensitive Receptor (Dwelling)	00:28	0	37:59	07:04
P1394	Sensitive Receptor (Dwelling)	00:47	79	91:10	15:24
P1399	Sensitive Receptor (Dwelling)	00:26	0	33:53	06:16
P1406	Sensitive Receptor (Dwelling)	00:18	0	23:03	04:09
P1409	Sensitive Receptor (Dwelling)	00:21	0	17:37	03:13
P1411	Sensitive Receptor (Dwelling)	00:48	42	77:00	12:43

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1413	Sensitive Receptor (Dwelling)	00:24	0	30:36	04:53
P1414	Sensitive Receptor (Dwelling)	00:45	62	71:06	11:39
P1416	Sensitive Receptor (Dwelling)	00:47	69	79:24	13:13
P1417	Sensitive Receptor (Dwelling)	00:47	73	77:30	12:56
P1421	Sensitive Receptor (Dwelling)	00:46	85	80:52	13:35
P1430	Sensitive Receptor (Dwelling)	00:46	72	80:24	13:31
P1433	Sensitive Receptor (Dwelling)	00:24	0	28:36	04:38
P1436	Sensitive Receptor (Dwelling)	00:25	0	32:54	05:20
P1437	Sensitive Receptor (Dwelling)	00:46	62	71:42	12:16
P1438	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1446	Sensitive Receptor (Dwelling)	00:43	57	65:21	11:23
P1451	Sensitive Receptor (Dwelling)	00:38	48	59:03	10:27

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1454	Sensitive Receptor (Dwelling)	00:36	39	51:44	09:16
P1456	Sensitive Receptor (Dwelling)	00:35	24	53:40	08:20
P1458	Sensitive Receptor (Dwelling)	00:37	39	56:42	10:16
P1463	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1465	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1466	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1471	Sensitive Receptor (Dwelling)	00:21	0	18:53	03:16
P1480	Sensitive Receptor (Dwelling)	00:26	0	18:59	03:21
P1481	Sensitive Receptor (Dwelling)	00:58	42	37:07	05:16
P1484	Sensitive Receptor (Dwelling)	00:28	0	24:20	04:26
P1485	Sensitive Receptor (Dwelling)	00:29	0	27:59	05:06
P1486	Sensitive Receptor (Dwelling)	00:29	0	34:53	05:40

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1491	Sensitive Receptor (Dwelling)	00:44	18	42:40	08:04
P1493	Sensitive Receptor (Dwelling)	00:42	12	37:43	07:08
P1495	Sensitive Receptor (Dwelling)	00:33	41	51:26	08:08
P1496	Sensitive Receptor (Dwelling)	00:52	96	70:54	10:25
P1497	Sensitive Receptor (Dwelling)	00:35	25	41:14	06:38
P1498	Sensitive Receptor (Dwelling)	00:40	22	42:23	08:05
P1499	Sensitive Receptor (Dwelling)	00:36	23	40:20	06:36
P1500	Sensitive Receptor (Dwelling)	00:40	25	38:39:00	07:20
P1501	Sensitive Receptor (Dwelling)	00:36	32	41:25:00	06:49
P1502	Sensitive Receptor (Dwelling)	00:41	31	49:13:00	09:16
P1504	Sensitive Receptor (Dwelling)	00:41	57	69:50:00	12:43
P1505	Sensitive Receptor (Dwelling)	00:48	57	56:02:00	10:44

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1506	Sensitive Receptor (Dwelling)	01:00	73	66:48	12:55
P1507	Sensitive Receptor (Dwelling)	00:55	60	59:05	11:29
P1508	Sensitive Receptor (Dwelling)	01:08	100	106:47	17:34
P1510	Sensitive Receptor (Dwelling)	00:57	120	105:02	20:02
P1512	Sensitive Receptor (Dwelling)	00:48	76	84:35	13:32
P1515	Sensitive Receptor (Dwelling)	00:46	68	79:24	13:32
P1516	Sensitive Receptor (Dwelling)	00:42	27	67:52	12:06
P1517	Sensitive Receptor (Dwelling)	00:44	48	72:34	12:44
P1519	Sensitive Receptor (Dwelling)	00:43	30	69:17	12:22
P1520	Sensitive Receptor (Dwelling)	00:20	0	10:18	01:45
P1521	Sensitive Receptor (Dwelling)	00:42	32	67:57	12:18
P1523	Sensitive Receptor (School)	00:41	37	71:43	13:21

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1524	Sensitive Receptor (Dwelling)	00:43	36	69:16	12:49
P1526	Sensitive Receptor (Dwelling)	00:49	92	88:32	16:46
P1527	Sensitive Receptor (Dwelling)	00:51	81	87:07	16:27
P1531	Sensitive Receptor (Dwelling)	00:48	88	82:57	15:11
P1534	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1536	Sensitive Receptor (Dwelling)	00:39	66	63:36	11:46
P1537	Sensitive Receptor (Dwelling)	00:03	0	00:44	00:08
P1538	Sensitive Receptor (Dwelling)	00:37	53	59:22	10:59
P1539	Sensitive Receptor (Dwelling)	00:07	0	02:04	00:22
P1542	Sensitive Receptor (Dwelling)	00:17	0	06:08	01:10
P1545	Sensitive Receptor (Dwelling)	00:17	0	06:25	01:13
P1546	Sensitive Receptor (Dwelling)	00:17	0	06:20	01:12

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1548	Sensitive Receptor (Dwelling)	00:17	0	06:27	01:14
P1550	Sensitive Receptor (Dwelling)	00:16	0	06:11	01:11
P1552	Sensitive Receptor (Dwelling)	00:17	0	06:13	01:11
P1553	Sensitive Receptor (Dwelling)	00:17	0	07:39	01:26
P1554	Sensitive Receptor (Dwelling)	00:17	0	06:17	01:12
P1556	Sensitive Receptor (Dwelling)	00:17	0	07:41	01:27
P1557	Sensitive Receptor (Dwelling)	00:16	0	06:09	01:10
P1558	Sensitive Receptor (Dwelling)	00:17	0	07:42	01:27
P1559	Sensitive Receptor (Dwelling)	00:16	0	06:05	01:09
P1560	Sensitive Receptor (Dwelling)	00:17	0	06:06	01:09
P1562	Sensitive Receptor (Dwelling)	00:17	0	07:51	01:28
P1563	Sensitive Receptor (Dwelling)	00:15	0	05:42	01:05

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1564	Sensitive Receptor (Dwelling)	00:17	0	07:57	01:30
P1565	Sensitive Receptor (Dwelling)	00:45	106	43:04:00	07:48
P1566	Sensitive Receptor (Dwelling)	00:17	0	08:08	01:32
P1567	Sensitive Receptor (Dwelling)	00:16	0	06:02	01:09
P1568	Sensitive Receptor (Dwelling)	00:18	0	08:12	01:32
P1569	Sensitive Receptor (Dwelling)	00:16	0	05:50	01:06
P1570	Sensitive Receptor (Dwelling)	00:16	0	06:04	01:09
P1571	Sensitive Receptor (Dwelling)	00:16	0	06:05	01:09
P1573	Sensitive Receptor (Dwelling)	00:16	0	05:58	01:08
P1575	Sensitive Receptor (Dwelling)	00:16	0	06:06	01:09
P1587	Sensitive Receptor (Dwelling)	00:40	17	26:08:00	04:41
P1589	Sensitive Receptor (Dwelling)	00:18	0	09:00	01:44

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1592	Sensitive Receptor (Dwelling)	00:41	14	25:35:00	04:36
P1593	Sensitive Receptor (Dwelling)	00:39	16	26:03:00	04:42
P1594	Sensitive Receptor (Dwelling)	00:36	15	25:10:00	04:34
P1595	Sensitive Receptor (Dwelling)	00:34	13	24:23:00	04:29
P1596	Sensitive Receptor (Dwelling)	00:33	12	23:18	04:18
P1600	Sensitive Receptor (Dwelling)	00:32	9	22:36	04:13
P1602	Sensitive Receptor (Dwelling)	00:32	8	21:32	04:02
P1605	Sensitive Receptor (Dwelling)	00:30	2	19:20	03:39
P1697	Sensitive Receptor (Dwelling)	00:24	0	11:05	02:12
P1701	Sensitive Receptor (Dwelling)	00:23	0	29:05:00	05:33
P1713	Sensitive Receptor (Dwelling)	00:23	0	27:41:00	05:17
P1745	Sensitive Receptor (Dwelling)	00:27	0	17:08	03:24

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1817	Sensitive Receptor (Dwelling)	00:25	0	17:57	03:38
P1832	Sensitive Receptor (Dwelling)	00:19	0	11:24	02:17
P1845	Sensitive Receptor (Dwelling)	00:39	15	24:28:00	04:58
P1902	Sensitive Receptor (Dwelling)	00:06	0	01:53	00:20
P1906	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1907	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1915	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1917	Sensitive Receptor (Dwelling)	00:19	0	06:51	01:23
P1923	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1924	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1925	Sensitive Receptor (Dwelling)	00:16	0	09:23	01:45
P1927	Sensitive Receptor (Dwelling)	00:21	0	11:01	02:11

Property / Receptor ID	Description	Worst Case Scenario			Expected (Realistic Annual Shadow Flicker [hrs:mins / year]
		Maximum Daily Shadow Flicker [hrs:mins / day]	No. of Days exceeding 30 mins / day threshold	Annual Shadow Flicker [hrs:mins / year]	
P1929	Sensitive Receptor (Dwelling)	00:16	0	09:54	01:49
P1930	Sensitive Receptor (Dwelling)	00:12	0	05:50	01:04
P1931	Sensitive Receptor (Dwelling)	00:15	0	09:58	01:51
P1933	Sensitive Receptor (Dwelling)	00:21	0	15:43	02:58
P1956	Sensitive Receptor (Dwelling)	00:00	0	00:00	00:00
P1808	Sensitive Receptor (Dwelling)	00:23	0	13:12	02:42
P2005	Sensitive Receptor (Dwelling)	00:39	73	56:24:00	10:55

17.4.4 Decommissioning Phase

There are no potential effects relating to shadow flicker during the decommissioning phase of the proposed wind farm as shadow flicker can only occur when the turbine blades are installed and rotating. Turbines would not be rotating during this phase.

17.5 MITIGATION MEASURES

Where daily shadow flicker exceedances have been predicted at buildings by the modelling software, a site visit will be undertaken firstly to determine the level of occurrence, existing screening and window orientation. The shadow flicker prediction data will be used to select dates on which a shadow flicker event could be observed at one or multiple affected properties and the following process will be followed.

1. Recording the weather conditions at the time of the site visit, including wind speeds and direction (i.e. blue sky, intermittent clouds, overcast, moderate breeze, light breeze, still etc.);

2. Recording the house number, time and duration of site visit and the observation point GPS coordinates;
3. Recording the nature of the sensitive receptor, its orientation, windows, landscaping in the vicinity, any elements of the built environment in the vicinity, vegetation; and,
4. In the event of shadow flicker being noted as occurring the details of the duration (times) of the occurrence will be recorded.

17.5.1 Screening Measures

The shadow flicker modelling predicts worst-case 'bare earth' conditions without vegetation (including forestry), buildings or other obstacles. In reality, existing screening in the form of buildings, vegetation and local topographic variations will have an influence on the level of shadow flicker that will actually be experienced by the identified shadow flicker receptors. When these additional screening features are taken into account, the actual effect in terms of incidence and duration may be significantly reduced or even eliminated.

In the event of an occurrence of shadow flicker exceeding guideline threshold values of 30 minutes per day at residential receptor locations. Bord na Móna will engage with any affected residents to investigate options for new or additional screening measures (such as planting), where appropriate, and agreeable to the affected residents, mitigation options will be discussed with the affected homeowner, including the following:

- Installation of appropriate window blinds in the affected rooms of the residence;
- Planting of screening vegetation;
- Other site-specific measures which might be agreeable to the affected party and may lead to the desired mitigation.

If agreement can be reached with the homeowner, then it would be arranged for the required mitigation to be implemented in cooperation with the affected party as soon as practically possible and for the full costs to be borne by the wind farm operator.

Where agreed screening measures are implemented, the effectiveness of the measures will be monitored and if the measures are not functioning to the satisfaction of the property owner/occupant, they will be included in the Turbine Shutdown Scheme as set out in Section 17.5.2 below.

A system for logging complaints related to shadow flicker will be put in place in advance of the commissioning of the proposed wind farm, and details of the process will be made available to local residents.

17.5.2 Turbine Shutdown Scheme

Shadow flicker control units will be installed as standard practice to automatically shut-down individual turbines during periods of predicted shadow flicker to prevent its occurrence at relevant receptors adjacent to the proposed wind farm. The shadow flicker control units will be added to any required turbines and are not cost prohibitive.

A shadow flicker control unit allows a wind farm's turbines to be programmed and controlled using the wind farm's SCADA control system to change a particular turbine's operating mode during certain conditions or times, or even turn the turbine off if necessary. All predicted incidents of shadow flicker can be pre-programmed into the wind farm's control software. The

wind farm's SCADA control system can be programmed to shut down any particular turbine at any particular time on any given day to ensure that shadow flickers occurrences at properties which are not naturally screened or cannot be screened with measures outlined above. Where such wind turbine control measures are to be utilised, they need only be implemented when the specific combined circumstances occur that are necessary to give rise to the shadow flicker effect in the first instance. Therefore, if the sun is not shining on a particular day that shadow flicker was predicted to occur at a nearby property, there would be no need to shut down the relevant turbines that would have given rise to the shadow flicker at the property. Similarly, if the wind speed was below the cut-in speed that caused the turbine rotor to rotate and give rise to a shadow flicker effect at a nearby property, there would be no need to shut down the relevant turbines that otherwise would have caused shadow flicker.

The atmospheric variables that determine whether shadow flicker will occur or not, will be continuously monitored at the wind farm site and the data fed into the wind farm's SCADA control system. The strength of direct sunlight is measured by way of photocells, and if the sunlight is of sufficient strength to cast a shadow, the shadow flicker control mechanisms come into effect. Wind speed and direction are measured by anemometers and wind vanes on each turbine and on the wind farm's met mast, and if wind speed and direction is such that a shadow will be cast, the shadow flicker control mechanisms come into effect. The moving blades of the turbine will require a short period of time to cease rotating and as such there may be a very short period (less than 3 to 5 minutes) during which the blades are slowed to a complete halt.

Essentially, this Turbine Shutdown Scheme will be the primary mitigation measure for shadow flicker effect and will be implemented for the proposed development based on the predicted shadow flicker at each shadow flicker receptor. The Turbine Shutdown Scheme will be employed to ensure that shadow flicker does not occur at the affected property(s).

These measures will be utilised at the proposed wind farm to prevent incidences of shadow flicker at any house if required. Therefore, the Derryadd Wind Farm could be brought in line with the requirements of the Draft Revised Wind Energy Development Guidelines 2019 should they come into force while the planning application is being considered by An Bord Pleanála.

Should a complaint be received within 12 months of commissioning of the wind farm, field investigation/monitoring will be carried out by Bord na Móna at the affected property. Notwithstanding the approach set out above should shadow flicker associated with the permitted development be perceived to cause a nuisance at any home, the affected homeowner is invited to engage with the Bord na Móna. The homeowner will be asked to log the date, time and duration of shadow flicker events occurring on at least five different days. The provided log will be compared with the predicted occurrence of shadow flicker at the residence, and if necessary, a field investigation will be carried out. A process will be established by Bord na Móna whereby local residents can highlight any concerns or complaints about the operation of the scheme. All concerns raised will be investigated by Bord na Móna and the turbine shutdown software adjusted accordingly, as required.

During the commissioning phase, there is potential for some shadow flicker to be experienced as the shadow flicker management software is installed and refined. However, the commissioning team will ensure that the maximum daily limit of 30 minutes per day is not exceeded during this temporary commissioning period.

17.6 RESIDUAL EFFECTS

The Bord na Móna is committed to minimising any adverse effects from the proposed wind farm on the local community. The implementation of mitigation measures, to screen shadow flicker effects from sensitive receptors and/or implement wind turbine control measures in accordance with a defined Turbine Shutdown Scheme, will ensure that any residual shadow flicker effects from the wind farm will be limited to less than 30 minutes per day (2006 WEDGs) at all shadow flicker receptors.

As noted previously, the immediate shutdown of a turbine(s) is subject to the technical capabilities of turbine technology where a controlled and safe slow-down of blade rotation is required.

Once the proposed mitigation measures are considered, the residual effect of shadow flicker on the identified receptors will be not significant and long-term, with any individual occurrence being a momentary effect with respect to the duration (maximum 30 minutes).

During commissioning, the shadow flicker effect on the identified receptors will be slight over a temporary period and will have a momentary to brief effect with respect to the duration. There will be no effects during the rest of the construction phase, or during the decommissioning phase.

17.7 CUMULATIVE EFFECTS

The shadow flicker model includes the predicted shadow flicker effect from the proposed development. There are no other permitted or planned wind farms within 5 km of the proposed turbine locations which could contribute to shadow flicker effects[5]. Therefore, no cumulative shadow flicker effects will occur in combination with other projects.

17.8 SUMMARY

The incorporation of set-back distances from the proposed turbines to properties, which have been considered and implemented in the design of the wind farm layout, means that there are no sensitive receptors located within 760 m of a proposed turbine location. The closest residential receptor is located approximately 780 m from a proposed turbine location. This design measure, along with the implementation of screening and turbine shutdown mitigation measures as detailed in section 17.5, will ensure that there are no significant post-mitigation effects of shadow flicker on the local community. It is also noted that the modelled shadow flicker effects in this assessment are based on worst-case conditions and, as a result, are highly conservative and overestimate the potential for, frequency and duration of the effects.

There are no construction phase effects. During the operational phase, mitigation measures will be implemented to minimise any adverse effects from the turbines. The operational software used to automatically stop turbines will be installed as standard practice and the implementation of the Turbine Shutdown Scheme as set out in section 17.5.2.

[5] No wind energy development submitted for planning or approved based on search of planning records conducted in November 2024.

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