- " *Wind Turbine Syndrome" symptoms are the same as those seen in the general population due to stresses of daily life. They include headaches, insomnia, anxiety, dizziness, etc.*
- *Low frequency and very low-frequency 'infrasound' produced by wind turbines are the same as those produced by vehicular traffic and home appliances, even by the beating of people's hearts. Such 'infrasound's' are not special and convey no risk factors.*
- *The power of suggestion, as conveyed by news media coverage of perceived 'wind-turbine sickness', might have triggered 'anticipatory fear' in those close to turbine installations."*

3. ***'A Rapid Review of the Evidence',*** *Australian Government National Health and Medical Research Council (NHMRC) Wind Turbines & Health, July 2010*

The purpose of this paper was to review evidence from current literature on the issue of wind turbines and potential impacts on human health and, in particular, to validate the finding of the *'Wind Turbine Sound and Health Effects - An Expert Panel Review'* (see Item 2 above) that:

- *" There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines. "*
- *There is currently no published scientific evidence to positively link wind turbines with adverse health effects.*
- *'This review of the available evidence, including journal articles, surveys, literature reviews and government reports, supports the statement that: There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines."*

4. ***Position Statement on Health and Wind Turbines',*** *Climate and Health Alliance, (February 2012)*

The Climate and Health Alliance (CAHA) was established in August 2010 and is a coalition of health care stakeholders who wish to see the threat to human health from climate change and ecological degradation addressed through prompt policy action. In its Position Statement in February 2012, CAHA states that:

"To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to them. There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency. There is no evidence in the peer reviewed published scientific literature that suggests that there are any adverse health effects from infrasound (a component of low frequency sound) at the low levels that may be emitted by wind turbines."

The Position Statement explores human perceptions of wind energy and notes that some people may be predisposed to some form of negative perception that itself may cause annoyance. It states that:

"Fear and anxious anticipation of potential negative impacts of wind farms can also contribute to stress responses, and result in physical and psychological stress symptoms... Local concerns about wind farms can be related to perceived threats from changes to their place and can be considered a form of "place-protection action", recognised in psychological research about the importance of place and people's sense of identity. "

CAHA notes the existence of "*misinformation about wind power"* and, in particular, states that:

'Some of the anxiety and concern in the community stems originally from a self-published book by an anti-wind farm activist in the United States which invented a syndrome, the so-called "wind turbine

syndrome". This is not a recognised medical syndrome in any international index of disease, nor has this publication been subjected to peer review."

CAHA notes that:

"Large scale commercial wind farms however have been in operation internationally for many decades, often in close proximity to thousands of people, and there has been no evidence of any significant rise in disease rates."

This, it states, is in contrast to the health impacts of fossil fuel energy generation.

5. ***'Wind Turbine Health Impact Study -Report of Independent Expert Panel' –*** *Massachusetts Departments of Environmental Protection and Public Health (2012)*

An expert panel was established with the objective to, *inter alia*, evaluate information from peer-reviewed scientific studies, other reports, popular media and public comments and to assess the magnitude and frequency of any potential impacts and risks to human health associated with the design and operation of wind energy turbines. In its final report, the expert panel set out its conclusions under a number of headings, including noise and shadow flicker.

In relation to noise, the panel concluded that there was limited or no evidence to indicate any causal link between noise from wind turbines and health effects, including the following conclusions:

- "There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."
- The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of psychological distress or mental health problems. There were two smaller, weaker, studies: one did note an association, one did not. Therefore, we conclude the weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.
- None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine."

In relation to shadow flicker, the expert panel found the following:

- "Scientific evidence suggests that shadow flicker does not pose a risk for eliciting seizures as a result of photic stimulation.
- There is limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects."

6. ***Wind Turbines and Health, A Critical Review of the Scientific Literature,*** *Massachusetts Institute of Technology (Journal of Occupational and Environmental Medicine Vol. 56, Number 11, November 2014)*

This review assessed the peer-reviewed literature regarding evaluations of potential health effects among people living in the vicinity of wind turbines. The review posed a number of questions around the effect of turbines on human health, with the aim of determining if stress, annoyance or sleep disturbance occur as a result of living in proximity to wind turbines, and whether specific aspects of wind turbine noise have unique potential health effects. The review concluded the following with regard to the above questions:

- Measurements of low-frequency sound, infrasound, tonal sound emission, and amplitude-modulated sound show that infrasound is emitted by wind turbines. The levels of infrasound at customary distances to homes are typically well below audibility thresholds.
- No cohort or case–control studies were located in this updated review of the peer-reviewed literature. Nevertheless, among the cross-sectional studies of better quality, no clear or consistent association is seen between wind turbine noise and any reported disease or other indicator of harm to human health.
- Components of wind turbine sound, including infrasound and low frequency sound, have not been shown to present unique health risks to people living near wind turbines.
- Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.

A further 25 reviews of the scientific evidence that universally conclude that exposure to wind farms and the sound emanating from wind farms does not trigger adverse health effects, were compiled in September 2015 by Professor Simon Chapman, of the School of Public Health and Sydney University Medical School, Australia, and is included as Appendix 5-2 of this EIAR. Another recent publication by Chapman and Crichton (2017) entitled ***'Wind turbine syndrome; A communicated disease'*** critically discusses why certain health impacts might often be incorrectly attributed to wind turbines.

7. ***Position Paper on Wind Turbines and Public Health HSE,*** *Public Health Medicine Environment and Health Group, February 2017*

The Health Service Executive (HSE) position paper on wind turbines and public health was published in February 2017 to address the rise in wind farm development and concerns regarding potential impacts on public health. The paper discusses previous observations and case studies which describe a broad range of health effects that are associated with wind turbine noise, shadow flicker and electromagnetic radiation.

A number of comprehensive reviews conducted in recent years to examine whether these health effects are proven has highlighted the lack of published and high-quality scientific evidence to support adverse effects of wind turbines on health.

The HSE position paper determines that current scientific evidence on adverse impacts of wind farms on health is weak or absent. Further research and investigative processes are required at a larger scale in order to be more informative for identifying potential health effects of exposure to wind turbine effects. They advise developers on making use of the Draft Revised Wind Energy Development Guidelines (2013), as a means of setting noise limits and set back distances from the nearest dwellings.

8. ***Environmental Noise Guidelines for the European Region.*** *World Health Organisation Regional Office for Europe, 2018.*

The WHO Environmental Noise Guidelines provide recommendations for protecting human health from exposure to environmental noise originating from various sources such as transportation noise, wind turbine noise and leisure noise. The Guideline Development Group (GDG) defined priority health outcomes and from this were able to produce guideline exposure levels for noise exposure.

For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB Lden. The GDG recognise the potential for increased risk of annoyance at levels below this value but cannot determine whether this increased risk can impact health. Wind turbine noise above this level is associated with adverse health effects.

The GDG points out that evidence on health effects from wind turbine noise (apart from annoyance) is either absent or rated low/very low quality and, therefore, effects related to attitudes towards wind

turbines are hard to differentiate from those related to noise and may be partly responsible for the associations. The GDG also recognises that the percentage of people exposed to noise from wind turbines is far lower than other sources such as road traffic and state that any benefit from specifically reducing population exposure to wind turbine noise in all situations remains unclear.

That being said, the GDG recommends renewable energy policies include provisions to ensure noise levels from wind farm developments do not rise above the guideline values for average noise exposure. The GDG also provides a conditional recommendation for the implementation of suitable measures to reduce noise exposure, however, it states that no evidence is available to facilitate the recommendation of one type of intervention over another.

9. ***The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive Health Adults' Woolcock Institute for Medical Research, New South Wales, Australia***

The purpose of this study was to examine the potential health effects of audible sound and inaudible infrasound has on noise sensitive adults over a period of 72 hours. Sufferers of wind turbine syndrome (WTS) have attributed their ill-health and particularly their sleep disturbance to the signature of infrasound. On this basis, the objectives of the study were to test the effects of 72 hours of infrasound exposure on human physiology, particularly sleep. The results of the study are outlined below:

- All staff and participants were asked whether they were able to differentiate in any way between infrasound and sham infrasound (the control), and none of them were able to.
- The study found that 72 hours of the simulated wind turbine infrasound (~90dB pk re 20 µPa) in controlled laboratory conditions did not worsen any measure of sleep quality compared with the same speakers being present but not generating infrasound (sham infrasound).
- The study found no evidence of that 72 hours of exposure to a sound level of ~90dB pk re 20 µPa of simulated wind turbine infrasound in double-blind conditions perturbed any physiological or psychological variable.
- None of the participants in the study who were exposed to infrasound developed what could be described as Wind Turbine Syndrome.
- This study suggests that the infrasound component of Wind Turbine Syndrome is unlikely to be a cause of any ill-health or sleep disruption, although this observation should be independently replicated.

5.6.2 Turbine Safety

Turbines pose no threat to the health and safety of the general public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s '*Wind Energy Development Guidelines for Planning Authorities 2006* and the Draft Wind Energy Development Guidelines (December 2019) iterate that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations and should be kept to a minimum. People or animals can safely walk up to the base of the turbines.

The 2006 Guidelines and 2019 draft Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The build-up of ice on turbines is unlikely to present problems. Wind turbines are fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to resuming operation.

Turbine blades are manufactured of glass reinforced plastic which will prevent any likelihood of an increase in lightning strikes within the Proposed Development site or the local area. Lightning

protection conduits are integral to the construction of turbines. Lightning conduction cables, encased in protection conduits, follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables are earthed adjacent to the turbine base.

5.6.3 Electromagnetic Interference

The provision of underground electric cables of the capacity proposed is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns.

The extremely low frequency (ELF) electric and magnetic fields (EMF) associated with the operation of the proposed cables fully comply with the international guidelines for ELF-EMF set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a formal advisory agency to the World Health Organisation, as well as the EU guidelines for human exposure to EMF. Accordingly, there will be no operational impact on properties (residential or other uses) as the ICNIRP guidelines will not be exceeded at any distances even directly above the cables. The EirGrid document '***EMF & You: Information about Electric & Magnetic Fields and the electricity Network in Ireland***' (EirGrid, 2017[14]) provides further practical information.

Further details on the potential impacts of electromagnetic interference to telecommunications and aviation are presented in Section 14.2 of this EIAR.

5.6.4 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government '***Key Issues Consultation Paper on the Transposition of the EIA Directive 2017***' and the guidance listed in Section 1.2.2 of Chapter 1: Introduction of this EIAR, the consideration of the effects on populations and on human health in an EIAR should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

Chapter 8: Land, Soils and Geology, Chapter 9: Water, Chapter 10: Air and Climate, Chapter 11: Noise and Vibration and Chapter 14: Material Assets (Traffic and Transport) of this EIAR provide an assessment of the effects of the Proposed Development on these areas of consideration.

As the existing Castledockrell Wind Farm is already operational and requires no additional infrastructure, the potential for health effects associated with the construction phase Proposed Development is not applicable.

The proposed measures outlined in Chapter 8 Land, Soils and Geology and Chapter 9 Hydrology and Hydrogeology ensures that the potential for impacts on the water environment are not significant. As mentioned in Chapter 9: Hydrology and Hydrogeology, there are no mapped public groundwater supplies or registered group scheme supplies in the area of the Proposed Development. Due to the existing nature of the original 11 Turbine wind farm, and lack of any construction, excavation or alteration works, the potential for impacts to surface water and groundwater is not likely. The chapter also notes that there are no watercourses or springs within the EIAR Site Boundary and the Proposed Development has very low potential for flood risk. Therefore, no effects on human health through water are likely as a result of the Proposed Development during the operational or decommissioning phase.

A wind farm is not a recognised source of pollution. It is not an activity which requires Environmental Protection Agency licensing under the Environmental Protection Agency Act 1992, as amended. As

[14] *EMF & You: Information about Electric & Magnetic Fields and the electricity network in Ireland Available at:* https://esb.ie/docs/default-source/default-document-library/emf-public-information_booklet_v9.pdf?sfvrsn=0

such, a wind farm is not considered to have ongoing significant emissions to environmental media and the subsequent potential for human health effects.

The Proposed Development is for the extension of lifetime the original 11 turbine wind farm, capable of offsetting carbon emissions associated with the burning of fossil fuels. During the operational phase, the wind farm has had, and will continue to have, a long term, significant, positive effect on air quality, as set out in Chapter 10, which will contribute to positive effects on human health.

The provision of aviation lighting on wind turbines is a standard and accepted part of any wind farm development. As such, aviation lighting is already in place on the turbines in this wind farm. This is a safety requirement of the Irish Aviation Authority (IAA). The standard lighting required by the IAA are medium intensity lights. Such lighting is designed specifically for aviation safety and is not intended to be overbearing or dominant when viewed from the ground thus striking a reasonable balance between aviation safety and visual impact.

It is considered that aviation lighting on the turbines will continue to have no significant effect on human health, beyond increasing aircraft safety in the context of the Proposed Development. The applicant will continue its engagement with IAA as required in relation to aviation lighting.

5.6.5 Vulnerability of the Project to Natural Disaster and Major Accidents

An assessment of the Proposed Development's vulnerability to natural disasters can be found in Chapter 15 of this EIAR. A brief discussion can be found below.

As outlined above a wind farm is not a recognised source of pollution. Should a major accident or natural disaster occur, the potential sources of pollution on-site during the operational and decommissioning phases, are limited. Sources of pollution with the potential to cause significant environmental pollution and associated negative effects on health, such as bulk storage of hydrocarbons or chemicals, storage of wastes etc., are limited.

There is limited potential for significant natural disasters to occur at the Proposed Development site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding, fire, and landslide events. The risk of flooding is addressed in Chapter 9 of this EIAR. It is considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited. As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for impacts on human health. The issue of turbine safety is addressed in Section 5.6.2 above.

Major industrial accidents involving dangerous substances pose a significant threat to humans and the environment; such accidents can give rise to serious injury to people or serious damage to the environment, both on and off the site of the accident. The Proposed Development is not regulated or connected to or close to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e., SEVESO sites and so there is no potential effects from this source. The nearest SEVESO sites to the Proposed Development site is Nitrofert Ltd., located over 31 kilometres southwest of the Proposed Development.

5.7 Property Values

There is currently only one study within the context of Ireland detailing the effect of wind farms on property values. this section provides a summary of this paper by the centre for Economic Research on Inclusivity and Sustainability (CERIS), as well as summaries on the largest and most recent studies from the United States and Scotland.

In 2023 CERIS published a working paper entitled ***'Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach'***. This paper looked at wind turbine developments in Donegal, Leitrim, Sligo, Mayo, Galway, Kerry and Cork and associated property values. This working paper utilised satellite imagery to identify individual turbines and sourced its housing data from www.daft.ie; while the published price on Daft is not equivalent to the final agreed sale price, it was assumed that the listing and transaction prices are correlated. The findings of this research revealed a potential decrease in property values of -14.7% within a 0-1km radius of a wind turbine. However, the sample size of only 225 houses within this range does not adequately represent the broader landscape of Irish rural housing and the distribution of wind turbines. The author states that there are 'no significant reduction in house prices beyond 1km' and that the effects seen within the 1km band were not persistent and diminished over the operational lifetime of the turbines.

The largest study of the impact of wind farms on property values has been carried out in the United States. 'The Impact of Wind Power Projects on Residential Property Values in the United States: A multi-Site Hedonic Analysis', December 2009, was carried out by the Lawrence Berkley National Laboratory (LBNL) for the U.S Department of Energy. This study collected data on almost 7,500 sales of single-family homes situated within ten miles of 24 existing wind farms in nine different American states over a period of approximately ten years. The conclusions of the study are drawn from eight different pricing models including repeat sales and volume sales models. Each of the homes included in the study was visited to demonstrate the degree to which the wind facility was visible at the time of the sale, and the conclusions of the report state that "The result is the most comprehensive and data rich analysis to date on the potential impacts of wind energy projects on nearby property values."

The main conclusion of this study is as follows:

> *"Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact."*

This study has been recently updated by LBNL who published a further paper entitled "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States", in August 2013. This study analysed more than 50,000 home sales near 67 wind farms in 27 counties across nine U.S. States yet was unable to uncover any impacts to nearby home property values. The homes were all within 10 miles of the wind energy facilities - about 1,100 homes were within 1 mile, with 331 within half a mile. The report is therefore based on a very large sample and represents an extremely robust assessment of the impacts of wind farm development on property prices. It concludes that:

> *"Across all model Specifications, we find no statistical evidence that home prices near wind turbines were affected in either the post-construction or post announcement/pre-construction periods."*

Both LBNL studies note that their results do not mean that there will never be a case of an individual home whose value goes down due to its proximity to a wind farm – however if these situations do exist, they are considered to be statistically insignificant. Therefore, although there have been claims of

significant property value impacts near operating wind turbines that regularly surface in the press or in local communities, strong evidence to support those claims has failed to materialise in all the major U.S. studies conducted thus far.

A further study was commissioned by RenewableUK and carried out by the Centre for Economics and Business Research (CEBR) in March 2014. Its main conclusions are:

- Overall, the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.
- The econometric analysis established that construction of wind farms at the five sites examined across England and Wales has not had a detectable negative impact on house price growth within a five-kilometre radius of the sites.

A study issued in October 2016 'Impact of Wind Turbines on House Prices in Scotland' (2016) was published by Climate Exchange. Climate Exchange is Scotland's independent centre of expertise on climate change which exists to support the Scottish Governments policy development on climate and the transition to a low carbon economy. A copy of the report is included as Appendix 5-3 of this EIAR.

The report presents the main findings of a research project estimating the impact on house prices from wind farm developments. It is based on analysis of over 500,000 property sales in Scotland between 1990 and 2014. The key findings from the study are:

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by Gibbons (2014[15]), we do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.
- Results vary across areas: The results vary across different regions of Scotland. Our data does not provide sufficient information to enable us to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

Although there have been no empirical studies carried out in Ireland on the impacts of wind farms on property prices, the literature described above demonstrates that at an international level, wind farms have not impacted property values in the local areas. It is a reasonable assumption based on the available international literature, that the provision of a wind farm at the proposed location would not impact on the property values in the area.

5.8 Shadow Flicker

5.8.1 Background

Shadow flicker is a phenomenon that occurs when rotating wind turbine blades cast shadows over a window in a nearby property. Shadow flicker is an indoor phenomenon, which may be experienced by an occupant sitting in an enclosed room when sunlight reaching the window is momentarily interrupted by a shadow of a wind turbine's blade. Outside in the open, light reaches a viewer (person) from a much less focused source than it would through a window of an enclosed room, and therefore shadow

[15] *Stephen Gibbons, 2014. "Gone with the Wind: Valuing the Visual Impacts of Wind Turbines through House Prices," SERC Discussion Papers 0159, Spatial Economics Research Centre, LSE.*

flicker assessments are typically undertaken for the nearby adjacent properties around a proposed wind farm site[16].

The frequency of occurrence and the strength of any potential shadow flicker impact depends on several factors, each of which is outlined below.

1. ***Whether the sunlight is direct and unobstructed or diffused by clouds:***

If the sun is not shining, shadow flicker cannot occur. Reduced visibility conditions such as clouds, haze, and fog greatly reduce the chance of shadow flicker occurring.

Cloud amounts are reported as the number of eights (okta) of the sky covered. Irish skies are completely covered by cloud for well over 50% of the time. The mean cloud amount for each hour is between five and six oktas. This is due to our geographical position off the northwest of Europe, close to the path of Atlantic low-pressure systems which tend to keep us in humid, cloudy airflows for much of the time. A study of mean cloud amounts at 12 stations over a 25-year period showed that the mean cloud amounts were at their minimum in April and their maximum in July. Cloud amounts were less by night than by day, with the mean minimum occurring roughly between 2100 and 0100 GMT and the mean maximum between 1000 and 1500 GMT at most stations. *(Source: Met Éireann, www.met.ie)*

2. ***The presence of intervening obstructions between the turbine and the observer:***

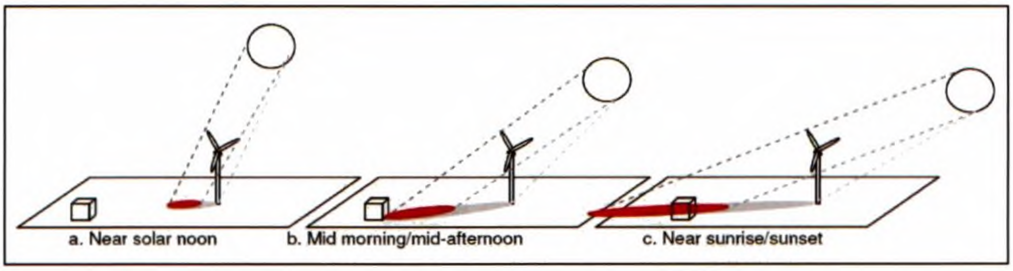
For shadow flicker to occur, the windows of a potentially affected property must have direct visibility of a wind turbine, with no physical obstructions such as buildings, trees and hedgerows, hills or other structures located on the intervening land between the window and the turbine.

Any obstacles such as trees or buildings located between a property and the wind turbine will reduce or eliminate the occurrence and/or intensity of the shadow flicker.

3. ***How high the sun is in the sky at a given time:***

At distances of greater than approximately 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. At distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low *('Wind Energy Development Guidelines for Planning Authorities',* DoEHLG, 2006). Figure 5-4 illustrates the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

Figure 5-4 Shadow-Prone Area as a Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, December 2008)



[16] *Parsons Brinckerhoff (2010) Update of UK Shadow Flicker Evidence Base Department of Energy and Climate Change. Department of Energy and Climate Change. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf*

4. ***Distance and bearing, i.e., where the property is located relative to a turbine and the sun:***

The further a property is from the turbine the less pronounced the impact will be. There are several reasons for this: there are fewer times when the sun is low enough to cast a long shadow; when the sun is low it is more likely to be obscured by either cloud on the horizon or intervening buildings and vegetation; and the centre of the rotor's shadow passes more quickly over the land reducing the duration of the impact.

At distance, the turbine blades do not cover the sun but only partly mask it, substantially weakening the shadow. This impact occurs first with the shadow from the blade tip, the tips being thinner in section than the rest of the blade. The shadows from the tips extend the furthest and so only a very weak impact is observed at a distance from the turbines. (Source: *Update of Shadow Flicker Evidence Base, UK Department of Energy and Climate Change,* 2010).

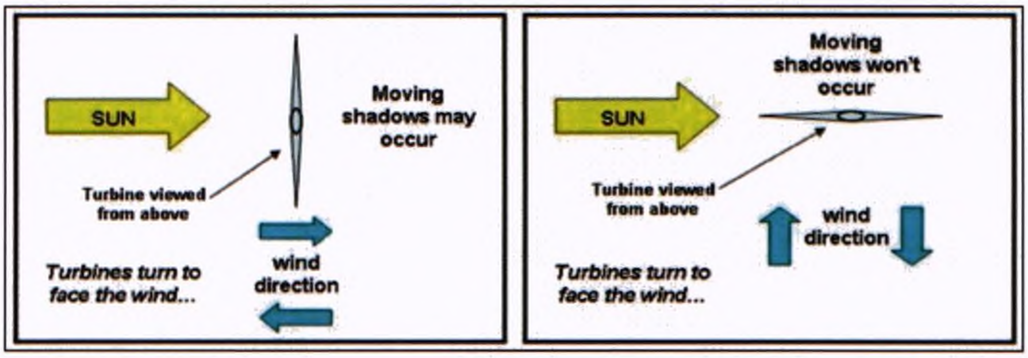
5. ***Property usage and occupancy:***

Where shadow flicker is predicted to occur at a specific location, this does not imply that it will be witnessed. Potential occupants of a property may be sleeping or occupying a room on another side of the property that is not subject to shadow flicker, or completely absent from the location during the time of shadow flicker events. As shadow flicker usually occurs only when the sun is at a low angle in the sky, i.e., very early in the morning after sunrise or late in the evening before sunset, even if there is a bedroom on the side of the property affected, the shadow flicker may not be witnessed if curtains or blinds in the bedroom are closed.

6. ***Wind direction, i.e., position of the turbine blades:***

The direction of wind turbine blades changes according to wind direction, as the turbine rotor turns to face the wind. In order to cast a shadow, the turbine blades have to be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 5-5.

Figure 5-5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC)



7. ***Rotation of turbine blades:***

Shadow flicker occurs only if there is sufficient wind for the turbine blades to be continually rotating. Wind turbines begin operating at a specific wind speed referred to as the 'cut-in speed', i.e., the speed at which the turbine produces a net power output, and they cease operating at a specific 'cut-out speed'. Therefore, even during the sunlight hours when shadow flicker has been predicted to occur, if the turbine blades are not turning due to insufficient wind speed, no shadow flicker will occur.

5.8.2 Guidance

The relevant Irish guidance for shadow flicker is derived from the '***Wind Energy Development Guidelines for Planning Authorities***' (Department of the Environment, Heritage and Local Government (DoEHLG), 2006 (hereafter referred to as the 'DoEHLG 2006 Guidelines')) and the '***Best Practice Guidelines for the Irish Wind Energy Industry***' (Irish Wind Energy Association, 2012).

The 2006 DoEHLG Guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year or 30 minutes per day.

The 2006 DoEHLG Guidelines state that shadow flicker lasts only for a short period of time and occurs only during certain specific combined circumstances, as follows:

- The sun is shining and is at a low angle in the sky, i.e., just after dawn and before sunset;
- The turbine is located directly between the sun and the affected property;
- There is enough wind energy to ensure that the turbine blades are moving; and
- The turbine blades are positioned so as to cast a shadow on the receptor.

Although the 2006 DoEHLG Guidelines thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters of the proposed turbines (710 metres in this case) within the Proposed Development site (as per IWEA guidelines, 2012). The DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted 2006 DoEHLG Guidelines are currently under review. The DoEHLG released the 'Draft Revised Wind Energy Development Guidelines' in December 2019 (hereafter referred to as the 'Draft 2019 DoEHLG Guidelines'). The Draft 2019 DoEHLG Guidelines recommend local planning authorities and/or An Bord Pleanála impose conditions 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 and the wind energy development shall be installed and operated in accordance with the shadow flicker study submitted to accompany the planning application, including any mitigation measures required."***

The Draft 2019 DoEHLG Guidelines are based on the recommendations set out in the 'Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review' (December 2013) and the 'Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach' (June 2017).

The assessment herein is based on compliance with the current 2006 DoEHLG Guidelines limit (30 hours per year or 30 minutes per day). However, it should also be noted the Proposed Development will be brought in line with the requirements of the Draft 2019 DoEHLG Guidelines, should they be adopted while this application is in the planning system, through the implementation of the mitigation measures outlined in Section 5.10.3.10.

5.8.3 Shadow Flicker Prediction Methodology

Shadow flicker occurs only under certain, combined circumstances, as detailed above. Where shadow flicker does occur, it is generally short-lived. The 2006 DoEHLG 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, all of which have been employed at the site of the Proposed Development. Proper siting of wind turbines is key to reducing or eliminating shadow flicker.

The occurrence of shadow flicker can be precisely predicted using specialist computer software programmes specifically developed for the wind energy industry, such as WindFarm (ReSoft) or WindFarmer (DNV.GL) or AWS OpenWind. The computer modelling of the occurrence and magnitude of shadow flicker is made possible by the fact that the sun rises and sets in the same position in the sky on every day each year.

Any potential shadow flicker impact can be precisely modelled to give the start and end time (accurate to the second) of any incidence of shadow flicker, at any location, on any day or all days of the year when it might occur. Where a shadow flicker impact is predicted to occur, the total maximum daily and annual durations can be predicted, along with the total number of days. Any incidence of predicted shadow flicker can be attributed to a particular turbine or group of turbines to allow effective mitigation strategies to be planned and proposed if the model indicates that an exceedance of the shadow flicker guideline limit might occur, as detailed further below.

For the purposes of this shadow flicker assessment, the software package WindPRO (Version 4.0.423) has been used to predict the level of shadow flicker associated with the Proposed Development. WindPRO is a commercially available software tool that enables developers to analyse, design and optimise proposed wind farms. It allows proposed turbine layouts to be optimised for maximum energy yield whilst taking account of environmental, planning and engineering constraints.

5.8.4 Shadow Flicker Assessment Criteria

5.8.4.1 Turbine Dimensions

The existing turbine dimensions of rotor diameter 71 metres and hub height 84.5 metres and tip height 120 metres have been modelled for this assessment.

5.8.5 Study Area

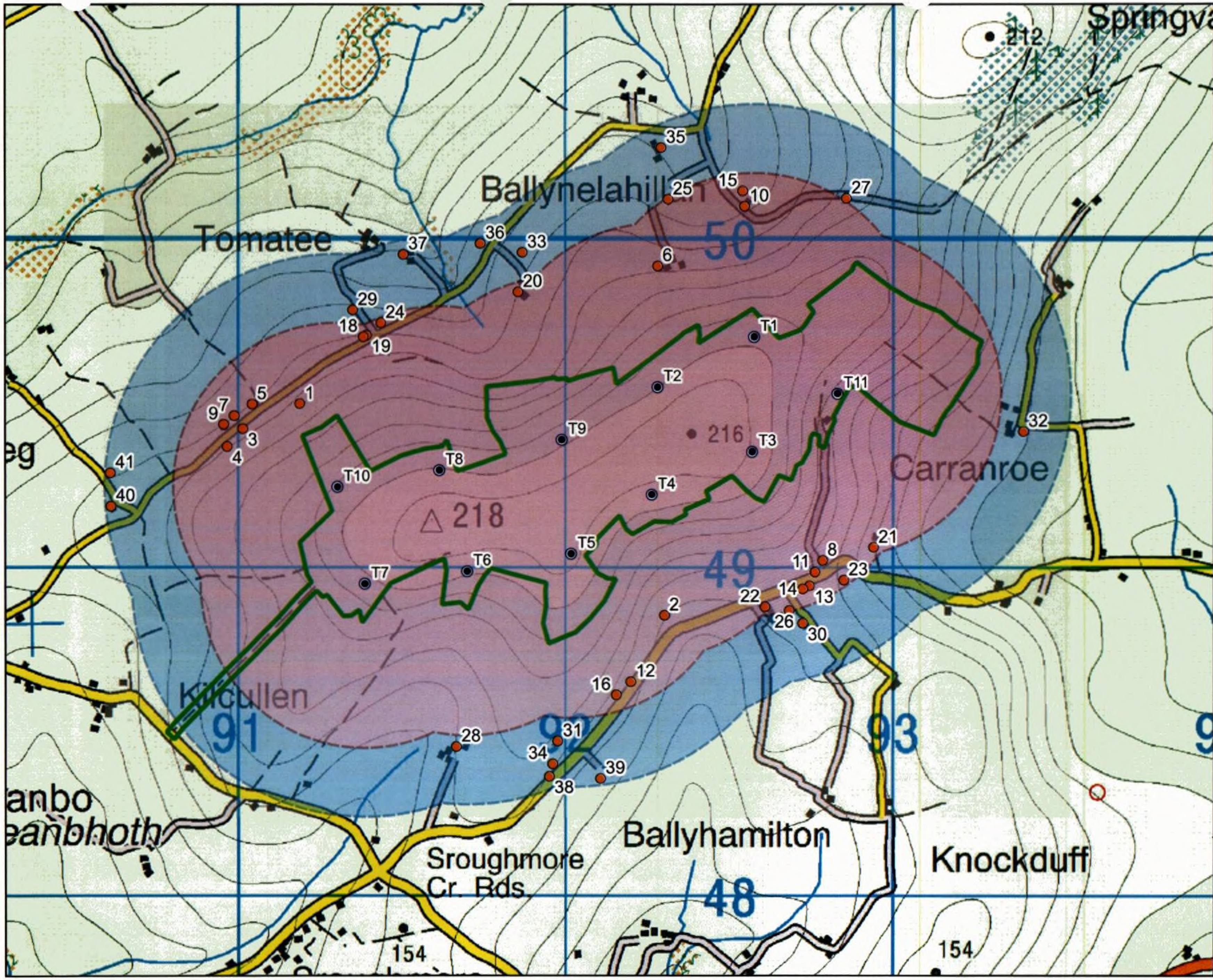
There is a total of 40 no. residential buildings including occupied, unoccupied/derelict and permitted, located within a distance of ten maximum rotor diameters (710 metres) from the original 11 no. turbine wind farm locations. Of these 40 no. dwellings, 3 no. are involved landowners, and 1 no. is currently in the planning permission stage.

The 710 metre study area was also the subject of a planning history search, to identify properties that may have been granted planning permission, but not yet been constructed. The locations of all dwellings in the study area are shown in Figure 5-6, with all dwellings detailed in Table 5-10 in Section 5.8.6 below.

The study area for the shadow flicker assessment is 710m, which is ten times the rotor diameter from each turbine, as set out in the *'Wind Energy Guidelines for Planning Authorities'*, DoEHLG, 2006 guidelines. All residential properties located within 710 metres have been included in the assessment. In addition, a planning history search to identify properties that may have been granted planning permission, but not yet constructed, was carried out.

The closest property to the Proposed Development is a third-party dwelling, located approximately 278m from the nearest existing turbine (T10).

The shadow flicker study area and sensitive receptor locations are shown in Figure 5-6.



Map Legend

- EIAR Site Boundary
- Proposed Development Turbines
- Dwellings within Shadow Flicker Study Area
- 500m Turbine Buffer
- 710m Shadow Flicker Study Area

N

Drawing Title	Shadow Flicker Study Area
Project Title	Castledockrell Wind Farm Extension of Operational Life
Drawn By: EM	Checked By: BT
Project No.: 210847	Drawing No.: Figure 5-6
Scale: 1:15,000	Date: 2024-10-30

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5.8.5.1 Assumptions and Limitations

At each property, shadow flicker calculations were carried out based on 4 no. notional windows facing north, east, south and west, labelled Windows 1, 2, 3 and 4 respectively. The degrees from north value for each window is:

- Window 1: 0 degrees from North
- Window 2: 90 degrees from North
- Window 3: 180 degrees from North
- Window 4: 270 degrees from North

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the study area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any additional incidences or durations or shadow flicker over and above those predicted in this assessment can be countered by extending the mitigation strategies outlined in Section 5.10.3.10.

The use of computer models to predict the amount of shadow flicker that will occur is known to produce an over-estimate of possible impact, referred to as the *'worst-case impact'*, due to the following limitations:

- The sun is assumed to be shining during all daylight hours such that a noticeable shadow is cast. This will not occur in reality.
- The wind is always assumed to be within the operating range of the turbines such that the turbine rotor is turning at all times, thus enabling a periodic shadow flicker. Wind turbines only begin operating at a specific 'cut-in speed', and cease operating at a specific 'cut-out speed'. In periods where the wind is blowing at medium to high speeds, the probability of there being clear or partially clear skies where the sun is shining and could cast a shadow, is low.
- The wind turbines are assumed to be available to operate, i.e., turned on at all times. In reality, turbines may be switched off during maintenance or for other technical or environmental reasons.
- The turbine rotor is considered (as a sphere) to present its maximum aspect to observers in all directions. In reality, the wind direction and relative position of the turbine rotor would result in a changing aspect being presented by the turbine. The rotor will actually present as ellipses of varying sizes to observers from different directions. The time taken for the sun to pass across the sky behind a highly elliptical rotor aspect will be shorter than the modelled maximum aspect.

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 29.79% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Kilkenny over the 30-year period from 1978-2007 (https://www.met.ie/climate/30-year-averages). The actual sunshine hours at the Proposed Development site and therefore the percentage of time shadow flicker could actually occur is 29.79% of daylight hours. Table 5-10 below lists the annual shadow flicker calculated for each property when the regional average of 29.79% sunshine is taken into account, to give a more accurate annual average shadow flicker prediction. Table 5-10 below also outlines whether a shadow flicker mitigation strategy is required for each property to mitigate potential exceedances of the daily and/or annual threshold figure.

5.8.6 Shadow Flicker Assessment Results

5.8.6.1 Daily and Annual Shadow Flicker

The WindPRO computer software was used to model the predicted daily and annual shadow flicker levels in significant detail, identifying the predicted daily start and end times, maximum daily duration and the individual turbines predicted to give rise to shadow flicker.

The model results assume worst-case conditions, including:

- 100% sunshine during all daylight hours throughout the year,
- An absence of any screening (vegetation or other buildings),
- That the sun is behind the turbine blades,
- That the turbine blades are facing the property, and
- That the turbine blades are moving.

The maximum daily shadow flicker model is based on the assumption that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 29.79% has been applied. Taking these probabilities into consideration, an approximation of the 'estimated actual' annual shadow flicker occurrence has been calculated and is presented in Table 5-10.

The predicted maximum daily and annual shadow flicker levels are then considered in the context of the 2006 DoEHLG Guidelines daily threshold of 30 minutes per day and annual threshold of 30 hours per year. If there is a predicted exceedance of the threshold limits at any property, the turbines that contribute to the exceedance are also identified.

The 2006 DoEHLG Guidelines recommend that shadow flicker at dwellings should not exceed a total of 30 hours per year. A total of 40 no. residential buildings have been included in the shadow flicker assessment, the results of which are presented in Table 5-10 below.

Properties which are in a derelict condition (i.e., uninhabitable) will not require mitigation measures to be employed.

Table 5-10 Shadow Flicker Results for Castledockrell Wind Farm, Co. Wexford.

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
1	691120	649540	Dwelling	278	T10	00:56:00	29:28:26	T07, T08, T10	Yes	Yes
2	692233	648896	Dwelling	340	T5	00:28:00	5:34:16	N/A	No	No
3	690945	649465	Dwelling	340	T10	01:04:00	18:34:48	T08, T10	Yes	Yes
4	690898	649410	Dwelling	359	T10	01:07:00	16:53:13	T08, T10	Yes	Yes
5	690974	649540	Dwelling	363	T10	00:46:00	19:00:08	T08, T10	Yes	Yes
6	692213	649960	Dwelling*	364	T1	01:37:00	48:10:59	T01, T02, T03, T09, T11	No	No
7	690918	649526	Dwelling	397	T10	00:47:00	15:22:21	T08, T10	Yes	Yes
8	692717	649063	Dwelling*	396	T3	00:31:00	7:50:25	T04	Yes	Yes
9	690888	649478	Dwelling	396	T10	00:56:00	14:39:09	T08, T10	Yes	Yes
10	692477	650142	Dwelling	399	T1	01:13:00	26:45:28	T01, T02, T11	Yes	Yes
11	692693	649027	Dwelling	415	T3	00:15:00	1:18:21	N/A	No	No
12	692130	648694	Dwelling	429	T5	00:00:00	0:00:00	N/A	No	No
13	692676	648985	Dwelling	445	T3	00:00:00	0:00:00	N/A	No	No
14	692471	650189	Dwelling	446	T1	01:12:00	25:42:55	T01, T02, T11	Yes	Yes
15	692656	648976	Dwelling	446	T3	00:00:00	0:00:00	N/A	No	No
16	692086	648653	Dwelling	452	T5	00:00:00	0:00:00	N/A	No	No
18	691313	649745	Dwelling	463	T10	01:00:00	23:55:04	T08, 10	Yes	Yes
19	691323	649749	Dwelling	468	T8	01:01:00	24:00:26	T08, 10	Yes	Yes
20	691788	649886	Dwelling	474	T9	01:05:00	26:09:43	T02, T08, T09	No	No
21	692874	649102	Dwelling	473	T3	00:25:00	4:40:56	N/A	No	No
23	692540	648921	Dwelling	475	T3	00:28:00	8:13:39	N/A	No	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
23	692782	649003	Dwelling	482	T3	00:25:00	4:26:56	N/A	No	No
24	691367	649787	Dwelling	483	T8	01:02:00	23:09:11	T08, T10	Yes	Yes
25	692246	650163	Dwelling*	493	T1	00:34:00	15:41:25	T01, T02	No	No
26	692614	648910	Dwelling	498	T3	00:25:00	4:52:33	N/A	No	No
27	692789	650166	Dwelling	507	T1	00:34:00	8:08:53	T01	Yes	Yes
28	691599	648496	Dwelling	535	T6	00:00:00	0:00:00	N/A	No	No
29	691281	649826	Dwelling	540	T10	00:49:00	16:15:23	T08, T10	Yes	Yes
30	692655	648872	Dwelling	546	T3	00:00:00	0:00:00	N/A	No	No
31	691909	648513	Dwelling	572	T5	00:00:00	0:00:00	N/A	No	No
32	693328	649455	Dwelling	577	T11	00:29:00	7:13:10	N/A	No	No
33	691801	650002	Dwelling	581	T2	00:30:00	12:49:49	N/A	No	No
34	691890	648444	Dwelling	640	T6	00:00:00	0:00:00	N/A	No	No
35	692222	650322	Dwelling	644	T1	00:27:00	8:04:07	N/A	No	No
36	691664	650026	Dwelling	648	T9	00:46:00	16:21:38	T08, T09	Yes	Yes
37	691436	649996	Dwelling	667	T8	00:26:00	7:23:00	N/A	No	No
38	691884	648405	Dwelling	674	T6	00:00:00	0:00:00	N/A	No	No
39	692039	648399	Dwelling	691	T5	00:00:00	0:00:00	N/A	No	No
40	690544	649229	Dwelling	694	T10	00:24:00	3:04:25	N/A	No	No
41	690542	649331	Dwelling**	695	T10	00:24:00	2:47:08	N/A	No	No

**Participating Landowner*
***Planning Permission*

Please note: Dwellings were assigned House IDs in early stage shadow flicker modelling. Following revisions of the dwelling list during community newsletter drops (see Appendix 2-2 Community Engagement Report), the property with House ID 17 was removed from the dwellings list and is not listed in the numbering shown above in Table 5-10

Of the 40 no. properties modelled, it is predicted that 18 no. properties, may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. Of these 18 no. properties, 3 no. are participating landowners, and therefore no mitigation is required. This prediction is assuming theoretical precautionary conditions (i.e., 100% sunshine on all days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) and in the absence of any turbine control measures.

Of the 40 no. properties modelled, when the regional sunshine average (i.e., the mean amount of sunshine hours throughout the year[17]) of 29.79% and is taken into account, the 2006 DoEHLG Guidelines limit of 30 hours is predicted to be exceeded at just one property, House 6, which is an involved landowner, and therefore no mitigation is required.

It is worth nothing that in reality, the 'estimated actual' shadow flicker is considered conservative and likely to be significantly less than predicted in Table 5-10 as the following items are not considered by the model:

- Receivers may be screened by cloud cover and/or vegetation/built form i.e., hedging, adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind farm;

At distances, greater than 500-1000 m '***the rotor blade of a wind turbine will not appear to be chopping the light, but the turbine will be regarded as an object with the sun behind it. Therefore, it is generally not necessary to consider shadow casting at such distances***[18]'. Section 5.10.3.10 outlines the mitigation strategies which may be employed at the potentially affected properties to ensure the daily and annual shadow flicker thresholds will not be exceeded.

5.8.7 Cumulative Shadow Flicker

The cumulative assessment of shadow flicker arising from the Proposed Development and other wind farms was carried out based on the methodology, assumptions and criteria outlined in Section 5.8.3 and Section 5.8.4.

For the assessment of cumulative shadow flicker, any other existing, permitted or proposed wind farms are considered where the project's ten times rotor diameter shadow flicker study area are located within the Shadow Flicker Study Area of ten times the rotor diameter for the Proposed Development. In this case, the closest wind farms are the existing Turbine 12 of Castledockrell Wind Farm located approx. 330m southwest of the Proposed Development, at its closest point (tip height: 120m, rotor diameter: 71m, hub height: 84.5m). As such the ten times rotor diameter shadow flicker study for this existing project would overlap with that of the Proposed Development ten times rotor diameter Shadow Flicker Study Area.

Of the 40 no. properties within 710m (Shadow Flicker Study Area) of the Proposed Development, 5 no. properties have the potential to experience cumulative shadow flicker impacts, when the existing Turbine 12 of Castledockrell Wind Farm is assessed alongside the Proposed Development. Figure 5-7 illustrates the zone of potential for cumulative shadow flicker between the Proposed Development, and the existing Turbine 12 of Castledockrell Wind Farm. Mitigation strategies are outlined in Section 5.10.5.7.

The results of the cumulative shadow flicker modelling are shown in Table 5-11 below.

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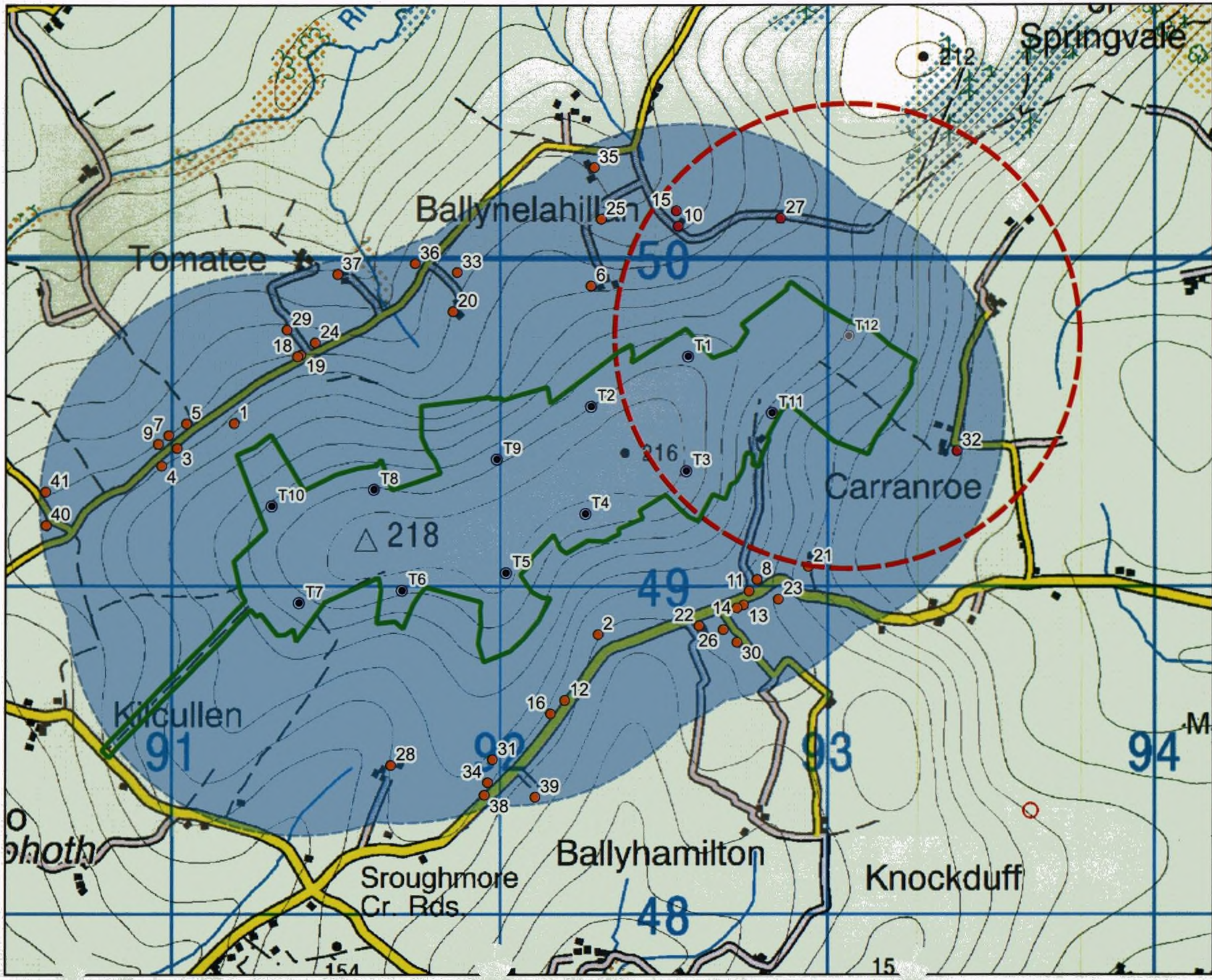
[17] The DoEHLG guidelines acknowledge that shadow flicker can only occur when the sun is shining and is at a low angle (after dawn and before sunset),and the turbine is directly between the sun and the affected property, and there is enough wind energy to ensure that the turbine blades are moving.
[18] Danish Wind Energy Association, 2003 http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/env/shadow/shadow2.htm

Table 5-11 Cumulative Shadow Flicker Results

House No.	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (29.79%) (hrs:min:sec)	Turbine(s) Giving Rise to Shadow Flicker	Further Assessment Required?
10	692477	650142	398.6	T1	01:13:00	103:33:00	30:50:57	T01, T02, T11, T12	Yes
14	692471	650189	445.9	T1	01:11:00	99:52:00	29:45:07	T01, T02, T11, T12	Yes
23	692873	649102	473.4	T3	00:25:00	15:49:00	4:42:43	T08, T09, T10	No
27	692789	650166	506.9	T1	01:11:00	82:17:00	24:30:49	T01, T12	Yes
32	693328	649455	576.8	T11	00:29:00	24:07:00	7:11:05	T11	No

**Turbines 1-11 are part of the Proposed Development, Turbine 12 is part of the Exiting Castledockrell wind Farm.*



Map Legend

- EIAR Site Boundary
- Proposed Development Turbines
- 710m Shadow Flicker Study Area
- Existing Castledockrell Turbine 12
- Turbine 12 710m Shadow Flicker Study Area
- Dwellings within Shadow Flicker Study Area
- Dwellings within Cumulative Shadow Flicker Study Area

Drawing Title: Cumulative Shadow Flicker Study Area	
Project Title: Castledockrell Wind Farm Extension of Operational Life	
Drawn By: EM	Checked By: BT
Project No.: 210847	Drawing No.: Figure 5-7
Scale: 1:15,000	Date: 2024-10-30

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Daily Cumulative

Of the properties with the potential for a cumulative impact to arise, Table 5-11 above illustrates that only 3 no. properties warrant further assessment. Table 5-12 below provides further assessment in relation to these properties and details that the Proposed Development gives rise to daily shadow flicker exceedance at 3 no. properties (Properties 10, 14 and 27).

Table 5-12 also shows that there is overlap on a number of days, when shadow flicker is predicted to arise from the Proposed Development and the existing Castledockrell Turbine 12. On this basis, there is potential for cumulative daily shadow flicker impact. Section 5.10.3.10 outlines the mitigation strategies which will be employed at the potentially affected properties to ensure the daily shadow flicker threshold will not be exceeded for the houses in question.

Table 5-12 Potential Cumulative Impact from the Proposed Development and Nearby Wind Farms/Turbines (i.e. existing T12 of Castledockrell Wind Farm)

House No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and T12	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Turbine 12	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Turbine 12	Mitigation Required by Proposed Development
10	01:13:00	T01, T02, T11, T12	2	99	0	6	Yes, days overlap
14	01:11:00	T01, T02, T11, T12	0	84	0	4	Yes, days overlap
27	01:11:00	T01, T12	89	26	79	50	Yes, days overlap

Annual Cumulative

Table 5-13 below shows there is a potential for annual cumulative impacts at 1 no. property (House 10). Mitigation strategies are outlined in Section 5.10.3.1.

Table 5-13 Potential Cumulative Impact from the Proposed Development and Nearby Wind Turbines

House no.	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Development (Turbines 1-11)	Max. Potential Annual Shadow Flicker contributed by T12	Max. Potential Cumulative Annual Shadow Flicker Exceedance that requires mitigation (hrs:mins:sec)	Proposed Development Turbines to be controlled	Post-mitigation Maximum Annual Shadow Flicker by the Proposed Development (hrs:mins:sec)
10	103:33:00	30:50:57	T01, T02, T11, T12	26:58:35	3:52:22	00:50:57	T01, T02, T11	≤30:00:00
14	99:52:00	29:45:07	T01, T02, T11, T12	26:03:10	3:41:57	00:00:00	N/A	≤30:00:00
27	82:17:00	24:30:49	T01, T12	8:09:46	16:21:02	00:00:00	N/A	≤30:00:00

5.9 Residential Amenity

Residential amenity relates to the human experience of one's home, derived from the general environment and atmosphere associated with the residence. The quality of residential amenity is influenced by a combination of factors, including site setting and local character, land-use activities in the area and the relative degree of peace and tranquillity experienced in the residence. The closest occupied dwelling is located approximately 278 metres north of an existing turbine location. The Proposed Development site is located in an area which is currently used for pastureland and land primarily used for agricultural purposes. Agricultural practices will continue to be carried out at the site should the Proposed Development application be successful. Thus, the existing land use will be retained in the surrounding landscape. This continuation of existing activities and land use has previously assisted in the assimilation of the Proposed Development into the previously existing receiving environment.

As noted previously, the Proposed Development site is the original 11 turbine wind farm which has been in operation since 2011. Since then, there have been 7 no. planning permissions sought for the construction of new dwellings within 1km of the Proposed Development site boundary.

When considering the amenity of residents in the context of a proposed wind farm, there are four main potential impacts of relevance: 1) Shadow Flicker, 2) Noise, 3) Visual Amenity and 4) Telecommunications. Shadow flicker and noise are quantifiable aspects of residential amenity while visual amenity is more subjective. Detailed shadow flicker and noise modelling have been completed as part of this EIAR (Section 5.8 above refers to shadow flicker modelling, Chapter 11 of the EIAR addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Chapter 13 of this EIAR. Impacts on human beings during the operational and decommissioning phases of the Proposed Development are assessed in relation to each of these key issues and other environmental factors such as traffic and dust; see Effects in Section 5.10 below. The impact on residential amenity is then derived from an overall judgement of the combination of effects due to shadow flicker, changes to land-use and visual amenity, noise, traffic, dust and general disturbance.

In the case of the existing Castledockrell Wind Farm, there are a number of properties which exist within the 4 x tip height buffer (i.e. 480m) and within 500m of the existing turbines. When the wind farm was originally permitted in 2005, the DoEHLG had not yet published the Wind Energy Development Guidelines (2006) (the Guidelines), which required a minimum setback distance of 500m or 4 x tip height from existing turbines. The original Castledockrell Wind Farm instead adopted a nominal setback distance of 275m as no governmental guidance was available at the time. The existing Castledockrell Wind Farm was permitted without any conditions relating to daily to annual shadow flicker limits, as these again were stipulated in the Guidelines. Castledockrell Wind Group Ltd made the choice to install SCADA systems on all turbines in order to assist in bringing the turbines in line with the shadow flicker limits outlined in the Guidelines, and maintain a higher degree of residential amenity for local landowners.

5.10 Likely Significant Impacts and Associated Mitigation Measures

The below assessment evaluates the impact (where there is the potential for an impact to occur) on health and safety, employment, population, land-use, tourism, noise, dust, traffic, shadow flicker and residential amenity during the operation and decommissioning phases, as a result of the Proposed Development.

5.10.1 'Do-Nothing' Scenario

If the Proposed Development were not to proceed, the existing wind farm will be decommissioned in 2025 when the current permission expires. The opportunity to maximise the generation capacity of Ireland's Wind Sector, at this location would be lost, along with the future opportunities to further contribute to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

5.10.2 Construction Phase

As has been detailed in Chapter 1 and Chapter 4 of this EIAR, no construction works or ground works are required as part of the existing Castledockrell Wind Farm, as the proposal seeks to extend the operational life of the existing wind farm.

Therefore, there is no potential for construction phase related impacts commonly discussed, such as may relate to Population and Human Health, including Health and Safety, Noise, Dust, and Traffic related impacts.

5.10.3 Operational Phase

5.10.3.1 Health and Safety

Pre-Mitigation Impact

The operational phase of the Proposed Development poses little threat to the health and safety of the public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s '*Wind Energy Development Guidelines for Planning Authorities 2006*' state that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations. People or animals can safely walk up to the base of the turbines.

The DoEHLG 2006 Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The build-up of ice on turbines is unlikely to present problems. The wind turbines are fitted with blade load sensors to detect blade imbalance s, which will detect any imbalance caused by icing of the blades, they also have oscillation sensors which will detect any oscillation in the tower which might be caused by an imbalance. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning. The turbine manufacturer also employs its own patented characteristic curve analysis method to detect when there is ice on the blade and stop the turbine to prevent ice throw.

The turbine blades are typically manufactured of wood and laminated layers of glass fibre which will prevent any likelihood of an increase in lightning strikes within Proposed Development site or the local area. Lightning conduction cables, encased in protection conduits, follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables are earthed adjacent to the turbine base.

The operation of the wind farm does not present a danger to the public or livestock. Rigorous safety checks are conducted on the turbines during design, construction, commissioning, and operation to ensure the risks posed to staff, landowners and general public are negligible.

Proposed Mitigation Measures

Notwithstanding the above, the following mitigation measures have been implemented during the operation of the Proposed Development to ensure that the risks posed to staff, landowners and general public remain negligible throughout the operational life of the wind farm.

Access to the wind farm site is through a locked gate entered via the L2012 Local Road to the west of the Proposed Development site. An Operational Controller (OC) monitors site activity 24/7, including monitoring weather conditions and turbine performance on site.

All visitors must undertake a site induction and log entry to the site on a specific app "Skylark Control". The access log is monitored by the OC to ensure anyone who has booked onsite also books offsite safely. If there is an incident or emergency onsite the OC will enact the Emergency Response Procedure for the wind farm and coordinate the emergency services to the incident.

Access to the turbines is through a door at the base of the structure, which will be locked at all times outside maintenance visits. The OC's number is displayed at the entrance of the existing wind farm site and at each turbine door.

Signs have also been erected at suitable locations across the site, including at the main gate of the wind farm site and the entrance of each turbine, for the ease and safety of operation of the wind farm. These signs include:

- Buried cable route markers at regular intervals and change of cable route direction;
- Directions to relevant turbines at junctions;
- "No access to Unauthorised Personnel" at appropriate locations
- Speed limits signs at site entrance and junctions;
- "Warning these Premises are alarmed" at appropriate locations;
- "Danger HV" at appropriate locations;
- "Warning – Keep clear of structures during electrical storms, high winds or ice conditions" at site entrance;
- "No unauthorised vehicles beyond this point" at specific site entrances; and
- Other operational signage required as per site-specific hazards.

An operational phase Health and Safety Plan has been developed to fully address identified Health and Safety issues associated with the operation of the site and provides for access for emergency services at all times. This Health and Safety Plan is updated regularly as necessary.

All major components of the wind turbines have an expected lifetime of at minimum 26 years (see Appendix 4-1 Lifetime Prediction Report) and are equipped with a number of safety devices to ensure safe operation during their lifetime. During the operation of the wind farm regular maintenance of the turbines is carried out by the turbine manufacturer or appointed service company. A project or task specific Health and Safety Plan has been developed for these works in accordance with the site's health and safety requirements.

Residual Impact

With the implementation of the above mitigation measures, there will be a long-term, imperceptible residual impact on health and safety during the operational life of the Proposed Development

Significance of Effects

Based on the assessment above there will be no significant direct or indirect effects.

5.10.3.2 Employment and Investment

The extension of the operational phase will present an opportunity for mechanical-electrical contractors and craftspeople to continue to be involved with the maintenance and operation of the wind farm. On a long-term scale, the Proposed Development will sustain the employment of the personnel involved in the maintenance and control of the wind farm. This will have a long-term slight positive effect.