



STATKRAFT

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED DERNACART WIND FARM, COUNTY LAOIS

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VOLUME 2 - MAIN EIAR

CHAPTER 9 – TELECOMMUNICATIONS AND AVIATION

DECEMBER 2019





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TABLE OF CONTENTS

<u>Page</u>

9 TELECOMMUNICATIONS AND AVIATION	1
9.1 INTRODUCTION	
9.1.1 Study Area	
9.2 TELECOMMUNICATIONS	
9.2.1 Methodology	
9.2.2 Relevant Guidance	
9.2.3 Scoping and Consultation	
9.2.4 Receiving Environment	
9.2.5 Characterising the impact by separation distance	
9.2.6 Telecommunications Impact Assessment	
9.1.2 Telecommunications Networks in the vicinity of Dernaca	rt 6
9.2.7 Mitigation Measures	
9.2.8 Television and Radio Reception	
9.2.9 Residual Impacts	
9.3 AVIATION	
9.3.1 Methodology	
9.3.2 Receiving Environment	
9.3.3 Consultation	
9.3.4 Potential Impacts	
9.3.5 Mitigation Measures	
9.3.6 Residual Impacts	
9.4 REFERENCES	

LIST OF APPENDICES

- Appendix 9.1: Ai Bridges Telecommunications Assessment
- Appendix 9.2: 2RN protocol

LIST OF FIGURES

		Paye
FIGURE 9-1:	LOCATION OF DERNACART WF AND NEIGHBOURING AIRFIELDS	10

LIST OF TABLES

TABLE 9-1:	LIST OF TELECOMMUNICATION STAKEHOLDER CONSULTEES AND RESPONSES RECEIVED
TABLE 9-2: TABLE 9-3:	CAPARD MAST SITE A AND B MICROWAVE RADIO LINKS
TABLE 9-4: TABLE 9-5:	SSR ZONE ARRANGEMENTS 7 Responses from Aviation Stakeholders 10
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9 TELECOMMUNICATIONS AND AVIATION

9.1 Introduction

This chapter assesses the potential impact from the proposed Dernacart Wind Farm development on local telecommunications services and aviation.

Ai Bridges (telecommunications specialists) carried out a telecommunications impact study on behalf of Statkraft Ireland Limited. The report from the study is provided in Appendix 9.1 of Volume 3 of the EIAR and has informed the compilation of this chapter. The purpose of the study was to ascertain whether the installation of up to 8 no. turbines and associated infrastructure at Dernacart would interfere with services provided by telecommunications operators in the area. The telecommunications impact study comprised of four primary stages:

- Telcom Operator Consultations
- Field Surveys
- Desktop Survey Network Modelling and Analysis
- Mitigation Measure Proposals
- Report Generation

Aviation interests in the vicinity of the development site have also been assessed to determine if the proposed development would have any implications for the operations of communications, navigation and surveillance systems used for air traffic control.

The effects and residual impacts of the proposed development on telecommunications and aviation are considered and described, taking account of mitigation measures to eliminate any potential impacts.

9.1.1 Study Area

Dernacart wind farm comprises of up to 8 wind turbines with a tip height of up to 185 m, hardstanding areas, upgrade of existing tracks and construction of new access tracks, construction of an on-site substation, temporary compound and associated works. The proposed Dernacart Wind Farm layout is shown on Figure 4.2 of Volume 2 of this EIAR.

The study area includes the turbine delivery route and underground grid connection cable between the proposed wind farm turbines and the proposed on-site substation, and between the on-site substation and the proposed 110 kV Bracklone substation in Portarlington.

The wind farm is located in Laois County approximately 1.8km northwest of Mountmellick and ranges in elevation from 80 m OD to 73 m OD.

9.2 Telecommunications

The rotating blades of wind turbines can occasionally cause interference to electro-magnetically-propagated signals. Such interference could, in theory, affect all forms of electromagnetic communications including:

- Satellite communications
- Radar
- Cellular radio communications
- Aircraft instrument landing systems
- Air traffic control
- Terrestrial telecommunication links
- Television broadcasts
- Loran a long range navigational system

Impacts on aviation are considered separately in Section 9.3 of this Chapter.

For the purposes of the telecommunications impact assessment, point-to-point and point-to-multipoint signals are considered, both of which are used extensively throughout Ireland.

Point to point (or line of sight) is a wireless telecommunications transmission link between two nodes located at specified fixed points. The term telecommunications link relates to the wireless transmission of data via radio frequencies between two fixed points. Telecommunications towers are generally used to transmit and receive signals over large distances. Radio frequency bands above 1 GHz are referred to as microwave radio links and are commonly used by telecommunications operators. These 'links' are used mainly by mobile phone operators, broadcasters and utilities or emergency service providers, to provide transmission networks that are flexible and cost effective.

Point to multipoint refers to the situation where a central node transmits to, and receives from, a number of independent locations. This includes television and radio broadcasting and reception, mobile phones (to the mobile phone mast) and land mobile systems. It is possible that dwellings in the immediate vicinity of the turbines could experience interference, and therefore require some remedial measures in relation to television reception.

Section 5.10 of the Department of Environment, Heritage, and Local Government's [now Department of Housing, Planning and Local Government] Planning Guidelines on Wind Energy Developments (2006) [the guidelines] state that:

"wind turbines, like all electrical equipment, produce electromagnetic radiation, and this can interfere with broadcast communications. The interference with broadcast communication can be overcome by the installation of deflectors or repeaters. Planning authorities should advise the developer to contact the individual broadcasters, both national and local, and inform them of the proposals. A list of the licensed operators is available on the ComReg website at www.comreg.ie. Mobile phone operators should also be advised of the proposed development."

Section 7.15 of the Guidelines state that:

"Conditions regarding measures to be taken to minimise interference with the transmission of radio and television signals, air and sea transport communications and other transmissions systems in the area may be necessary. Where electromagnetic interference is difficult to predict, conditions may require the developer to consult with the service provider concerned and undertake remedial works to rectify any interference caused."

The Ai Bridges study evaluated the effects that the operation of the proposed wind farm could have on existing telecommunications networks. Consultation was carried out with all known Telecommunications Operators (TOs) that could potentially be affected by the proposed wind farm.

The telecommunications network is constantly evolving and the potential impact of Dernacart Wind Farm on local telecommunications signals is difficult to accurately predict for the following reasons:

- The network topology is likely to change significantly over time as a result of technological advances including migration towards 4G and the impending 5G networks
- Network operators are beginning to share services and consolidate the existing network which is likely
 to lead to an increase in the number of redundant and decommissioned services

A key objective of the assessment process is to identify turbines in close proximity to existing masts and telecommunication links with a view to relocating turbines that could potentially impact on local telecommunication operations. If a turbine could not be relocated due to other site constraints, further consultation was carried out with the affected TOs to consider the potential impact and agree an appropriate mitigation strategy if required. On that basis, obtaining the cooperation of the TOs was a key aspect of the process to enable the wind farm to be developed without adversely affecting existing telecommunications services.

Chapter 9 – Telecommunications and Aviation

Statkraft Ireland Ltd. **Dernacart Wind Farm EIAR** Volume 2 – Main EIAR

It is possible that telecommunication services in the immediate vicinity of the turbines could require mitigation measures to negate any potential impact. Accordingly, the Developer has given an undertaking to cover the cost of implementing the necessary mitigation measures to prevent any degradation of service that is currently provided, should the result of a more detailed pre-construction study establish their necessity. The consultation responses from the relevant TOs that could potentially be affected by the Dernacart Wind Farm development, are shown in Table 9.6. urposesont

9.2.1 Methodology

The following sources of information were considered in this assessment:

- The design layout of the proposed development
- Published literature as described below
- A desk-based assessment of the existing telecommunications network

The following assessment methodology was applied in this assessment:

- **Consultation** with all known telecommunications operators (TOs) that could potentially be affected by the proposed wind farm.
- Data gathering exercise to establish all known telecommunications links in the area.
- Preparation of constraints mapping using data collected from the TOs, to identify turbines within specified separation distance from existing telecommunications links and masts.
- Preliminary Telecommunications Impact Assessment (TIA) including the following:
 - Design review to relocate turbines away from existing telecommunications services, where _ possible.
 - Further consultation with affected TOs to discuss residual impacts, identify critical telecommunications links and agree a mitigation strategy.
 - Finalise turbine layout avoiding critical telecommunications links and incorporate concerns raised by the TOs.
- Undertaking by the Developer to implement an appropriate **mitigation strategy**, in conjunction with the relevant TO, to eliminate any anticipated or residual impacts.

Further information regarding the methodology implemented for assessing the potential effects on the telecommunications network is contained in Appendix 9.1.

9.2.2 Relevant Guidance

A review of relevant planning and policy documents was undertaken to identify relevant objectives relating to telecommunication. The following documents have been reviewed:

- 'Wind Energy Development Planning Guidelines', published by the Department of the Environment, Heritage and Local Government (2006).
- 'Best Practice Guidelines for the Irish Wind Energy Industry', published by the Irish Wind Energy Association (2012).
- Laois County Development Plan 2017-2023.
- Offaly County Development Plan 2014-2020.
- 'Tall structures and their impact on broadcast and other wireless services', published by Ofcom, a regulatory body independent from UK Government (2009).
- 'RF Measurement Assessment of Potential Wind Farm Interference to Fixed Links and Scanning Telemetry Devices', published by ERA on behalf of Ofcom (2009).

- 'Wind Energy Development Planning Guidelines', Department of the Environment, Heritage and Local Government, 2006.
- 'Best Practice Guidelines for the Irish Wind Energy Industry', Irish Wind Energy Association, 2012.

9.2.3 Scoping and Consultation

In line with the Wind Energy Development Planning Guidelines and Best Practice Guidelines for Irish Wind Energy, consultation was undertaken by Ai Bridges to provide information on the proposed development to all relevant telecommunications service providers, and to discuss concerns as well as the potential for benefits of the proposed wind farm. The service providers were provided with an indicative turbine layout and asked to advise whether any impact could occur to their networks. The telecommunications consultation process commenced in January 2019.

Consulted stakeholders include authorities with associated telecommunication infrastructure, wireless broadcasters, cellular network providers, broadband suppliers and wireless internet service providers (WISP).

The following TO stakeholders were consulted with regarding existing telecommunication links in the area:

Table 9-1: List of Telecommunication Stakeholder Consultees and Responses Received

ID	Operator	Response received (yes/no)	Issues raised by Operator
1	Airspeed / Enet	Yes	No Issues.
2	An Garda Síochána	No	No response received.
3	Broadcast Authority of Ireland (BAI)	No	No response received.
4	BT Ireland	Yes	No Issues.
5	Eir/Meteor	Yes	Eir/Meteor raised concerns regarding one microwave radio link (Capard – Cooltycannon).
6	OpenEir	Yes	OpenEir raised concerns regarding one microwave radio link; however, they have stated that they expect this link to be decommissioned in the next few months.
7	ESB Services	No	No response received.
8	HSE	No	No response received.
9	Irish Aviation Authority (IAA) No	No response received.	
10	Imagine Broadband	Yes	No Issues.
11	Laois County Council	No	No response received.
12	Ripplecom	No	No response received.
13	2RN*	Yes	No Issues.
14	Tetra Ireland (TI)	No	No response received.
15	Three Ireland	Yes	No Issues.
16	Virgin Media	Yes	No Issues.
17	Vodafone	Yes	Vodafone Ireland have raised concerns regarding one microwave radio link (Capard – Clonyquin)

*2rn distributes and transmits the programme services of RTE Radio and Television, TG4, Virgin Media and Today FM. They also provide transmission services to local and regional radio broadcasters, as well as site services to mobile phone and broadband operators, private communications companies and emergency services

Approximately half of the TOs provided a response. The responses received and the issues they raised, are presented in Appendix 19.1.

9.2.4 Receiving Environment

Baseline studies were carried out to establish the location of existing telecommunications links and masts relative to the proposed turbine locations, to assess the potential for interference. GIS was used to map and process available in-house telecommunications data. This allowed turbines in close proximity to existing masts and links which could potentially impact on existing telecommunication services to be identified for further assessment.

There are two telecoms mast sites within 10km to the southwest of the proposed wind farm. These sites are at Capard (Site A and Site B).

9.1.1.1 Capard Mast – Site A and Site B

Capard Site A is located ca. 8km southwest of the proposed wind farm and consists of four separate communications masts. Capard Site B is located ca. 6km southwest of the proposed wind farm and consists of a single communications mast. Table 9.2 details the number of radio links observed with a bearing in the direction of the proposed wind farm.

Table 9-2: Capard Mast Site A and B Microwave radio links

Mast Site	Mast Number	Microwave radio links obs direction of Dernacart Wind	erved with a bearing in Farm
Capard A	Mast 1	11	
Capard A	Mast 2	2	
Capard A	Mast 3	7	
Capard A	Mast 4	0	
Capard B	Mast 1	7	

9.2.5 <u>Characterising the impact by separation distance</u>

In many cases, impacts can be sufficiently characterised and mitigated by implementing a separation distance and ensuring the area is free from wind turbines. The separation distance required depends on the specific parameters of each telecommunication signal. Following detailed discussion with the TOs, a required separation distance to each telecommunications links was requested by each TO. Turbines that achieve this separation distance are considered unlikely to cause interference. Turbines situated within this area were either relocated or identified for further assessment.

9.2.6 Telecommunications Impact Assessment

In many cases, impacts can be sufficiently mitigated by ensuring sufficient separation distance between the turbine and any telecommunications link or mast as described above. On that basis, the developer has endeavoured to achieve a design layout that met the requested separation distances from known telecommunication links and masts, but in certain cases this was not possible due to other site constraints.

Interference to a communication system can occur in the following:

- Signal scattering as a result of the obstruction presented by the blades, an effect that mimics the presence of a lower power source operating from the location of the wind turbine.
- Signal obstruction as it passes through the area swept by the rotating blade or the tower.
- Electromagnetic fields associated with the wind turbine generator.

Reflection and Signal Scattering

Wind turbines can act as sources of re-radiation producing delayed 'ghost' signals that are modulated in amplitude by the rotation of the blades. Radio waves can be reflected by many surfaces including turbines, reflection can interfere with the quality of the signal.

Signal Obstruction

If an absorbing object such as a wind turbine is placed in the path of a radio wave obstruction can occur, detrimentally affecting the signal detected at the receiver. This is an impact that needs to be avoided in the case of point-to-point links, unless appropriate mitigation measures are provided to negate the impact.

Electromagnetic Fields

The operation of a wind turbine generator, and associated electrical transmission infrastructure, creates an electromagnetic field which can theoretically interfere with telecommunication signals. However, electromagnetic field levels in the vicinity of wind turbines are relatively low and diminish rapidly with distance.

Following consultation, details of links from service providers were mapped with buffer distances in order to identify any conflicts. This assessment found that there is sufficient separation distance between the turbines and the telecommunications links identified by the service providers.

9.1.2 Telecommunications Networks in the vicinity of Dernacart

Following field surveys and consultation with network operators, six technologies were considered for analysis:

- Licensed Transmission Networks
- Licence-exempt Telecommunications Networks
- GSM Networks
- 3G/4G Networks
- Tetra Network
- Aviation Telecommunications Network

Licensed Transmission Networks

At the time of writing of this report, only two telecom operators have raised concerns in relation to the proposed development – Eir and Vodafone (refer to Table 9.3), however, not all operators have responded to consultations. Findings from the field survey indicate that there may be more than two licensed PTP Microwave radio links passing through/near the proposed wind farm. OpenEir have a PTP link that crosses the wind farm, however this is due to be decommissioned in the next few months and therefore was not considered further.

Link ID	Link IDOperatorLink Description1EirPTP microwave radio link from Capard to Cooltycannon (15GHz assumed)2VodafonePTP microwave radio link from Capard to Clonyquin (15GHz)		Wind Farm Potential Impacts
A			Likely to be impacted by Turbine 3
2			Possibly impacted by Turbine 4

Licence-Exempt Telecommunications Networks

No licence exempt infrastructure was identified by operators during the consultation process. However, during the field survey a number of unlicensed radio antennas were observed with bearings in the general direction of the proposed wind farm.

GSM Access Network

None of the telecom operators contacted during consultation have stated any concerns regarding their GSM Access Networks.

3G/4G Access Network

None of the telecom operators contacted during consultation have stated any concerns regarding their 3G/4G Access Networks.

TETRA Networks

TETRA Ireland raised no concerns in relation to the proposed wind farm development.

Aviation Telecommunications Network

Tables 9.3 and 9.4 detail the Assessment Zone arrangement for the tow types of aviation radar surveillance systems: Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR).

Table 9-3: PSR Zone Arrangements

Zone	Description
Zone 1 – Safeguarding	0 – 500m
Zone 2 – Detailed Assessment	500m – 15km and in radar line of sight
Zone 3 – Simple Assessment	Further than 15km and in radar line of sight
Zone 4 – No Assessment	Not in radar line of sight

Table 9-4: SSR Zone Arrangements

Zone	Description
Zone 1 – Safeguarding	0 – 500m
Zone 2 – Detailed Assessment	500m – 16km and in radar line of sight
Zone 4 – No Assessment	Further than 16km and not in radar line of sight

The nearest airport/airfield to Dernacart Wind Farm is Ridge Aviation which is located ca. 9km to the southeast of the proposed wind farm. There are no PSR or SSR radar systems at this airfield. The nearest PSR/SSR system is located at Dublin airport which is in excess of 75km from the proposed wind farm. This is categorised as Zone 4 and therefore no assessment is required. As there are no aviation radar navigational equipment in close proximity to the proposed wind far, there should be no impact to the IAA telecommunications network.

9.2.7 <u>Mitigation Measures</u>

Telecommunications

Section 5.10 of the Department of Environment Heritage and Local Government (DoEHLG) Planning Guidelines on Wind Energy Developments (2006) acknowledges that "electromagnetic interference can be overcome".

The preliminary telecommunication impact assessment identified during the consultation the operators with the highest likelihood for impact. It was agreed with these operators that there are a number of mitigation options that can be explored to overcome any residual impacts. The following link mitigation measures will be implemented as necessary to overcome electromagnetic interference:

- Technology Upgrade: Replacement of the existing telecommunications service equipment with another less affected type
- Diverting telecommunications links The possibility of diverting telecommunication links to another telecommunications tower in the vicinity can be investigated.
- **Special Purpose Mitigation Tower** the possibility of diverting the existing links and consolidating the existing towers to one tower can be explored.
- **Relocation of telecommunications equipment** The possibility of moving telecommunication equipment to another telecommunications tower in the vicinity can be investigated.
- **Fiber-optic communication systems** The possibility of installing fibre cables underground in conjunction with Wind Farm electricity transmission cables could be explored. The use of underground fibre optic cable in lieu of telecommunication links would avoid the wind farm interference effects
- Wind Turbine Tower To mitigate interference the turbine tower could be utilised as a transmitter/receiver (hop point).
- **Combination** The possibility of providing a mix of the above could be explored.

Mitigation options may be different for each service affected, depending on the type of service and the level of any interference expected.

In relation to the Eir link between Capard and Cooltycannon, the proposed mitigation is to re-route the link for Cooltycannon (OY_4718) to another Eir site away from the wind farm area.

In relation to the Vodafone link between Capard and Clonyquin, it is proposed to mitigate this by re-routing the link to Clonyquin from another Vodafone site (at Portarlington), away from the wind farm area.

9.2.8 <u>Television and Radio Reception</u>

Consultation with RTE indicates that there will be no impact to any of their microwave telecoms links but there is low to moderate risk of interference to TV reception to households to the west and north west of the windfarm development. Mitigation of this potential interference could require some remedial measures in relation to television reception. In practice, such measures are not difficult to implement, are relatively inexpensive and if necessary will be undertaken by the developer in conjunction with 2rn/RTÉ.

A 2rn Protocol Agreement has been signed by the Developer and 2rn in relation to interference on viewers' television sets and broadcast radio receivers. This protocol has been included in Appendix 9.2.

9.2.9 Residual Impacts

The implementation of a suitable mitigation strategy will ensure that local telecommunications are not adversely affected by the development of the Dernacart Wind Farm. The telecommunications mitigation strategy shall be carefully implemented to ensure there are no unintended consequential effects, such as:

- (a) Introducing any new impacts to existing telecommunications services.
- (b) The cumulative effects of additional turbines, or additional wind farms.
- (c) Cumulative effects of any mitigation methods.
- (d) Any interaction with regard to other existing or proposed wind farms, or telecommunications facilities, in the area.

9.3 Aviation

The potential effects of wind turbines on aviation interests has been widely publicised. There are two dominant scenarios:

- Physical Obstruction: turbines can present a physical obstruction at, or close to, an aerodrome or other aviation activity site; and
- Radar/Air Traffic Services: turbine induced clutter appearing on a radar display can affect the safe provision of air traffic services as it can mask an unidentified aircraft from the air traffic controller and /or prevent the controller from accurately identifying aircraft under his control. In some cases, radar reflections can affect the performance of the radar itself.

The potential for the development to have an effect on aviation interests has been considered, either in terms of Air Traffic Control (ATC) radars or flight operations, of the Irish Aviation Authority (IAA), the Department of Defence (DoD), Limetree Airfield (c. 6.1km south-east of the proposed development site) and Ridge Aviation (c.10km south-east of the proposed development site).

9.3.1 <u>Methodology</u>

Aviation Stakeholders were identified in accordance with the guidance published in the Irish Aviation Authority (IAA) *Aerodrome Licensing Manual* (IAA, 2014a), the IAA draft *Policy on Land Use and Planning and Offshore Development* (IAA, 2014b) and the UK Civil Aviation Authority (CAA) Civil Air Publication (CAP) 764, *Policy and Guidelines on Wind Turbines* (CAP 764, 2013), with the suggested anticipated extents of effect utilised as a minimum during assessment. The recommended consultation zone within the vicinity of an aerodrome with a surveillance radar facility is 30 kilometres (km), with a range of up to 17 km recommended for a non-radar equipped licensed aerodrome. Casement Aerodrome does not have a surveillance radar.

However, it is acknowledged that objections from beyond the recommended Aviation Stakeholder consultation distances can occur, and this has been taken into consideration. The assessment has been informed by the results of a desk-based study and with reference to the existing and extensive evidence base regarding the effects of onshore wind farm development.

FT consulted with the Irish Aviation Authority (IAA), Dublin Airport Authority (DAA) and the Department of Defence (DoD) to establish if the proposed development could potentially impact on aviation. A Scoping Report was sent as part of this consultation. A desktop study was carried out to identify any aerodromes within 20km of the proposed development.

Relevant guidance and policy

Guidelines on Wind Energy Developments (2006)

Section 5.11 of the of the Department of Environment Heritage and Local Government (DoEHLG) Planning Guidelines on Wind Energy Developments (2006) guidelines states, "The siting of wind turbines may have implications for the operations of the Communications, Navigation and Surveillance systems used for Air Traffic Control for the separation and safety of aircraft. Wind turbine siting may also have implications for the flight paths of aircraft." Section 5.11 of the guideline's states, "wind energy developers should be advised to contact the Irish Aviation Authority at the pre-planning stage of consultation, with details of locations and proposed heights of turbines, to ensure that the proposed development will not cause difficulties with air navigation safety."

9.3.2 <u>Receiving Environment</u>

Limetree Airfield is located ca. 6.1km south-east of the proposed Dernacart Wind Farm. Ridge Aviation is situated ca.10km south-east of the proposed development site. Other airfields in the vicinity include Kilrush Airfield and Birr Airfield, however both are located more that 30km away from the site location – refer to Figure 9.1.

With regards to aviation telecommunication systems, the nearest PSR/SSR system is located at Dublin airport which is in excess of 75km from the proposed wind farm (i.e. EUROCONTROL Assessment Zone 4 – No assessment required.)



Figure 9-1: Location of Dernacart WF and Neighbouring Airfields

9.3.3 <u>Consultation</u>

FT has undertaken a specific aviation consultation with the various aviation stakeholders to establish whether any services or infrastructure in the vicinity of the proposed Dernacart Wind Farm can be affected by it.

Table 9-5: Responses from Aviation Stakeholders

Aviation Stakeholders	Response date	Impact Identified	Further comments
Limetree Airfield	11/09/2019	Observation	Concerned about closeness to airfield. On receipt of co-ordinates the airfield confirmed that they have no observation to make.
Ridge Aviation	11/09/2019	None	

Aviation Stakeholders	Response date	Impact Identified	Further comments
Kilrush Airfield	No response		
Birr Airfield	No response		

During a phone call with Limetree Airfield, concerns were raised about the distance of the proposed site to the existing airfield. A follow up email was requested with details about tip heights and turbine locations. Subsequently the airfield confirmed that they have no observation to make.

Ridge Aviation expressed no concerns about the development.

No response was received from Kilrush or Birr airfields.

9.3.4 <u>Potential Impacts</u>

Construction Phase

The IAA have no specific observations or requests with regard to the proposed development. During the construction phase there is potential for cranes to affect overflying aircraft if not properly lit.

Operational Phase

During the operational phase of the development it is not anticipated that there will be any impacts on the surrounding environment.

As there are no aviation radar navigational equipment (PSR or SSR) in close proximity to the proposed development there should be no impact to the IAA telecommunications network.

9.3.5 <u>Mitigation Measures</u>

In the event of planning consent being granted, the applicant is expected be conditioned to contact the IAA to; (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide asconstructed coordinates in WGS84 format together with ground and tip height elevations at each wind turbine location and (3) notify the IAA of intention to commence crane operations with a minimum of 30 days prior notification of their erection. All other requirements can be clarified when the applicant consults with the IAA to agree the aeronautical obstacle warning light scheme, should planning be granted.

The Department of Defence requirements will be implemented as follows:

- Single turbines or turbines delineating corners of a wind farm will be illuminated by high intensity obstacle strobe lights (Red);
- Obstruction lighting elsewhere in a windfarm will be of a pattern that will allow the hazard to be identified and avoided by aircraft in flight;
- Obstruction lights used will be incandescent or of a type visible to Night Vision Equipment. Obstruction lighting fitted to obstacles must emit light at the near Infra-Red (IR) range of the electromagnetic spectrum specifically at or near 850 nanometres (nm) of wavelength. Light intensity to be of similar value to that emitted in the visible spectrum of light Obstruction lights used should be incandescent
 or of a type visible to Night Vision Equipment.

Residual Impacts

No residual impacts are expected following the implementation of the above measures.

9.3.6

9.4 References

'Wind Energy Development Planning Guidelines', Department of the Environment, Heritage and Local Government, 2006.

'Best Practice Guidelines for the Irish Wind Energy Industry', Irish Wind Energy Association, 2012.

Laois County Development Plan 2017-23

'Tall structures and their impact on broadcast and other wireless services', Ofcom, 2009.

Telecommunications Antennae and Support Structures – Guidelines for Planning Authorities, Department of the Environment, 1996

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"En-route Obstacles to Air Navigation", Irish Aviation Authority (IAA) Statutory Instruments, S.I 423, 1999.