Report

Ballyfasy Wind Farm

Aviation Review Statement

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Executive Summary

Ai Bridges Ltd have been commissioned to review the possible impacts of the proposed wind farm on aviation systems in the vicinity of the proposed wind farm development at Ballyfasy. As part of the review, the following subjects were considered:

- Annex 14 - Obstacle Limitation Surfaces (OLS)
- Annex 15 – Aerodrome Surfaces
- Building Restricted Areas (BRA)
- Minimum Sector Altitudes (MSA)
- Instrument Flight Procedures
- Permitted Wind Farms in vicinity of Proposed Wind Farm
- Communications and Navigation Systems
- Radar Surveillance Sensors
- Flight Inspection and Calibration
- IAA - Aeronautical Obstacle Warning Light Scheme
- Department of Defence Aeronautical Safeguarding
- Garda Air Support Unit (GASU) and Emergency Aeromedical Service (EAS)

Annex 14 - Obstacles Limitation Surfaces (OLS)

A review shows that the proposed wind farm would be located outside the Outer Horizontal Surface of the Waterford Airport Runway Obstacle Limitation Surfaces (OLS), as defined in ICAO (International Civil Aviation Organization) Annex 14.

As the proposed wind farm is situated outside the Outer Horizontal Surface and there is no penetration of the take-off or approach surfaces, it is unlikely that there will be any impacts to the OLS surfaces for Waterford Airport.

Annex 15 - Aerodrome Surfaces

Following a review of "*Terrain and obstacle requirements Area 1*" as defined in ICAO Annex 15, wind turbines need to be registered if they are more than 100 meters above terrain. From the centre point (ARP – Airport Reference Point) of Waterford Airport to the boundary of the Area 1 of the Annex 15 Aerodrome Surface is 45 km. This area encloses the TMA area i.e. Total Maneuvering Area and this is used for circling and maneuvering by aircraft. Should the proposed windfarm be permitted, the turbines would be within 45 km of Waterford Airport's ARP and would be greater than 100m in height. Therefore, the turbines would be required to be included in the IAA Electronic Air Navigation Obstacle Dataset.

Building Restricted Areas (BRA)

A Building Restricted Area is the airspace surrounding an aviation facility that needs to be clear from physical intrusions. The purpose of the safeguarded areas is to identify developments with the potential for causing unacceptable interference to navigation facilities. A review shows that the proposed wind farm is over 10 km from the BRA surfaces at Waterford Airport. At this distance there will be no impacts to the BRAs due to wind turbines at Ballyfasy.

Minimum Sector Altitudes (MSA)

The Minimum Sector Altitudes (MSA) is the lowest altitude which may be used to provide a minimum obstacle clearance of 1000 ft above all obstacles within a sector of 25 nautical miles (46 km) from the NDB at Waterford Airport. The maximum turbine tip-height at the proposed wind farm site could be up to 1316 ft above mean sea level (AMSL). There is over 1000 ft from the maximum height of the wind farm to the relevant MSA altitude (3600 ft) and therefore there would appear to be no impact on the published MSA altitudes for Waterford Airport.

Instrument Flight Procedures

There are 6 published Instrument Flight Procedures for flights to/from Waterford Airport. Due to the distance of the proposed wind farm from the airport, and due to the proximity of the existing wind farm at Ballymartin, which is the most significant aviation obstacle in the vicinity of Ballyfasy, there should be no impact to these flight procedures.

Following the consultation process it was identified that there are plans to extend the length of the runway at Waterford Airport from 1433m to 2287m in the next few years. This extension may require the existing flight procedures for the airport to be updated/modified. It is highly unlikely that the proposed turbines at Ballyfasy would have an impact on any amended flight procedures for flights to/from the extended runway, as the existing wind farm at Ballymartin, would remain the most significant aviation obstacle in the Ballyfasy area.

Communications and Navigation Systems

As the proposed wind farm is approximately 19 km from the Localizer and transmitting antennas at Waterford Airport, it is highly unlikely that wind turbines at the proposed development will have any impact on these ATS communications and radio navigational aids.

Radar Surveillance Sensors

For Radar Surveillance Systems, EUROCONTROL Guidelines require a 16 km safe distance from the surveillance radar system (SSR), for a "*Zone 4 - No Assessment*" condition. It has been highlighted in the analysis that turbines located at the proposed farm would be located at a distance of over 65 km from the radar stations at Shannon, Woodcock Hill and Dublin Airport and in Assessment Zone 4 of the EUROCONTROL Guidelines. As turbines at the proposed development would be located in Assessment Zone 4, a detailed impact assessment on Radar Surveillance Systems will not be required by the IAA.

Flight Inspection and Calibration

Flight checks are conducted annually to ensure that flight procedures and associated navigational aids are safe and accurate. These flight checks are carried out by an IAA approved Flight Inspection Service Provider. The checks are carried out during annual inspections consisting of radial and orbital test flights around Waterford Airport for calibration of instrument landing systems. It is unlikely that the Flight Inspection Procedures will be impacted as the proposed wind farm is sufficiently far from the airport runways and the flight inspection procedures should already account for the existing obstacles (e.g. terrain and existing wind farms).

IAA - Aeronautical Obstacle Warning Light Scheme

In the event of a grant of planning consent the IAA are likely to request lighting of the proposed wind turbines in the interest of aviation safe-guarding as the proposed development would be considered as an en-route obstacle.

Department of Defence Aeronautical Safeguarding

The Irish Air Corps position on wind farms / tall structures are outlined in the paper which was published in 2014: "*Air Corps Wind Farm/ Tall Structures Position Paper*". In the position paper the Irish Air Corps outlines restricted areas where they would object to the installation of wind turbines /tall structures. The areas defined by the Air Corps have been mapped and analysis shows that the proposed wind farm site is partially located within a critical low level flying route (i.e. within 3 NM of the M8 motorway).

Although the proposed wind farm site is located within 3 NM of the M9 motorway and the N25 national primary road, it should be noted that low-level flights along these routes are likely to avoid the proposed wind farm site, due to high terrain and the existing wind farms at Ballymartin and Rahora. However, a further technical assessment may be requested by the Irish Air Corps.

Garda Air Support Unit (GASU) and Emergency Aeromedical Service (EAS)

The standard concerns that are being raised in recent consultations with the Irish Air Corps also highlight the potential for obstacles that could impact the operations of the Garda Air Support Unit (GASU) and the Emergency Aeromedical Service (EAS). An assessment of GASU and EAS operations indicates that they are unlikely to be impacted by the proposed wind farm development.

Abbreviations

AGL	Above Ground Level
AMSL	Above Mean Sea Level
ARP	Airport Reference Point
BRA	Building Restricted Area
DME	Distance Measuring Equipment
DoD	Department of Defence
EAS	Emergency Aeromedical Service
GASU	Garda Air Support Unit
GP	Glide Path
HLS	Helicopter Landing Site
IAA	Irish Aviation Authority
IAC	Irish Air Corps
ICAO	International Civil Aviation Organization
IFP	Instrument flight Procedure
ILS	Instrument Landing System
NATS	National Air Traffic Services (UK)
NDB	Non-directional beacon
NM	Nautical Miles
OLS	Obstacle Limitation Surface
PSR	Primary Surveillance Radar
RWY	Runway
SID	Standard Instrument Departure Route
STAR	Standard Arrival Route
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules
VOR	VHF Omni-directional Range Station

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Appendices

Abbreviations

AGL	Above Ground Level
AMSL	Above Mean Sea Level
ARP	Airport Reference Point
BRA	Building Restricted Area
DME	Distance Measuring Equipment
DoD	Department of Defence
EAS	Emergency Aeromedical Service
GASU	Garda Air Support Unit
GP	Glide Path
HLS	Helicopter Landing Site
IAC	Irish Air Corps
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
ILS	Instrument Landing System
OLS	Obstacle Limitation Surface
PSR	Primary Surveillance Radar
RWY	Runway
SID	Standard Instrument Departure Route
STAR	Standard Arrival Route
SSR	Secondary Surveillance Radar
NATS	National Air Traffic Services (UK)
NM	Nautical Miles
VOR	VHF Omni-directional Range Station

1. Introduction

This section provides a brief summary of the proposed wind farm development at Ballyfasy and of the nearest significant aviation installation at Waterford Airport.

1.1 Wind Farm Site Information

The proposed wind farm development is located in County Kilkenny approximately 20 km north of Waterford Airport. Figure 1 shows the proposed wind farm site with respect to Waterford Airport and the IAA radar stations at Shannon Airport and Woodcock Hill.

Figure 1. Location of proposed wind farm at Ballyfasy, Co Kilkenny

1.2 Waterford Airport

Table 2 below shows the co-ordinates of Waterford Airport and the distance from the Airport reference Point (ARP) to the proposed wind farm site. Waterford Airport operates in Class G controlled airspace with Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) Flight rules

Location	Installation	Description	Airport Ref. Point ARP	ARP Distance to Proposed Wind Farm
Kilowen, Co Waterford	International Airport	Single Asphalt Runway Airspace: Class G	52 11 14 N 07 05 13 W (Mid-point of Runway 03/21).	19.7 km

Table 1. Waterford Airport Details

The aeronautical navigation aids at the aerodrome include DME, NDB, ILS LOC and ILS GP.

Figure 2. Waterford International Airport

2. Aviation Review

In this section a review of the following a review of the following Aviation topics is provided.

- Annex 14 - Obstacle Limitation Surfaces (OLS)
- Annex 15 – Aerodrome Surfaces
- Building Restricted Areas (BRA)
- Minimum Sector Altitudes (MSA)
- Instrument Flight Procedures
- Permitted Wind Farms in vicinity of proposed Wind Farm
- Communications and Navigation Systems
- Radar Surveillance Sensors
- Flight Inspection and Calibration
- IAA - Aeronautical Obstacle Warning Light Scheme
- Department of Defence (DoD) Aeronautical Safeguarding
- Garda Air Support Unit (GASU) and Emergency Aeromedical Service (EAS)

2.1 Annex 14 Obstacle Limitation Surfaces (OLS)

A review of the Annex 14 Obstacles Limitation Surfaces (OLS) was first was carried out by first plotting the proposed wind farm location and the airport obstacle surfaces. The obstacle limitation surfaces for Waterford Airport are plotted based on the following:

- Annex 14 to the Convention on International Civil Aviation Aerodromes Volume I - Aerodrome Design and Operations Seventh Edition July 2016"
- Certification Specifications and Guidance Material for Aerodromes Design CS-ADR-DSN Issue 4, 8th of December 2017

Figure 3 below shows the OLS in relation to the proposed Ballyfasy wind farm. The distance from the ARP at Waterford Airport (i.e. the runway centre-point), to the nearest point of the proposed wind farm site is 19.7 km. The analysis of the OLS plots indicates that turbines at the proposed wind farm would not penetrate the Outer Horizontal Surface, which extends to 15 km from the Airport Reference Point (ARP) or runway centre-point.

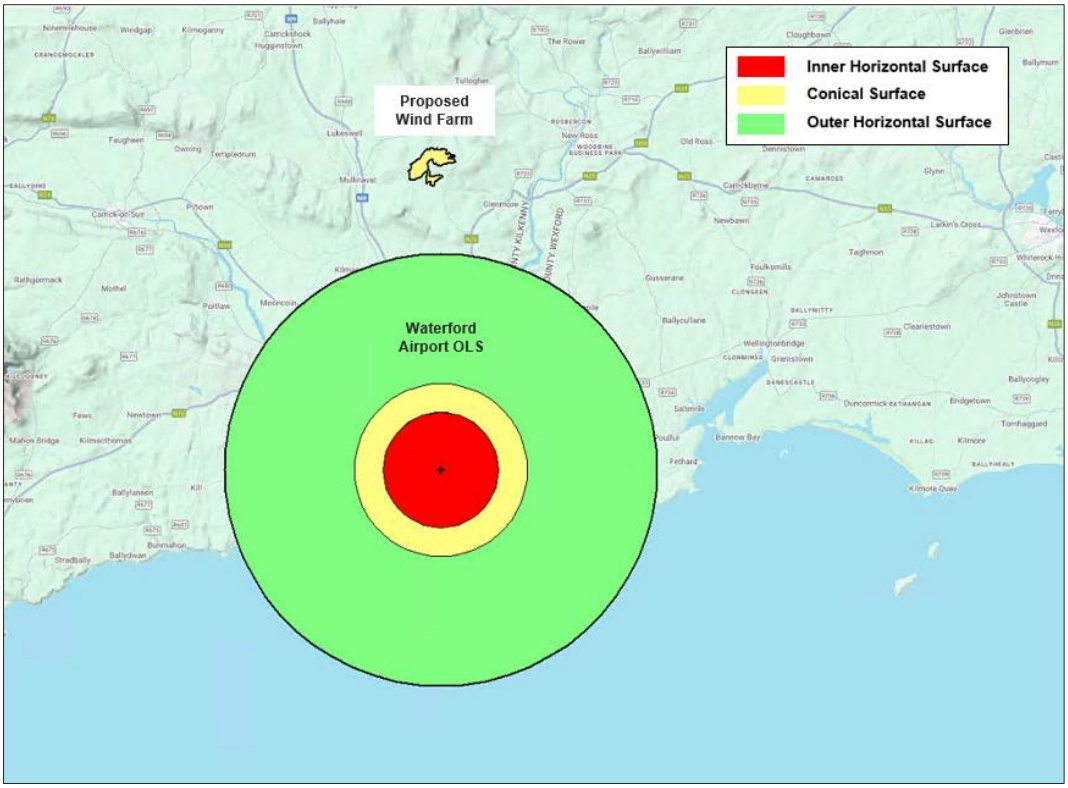


Figure 3. Ballyfasy Wind Farm in relation to Waterford Airport OLS.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Annex 14 Obstacle Limitation Surfaces	No action.	None

Table 2. Aviation Impact Review - Annex 14 Obstacle Limitation Surfaces

2.2 Annex 15 Aerodrome Surfaces

Turbines at the proposed wind farm would penetrate the ICAO Annex 15 Aerodrome Surface as shown in Figure 4. The "*Terrain and obstacle requirements Area 1*" is defined in ICAO Annex 15 as an area of 45 km from the Aerodrome ARP. (An illustration of ICAO Annex 15 Area 1 Surface is provided in Appendix A).

As the proposed wind farm is at a distance of 20 km from the ARP at Waterford Airport, there is penetration of the Annex 15 surface. All obstacles, if they are more than 100 meters above terrain for a distance of 45 km from Waterford ARP, need to be registered in the IAA Air Navigation Obstacle Data Set. This 45 km area is known as the TMA area i.e. Total Maneuvering Area and is used for en-route circling and maneuvering and is shown in Figure 4.

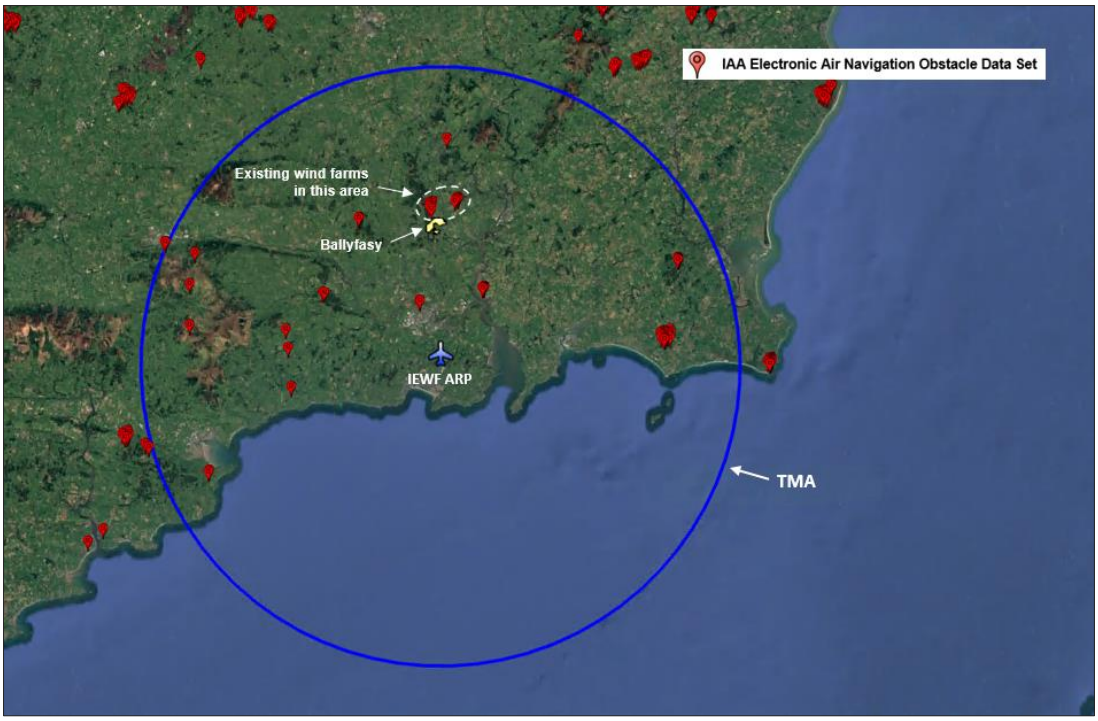


Figure 4. Annex 15 Aerodrome Surface and IAA Electronic Air Navigation Obstacle Data Set

It should also be noted that there are other existing tall structures (obstacles) in the vicinity of the proposed wind farm, notably the operational wind farms at, Ballymartin and Rahora.

The IAA Electronic Air Navigation Obstacle Data Set permitted obstacles are shown relative to the proposed wind farm in Figure 5.

Figure 5. Operational and Permitted Obstacles in vicinity of Ballyfasy Wind Farm

Although there are other obstacles in close proximity to the proposed wind farm, all new obstacles must be considered and assessed to see if they cause a “hazard to air navigation” and all Terrain Obstacle Data (including man-made obstacles) have to be considered by the relevant Aviation Authorities.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Annex 15 Aerodrome Surfaces	The proposed wind turbines would be required to be included in the IAA Obstacle Data Set.	None

Table 3. Aviation Impact Review - Annex 15 Aerodrome Surfaces

2.3 Building Restricted Areas (BRA)

A Building Restricted Area is the airspace surrounding an aviation facility that needs to be clear from physical intrusions. The purpose of the safeguarded areas is to identify developments with the potential for causing unacceptable interference to navigation facilities.

The navigation facilities to be considered at Waterford Airport are the ILS Localisers, Glidepaths and DMEs that provide guidance for aircraft landing on runways 03 and 21. The minimum safeguarded areas for these facilities are defined by the International Civil Aviation Organisation (ICAO) in the document ICAO EUR DOC 015, Section 7. The BRA parameters as specified by the ICAO are provided in Appendix B of this report.

Figure 6 below illustrates that the proposed wind farm at Ballyfasy is over 10 km from the Waterford BRA (safeguarded area for Runways 03 and 21). At this distance turbines at the proposed wind farm will have no impact on the navigation facilities associated with the Building Restricted Areas for Waterford Airport.

Figure 6. Proposed Wind Farm relative to Waterford Airport BRA (RWY 03 and 21)

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Building Restricted Areas	No action.	None

Table 4. Aviation Impact Review - Building Restricted Areas

2.4 Minimum Sector Altitudes

A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is within 25 nautical miles from the NDB at Waterford Airport. The MSA provides a minimum obstacle clearance of 1000 ft above the highest obstacle within specified sectors. Turbines at the proposed wind farm would be located within the Northern Sector (MSA 3600 ft), as shown in Figure 7. According to the wind farm location, the maximum construction height for the site would be 2600 ft / 792.5 m AMSL (3600 ft MVA minus 1000 ft).

A 591 ft (180 m) turbine located at the highest point (725 ft) within the proposed site boundary would result in an obstacle of 1316 ft AMSL. This is below the 2600 ft threshold, therefore the MSA of the Main Sector will not be affected and there will be no impact on the published MSA altitude figures.

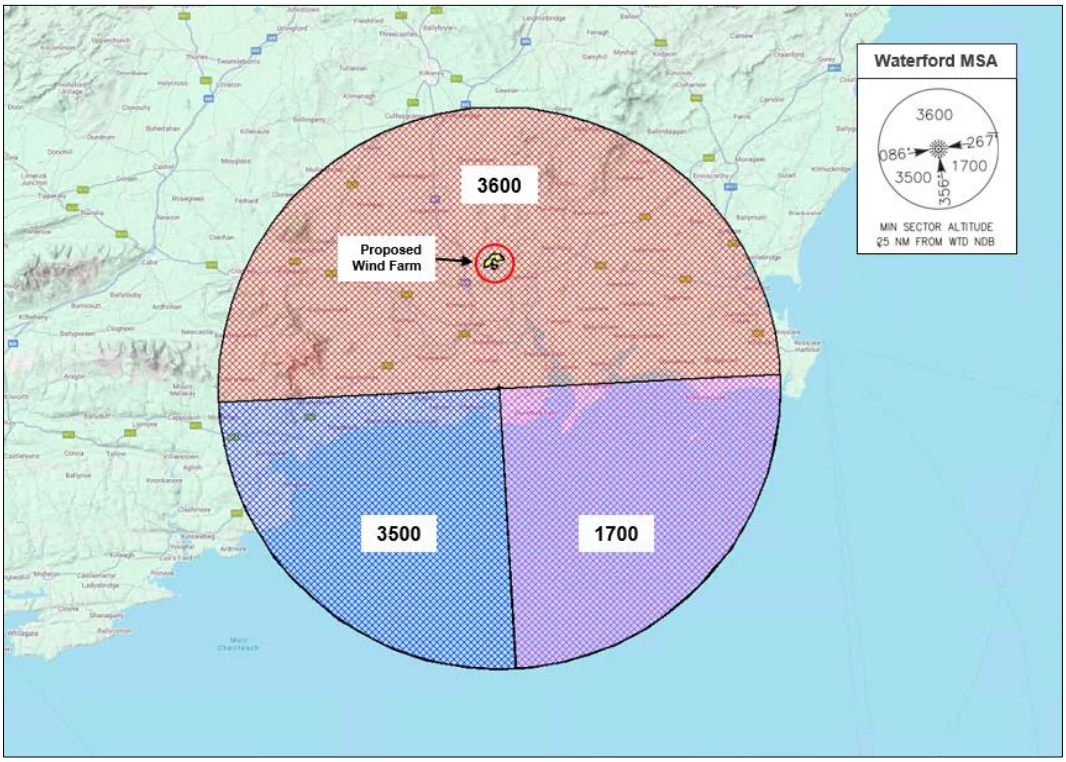


Figure 7. Waterford Airport (EIWF) Minimum Sector Altitudes

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Minimum Sector Altitudes	No action	None

Table 5. Aviation Impact Review - Minimum Sector Altitudes

2.5 Instrument Flight Procedures

There are 6 published Instrument and Visual Flight Procedures for arrivals to and departures from Waterford Airport. Due to the distance of the proposed wind farm from the airport (and as there are existing wind farms adjacent to Ballyfasy), it is unlikely that there will be any impacts on the Instrument Flight Procedures for flights to/from Waterford Airport.

Table 6 below lists the Instrument Flight Procedures for Waterford Airport. A review of each of these procedures is provided in Section 2.5.1 to Section 2.5.6 that follows.

Aerodrome	Aerodrome Procedure	Procedure / Chart ID
Waterford	Instrument Approach Chart ILS CAT 1 or LOC RWY 21 - ICAO	EIWF AD 2.24-3.1
Waterford	Instrument Approach Chart NDB/DME RWY 21 – ICAO	EIWF AD 2.24-5
Waterford	Instrument Approach Chart NDB/DME RWY 03 – ICAO	EIWF AD 2.24-6
Waterford	Visual Approach Chart – ICAO	EIWF AD 2.24-7
Waterford	Instrument Approach Chart RNP RWY 02 – ICAO	EIWF AD 2.24-8
Waterford	Instrument Approach Chart RNP RWY 20 – ICAO	EIWF AD 2.24-9

Table 6. Instrument and Visual Flight Procedures – Waterford Airport

A detailed instrument flight procedure analysis is outside of the scope of this report; however, from the review of IFPs, it is envisaged that turbines at the proposed development will have no impact on the flight procedures for Waterford Airport.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Flight Procedures	No action	None.

Table 7. Aviation Impact Review - Instrument Flight Procedures

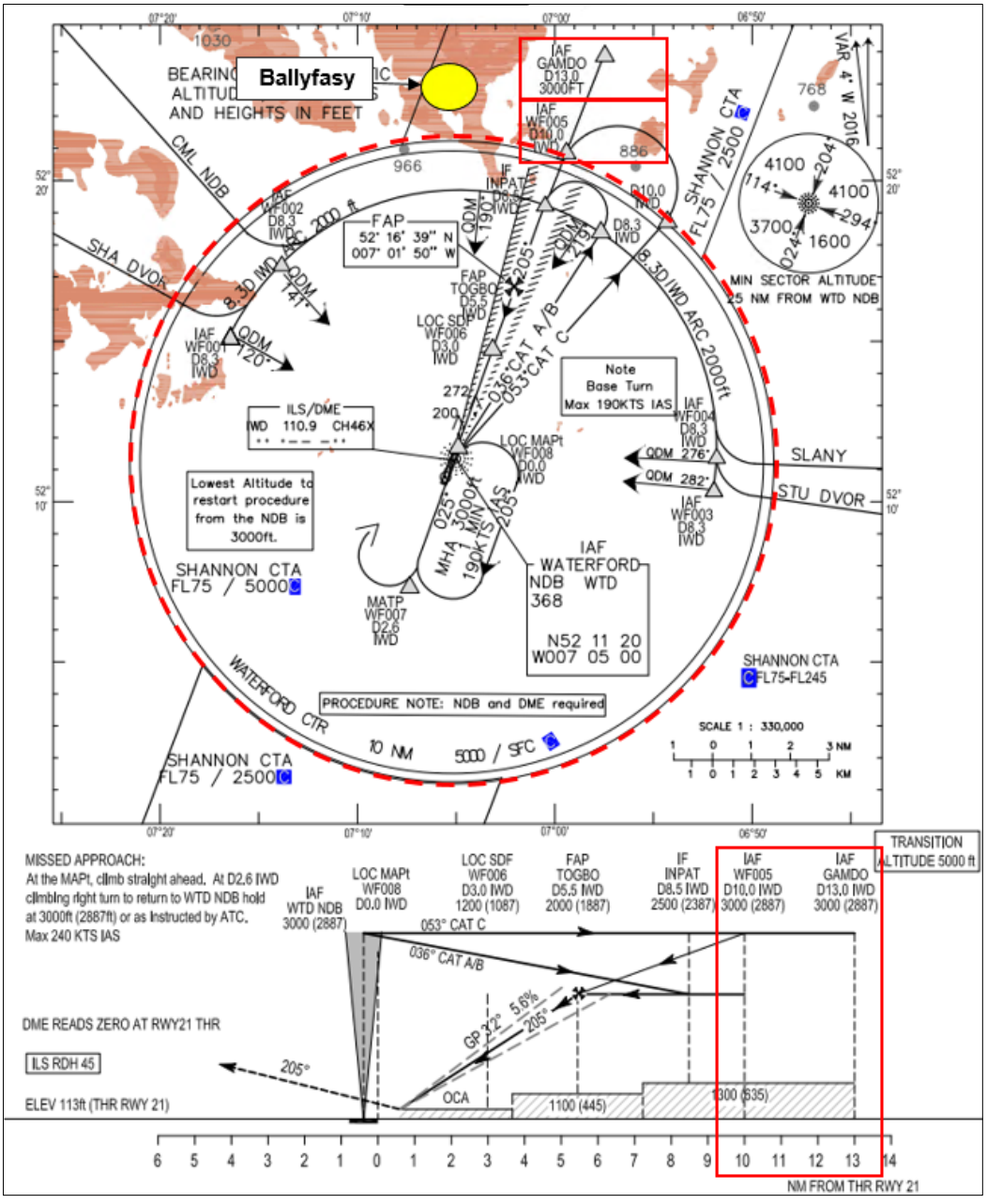
Note: There are plans to extend the length of the runway at Waterford Airport from 1433 m to 2287 m in the next few years. This extension may require the existing flight procedures for the airport to be updated/modified.

The proposed turbines at Ballyfasy should not impact any amended flight procedures for flights to/from the extended runway, as the existing wind farm at Ballymartin, would remain the most significant aviation obstacle in the Ballyfasy area.

2.5.1 Instrument Approach Chart ILS CAT 1 or LOC RWY 21 - ICAO

The Instrument Approach Chart (ILS CAT 1 or LOC) for runway RWY 21 is shown in the figure below. The procedure specifies that flights approaching RWY 21 from the northeast, which are beyond 10 NM from the runway threshold (THR), should have a flight altitude of 3000 ft.

As the maximum turbine height at the proposed development is 1316 ft (assuming a turbine tip-height of 180m), there should be no impacts to this flight procedure.

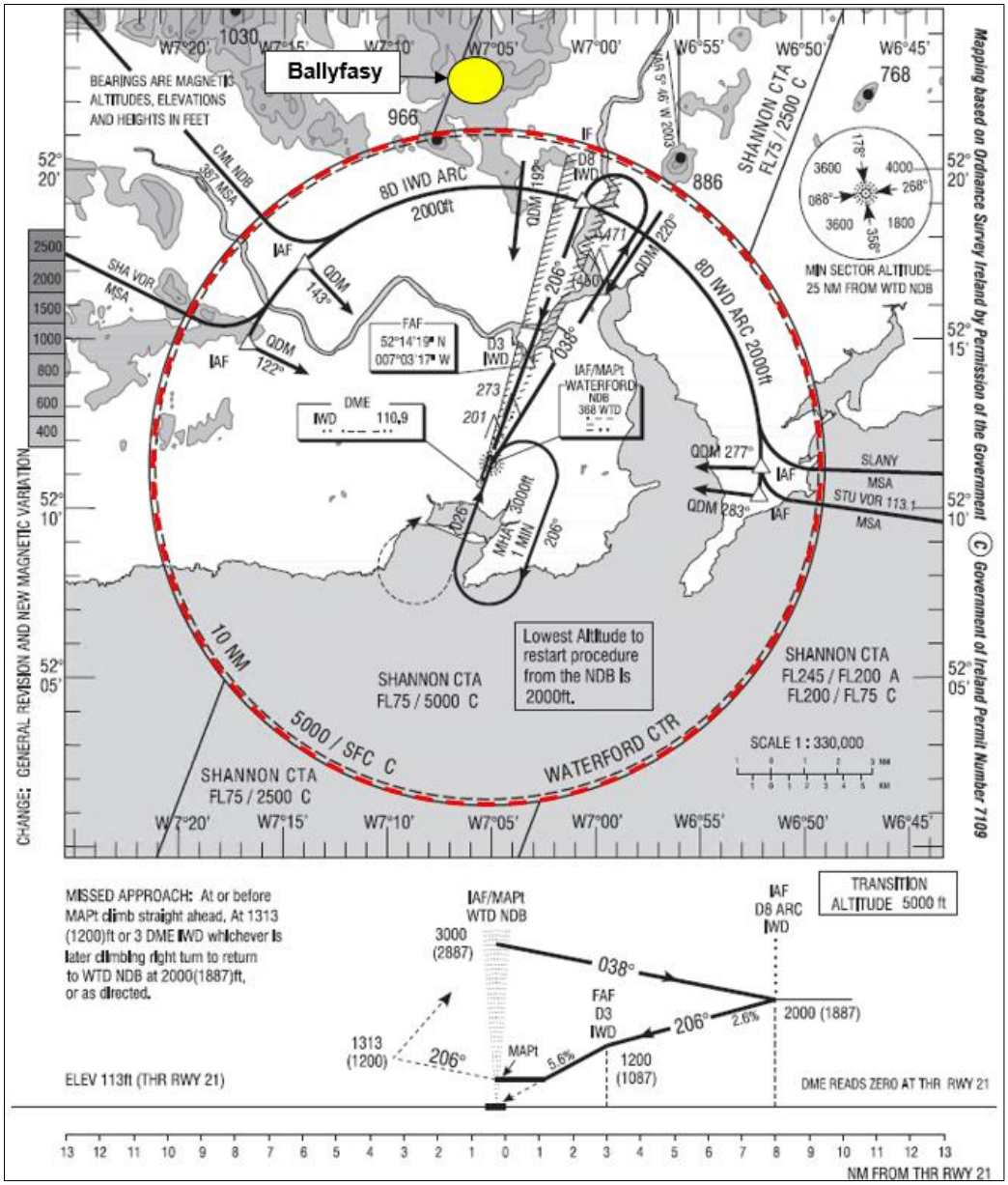


Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Approach Chart ILS CAT 1 or LOC RWY 21 – ICAO	No action	None

2.5.2 Instrument Approach Chart NDB/DME RWY 21 – ICAO

The Instrument Approach Chart (NDB/DME) for runway RWY 21 is shown in the figure below. None of the procedures specified in this chart extend beyond the Waterford Control Zone (CTR) which extends to 10 NM (18.5 km) from the runway.

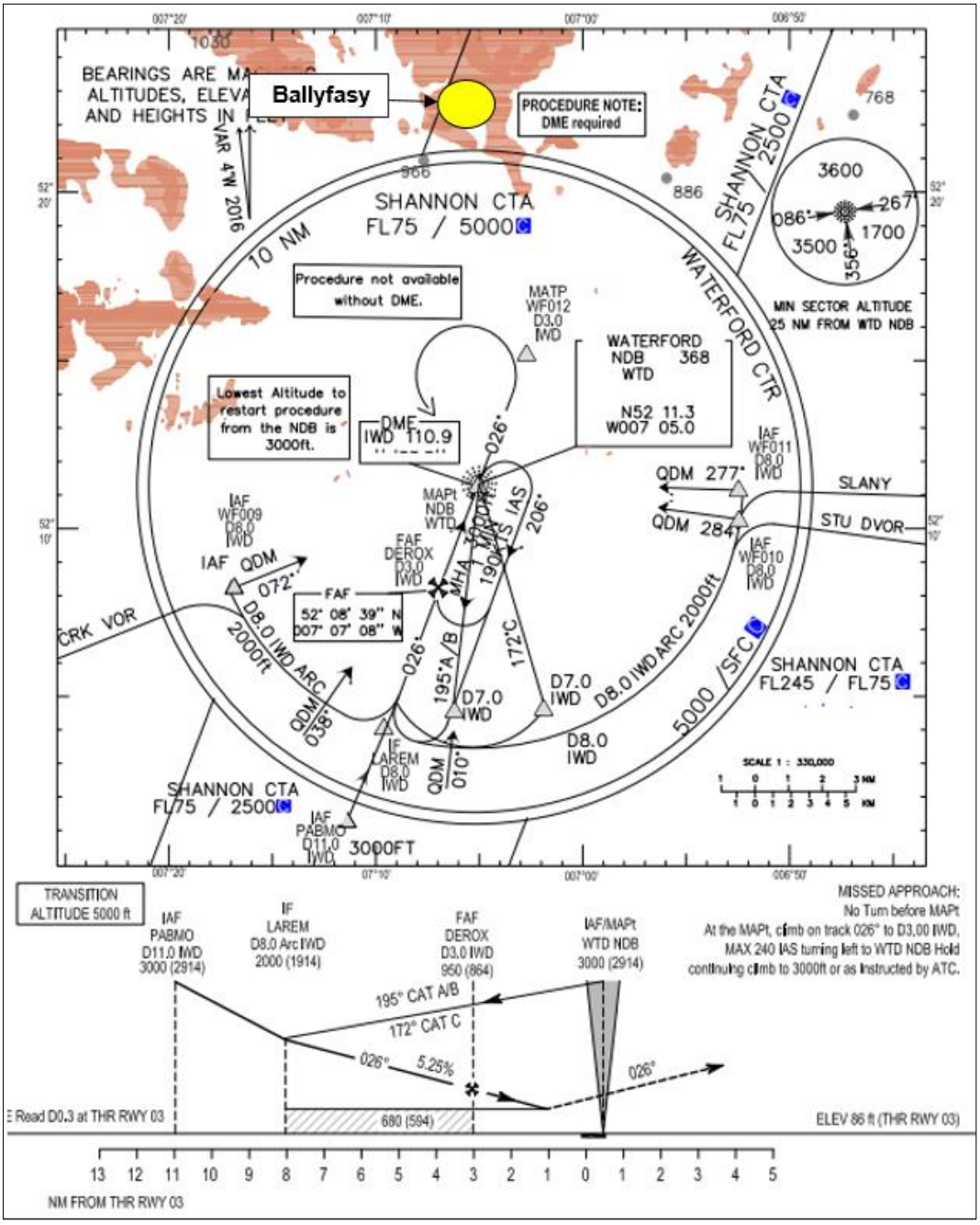
As the proposed wind farm is 19.7 km from the runway and outside the CTR, there should be no impacts to this flight procedure.



Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Approach Chart NDB/DME RWY 21 – ICAO	No action	None

2.5.3 Instrument Approach Chart NDB/DME RWY 03 – ICAO

The Instrument Approach Chart (NDB/DME) for runway RWY 03 is shown in the figure below. Approach flights to RWY 03 arrive from the southern half of the airport and would not be impacted by the proposed wind farm development which is located 19.7 km to the north of the ARP.



Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Approach Chart NDB/DME RWY 03 – ICAO	No action	None

2.5.4 Visual Approach Chart – ICAO

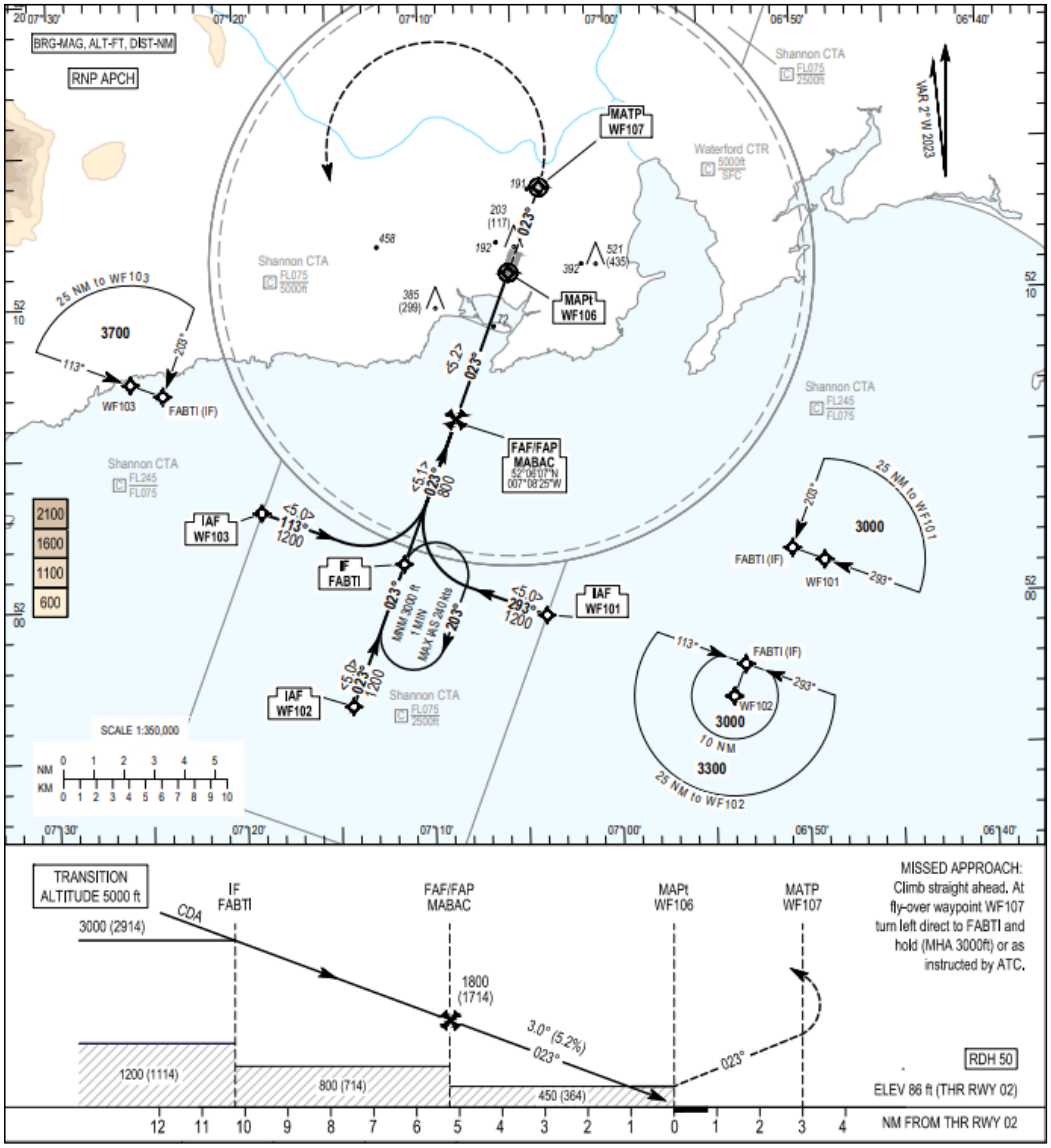
The Visual Approach Chart for Waterford Airport is shown in the figure below. Assuming a turbine tip-height of 180m, the maximum height of any turbine at Ballyfasy would be 1316 ft AMSL. Ballymartin wind farm is adjacent to Ballyfasy and is marked on the Visual Approach Chart with an obstacle height of 1329 ft.

As the turbines at Ballyfasy are lower (AMSL), Ballymartin wind farm would remain the most significant obstacle in the area.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Visual Approach Chart – ICAO	No action	None

2.5.5 Instrument Approach Chart RNP RWY 02 – ICAO

The Instrument Approach Chart (RNP) for runway RWY 02 is shown in the figure below. None of the procedures specified in this chart extend beyond 10 NM (18.5 km) to the north of the runway. As the proposed wind farm is 19.7 km to the north of the runway, there should be no impacts to this flight procedure.

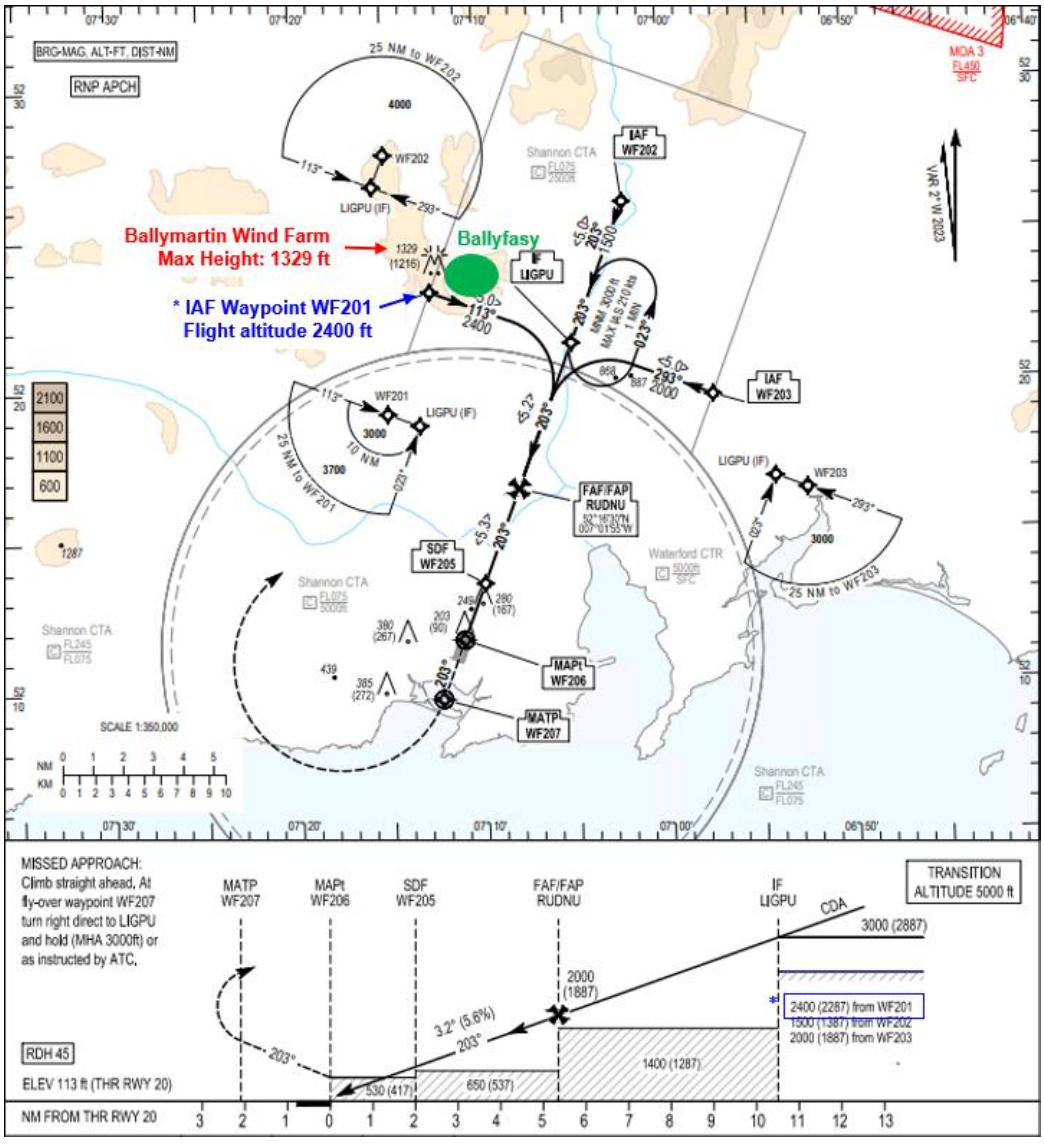


Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Approach Chart RNP RWY 02 – ICAO	No action	None

2.5.6 Instrument Approach Chart RNP RWY 20 – ICAO

The Instrument Approach Chart (RNP) for runway RWY 20 is shown in the figure below. The chart does specify a procedure for a flight path over the vicinity of the proposed wind farm. However, the chart specifies that the flight altitude over Ballyfasy (at Waypoint IAF WF201) should be 2400 ft, which is more than 1000 ft higher than any of the proposed turbines at Ballyfasy.

In addition, Ballymartin wind farm is marked on the IFP chart, and as the turbines at Ballyfasy would lower, Ballymartin would remain the most significant obstacle in the area. For these reasons, the proposed development at Ballyfasy should have no impact on this flight procedure.



Aviation Impact Review	Mitigation Measure Action	Residual Impact
Instrument Approach Chart RNP RWY 20 – ICAO	No action	None

2.6 Operational Permitted Wind Farms in vicinity of Proposed Wind Farm

The Planning References for the permitted wind farms in the vicinity of the proposed wind farm are shown below in Table 8. None of these wind farms required a Full Assessment of Instrument Flight Procedures.

Wind Farm	Planning Reference	Status
Rahora, Co. Kilkenny	03/1117	Operational Wind Farm
Ballymartin, Co. Kilkenny	07/2141	Operational Wind Farm

Table 8. Operational and Permitted Wind Farms in vicinity of Proposed Wind Farm

2.7 Communications and Navigation Systems

The AIP document EIWD AD 2-18/19 provides the information for communication and navigation facilities for Waterford Airport. The table below shows the channel frequencies for the ATS communications Facilities and the Radio Navigation and Landing Aids for the airport.

Aerodrome	ATS Communications Facilities Channel Frequency	Radio Navigation and Landing Aids Channel Frequency	Approximate Distance to Localizer and Transmitting antennas	Impacts of wind fam
Waterford	121MHz -130MHz	110KHz – 331MHz	19 km	No impacts

Table 9. Impacts on Communications and Navigation Systems

As the proposed wind farm is approximately 19 km from the Localizer and transmitting antennas, it is very unlikely that turbines at the proposed wind farm will have any impact on these ATS communications and radio navigational aids. Typically, interference to VHF communications systems will only occur when obstacles are in close proximity to the VHF transmitter e.g. less than 500m.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Communication and Navigation Systems	No action	None

Table 10. Aviation Impact Review - Communication and Navigation Systems

2.8 Radar Surveillance Sensors

The tables below show the Irish Aviation Authority Assessment Zone arrangement for the two types of aviation radar surveillance systems; Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR).

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

Table 11. PSR Zone Arrangements

Zone	Description	Assessment Requirements
Zone 1	0 - 500m	Safeguarding
Zone 2	500m - 16km but within maximum instrumented range and in radar line of sight	Detailed Assessment
Zone 4	Further than 16km or not in radar line of sight	No Assessment

Table 12. SSR Zone Arrangements

The EUROCONTROL Guidelines require a 16km safe distance for a “Zone 4 - No Assessment” condition and detailed assessments are required for any proposed wind within 16km of a secondary surveillance radar.

It should be noted that in the UK, NATS (Air Traffic Control) safeguards SSR to a distance of 10km. The guidelines used by NATS (*CAP 764: Chapter 2: Impact of wind turbines on aviation*) state that:

> *“Wind turbine effects on SSR are traditionally less than those on PSRs but can be caused due to the physical blanking and diffracting effects of the turbine towers, depending on the size of the turbines and the wind farm. These effects are typically only a consideration when the turbines are located very close to the SSR i.e. less than 10 km.”*

To determine which Assessment Zones are applicable to the proposed wind farm a desktop assessment was carried out. The nearest radar surveillance sites to the proposed wind farm development are at Shannon Airport, Woodcock Hill and Dublin Airport. These radar sites are shown relative to the proposed wind farm in Figure 8 below.

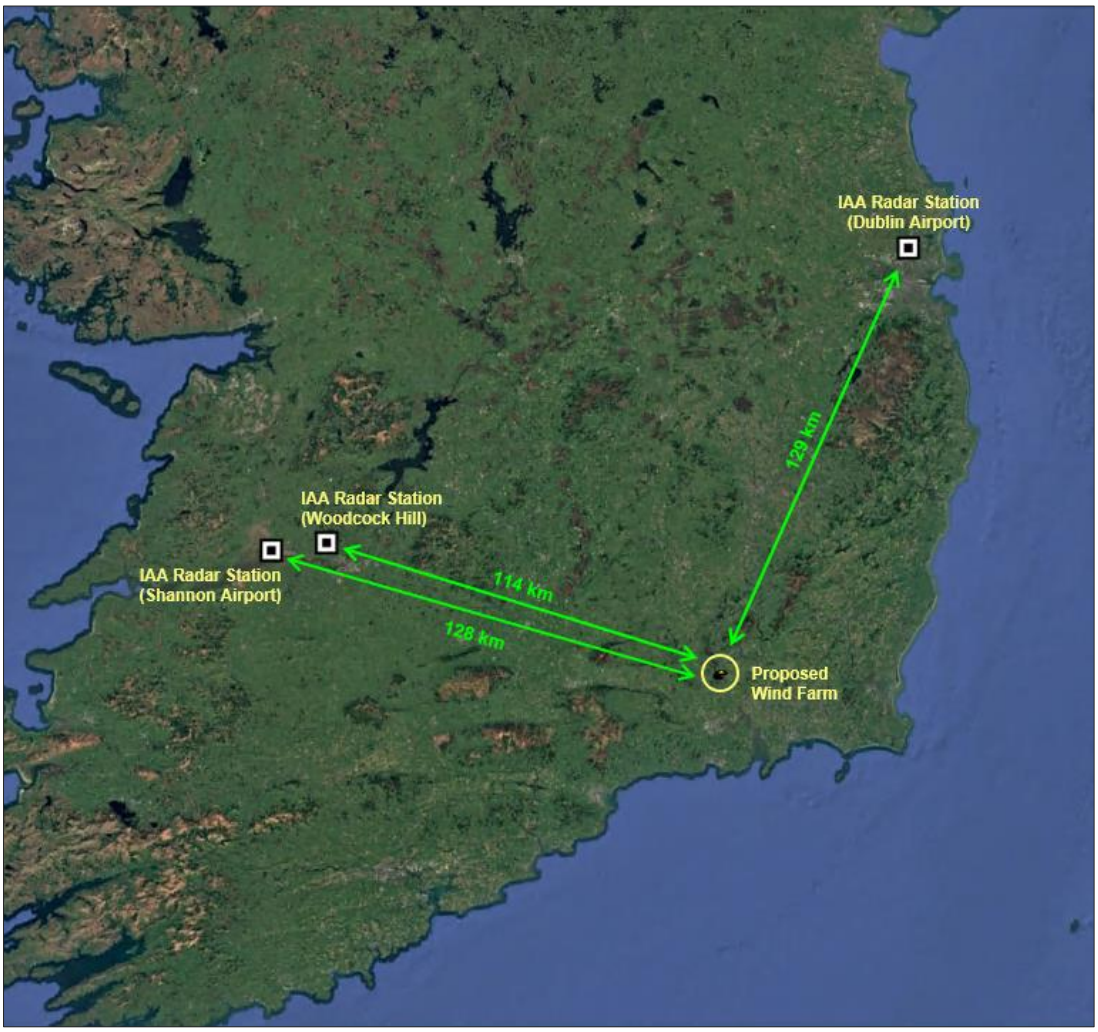


Figure 8. Radar Surveillance Sites relative to Ballyfasy Wind Farm.

A review of each radar station is provided in Sections 2.8.1 to 2.8.3 that follow. The findings of the review indicate that the proposed wind farm is sufficiently far from the radar stations that there would be no impacts, and a detailed radar assessment would not be required by the IAA.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Radar Surveillance Sensors	No action	None

Table 13. Aviation Impact Review - Radar Surveillance Sensors

2.8.1 Shannon Airport Radar Assessment

The radar surveillance site at Shannon Airport consists of a PSR and a SSR. The PSR and the SSR antennas are co-located on the same structure at Shannon Airport (Figure 9).

Figure 9. Shannon Airport Radar Station

Table 14 below shows the (EuroControl & NATS) assessment zone applicable to the nearest point where a turbine could potentially be located. The applicable assessment zone has been based on distance from the Radar Station and whether a radar line-of-sight condition exists.

Wind Farm ID	Distance to PSR/SSR Radar Station	Radar LOS Assessment (EuroControl Guidelines)	Radar LOS Assessment (NATS Guidelines – UK)
Ballyfasy	128 km	Detailed Assessment Not Required	Detailed Assessment Not Required

Table 14. EuroControl / UK Safeguarding Guidelines – Shannon Airport Radar Station

As the table above show, the proposed wind farm is within Assessment Zone 4 as specified by the EUROCONTROL guidelines, which would indicate that a detailed technical assessment would not be required for the impact on the PSR/SSR radar station at Shannon Airport.

2.8.2 Woodcock Hill Radar Assessment

The radar surveillance site at Woodcock Hill consists of a SSR system housed in the dome-shaped structure shown in Figure 10.

Figure 10. Woodcock Hill Radar Station

Table 15 below shows the (EuroControl & NATS) assessment zone applicable to the nearest point where a turbine could potentially be located. The applicable assessment zone has been based on distance from the Radar Station and whether a radar line-of-sight condition exists.

Wind Farm ID	Distance to PSR/SSR Radar Station	Radar LOS Assessment (EuroControl Guidelines)	Radar LOS Assessment (NATS Guidelines – UK)
Ballyfasy	114 km	Detailed Assessment Not Required	Detailed Assessment Not Required

Table 15. EuroControl / UK Safeguarding Guidelines – Woodcock Hill Radar Station

As the table above show, the proposed wind farm is within Assessment Zone 4 as specified by the EUROCONTROL guidelines, which would indicate that a detailed technical assessment would not be required for the impact on the SSR radar station at Woodcock Hill.

2.8.3 Dublin Airport Radar Assessment

The radar surveillance site at Dublin Airport consists of two PSR/SSR (MSSR) radar stations as shown below in Figure 11 and Figure 12.

Figure 11. Dublin Airport MSSR Radar Station #1

Figure 12. Dublin Airport MSSR Radar Station #2

Table 16 below shows the (EuroControl & NATS) assessment zone applicable to the nearest point where a turbine could potentially be located. The applicable assessment zone has been based on distance from the Radar Station and whether a radar line-of-sight condition exists.

Wind Farm ID	Distance to PSR/SSR Radar Station	Radar LOS Assessment (EuroControl Guidelines)	Radar LOS Assessment (NATS Guidelines – UK)
Ballyfasy	129 km	Detailed Assessment Not Required	Detailed Assessment Not Required

Table 16. EuroControl / UK Safeguarding Guidelines – Dublin Airport Radar (Station #1 and #2)

As the table above show, the proposed wind farm is within Assessment Zone 4 as specified by the EUROCONTROL guidelines, which would indicate that a detailed technical assessment would not be required for the impact on the PSR/SSR at Dublin Airport.

2.9 Flight Inspection and Calibration

Flight checks are conducted annually to ensure that flight procedures and associated navigational aids are safe and accurate. These flight checks are carried out by an IAA approved Flight Inspection Service Provider. The checks are carried out during annual inspections consisting of radial and orbital test flights around Waterford Airport for calibration of instrument landing systems.

It is unlikely that the Flight Inspection Procedures will be impacted as the proposed wind farm is sufficiently far from the airport runways and the flight inspection procedures should already account for the existing obstacles (e.g. terrain and existing wind farms).

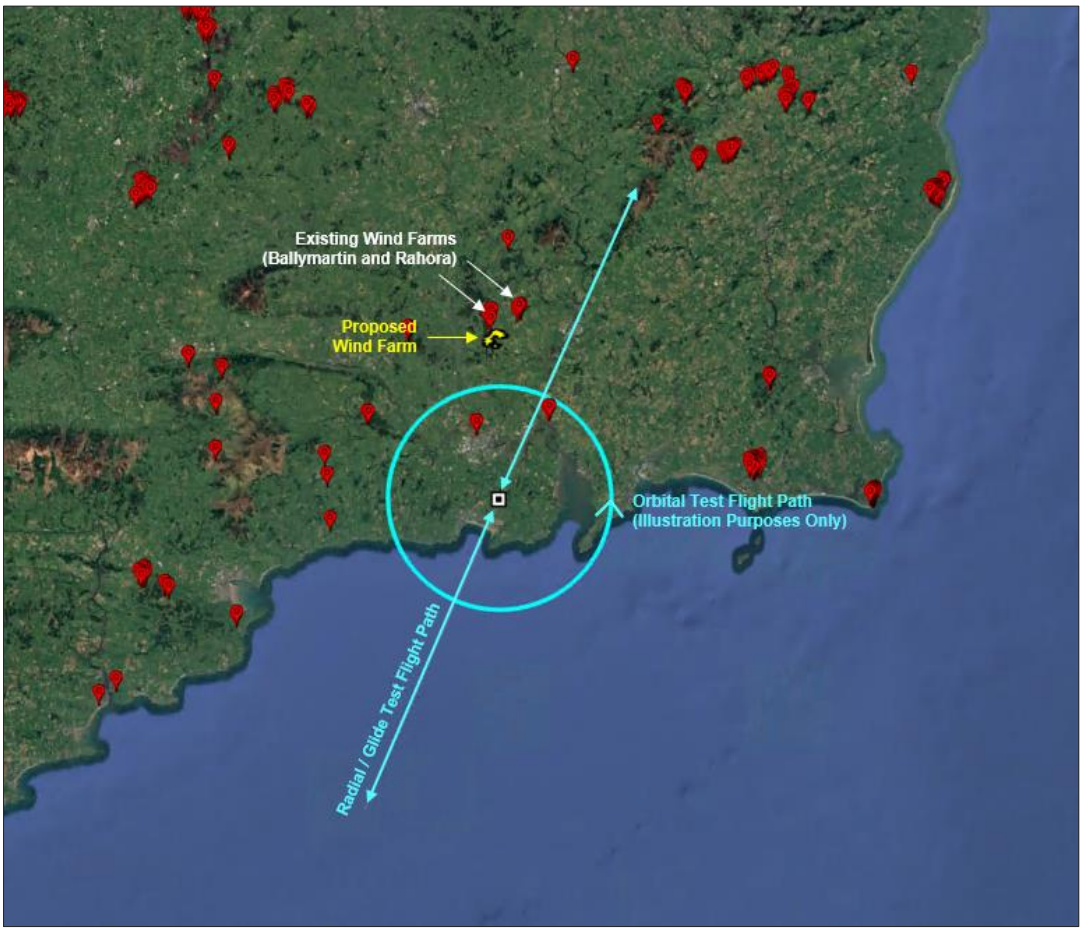


Figure 13. Flight Inspection and Calibration Test Procedures should account for existing obstacles (e.g. terrain and existing wind farms)

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Flight Inspection and Calibration	No action	None

Table 17. Aviation Impact Review - Flight Inspection and Calibration

2.10 IAA - Aeronautical Obstacle Warning Light Scheme

In the event of a grant of planning consent the IAA-ANSP would require the lighting of the proposed wind turbines in the interest of aviation safeguarding as the proposed development may be considered as an en-route obstacle. The developers of the proposed turbines would intend to implement an aeronautical obstacle warning light.

It is recommended that lighting requirements should be in accordance with Chapter Q – Visual Aids for denoting Obstacles; CS ADR.DSN.Q.851 and GM.ADR.DSN.Q.851 (Pages 729/730) of the EASA Easy Access Rules for Aerodromes (Reg (EU) No. 139/2014) where it states that

> *"Applicability: When considered as an obstacle a wind turbine should be marked and/or lighted."*

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Aeronautical Obstacle Warning Light Scheme	It is likely that the IAA would request that the wind farm, if permitted, would be fitted with Aeronautical Obstacle Warning Lights in accordance with industry standards. Subject to further consultation with the IAA.	None

Table 18. Aviation Impact Review - Aeronautical Obstacle Warning Light Scheme

2.11 Irish Air Corps / DoD Safeguarding

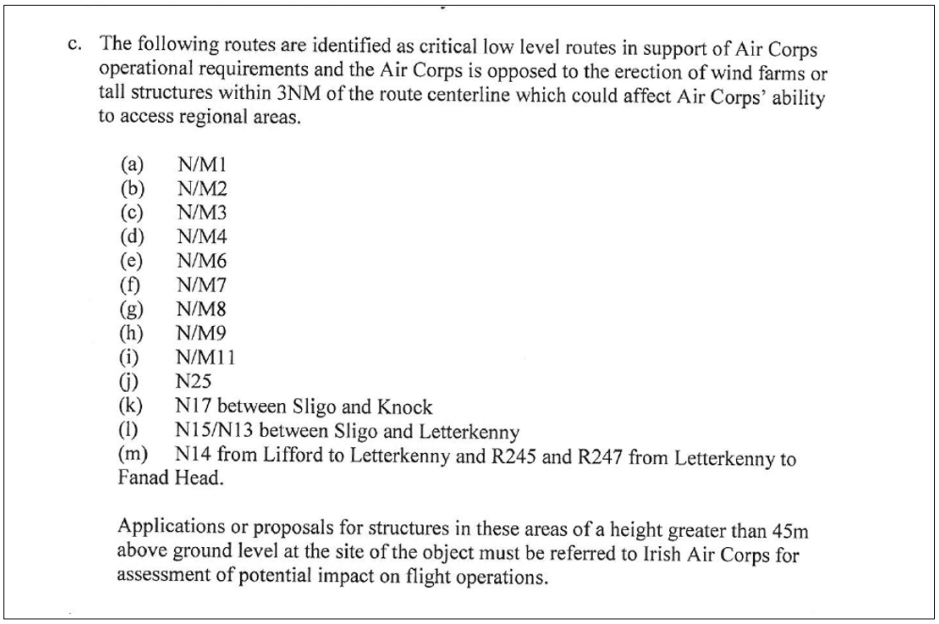
The standard concerns that are being raised by the Department of Defence, relate to the potential impact of wind turbines on the aviation activities of the Irish Air Corps (IAC). The Department of Defence highlights IAC Restricted Areas (for wind farms/ tall structures). They also request a specific Aeronautical Obstacle Warning Light Scheme for turbines that are permitted.

An assessment of the IAC Restricted Areas is provided in Section 2.12.1, and a review of the IAC Aeronautical Obstacle Warning Light Scheme is provided in Section 2.12.2

2.11.1 Department of Defence – IAC Restricted Areas

The Irish Air Corps Position Paper "*Air Corps Wind Farm/ Tall Structures Position Paper*" published on 08th August 2014 (Appendix C), states that the Air Corps are likely to oppose any wind farm / tall structure in the following restricted areas:

- Lands underlying military airspace for flying activity. (Areas contained in Danger Areas EI-D1, EI-D5, EI-D6, EI-D13, EI-D14, Restricted Areas EI-R15, EI-R16 within 20 NM of Baldonnel, MOAs 3 and 4 within 20 NM of Baldonnel.
- Low Flying Training Areas within MOA 4 in the areas of; Blessington, Edenderry/Allenwood/Rathangan, Kilmeague/Newbridge.
- Low Flying Training Area West – LFTA WEST.
- A distance of 5 NM or less from military installations.
- Critical low level flying routes in support of Air Corps operation requirements, as described in Figure 14 below.



c. The following routes are identified as critical low level routes in support of Air Corps operational requirements and the Air Corps is opposed to the erection of wind farms or tall structures within 3NM of the route centerline which could affect Air Corps' ability to access regional areas.

(a) N/M1
(b) N/M2
(c) N/M3
(d) N/M4
(e) N/M6
(f) N/M7
(g) N/M8
(h) N/M9
(i) N/M11
(j) N25
(k) N17 between Sligo and Knock
(l) N15/N13 between Sligo and Letterkenny
(m) N14 from Lifford to Letterkenny and R245 and R247 from Letterkenny to Fanad Head.

Applications or proposals for structures in these areas of a height greater than 45m above ground level at the site of the object must be referred to Irish Air Corps for assessment of potential impact on flight operations.

Figure 14. Irish Air Corps – Critical Low-Level Routes

The nearest of the Air Corps restricted areas to the proposed wind farm are the low-level flight routes around the M9 motorway and the N25 national primary road. The proposed wind farm site is partially located within the restricted area around the M9 and partially located within the restricted area around the N25 as shown in Figure 15 below. As some of the proposed turbines

at Ballyfasy would be located inside the restricted areas, the Irish Air Corps may raise concerns in relation to the proposed development.

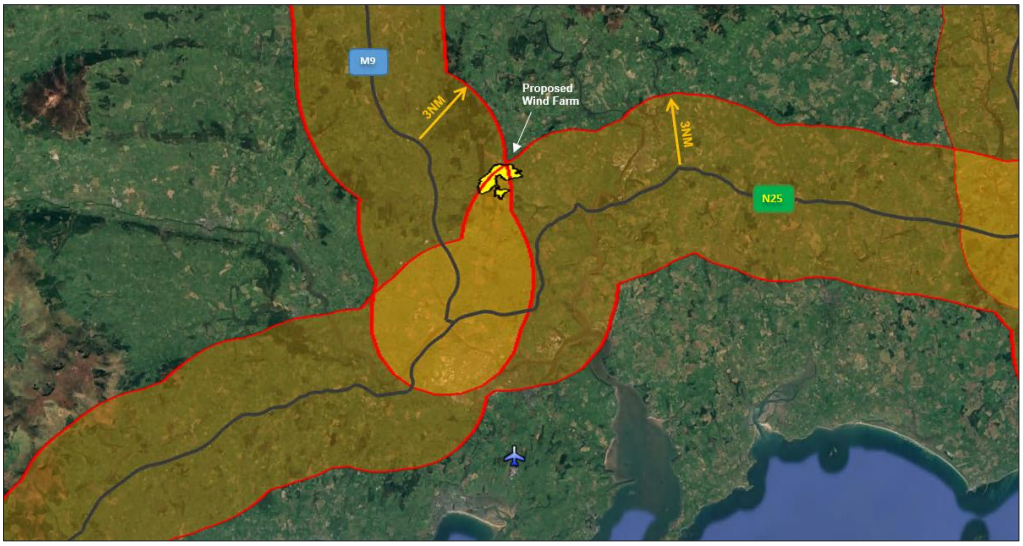


Figure 15. Proposed Wind Farm relative to IAC Critical Low Level Flight Route (M8)

Although the proposed wind farm is located within the restricted areas, it should be noted that there are other existing wind farms that are located within 3NM of the M9 and the N25 (e.g., Ballymartin and Rahora wind farms) as shown below in Figure 16. Low-level IAC flights over Ballyfassy would not occur due to its proximity to these existing farms.

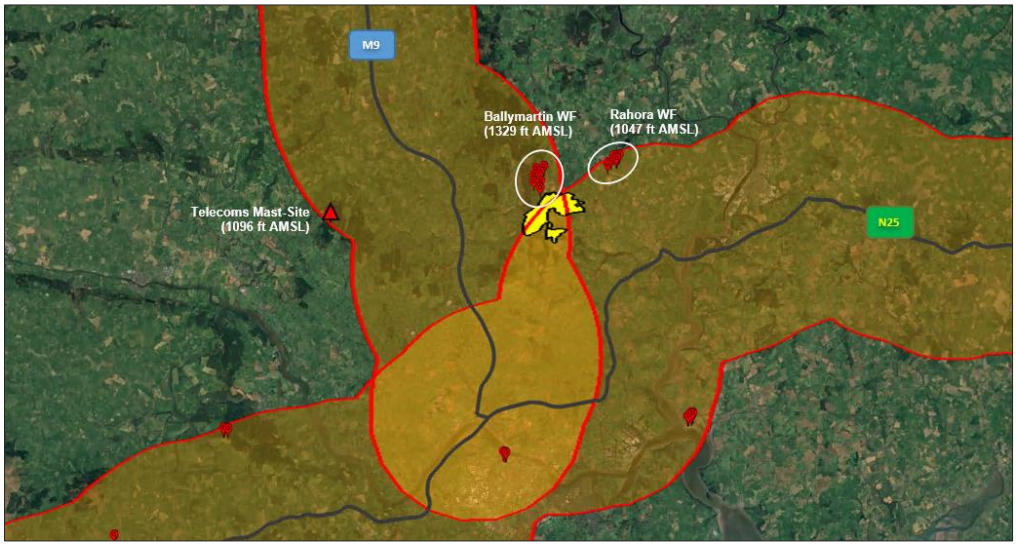


Figure 16. Existing Wind Farms located within 3 NM of Low-Level Route Restricted Areas

A summary analysis of IAC (low-level flight route) restricted area is provided below.

- The area to the east of the M9 motorway, where Ballyfasy is situated, is unsuitable for low-level aircraft maneuvering due to the high terrain in the area and due to the proximity of existing wind farms.
- In poor weather conditions it is unlikely that low-level flights would pass over Ballyfasy, as any flights along the M9 or N25 would be required to avoid the existing wind farms

at Ballymartin and Rahora. The hills to the east of the M9 would also contribute to lower visibility and lower cloud base cover.

- In good weather conditions, a wind farm at Ballyfasy could potentially be used as a visual landmark to aid Visual Flight Rules (VFR) navigation. There are existing wind farms in the area (i.e. Ballymartin and Rahora) and the addition of new turbines at Ballyfasy could make it easier for pilots to identify their flight position.

- In the rare event where a pilot decides to undertake a reverse course manoeuvre along the M9, by performing a 180° turn, it is unlikely that this would be initiated near Ballyfasy. The existing wind farms at Ballymartin and Rahora are marked as obstacles on existing aviation charts and Air Corps flight rules and procedures would account for these. Any reverse course manoeuvre along the M9 would likely only commence further south or further north of the Ballyfasy area, so as to avoid the high terrain and existing wind farms. Similarly, a reverse course manoeuvre along the N25 is unlikely to be initiated near Ballyfasy. Any reverse course manoeuvre along the N25 would likely only commence further south of Ballyfasy in an area which is clear of hills and existing wind farms.

- In a worst-case scenario of deteriorating visibility and/or reducing cloud base where a pilot is forced to undertake a reverse course manoeuvre, along the M9, in the vicinity of Ballyfasy. The turn radius for an aircraft with a true airspeed of 80 knots in a 25° bank turn (as per ICAO recommendations) would be 0.2 NM. A worst-case scenario, where the pilot decides to commence a reverse-course manoeuvre as they are flying south along the M9 adjacent to Ballyfasy (0.05 NM to the right of the road, as per the Rules of the Air), would result in the aircraft being 0.15 NM east of the motorway. This would be at least 1.57 NM /9540 ft clear of any of the proposed turbines at Ballyfasy. Similarly, in a worst-case scenario, where the pilot decides to commence a reverse-course manoeuvre (flying northeast along the N25), there would be a clearance distance of at least 11848 ft.

  If a worst-case crosswind of 25 kts is also considered (for IAC flights along the M9 or N25), the radius of turn would be increased to 0.33 NM; however, there would still be a clearance distance of over 8000 ft between the aircraft and any of the proposed turbines at Ballyfasy. (The formula used in these calculations has been taken from the "*Pilot's Handbook of Aeronautical Knowledge – Federal Aviation Administration – 2016"* and is provided in Appendix D of this report.)

- All modern aircraft are equipped with a range of Global Navigation Satellite Systems (GNSS), e.g. GPS, GLNASS, Galileo, etc. These GNSS systems provide pilots with accurate navigation information including data to avoid obstacles during VFR operations. Should the proposed wind farm at Ballyfasy be permitted the turbine location would be submitted to the IAA and aviation charts and GNSS databases would be updated accordingly.

For the reasons outlined above any impacts on Air Corps operations in the area are expected to be negligible.

Aviation Impact Review	Mitigation Measures	Residual Impact
Department of Defence – IAC Restricted Areas	Subject to pilot flight plan.	None

Table 19. Aviation Impact Review – IAC Restricted Areas

2.11.2 Department of Defence – IAC Aeronautical Obstacle Warning Light Scheme

To-date there has been no consultation response from the Department of Defence highlighting any requirements for an IAC Aeronautical Obstacle Warning Light Scheme. Based on the analysis provided in Section 2.11.1 above, a further detailed technical assessment could be undertaken to address any concerns that the IAC/DoD in relation to the aeronautical lighting.

Any concerns or observations raised would be taken into account and a suitable mitigation measure proposal would be considered in accordance with the IAC pilot flight plans.

2.12 Garda Air Support Unit (GASU) and Emergency Aeromedical Service (EAS)

The standard concerns that are being raised in recent consultations with the Air Corps also highlight the potential for obstacles that could impact the operations of the Garda Air Support Unit (GASU) and the Emergency Aeromedical Service (EAS). The excerpt below is taken from a response received from the IAC in relation to a third-party wind farm project:

> "*Having consulted with the subject matter experts in the Irish Air Corps, the Department of Defence wishes to make the following observations:*
>
> - *The Department of Defence cannot support, based on military advises, the erection of wind farms or other tall structures within 3 NM of roads identified as critical low level routes in support of operational requirements. The erection of obstacles within low-level helicopter routes could affect the Irish Air Corps ability to access regional areas and to fulfil its role.*
> - *If this proposed development was to go to the planning stage, the Department of Defence would be obligated to raise the following concerns and advise the planning authorities that the proposed windfarm*
>
> *a) lies wholly within 3 nautical miles of the [Motorway/National Road] which is identified as a critical low level route used by state aircraft on operational taskings. A windfarm or any other tall structures within a low-level route will be an obstacle to state aircraft not operating within the civil rules of the air;*
>
> *b) The [Motorway/National Road] low level route requires protection from obstacles for low level state aircraft on operational tasking's such as:*
>
> *(i) The Garda Air Support Unit (GASU)*
> *(ii) The Emergency Aeromedical Service (EAS)"*

A review of the GASU and EAS services is provided in Sections 2.13.1 and 2.13.2 that follow. The findings of the review indicate that the proposed wind farm would have no impacts on these aviation services.

Aviation Impact Review	Mitigation Measure Action	Residual Impact
Garda Air Support Unit (GASU) and Emergency Aeromedical Service (EAS)	No action.	None

Table 20. Aviation Impact Review - GASU and EAS

2.12.1 The Garda Air Support Unit (GASU)

The Garda Air Support Unit is based at Casement Aerodrome, Baldonnel and is typically deployed to incidents in the following cases:

- Immediate threat to life
- Incidents of a criminal, terrorist or other nationally important nature
- Immediate threat of serious public disorder
- Tasks leading to the prevention or detection of crime
- Evidence gathering
- Intelligence gathering
- Photographic tasks
- Traffic Management/Monitoring

The unit consists of one fixed-wing aircraft (a Pilatus Britten-Norman BN 2T-4S Defender 4000) and two helicopters (Eurocopter EC 135 T2).

Figure 17. GASU - Pilatus Britten-Norman BN 2T-4S Defender 4000

Figure 18. GASU - Eurocopter EC135 T2

The proposed wind farm is located in an area that is sparsely populated and on forested terrain. For these reasons, it is highly unlikely that the proposed wind farm development would have any significant impacts on GASU operations.

In the unlikely event of GASU operations in the general area, it should be noted that all modern aircraft are equipped with a range of Global Navigation Satellite Systems (GNSS), e.g. GPS, GLNASS, Galileo, etc. These GNSS systems provide pilots with accurate navigation information including data to avoid obstacles during VFR operations. Should the proposed wind farms be permitted the associated turbine locations would be submitted to the IAA and aviation charts and GNSS databases would be updated accordingly.

GASU Aircraft	Impact of proposed wind farms - Opinion
Fixed-wing Airplane (Pilatus Britten-Norman BN 2T-4S Defender 4000)	Low – Fixed-wing aircraft are unlikely to be deployed in low level activity in the subject areas. In addition, the aircraft would be equipped with modern communications systems and navigational equipment. Should the wind farm be permitted, the turbines would be fitted with aeronautical lighting and would be clearly marked in aviation charts.
Helicopter (Eurocopter EC135 T2)	Low – Helicopter landings in the subject area would not occur as the proposed wind farm located in forested terrain. In addition, the aircraft would be equipped with modern communications systems and navigational equipment. Should the wind farm be permitted, the turbines would be fitted with aeronautical lighting and would be clearly marked in aviation charts.

Table 21. Impact of proposed wind farm on GASU Operations

2.12.2 The Emergency Aeromedical Service (EAS)

The air ambulance service in Ireland is known as the Emergency Aeromedical Service (EAS). The EAS crew (which include National Ambulance Service (NAS) paramedics) deal with time-critical emergency callouts to major emergencies such as road collisions and urgent medical events. The EAS currently operate two air ambulance helicopters operating from two bases:

- Custume Barracks, Athlone, Co Westmeath.
- Rathcoole Aerodrome, Rathcoole, Mallow, Co Cork.

The two helicopter borne emergency air ambulances consist of an Air Corps operated aircraft based at Custume Barracks in Athlone, and an aircraft located at Rathcoole Aerodrome in North County Cork. As shown below in Figure 19, both EAS bases are similar distances from the proposed wind farm site at Ballyfasy (i.e. approximately 130 km).

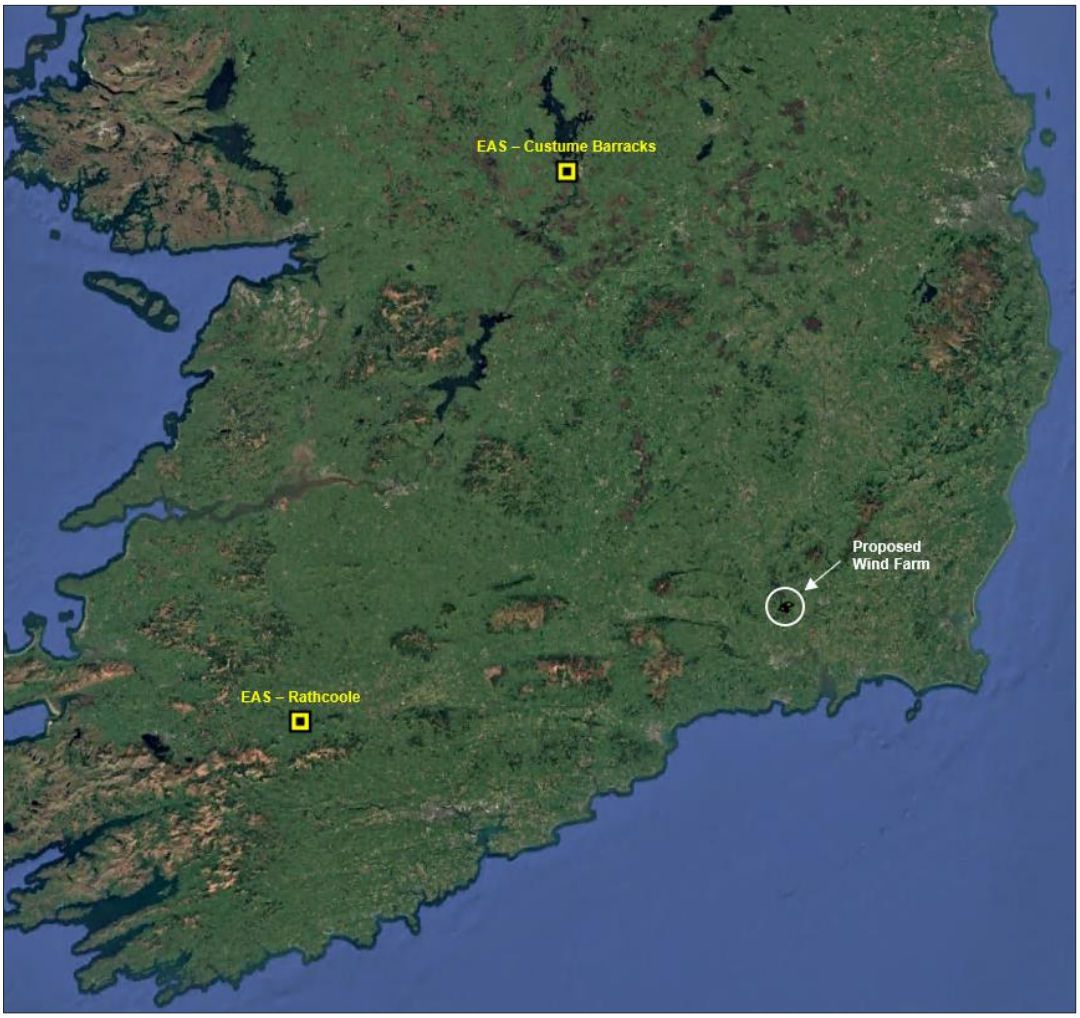


Figure 19. EAS Base Locations

The proposed wind farm site is located in an area that is relatively sparely populated, and helicopter landings are highly unlikely to occur in the subject area due to the forested terrain of the proposed site.

Also, should the proposed wind farms be permitted the associated turbine locations would be submitted to the IAA and aviation charts and GNSS databases would be updated accordingly.

EAS helicopters would also be fitted with GNSS systems which would clearly identify any potential objects in the operational area (e.g. wind turbines).

In addition, the footprint of the proposed wind farm development is small and any flight diversions for EAS operations would have negligible time impacts. For these reasons, turbines at the proposed wind farm should have no impact on EAS flights from Athlone or Rathcoole.

EAS Aircraft	Impact of proposed wind farms – Opinion
Helicopter (Eurocopter EC135)	Low – Helicopter landings at the subject area are highly unlikely to occur as the proposed wind farm site is in an area that is sparely populated and is located on forested terrain. In addition, the aircraft would be equipped with modern communications systems and navigational equipment. Should the wind farm be permitted, the turbines would be fitted with aeronautical lighting and would be clearly marked in aviation charts.

Table 22. Impact of proposed wind farm on EAS Operations

3. Summary

A summary of the aviation review for the proposed wind farm at Ballyfasy is provided in Table 23 below.

Item	Residual Impact	Summary
Annex 14 - Obstacle Limitation Surfaces (OLS)	None	The proposed turbines are located outside the OLS Surfaces for Waterford Airport.
Annex 15 - Aerodrome Surfaces	None	Turbines at the proposed wind farm would penetrate the ICAO Annex 15 Aerodrome Surface for Waterford Airport and the IAA are likely to request that turbines at the proposed wind farms be included in the IAA Aeronautical Electronic Obstacle Data Sets
Building Restricted Areas	None	A review shows that Ballyfasy is over 10 km from the BRAs for Waterford Airport. At this distance there would be no impacts due to the proposed wind farm.
Minimum Sector Altitudes (MSA)	None	A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is within 25 nautical miles of the NDB at Waterford Airport. The maximum allowable structure in the applicable sector is 2600 ft (AMSL). Turbines at the proposed wind farm would not exceed the 2600 ft threshold, therefore the MSA of the applicable sector will not be affected and there will be no impact on the published MSA altitude figures.
Instrument Flight Procedures	None	A review shows that the proposed wind farm is sufficiently far from Waterford Airport that it is highly unlikely that there would be any impacts to instrument flight procedures for flights to/from the airport for precision aircraft. Should the proposed Ballyfasy development proceed, the existing wind farm at Ballymartin would remain the most significant aviation obstacle in the subject area, and no changes to the flight procedures for Waterford Airport would be required.
Communications and Navigation Systems	None	As the proposed wind farm is approximately 19 km from the Localizer and transmitting antenna at Waterford Airport, it is very unlikely that the proposed development will have any impact on these ATS communications and radio navigational aids.
Radar Surveillance Sensors	None	The proposed wind turbines would be located in Assessment Zone 4 (EuroControl guidelines) for SSR and PSR instruments and a detailed Impact Assessment will not be required
Flight Inspection and Calibration	None	A review of the Flight Inspection Procedures indicates that there will be no impact due to the proposed wind farm development.
IAA - Aeronautical Obstacle Warning Light Scheme	None	It is possible that the IAA may request that the wind farm, if permitted, would be fitted with Aeronautical Obstacle Warning Lights in accordance with industry standards. Subject to further consultation with the IAA.
DoD Aeronautical Safeguarding	Observation	The proposed wind farm is partially located within the IAC restricted area along the M9 motorway and N25 national primary road (i.e. IAC low-level flight routes), and the Irish Air Corps may raise concerns in relation to the proposed wind farm development. However, it should be noted that low-level flights along these roads are likely to avoid the proposed wind farm site due to high terrain and the existing wind farms at Ballymartin and Rahora, which are adjacent to the proposed development.
Garda Air Support Unit and Emergency Aeromedical Service	None	An assessment of GASU and EAS operations indicate that they are unlikely to be impacted by the proposed wind farm development.

Table 23. Ballyfasy Wind Farm – Aviation Review Summary

APPENDIX A - ICAO Annex 15 Area 1 and Area 2 Surfaces.

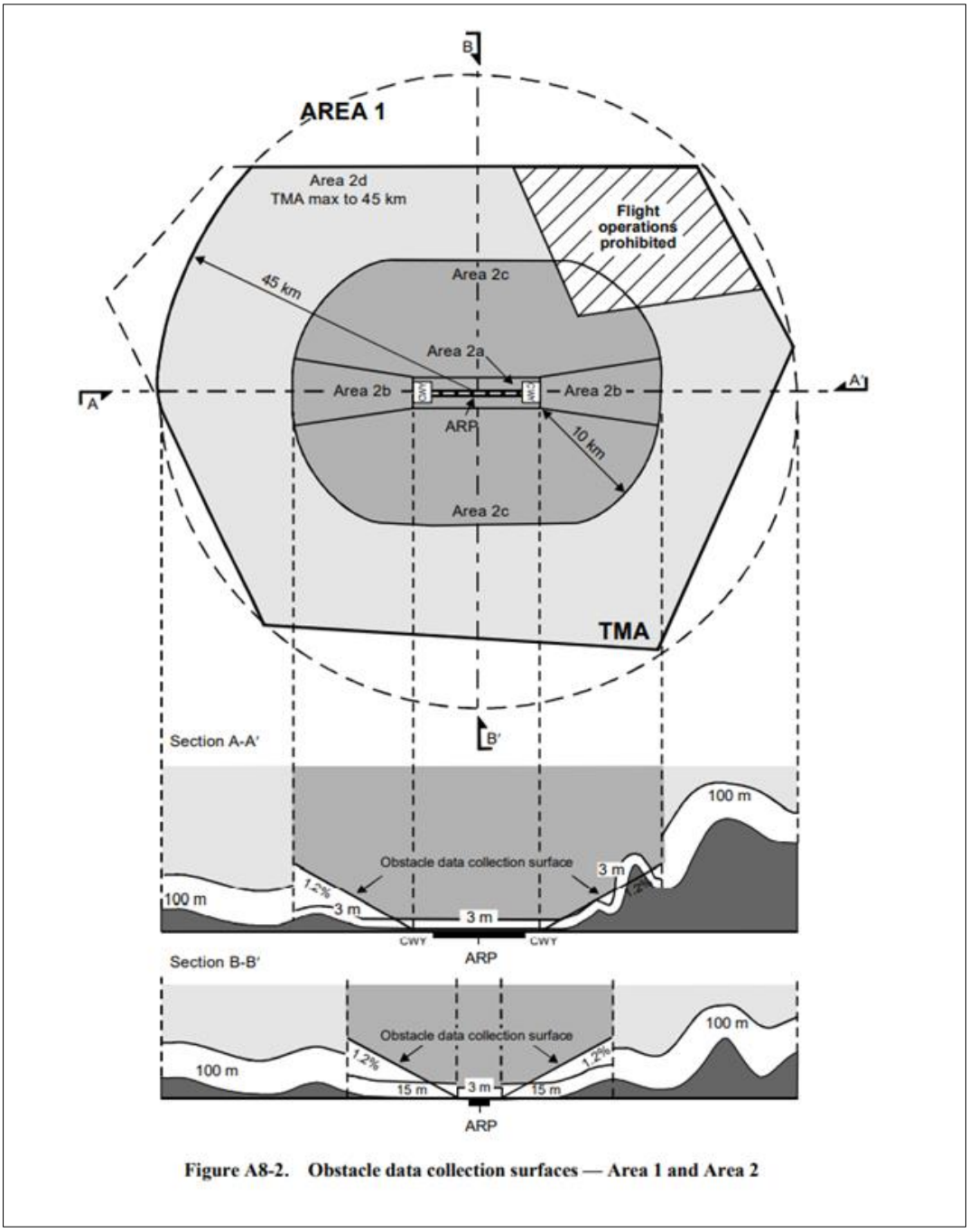


Figure A8-2. Obstacle data collection surfaces — Area 1 and Area 2

Figure A1 - ICAO Annex 15 Area 1 and Area 2 Surfaces.

APPENDIX B - ICAO Building Restricted Areas.

Figure B1 below shows an example BRA shape for directional facilities. Table B1 provides harmonized guidance figures for the directional navigational facilities in accordance with Figure B1.

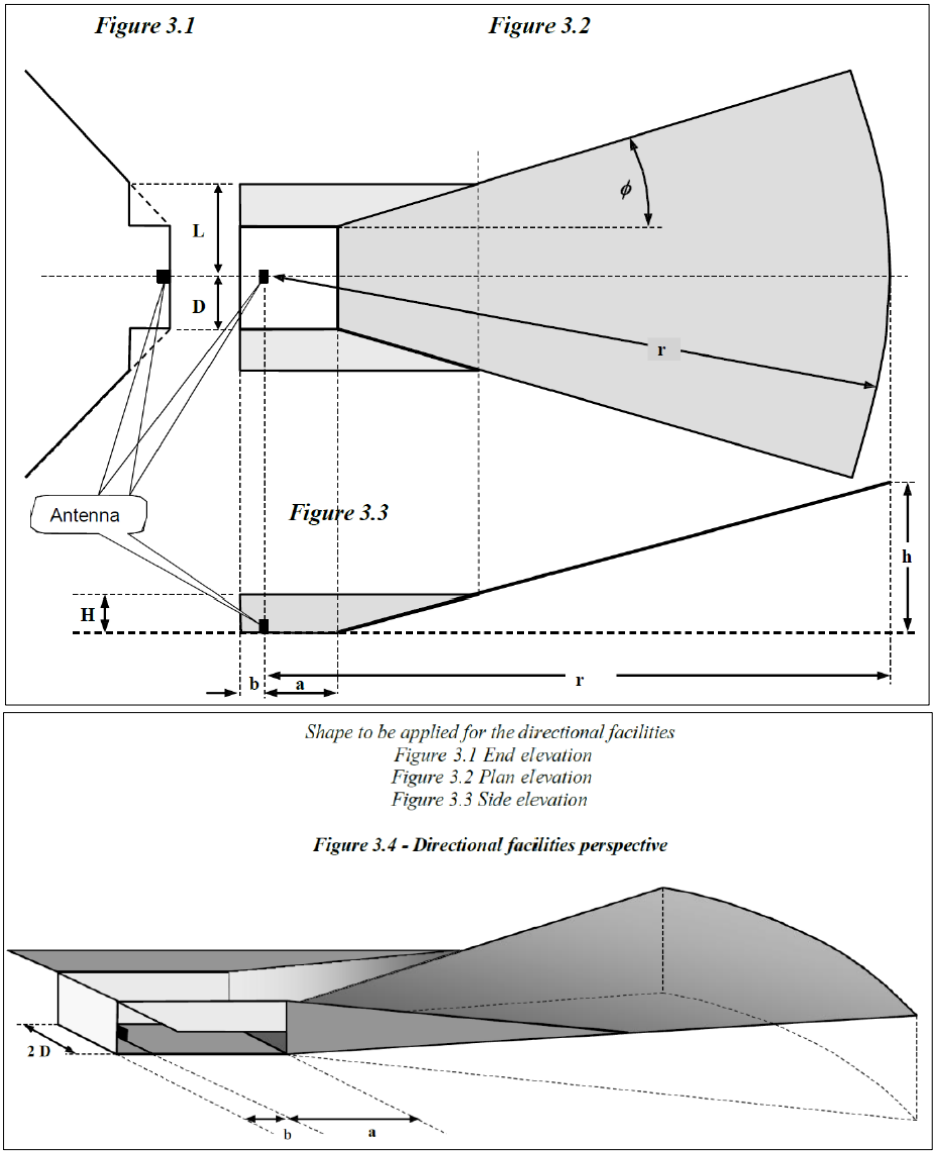


Figure B1 - Example BRA shape for directional facilities (ICAO EUR DOC 015 Figures 3.1-3.4)

*Type of **navigation** facilities*	***A*** *(m)*	***b*** *(m)*	***h****(m)*	***r*** *(m)*	***D*** *(m)*	***H*** *(m)*	***L*** *(m)*	***ϕ*** *(°)*
ILS LLZ (medium aperture single frequency)	Distance to threshold	500	70	a+6000	500	10	2300	30
ILS LLZ (medium aperture dual frequency)	Distance to threshold	500	70	a+6000	500	20	1500	20
ILS GP M–Type (dual frequency)	800	50	70	6000	250	5	325	10
MLS AZ	Distance to threshold	20	70	a+6000	600	20	1500	40
MLS EL	300	20	70	6000	200	20	1500	40
DME (directional antennas)	Distance to threshold	20	70	a+6000	600	20	1500	40

Table B1 - Harmonized guidance figures for the directional navigational facilities (ICAO EUR DOC 015 Table 2)

APPENDIX C – Air Corps Wind Farm / Tall Structures Position Paper, August 2014

Óglaigh na hÉireann
DEFENCE FORCES IRELAND

Ceanncheatru an Aer Chor
Air Corps Headquarters

08 August 14

GOC AC

Air Corps Wind Farm/Tall Structures Position Paper

Sir,

1. The attached is the draft Air Corps Position Paper agreed and developed in concert with the flying units under the auspices of CAS Ops.
2. It is recommended that it be forwarded to the Directorate of Operations for transmission to the Department of Defence.
3. The AC position contained within this paper should be notified to planning authorities including An Bord Pleanala. It should also be forwarded to the Department of the Environment, Heritage and Local Government to inform its policies and guidance in respect of wind farms.

Raymond Martin, Lt Col
CATSO

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CATSO Air Corps Headquarters, Casement Aerodrome, Baldonnel, Dublin 22
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Óglaigh na hÉireann
DEFENCE FORCES IRELAND

Ceanncheatru an Aer Chor
Air Corps Headquarters

Air Corps Wind farm/Tall Structures Position Paper.

1. **Objective:**
This position paper is intended to ensure that
   a. Air Corps operations and training may be accomplished in a safe and economical manner;
   b. Baldonnel remains a viable aerodrome for IFR and VFR traffic;
   c. The ability to train military flying skills is protected;
   d. Vital navigation routes to and from the regions to Baldonnel and the Dublin area are protected to safeguard the ability of the Air Corps to fulfill its role.

2. **Statement of position.**

   a. The Air Corps is opposed the erection of wind farms or other obstacles which will affect its ability to train and operate in a safe and economic manner.

   b. The Air Corps is opposed to any wind farms or tall structures in the following areas:

   (1) Lands underlying military airspace used for flying activity

   (a) The area contained in Danger Area EI-D1.
   (b) The area contained in Danger Area EI-D5.
   (c) The area contained within Danger Area EI-D6.
   (d) The area contained within Danger Area EI-D13.
   (e) The area contained within Danger Area EI-D14.
   (f) The area contained within Restricted Area EI-R15.
   (g) The area contained within Restricted Area EI-R16 within 20NM of Baldonnel.
   (h) The area contained within Military Operating Areas, MOAs 3 and 4 within 20NM of Baldonnel.

   (2) Areas wherein military flying occurs at low level as identified in the annexes listed below.
   (a) Annex A: Low flying training areas within MOA 4 in the areas of
      a. Blessington
      b. Edenderry/Allenwood/Rathangan
      c. Kilmeague/Newbridge

   (b) Annex B: low flying training area West (LFTA WEST).

(3) A distance of 5NM or less from military installations.

c. The following routes are identified as critical low level routes in support of Air Corps operational requirements and the Air Corps is opposed to the erection of wind farms or tall structures within 3NM of the route centerline which could affect Air Corps' ability to access regional areas.

(a) N/M1
(b) N/M2
(c) N/M3
(d) N/M4
(e) N/M6
(f) N/M7
(g) N/M8
(h) N/M9
(i) N/M11
(j) N25
(k) N17 between Sligo and Knock
(l) N15/N13 between Sligo and Letterkenny
(m) N14 from Lifford to Letterkenny and R245 and R247 from Letterkenny to Fanad Head.

Applications or proposals for structures in these areas of a height greater than 45m above ground level at the site of the object must be referred to Irish Air Corps for assessment of potential impact on flight operations.

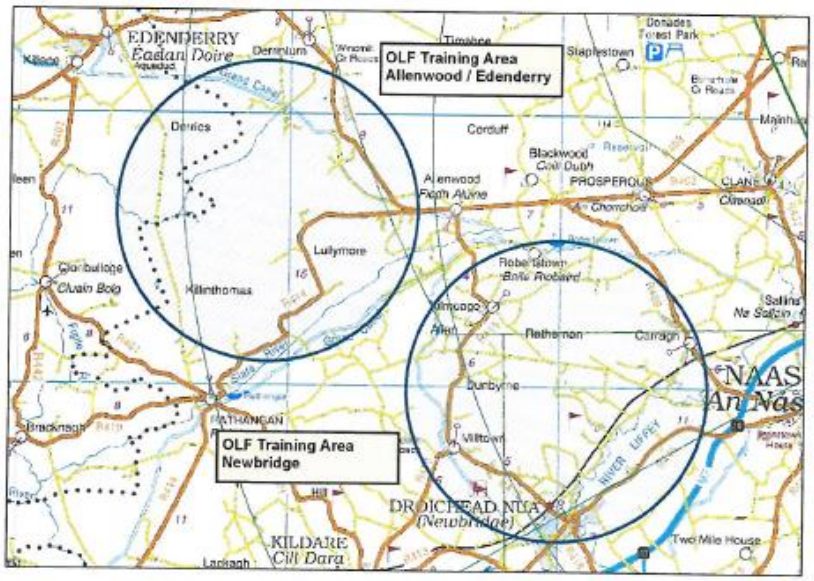
d. In MOA 4 outside of the areas identified in b.(1) (2) and (3), and in MOA 5, applications or proposals for objects of a height greater than 45m above ground level at the site of the object must be referred to the Irish Air Corps for assessment of potential impact on flight operations.

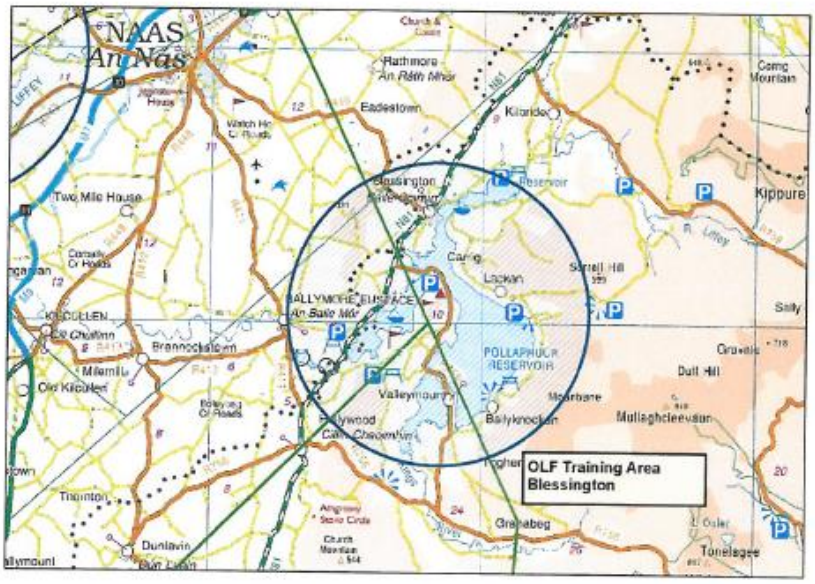
e. In all locations where wind farms or masts are permitted it should be a condition that they meet the following lighting requirements

(1) Single turbines or structures, or turbines delineating corners of a wind farm, should be illuminated by high intensity strobe lights (Red).
(2) Obstruction lighting elsewhere in a wind farm will be of a pattern that will allow the hazard be identified and avoided by aircraft in flight.
(3) Obstruction lights used should 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 850nanometres (nm) of wavelength. Light intensity to be of similar value to that emitted in the visible spectrum of light.

Annex A

Low Flying Areas - MOA 4





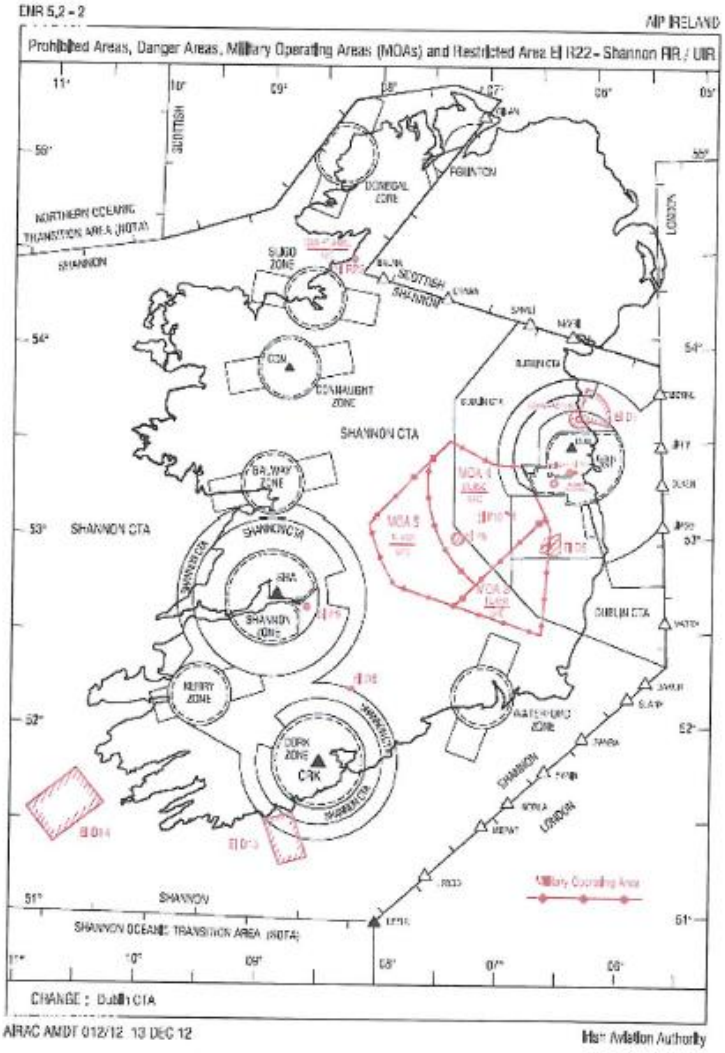
Annex B

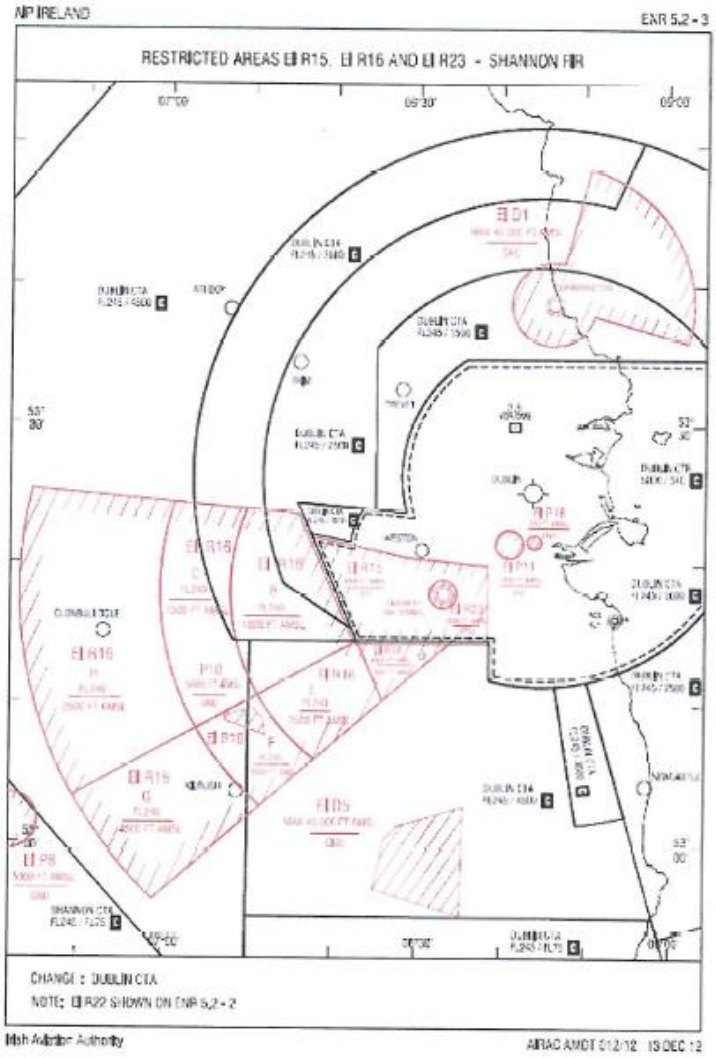
Low Flying Area – LFTA WEST

1. Area contained within the following grid L6972; L6945; M0745; M0772
2. Routes are primarily within valley areas.
3. Applications for wind farms/masts should be referred to Air Corps Operations for assessment against low flying routes.

Annex C

Designated Airspace
Restricted Areas, Danger Areas and Military Operating Areas





Annex D

Low Level Routes

APPENDIX D – Radius of Turn Calculations

The Radius of Turn calculations are based on the following formula which was taken from the "*Pilot's Handbook of Aeronautical Knowledge – Federal Aviation Administration - 2016*"

Radius of Turn: $R = V^2 / 11.26 \tan \theta$

V = Velocity
Tan θ = Tangent of Bank Angle

Sample Calculation:

An aircraft travelling at a velocity of 80 KTs (V) turning with a bank angle of 25° (Tan θ).

Radius of Turn = 6400/11.26 x 0.47 = 1209 feet (0.2 NM)