APPENDIX 15-6

AVIAIATION REVIEW STATEMENT

Report

Lackareagh Wind Farm

Aviation Review Statement

Document Number:	001/AB202403			
Author:	PT\DMG			
Approved for Release:	Rev 3.0	K Hayes	**Date:**	07/06/24

Document Filename: *Lackareagh Wind Farm - Aviation Review Statement*

Executive Summary

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

- Annex 14 - Obstacle Limitation Surfaces (OLS)
- Annex 15 – Aerodrome Surfaces
- Minimum Sector Altitudes (MSA)
- Instrument Flight Procedures
- Permitted Wind Farms in vicinity of Proposed Wind Farm
- Communications, Navigation and Systems
- Radar Surveillance Safeguarding Systems
- Flight Inspection and Calibration
- Aeronautical Obstacle Warning Light Scheme
- Irish Air Corps / Department of Defence Safeguarding

During initial consultations with the EIAR consultants, the IAA raised specific concerns in relation to the safeguarding of Instrument Flight Procedures (IFPs), Instrument Landing Systems (ILS) Flight Checks, Navigation Aids serving Shannon Airport and the Radar Surveillance Systems at Woodcock Hill.

In subsequent consultations, the IAA have indicated that they do not anticipate any issues in relation to Instrument Flight Procedures for Shannon Airport. The IAA consultation response received on December 8th 2022 indicated that there are no impacts on the Instrument Flight procedures (IFPs) for Shannon Airport. The IAA also indicated no impacts on the Navigational Aids (NAVAIDs) for Shannon Airport

The IAA did however raise concerns in relation the potential impact of the proposed turbines on their Radar Surveillance Safeguarding System, specifically the potential impact on the Secondary Surveillance Radar (SSR) Station at Woodcock Hill. However it should be noted that the proposed turbines are located at distances 14 km to 16 km from the MSSR which is at a similar distance to the permitted turbines at Carrownagowan Wind Farm development which has been consented for planning. The detailed technical assessment which was conducted for Carrownagowan wind farm has been reviewed and has informed the Radar Surveillance Safeguarding System Technical Assessment that was conducted by Cyrrus Limited against the proposed Lackareagh Wind Farm. The results of this Impact Assessment conclude that due to the distance for the wind farm from the Woodcock Hill MSSR Radar that is foreseen that there will not be any operational effects.

In a further correspondence on Dec 16th 2022 the IAA have requested that a screening assessment be undertaken to confirm that the development would have no impacts on ILS

RWY 24 Commissioning Flight Checks. The screening assessment within this document shows that the finalized turbine site layouts will have a “No Impact” condition on ILS Flight Check Procedures.

The IAA have also stated that in the event of planning consent being granted to Lackareagh wind farm, the applicant should be conditioned to contact the IAA to :

- *Agree an aeronautical obstacle warning light scheme.*
- *Provide as-constructed coordinates in WGS84 format together with ground and blade tip height elevations at each turbine location.*
- *Notify the Authority to commence crane operations with at least 30 days prior notification of their erection.*

Sections

Appendices

1. Introduction

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

1.1 Wind Farm Site Information

The proposed wind farm development is located in County Clare approximately 16 km north of Limerick City. The wind farm is proposed to consist of seven wind turbines. The proposed wind turbine co-ordinates and turbine heights are shown below in Table 1. Figure 1 shows the proposed wind turbine layout with respect to Shannon Airport.

Turbine	Co-ordinates (WGS)		Turbine Tip Height (AGL) (m)	Turbine Base AOD (m)	Tip Height (AMSL)	
	Lat	Long			(m)	(ft)
T01	52° 48' 55.94"N	08° 33' 38.30"W	180	230	410	1346
T02	52° 48' 43.02"N	08° 33' 34.08"W	180	187	367	1205
T03	52° 48' 34.29"N	08° 32' 01.48"W	180	366	546	1791
T04	52° 48' 16.40"N	08° 32' 9.27"W	180	291	471	1547
T05	52° 48' 4.16"N	08° 32' 2.45"W	180	295	475	1558
T06	52° 48' 1.28"N	08° 32' 38.45"W	180	201	381	1249
T07	52° 47' 48.10"N	08° 32' 33.64"W	180	202	382	1254

Table 1. Lackareagh Wind Turbine Details

Figure 1. Location of the proposed wind farm at Lackareagh, Co Clare

1.2 Shannon Airport

The co-ordinates for Shannon Airport and the distance from the Airport reference Point (ARP) to the proposed wind farm site is shown in Table 2 below.

Shannon Airport operates in Class C 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
Shannon, Co Clare	International Airport	Single Asphalt Runway Airspace: Class C	52 42 07 N 008 55 29 W (Mid-point of Runway 06/24).	27.5 km

Table 2. Shannon Airport Details

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

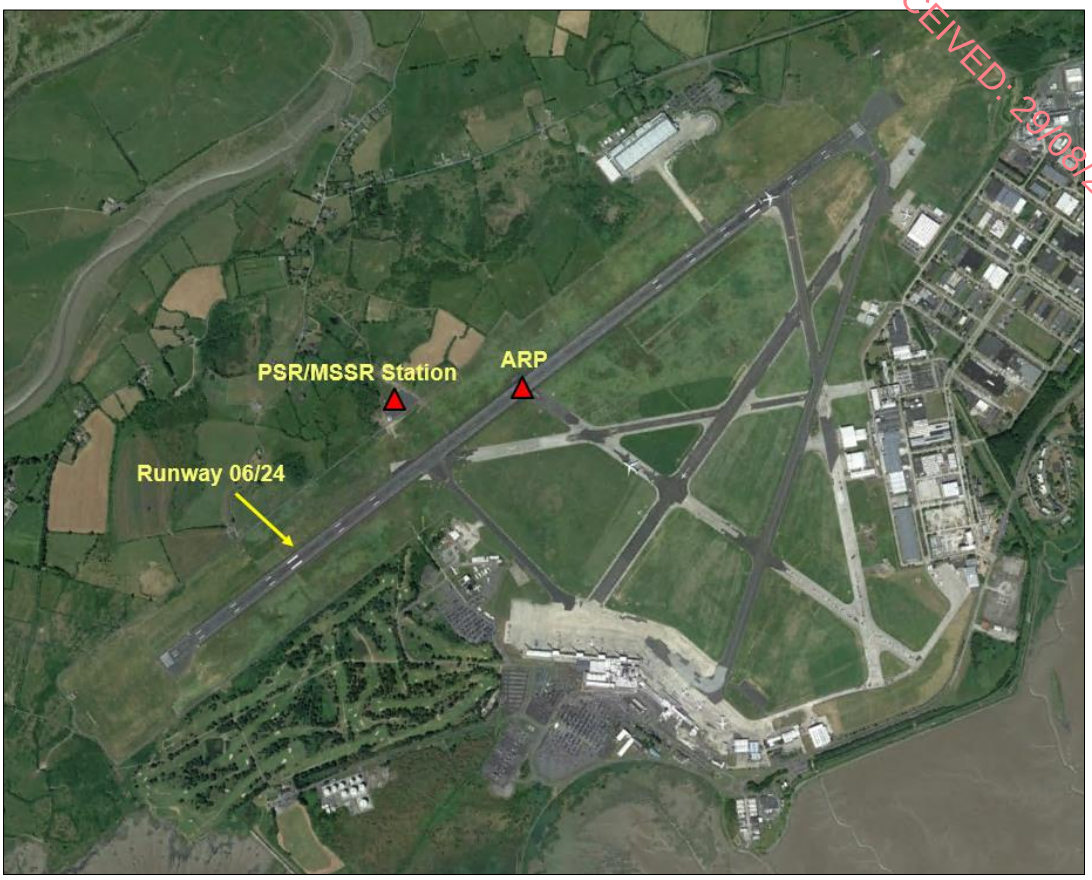


Figure 2. Shannon International Airport

2. Aviation Review

In this section a review of the aviation and aeronautical safeguarding surfaces and infrastructure is presented by considering the following:

- Annex 14 - Obstacle Limitation Surfaces (OLS)
- Annex 15 – Aerodrome Surfaces
- Minimum Sector Altitudes (MSA)
- Instrument Flight Procedures
- Permitted Wind Farms in vicinity of proposed Wind Farm
- Communications and Navigation Systems
- Radar Surveillance Systems
- Flight Inspection and Calibration
- Aeronautical Obstacle Warning Light Scheme
- Irish Air-Corps / DoD Safeguarding

Annex 14 - Obstacles Limitation Surfaces (OLS)

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

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

Annex 15 - Aerodrome Surfaces

Following a review of ”Terrain and obstacle requirements Area 1” as defined in ICAO Annex 15, the proposed wind turbines need to be registered if they are more than 100 meters above terrain. From the centre point (ARP – Airport Reference Point) of Shannon Airport to the boundary of the Area 1 of the Annex 15 Aerodrome Surface is 45km. 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 Shannon 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.

Minimum Sector Altitudes (MSA)

The Minimum Sector Altitudes (MSA) is the lowest altitude which may be used that will provide a minimum obstacle clearance of 1000ft above all obstacles within a specified distance from an airport. For Shannon International Airport MSAs are defined to an area which extends 25 nautical miles (46 km) from the VOR/DME located at the airport. The proposed wind farm site is located within the eastern MSA sector. There is over 1000 ft from the maximum height of the

wind farm to the relevant MSA altitude and therefore there would appear to be no impact on the published MSA altitudes for Shannon International Airport.

Instrument Flight Procedures

There are 9 Instrument Flight Procedures for flights to/from Shannon International Airport. A detailed instrument flight procedure analysis is outside of the scope of this report; however, from the desktop assessment conducted, the proposed turbines are outside the Annex 14 take-off and approach surfaces for Runway 24 and Runway 06 respectively. It is also unlikely that there would be any impact to precision approach flights (using Instrument Landing Systems approach). For standard instrument departures (SID) for Runway 06 there would not appear to be any infringement on designated flight paths.

Communications, Navigation Systems

As the proposed wind farm is more than 20 km from the Localizer and transmitting antennas at Shannon International Airports, it is very unlikely that the proposed wind farm will have any impact on these ATS communications and radio navigational aids.

Radar Surveillance Systems

For Radar Surveillance Systems, EUROCONTROL Guidelines require a 16km 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 28 km from the Primary Surveillance Radar (PSR) station at Shannon Airport. At this distance the proposed wind farm would be in Assessment Zone 4 of the EUROCONTROL Guidelines, for the radar station. As the turbines would be located in Assessment Zone 4, a detailed impact assessment on Radar Surveillance Systems will not be required by the IAA.

In the case of the Secondary Surveillance Radar (SSR) it has been highlighted that the proposed turbines are within 16 km of the MSSR at the Woodcock Hill and the IAA are likely to request a further technical assessment. It should be noted that there are wind farm developments in the vicinity of Lackareagh (e.g. Carrownagowan) that have been assessed and have been deemed not to have any adverse impacts on the MSSR radar equipment and have received planning permission.

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 for Shannon Airport for calibration of instrument landing systems.

From the screening assessment conducted, the Flight Inspection Procedures for Shannon Airport are unlikely to be impacted. As Moylussa Mountain is the dominant obstacle in the area the proposed wind turbines should have no impact on the Flight Calibration Procedures.

Aeronautical Obstacle Warning Light Scheme

In the event of a grant of planning consent the IAA would 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.

Irish Air Corps / Department of Defence (DoD) 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 proposed wind farm site is located outside the restricted areas. As the proposed wind farm is not located in a restricted area it should have no impacts on the Irish Air Corps activities.

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 and the relevant airport obstacle surfaces. The obstacle limitation surfaces for Shannon Airport has been 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*

The OLS surfaces in relation to the proposed wind farm are shown in Figure 3 below. The distance from the Shannon Airport ARP, runway centre-point, to the nearest of the proposed turbines is 27.5 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 Shannon Airport Reference Point (ARP) or runway centre-point.

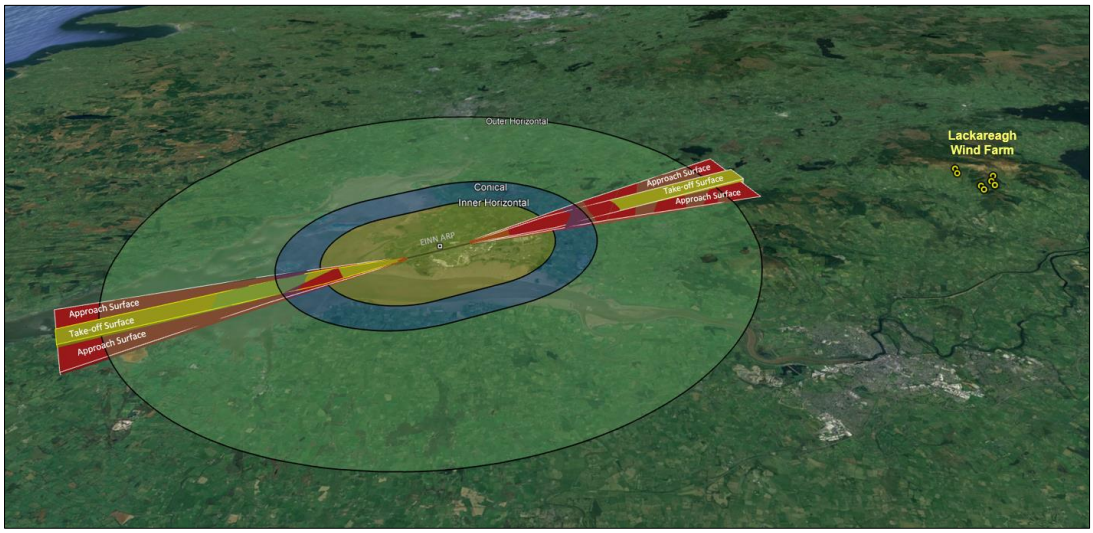


Figure 3. Proposed Wind Farm in relation to Shannon Airport OLS surfaces.

2.2 Annex 15 Aerodrome Surfaces

The "*Terrain and obstacle requirements Areas 2*" is defined in ICAO Annex 15 as an area which can extend up to 45km from the Aerodrome ARP. (An illustration of ICAO Annex 15 Area 2 Surface is provided in Appendix A).

All obstacles, if they are more than 100 meters above terrain for a distance of up to 45km from an aerodrome ARP, need to be registered in the IAA Air Navigation Obstacle Data Set. This 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.

For Shannon International Airport the TMA Area extends 45 NM (nautical miles) from its ARP. Turbines at the proposed wind farm site would penetrate the ICAO Annex 15 Aerodrome Surfaces as shown in Figure 4. Therefore the turbines would be required to be included in the IAA Electronic Air Navigation Obstacle Dataset.

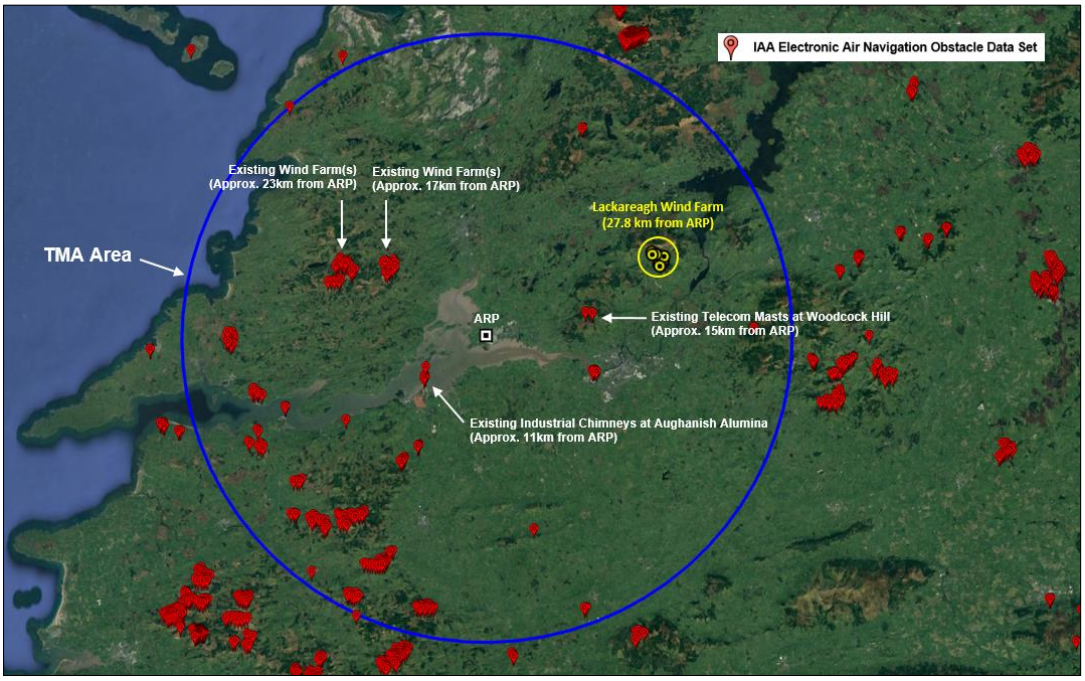


Figure 4. Annex 15 Aerodrome Surfaces and IAA Electronic Air Navigation Obstacle Data Set

There are other existing tall structures in the vicinity of the proposed wind farm, notably Woodcock Hill Telecoms Masts. It should also be noted that planning permission has been granted for Carrownagowan Wind Farm development and which is adjacent to the proposed Lackareagh Wind Farm thus no impacts to Annex 15 surfaces are anticipated.

2.3 Minimum Sector Altitudes

A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is within 25 nautical miles from the VOR/DME at Shannon Airport. The MSA provides a minimum obstacle clearance of 1000 ft above the highest obstacle within specified quadrants.

Wind turbines at the proposed site would be located within the eastern sector (MSA 3400 ft) shown in Figure 5. According to the wind farm location, the maximum construction height for the site would be 2400 ft / 731.5m AMSL (3400 ft MVA minus 1000 ft).

Turbine T03 is highest of the proposed turbines with a maximum tip-height of 1791ft. This is below the 2400 ft threshold, therefore the MSA of the Main Quadrant will not be affected and there will be no impact on the published MSA altitude figures.

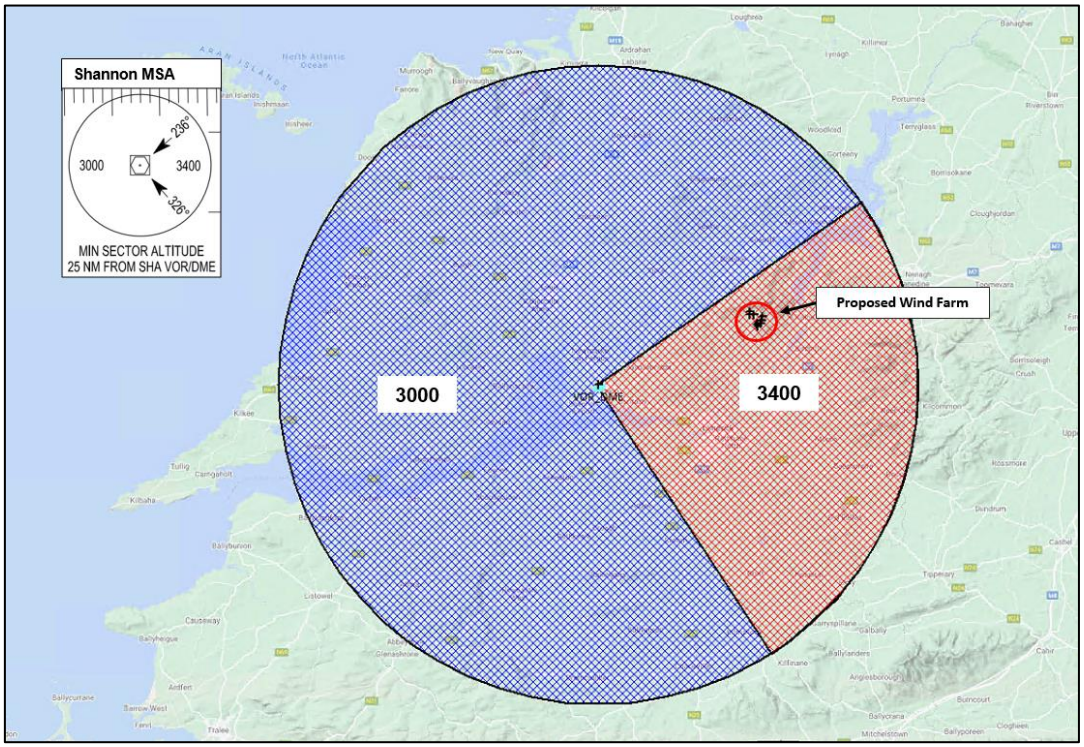


Figure 5. Minimum Sector Altitudes – Shannon Airport

2.4 Instrument Flight Procedures (IFPs)

There are 9 published Instrument and Visual Flight Procedures for arrivals to and departures from Shannon Airport. Due to the distance of the proposed wind farm from the airport, it is unlikely that there will be any impacts on the Instrument Flight Procedures for flights to/from Shannon Airport. Table 3 below lists the Instrument Flight Procedures for Shannon Airport.

Aerodrome	Aerodrome Procedure	Chart ID	WF Impacts
Shannon	RNAV Standard Instrument Departure Chart RWY 06 – ICAO	EINN AD 2.24-5	No Impacts
Shannon	RNAV Standard Instrument Departure Chart RWY 24 – ICAO	EINN AD 2.24-6	No Impacts
Shannon	RNAV Standard Arrival Chart RWY 06 – ICAO	EINN AD 2.24-7	No Impacts
Shannon	RNAV Standard Arrival Chart RWY 24 – ICAO	EINN AD 2.24-8	No Impacts
Shannon	Instrument Approach Chart ILS or LOC RWY 06 – ICAO	EINN AD 2.24-10	No Impacts
Shannon	Instrument Approach Chart VOR RWY 06 – ICAO	EINN AD 2.24-11	No Impacts
Shannon	Instrument Approach Chart ILS CAT I & II or LOC 24 – ICAO	EINN AD 2.24-13	No Impacts
Shannon	Instrument Approach Chart VOR RWY 24 – ICAO	EINN AD 2.24-14	No Impacts
Shannon	Visual Approach Chart – ICAO	EINN AD 2.24-15	No Impacts

Table 3. Instrument and Visual Flight Procedures – Shannon Airport

An assessment of the Instrument Flight Procedures for Shannon Airport is provided below in Section 2.4.1 and indicates that the proposed wind farm will have no impacts. This correlates with the assessment received from the IAA in which they state that they do not anticipate any impacts to the Instrument Flight Procedures for Shannon Airport. The IAA response is provided in Section 2.4.2.

2.4.1 Instrument Flight Procedures - Desktop Assessment

The proposed wind farm location is shown below in Figure 6 in relation to Shannon Airport's instrument departure chart for Runway 06 (Ref. EINN AD 2.24-5 - Standard Instrument Departure Chart RWY 24). As the figure shows the proposed wind farm is located beneath the departure flight routes via DIGAN and TOMTO. However, climb altitude calculations indicate that aircraft abiding by the flight rules should have sufficient altitude by the time they fly over the wind farm that there will be no issues.

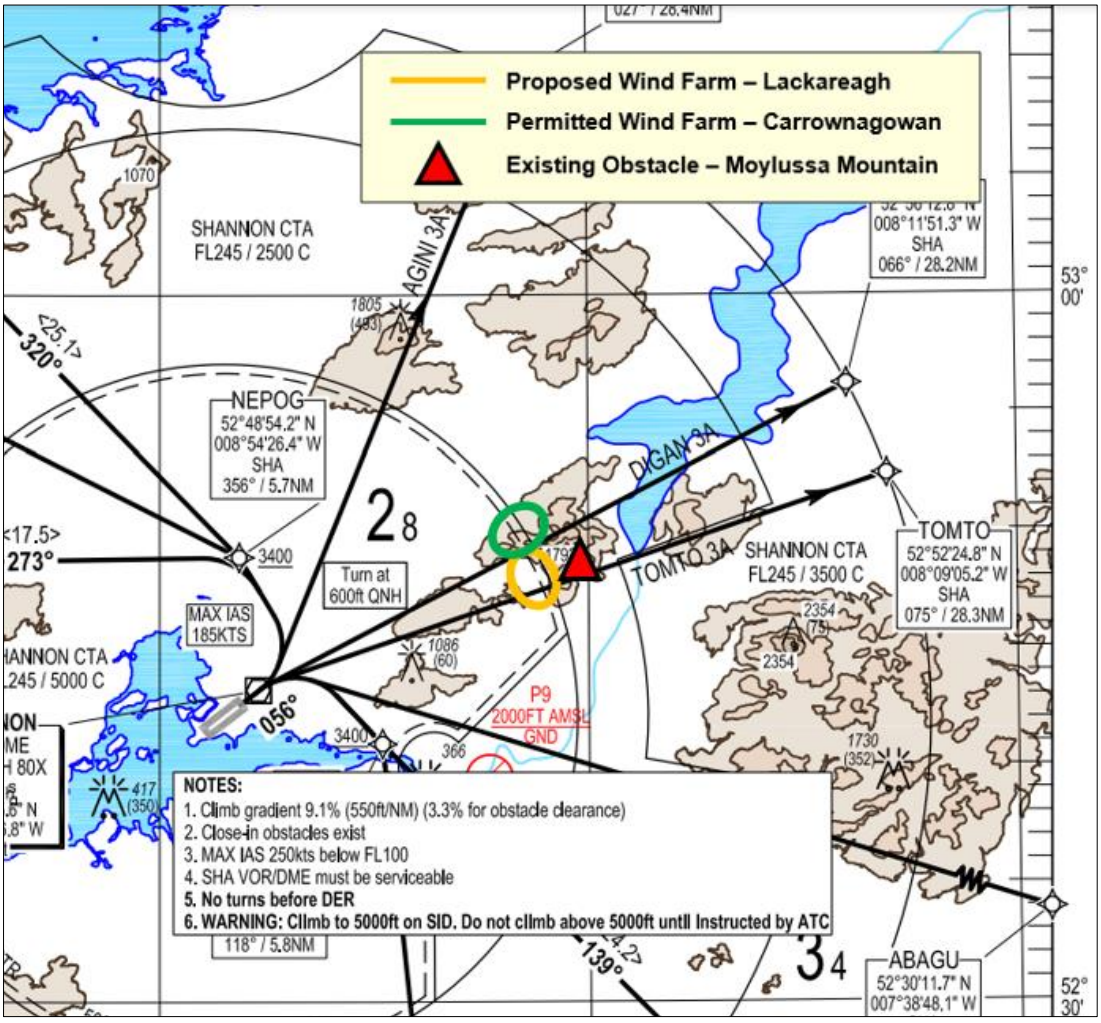


Figure 6. EINN AD 2.24-5 – Standard Instrument Departure Chart RWY 06

Figure 7 shows the departure flight path to TOMTO which passes just south of the proposed wind farm site. The flight path from the end of Runway 06 to the wind farm is 26 km. Calculations indicate that the obstacle clearance altitude over the proposed wind farm is over 1000 ft above the highest of the proposed turbines. As there are no infringements, there should be no changes to the published obstacle climb gradients required.

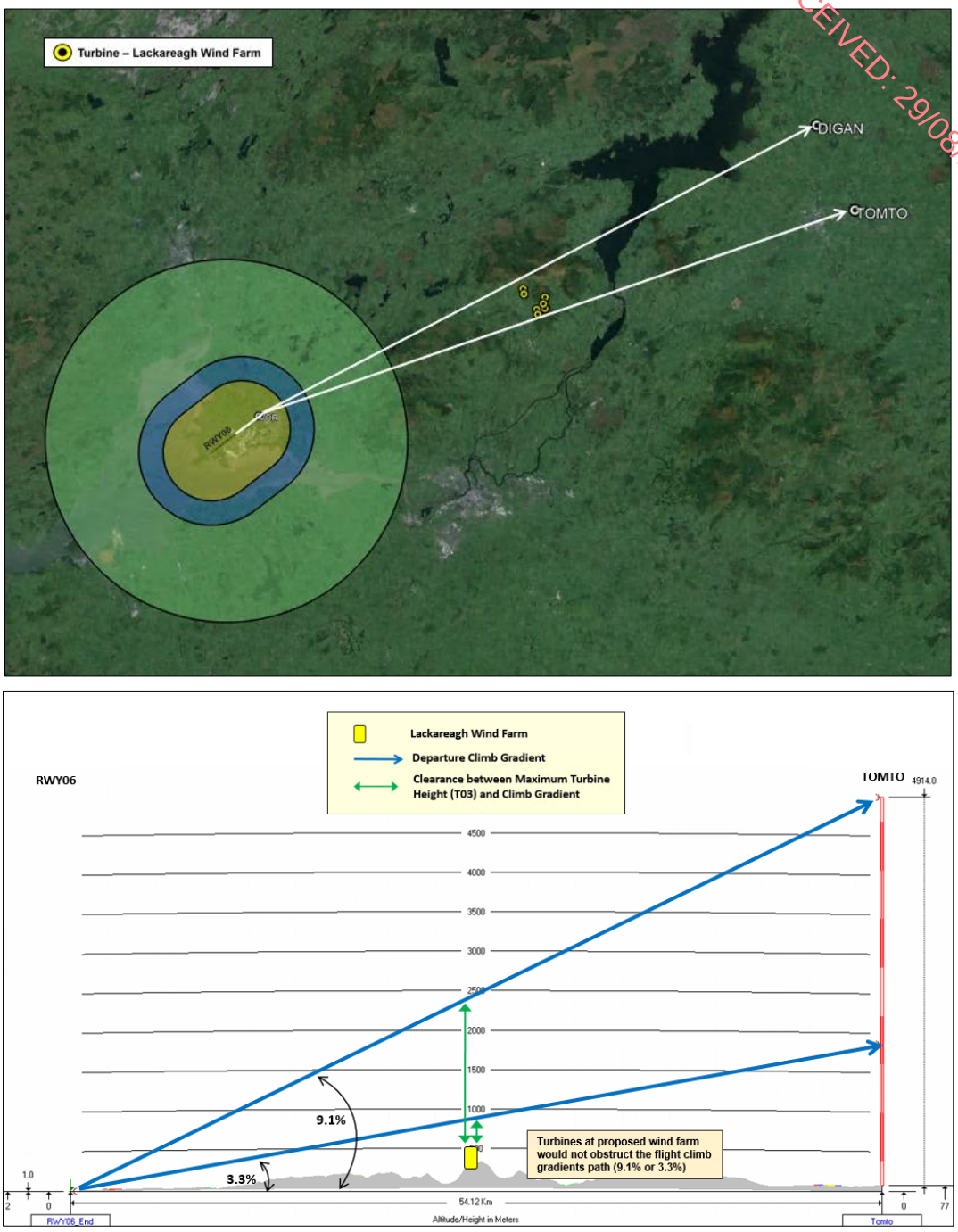


Figure 7. Standard Instrument Departure Flight Path – TOMTO

Climb Gradient	Altitude over Wind Farm (nearest Pt)		Clearance to highest possible turbine (ft)
	meters	ft	
9.1 % (5.2°)	2366	7763	5972
3.3 % (1.89°)	857	2812	1021

Table 4. Climb Gradient Clearance Calculations

2.4.2 Instrument Flight Procedures - IAA Consultation Response

During the consultation process with the EIAR consultants, the IAA have indicated that they do not anticipate any impacts to the Instrument Flight Procedures for Shannon Airport. In the correspondence, the IAA have stated the following in relation to Instrument Flight Procedures (IFP):

> *"The elevation of the site in question is 296m Above Mean Sea Level. We add to this an estimated height for a wind turbine of c.175m = obstacle elevation 470m AMSL. This is sufficiently below the IFP surfaces such that I have no concerns here."*

The text quoted above is an extract from the correspondence received from the IAA on December 8th 2022. The full text of the correspondence can be found in Appendix B1 of this report. It should also be noted that the obstacle elevation height stated in the IAA response on December 8th is an estimated height, using an average site elevation and a turbine height of 175m. In an earlier correspondence from the IAA (29th August 2022), the IAA used the elevation of the worst-case turbine on the site T03 (formerly referred to as T04a in the IAA consultation) with a turbine height of 180 m. The IAA state that even when using the worst-case scenario, the turbine elevations are well within their Safeguarding Grid Elevation of 614m:

> *"Taking the worst case turbine on a site at 373m AOD (T4* which from the attached kml is the furthest North East proposed turbine) and adding a turbine max height of 180m = 553m AOD elevation. We apply a Safeguarding Grid elevation of 614m for this particular grid (401m closer to Shannon for some of the other proposed turbines), which should be well within our limits."*

** T4 referred to in the IAA consultation response in August 2022 is now wind turbine T03 in the finalized turbine layout.*

2.4.3 Instrument Flight Procedures – East Clare Permitted Wind Farm

The Planning References for the permitted Wind Farm(s) in the vicinity of the proposed wind farm are shown below in Table 5.

As the Carrownagowan wind farm has been permitted there was no amendments or re-design of the Instrument Flight Procedures required at Shannon Airport.

As the Fahybeg wind farm has been permitted there was no amendments or re-design of the Instrument Flight Procedures required at Shannon Airport. There is also no impact to the ILS at Shannon Airport

Wind Farm	Planning Reference	Description
Carrownagowan	Planning Application: 229000 (Clare County Council) https://www.eplanning.ie/ClareCC/AppFileRefDetails/229000/0	Permitted Wind Farm
Fahy Beg	https://www.pleanala.ie/en-ie/case/317227	Permitted Wind Farm

Table 5. Permitted wind farms in vicinity of proposed wind farm.

On review of the planning application \ permission documents for Carrownagowan Wind Farm the IAA have stated:

> *"I wish to confirm that the IAA ANSP has no objections in regard to the planning process for the proposed Carrownagowan / Moylussa Clare East Wind Farm. "*

The above statement from the IAA has been taken from "Letter from the Irish Aviation Authority" which is publicly available to view in Appendix 4 of the RFI Response to Item 3, Carrownagowan Wind Farm (ABP-308799-20).The full text of the IAA Letter is shown in Appendix C of this report. The complete RFI document can be found at the following URL:

https://carrownagowanplanning.ie/wp-content/uploads/2022/02/RFI%20Response%20Item%203.pdf

On review of the planning application \ permission documents for Fahybeg Wind Farm the details of an assessment was conducted by an Aviation Design Consultant, Osprey CSL, who have stated

> *"it is not anticipated that there would be that there would be any effects on the Instrument Flight Procedures "*

This is a reference to Instrument Flight Procedures at Shannon Airport stating that there would be no impact to Instrument Flight Procedures. The complete planning document can be found at the following URL :

https://www.pleanala.ie/publicaccess/EIAR-NIS/317227/cb973e55-e538-49d5-88f3-3990fe2778a0.pdf?r=230943242022

An extract from the Report shows the Executive Summary is shown below.

Executive Summary

Osprey CSL has been commissioned by RWE Renewables Ireland to assess the potential impact of 8 Wind Turbines in the vicinity of Shannon Airport, with a height of 170m Above Ground Level (AGL).

This report is a high-level assessment of the potential impact the Wind Turbines may have in relation to the Airports Obstacle Limitation Surfaces (OLS) and Instrument Flight Procedures (IFPs) for Shannon Airport.

Impact on the OLS

It is not anticipated that there would be any effects on the Obstacle Limitation Surfaces.

Impact on the IFPs

It is not anticipated that there would be any effects on the Instrument Flight Procedures.

Issue 2 Statement (27/10/22)

A review has been carried out for an updated turbine layout where, although there is no change to the windfarm site boundary, the turbine locations are slightly different and the maximum tip height has increased from 170m to 176.5m.

The updated turbine layout data was received by e-mail on the 26/10/22 and details are specified in the below table:

Turbine	Radius of operation (m)	Ground Elevation (m)	Maximum tip height (AGL) (m)	Maximum tip elevation (AMSL)(m)	WGS84 Latitude	WGS84 Longitude
T1	176.5	116.27	176.5	292.77	52.785257	-8.547886
T2	176.5	143	176.5	319.5	52.782556	-8.544799
T3	176.5	221.23	176.5	397.73	52.784965	-8.534926
T4	176.5	193.56	176.5	370.06	52.786030	-8.525926
T5	176.5	187.517	176.5	364.017	52.783356	-8.531097
T6	176.5	156.78	176.5	333.28	52.782413	-8.524785
T7	176.5	125.55	176.5	302.05	52.776011	-8.535439
T8	176.5	154.45	176.5	330.95	52.779445	-8.537260

Shannon Airport – Safeguarding Scoping Report – Wind Turbines RWE Renewables Ireland | Executive Summary iii
71590 -001 | V2

COMMERCIAL IN CONFIDENCE

An extract from the EIAR Report for Fahybeg relating to the Instrument Landing System (ILS) Impact Assessment can be found at the URL below i.e. showing no Impact to ILS at Shannon.

https://www.pleanala.ie/publicaccess/EIAR-NIS/317227/1dcb639c-77f5-4f12-89beb169ef6f19a6.pdf?r=076775037244

16.4.3.2 Aviation

FCSL carried out an ILS Impact Assessment , below are the main findings on potential impact to the Shannon Runway 24 ILS. A copy of this report can be found in Appendix 16.3.

"flight inspection aircraft flying centreline and part orbit flight profiles associated with the Shannon Airport Runway 24 ILS will remain sufficiently clear of the proposed Fahy Beg Wind Farm site.

The proposed Fahy Beg Wind Farm will therefore have no adverse effect on flight inspection procedures and profiles associated with the Runway 24 ILS."

An IFP Safeguarding Scoping Assessment was carried out by Osprey, who are approved vendors of the IAA. The Obstacle Limitation Surfaces and Instrument Flight Procedures Safeguarding Scoping Report indicates no impacts foreseen. There also seems to be some headroom to allow for the turbines further up the hill into the OHL setback area without affecting the results. This report can be found in Appendix 16.2.

As the proposed grid connection will be operating underground within the public roadway, there are no operational related impacts on aviation interests as a result of the operation of the GCR.

2.5 Communication and Navigation Systems

The AIP document EIKN AD 2-18/19 provides the information for communication and navigation facilities for Shannon Airport. The table below shows the channel frequencies for the ATS communications Facilities and the Radio Navigation and Landing Aids at 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 farm
Shannon	118MHz –131MHz	339 kHz – 330 MHz	26 km	No impacts

Table 6. Impacts on Communications and Navigation Systems

An assessment of the Communications and Navigation Systems for Shannon Airport is provided below in Section 2.6.1 and indicates that the proposed wind farm will have no impacts. This correlates with the assessment received from the IAA in which they state that they do not anticipate any impacts to the Navigational Aids for Shannon Airport. The IAA response is provided in Section 2.6.2.

2.5.1 Communication and Navigation Systems - Desktop Assessment

As the proposed wind farm is over 20km from the Localizers 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.

2.5.2 Communication and Navigation Systems - IAA Consultation Response

During the consultation process with the EIAR consultants, the IAA have indicated that they do not anticipate any impacts to the Navigational Aids for Shannon Airport. In the correspondence, the IAA have stated the following in relation to Navigational Aids (NAVAIDs)

> *"The proposed location of the Wind Farm should be and adequate distance so as not to adversely affect these systems, but I'm asking technical colleagues (copied) in this area to confirm this."*

The text quoted above is an extract from the correspondence received from the IAA on December 8th 2022. The full text of the correspondence can be found in Appendix B1 of this report.

2.6 Radar Surveillance Safeguarding Systems

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 7. 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 8. 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.”*

2.6.1 Irish Aviation Authority - Radar Surveillance Sensors

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 the IAA Radar Station sites at Shannon Airport (PSR and SSR) and at Woodcock Hill (SSR). Both IAA radar sites are shown relative to the proposed wind farm at Lackareagh in Figure 8 below. Photos of both radar sites are provided in Appendix C of this report.

Figure 8. IAA Radar Surveillance Sites relative to proposed wind farm.

The Assessment Zone (EUROCONTROL & NATS) applicable to the nearest of the proposed turbines is shown below in Table 9. The applicable assessment zone has been based on distance from the Radar Station and whether a radar line-of-sight condition exists.

As the table below shows, a detailed technical assessment is not required for the Radar Station at Shannon Airport; however, the IAA may request a detailed assessment for the Radar Station at Woodcock Hill.

Radar Station	Radar Type	Distance to nearest Turbine	Detailed Radar Assessment Required	
			(EuroControl Guidelines)	(NATS Guidelines – UK)
Shannon Airport	PSR / SSR	28.3 km (T02)	Not Required (Assessment Zone 4)	Not Required (> 10km)
Woodcock Hill	SSR	14.0 km (T07)	Required (Assessment Zone 2)	Not Required (> 10km)

Table 9. EUROCONTROL / UK Safeguarding Guidelines – Shannon and Woodcock Hill Radar Stations

It should be noted that in the UK, a detailed assessment would not be required for the Radar Station at Woodcock Hill, as NATS deem the impact due to turbines that are more than 10 km form a SSR, to be negligible.

2.6.2 Radar Safeguarding – East Clare Permitted Wind Farms

There are two other consented wind farm developments adjacent to the proposed Lackareagh development.

In 2022 planning permission was granted for Carrownagowan wind farm which consists of 19 wind turbines. In 2024 planning permission was granted for Fahy Beg Wind Farm which consists of 8 wind turbines.

Both of these consented wind farms are depicted in Figure 9 below

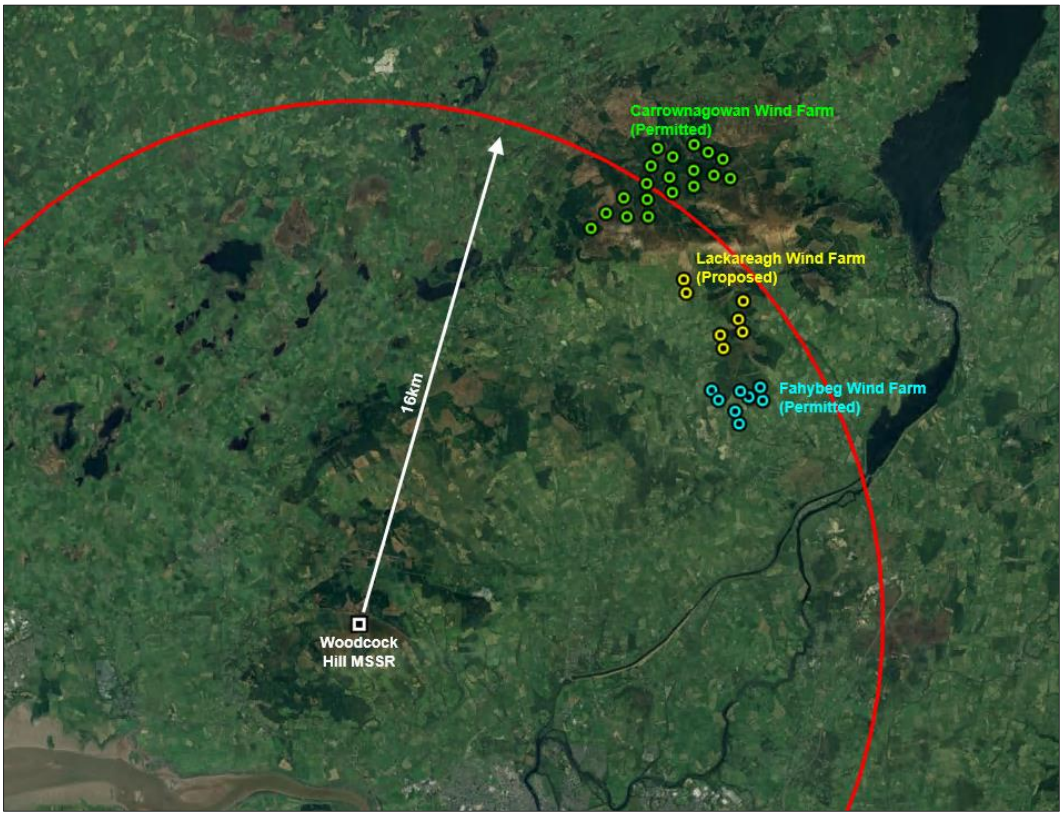


Figure 9. Lackareagh, Carrownagowan and Fahy Beg wind farms shown relative to MSSR Radar at Woodcock Hill

2.6.2.1 Carrownagowan Wind Farm – Consented Planning

In 2022 planning permission was granted for Carrownagowan wind farm which consists of 19 turbines, details of which are publicly available on the Carrownagowan Wind Farm website.

During the planning process a Radar Impact Assessment was carried out by an IAA Approved Designer and which concluded that no mitigation measures were necessary for the Monopulse Secondary Surveillance Radar (SSR) at Woodcock Hill. It should be noted that the permitted wind farm is located adjacent to the proposed wind farm at Lackareagh as shown in Figure 9.

Table 10 below shows that six of the permitted Carrownagowan wind turbines are within 16 km, and in Radar LOS of the MSSR at Woodcock Hill (i.e. EUROCONTROL Zone 2 – Detailed Assessment required). The proposed wind turbines at Lackareagh are located at a similar distance from the MSSR and any impacts to radar would be similar to the permitted turbines at Carrownagowan. The Radar Assessment for the permitted Carrownagowan wind farm can be found in the Technical Safeguarding Report for Carrownagowan Wind Farm : https://carrownagowanplanning.ie/wp-content/uploads/2022/02/RFI%20Response%20Item%203.pdf

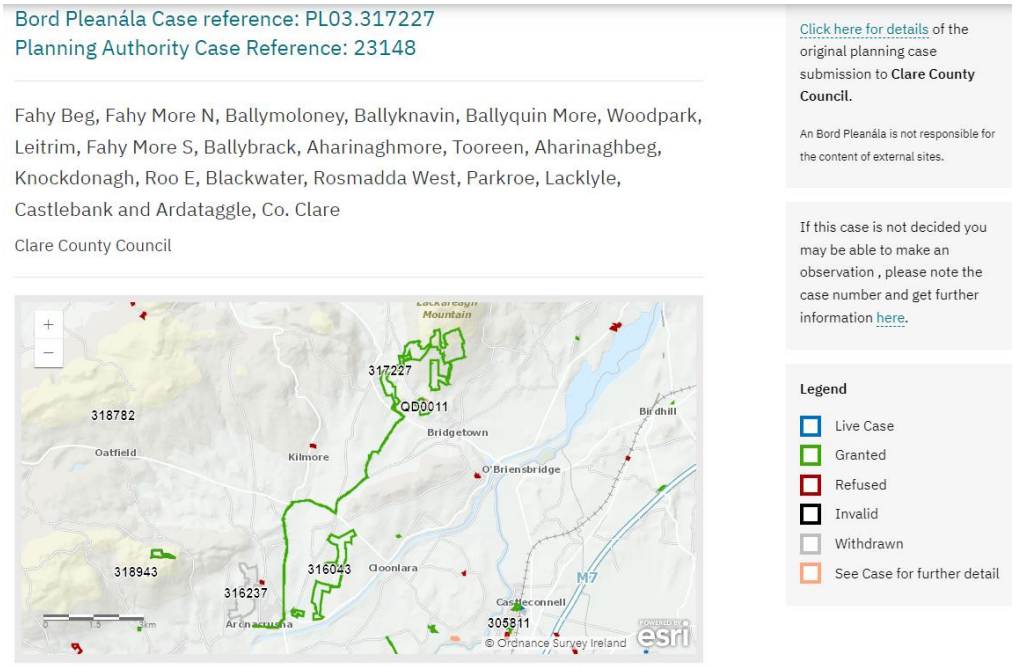
A consultation response from then IAA states that they accepted the findings of this Technical Safeguarding Assessment. The assessment reported no impacts to the MSSR at Woodcock Hill. This RFI request from the IAA is included in Appendix C of this report for reference.

Turbine / Obstacle ID	Gnd Level mAOD (m)	Turbine Tip Height (AGL) (m)	Max HeightAOD (m)	Distance from WCH SSR (km)	Within 16km of WCH SSR	In Radar LOS (Y/N)	Detailed Assessment Required (EuroControl Guidelines)	IAA Objection
Carrownagowan T01	246	169	415	14.0	Y	Y	Y	None
Carrownagowan T02	247	169	416	14.7	Y	Y	Y	None
Carrownagowan T03	300	169	469	14.9	Y	Y	Y	None
Carrownagowan T04	326	169	495	15.3	Y	Y	Y	None
Carrownagowan T05	243	169	412	15.3	Y	Y	Y	None
Carrownagowan T06	247	169	416	15.7	Y	Y	Y	None
Carrownagowan T07	245	169	414	16.3	N	N	N	None
Carrownagowan T08	313	169	482	16.8	N	N	N	None
Carrownagowan T09	225	169	394	16.1	N	N	N	None
Carrownagowan T10	238	169	407	16.6	N	N	N	None
Carrownagowan T11	277	169	446	17.2	N	N	N	None
Carrownagowan T12	311	169	480	17.5	N	N	N	None
Carrownagowan T13	314	169	483	17.7	N	N	N	None
Carrownagowan T14	311	169	480	18.0	N	N	N	None
Carrownagowan T15	278	169	447	17.9	N	N	N	None
Carrownagowan T16	250	169	419	17.9	N	N	N	None
Carrownagowan T17	221	169	390	17.2	N	N	N	None
Carrownagowan T18	195	169	364	16.6	N	N	N	None
Carrownagowan T19	189	169	358	17.2	N	N	N	None
Moylussa Mt (Summit)	532	N/A	532	17.7	N	Y	N/A	-

Table 10. Carrownagowan Turbines / Objects in vicinity of proposed development

2.6.2.2 Fahybeg Wind Farm – Consented Planning

In 2024 planning permission was granted for Fahybeg Wind Farm wind farm which consists of 19 turbines, details of which are publicly available on the An Bord Pleanala website



It should be noted that the permitted wind farm is located due south and adjacent to the proposed wind farm at Lackareagh as shown in Figure 9. Table 11 below shows that all of the eight of the permitted Fahybeg wind turbines, are within 16 km, and in Radar LOS of the MSSR at Woodcock Hill (i.e. EuroControl Zone 2 – Detailed Assessment required). The proposed wind turbines at Lackareagh are located at a similar distance from the MSSR and any impacts to radar would be similar to the permitted turbines at Fahybeg.

Turbine ID	Ground Level AMSL (m)	Turbine Tip Height (AGL) (m)	Maximum Height (AMSL) (m)	Distance from WCH SSR (km)	Within 16km of WCH SSR	In Radar LOS (Y/N)	Detailed Assessment Required (EuroControl Guidelines)	IAA Objection
Fahybeg T01	116	176.5	293	12.9	Y	Y	Y	None
Fahybeg T02	143	176.5	320	12.9	Y	Y	Y	None
Fahybeg T03	221	176.5	398	13.6	Y	Y	Y	None
Fahybeg T04	194	176.5	370	14.2	Y	Y	Y	None
Fahybeg T05	188	176.5	364	13.8	Y	Y	Y	None
Fahybeg T06	157	176.5	333	14.1	Y	Y	Y	None
Fahybeg T07	126	176.5	302	13.1	Y	Y	Y	None
Fahybeg T08	154	176.5	331	13.2	Y	Y	Y	None

Table 11. Fahy Beg Turbines

2.6.3 Radar - Technical Safeguarding Assessment

The IAA consultation response received on December 8th 2022, as shown in Appendix B, indicated that they had a concern in relation to Surveillance Radar at Woodcock Hill

> *"As you will see from the Google Earth extract, Woodcock Hill is location of one of the IAA ANSP's Secondary Surveillance Radar stations. Given the estimated elevation of the Wind Farm of 470m, this creates issues for these systems based on the proposed location."*

In a further statement the IAA go on to state that :

> *"but I do need to caution that we have had numerous such requests for siting wind farms near our radar site, which in nearly all cases are generating issues for us (see in the last attachment EUROCONTROL Guidance on Impacts of Wind Turbines on Surveillance Sensors)"*

Ai Bridges identified in a desktop screening assessment that the permitted Carrownagowan Wind Farm consists of turbines that are at the higher elevations than the elevations highlighted by the IAA.

Ai Bridges then commissioned Cyrrus Limited to conduct a detailed Technical Safeguarding Assessment Report including a Radar Line of Sight Assessment for the proposed Lackareagh development. This report has been included in Appendix E. The detailed calculations contained within this report show that false targets due to bistatic reflections from the turbine towers will not occur from Woodcock Hill Radar. The volumes of the shadow regions from the turbines are calculated to be relatively small and considered operationally tolerable. The detailed calculation methods are based on the EUROCONTROL Guidelines

The report also concludes that the consented Carrownagowan and Fahybeg wind farms are sited either side of the proposed Lackareagh development, both of which have not caused any radar impacts to the Woodcock Hill MSSR radar.

2.7 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 Shannon Airport for calibration of instrument landing systems.

The Flight Inspection Service Provider conducts radial and orbital test flights around the Localizer at the airport. At Shannon Airport the orbital flights are conducted at 6 NM (nautical miles), 17 NM from the runway Localizer as shown in the figure below.

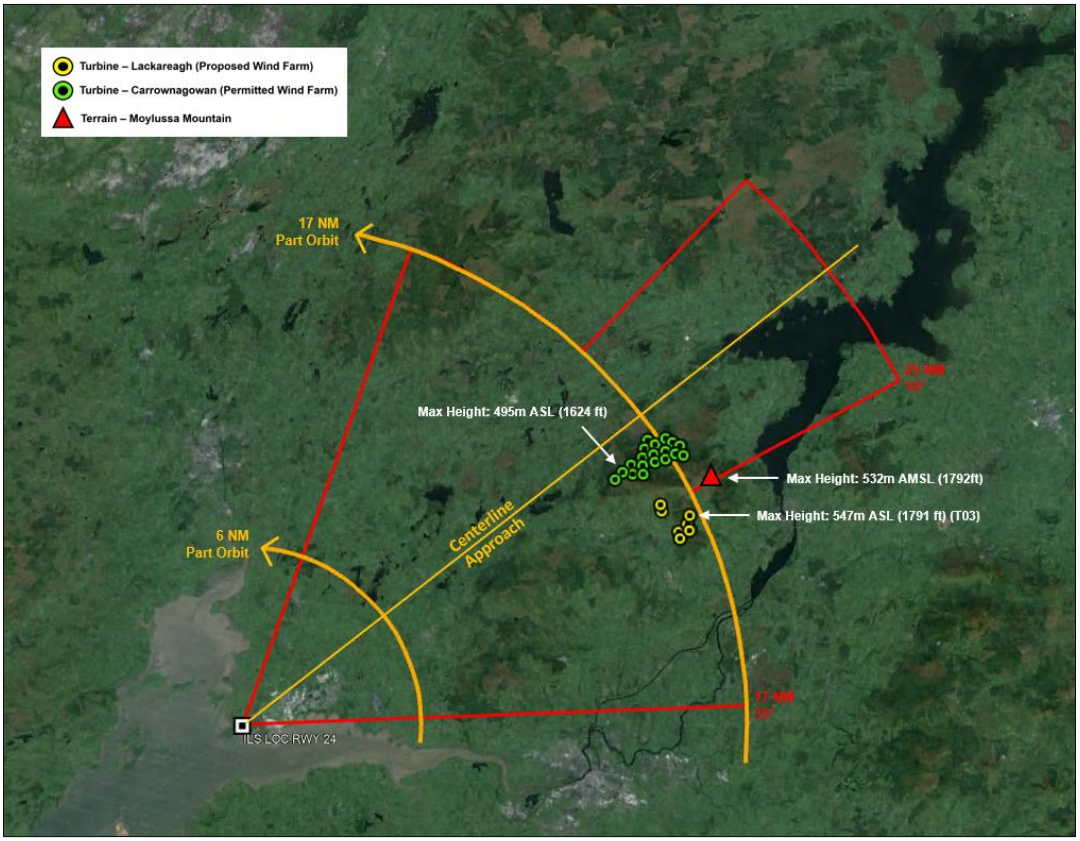


Figure 10. Flight Inspection and Calibration Test Procedures should account for Existing Obstacles (i.e. existing/permitted wind farms and terrain)

It should be noted that planning permission has recently been granted for the Carrownagowan wind farm which is adjacent to the proposed wind farm. As part of the Planning Application the Flight Inspection Service Provider submitted an ILS Flight Inspection Impact report, in which vertical obstacle clearances were calculated. In the report it was stated that test flights should remain 1000 ft above the highest obstacle in the area i.e. the summit of Moylussa Mountain 1792ft as marked on the IAA Aeronautical Information Package (AIP) charts e.g. RNAV Standard Departure Chart for Runway 06, EINN AD 2.24-5.1

Although the IAA may decide that a further assessment is required, it is unlikely that the Flight Inspection Procedures will be significantly impacted as the procedures should already account for the existing obstacles of Carrownagowan Wind Farm turbines and the terrain obstacle AMSL at Moylussa of 1792ft.

The minimum obstacle clearance is depicted below in Figure 11 and the proposed wind farm location in relation to Moylussa Mountain and the permitted Carrownagowan Wind Farm is shown in Figure 12 which clearly shows that only two of the proposed Lackeragh turbines are inside the MOC of the secondary flight area of the radio flight area.

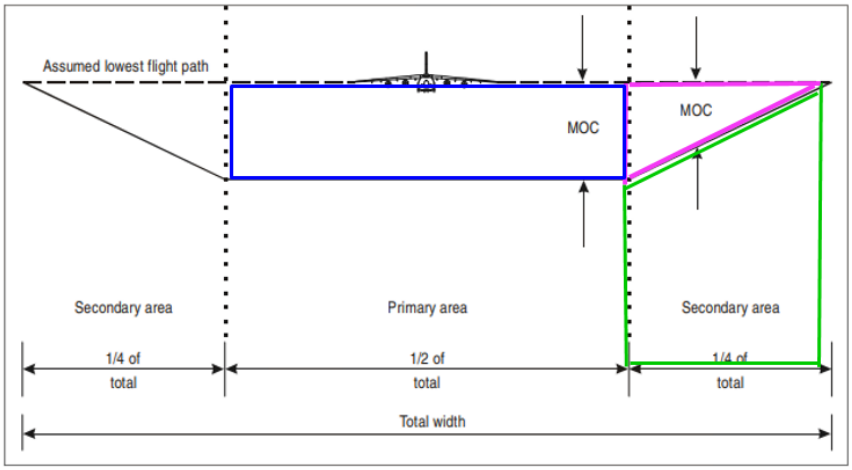


Figure I-2-1-2. Relationship of minimum obstacle clearances in primary and secondary areas in cross-section

- MOC = Minimum Obstacle Clearance of 1000ft

Figure 11. Primary and Secondary Flight areas showing Minimum Obstacle Clearance Requirement

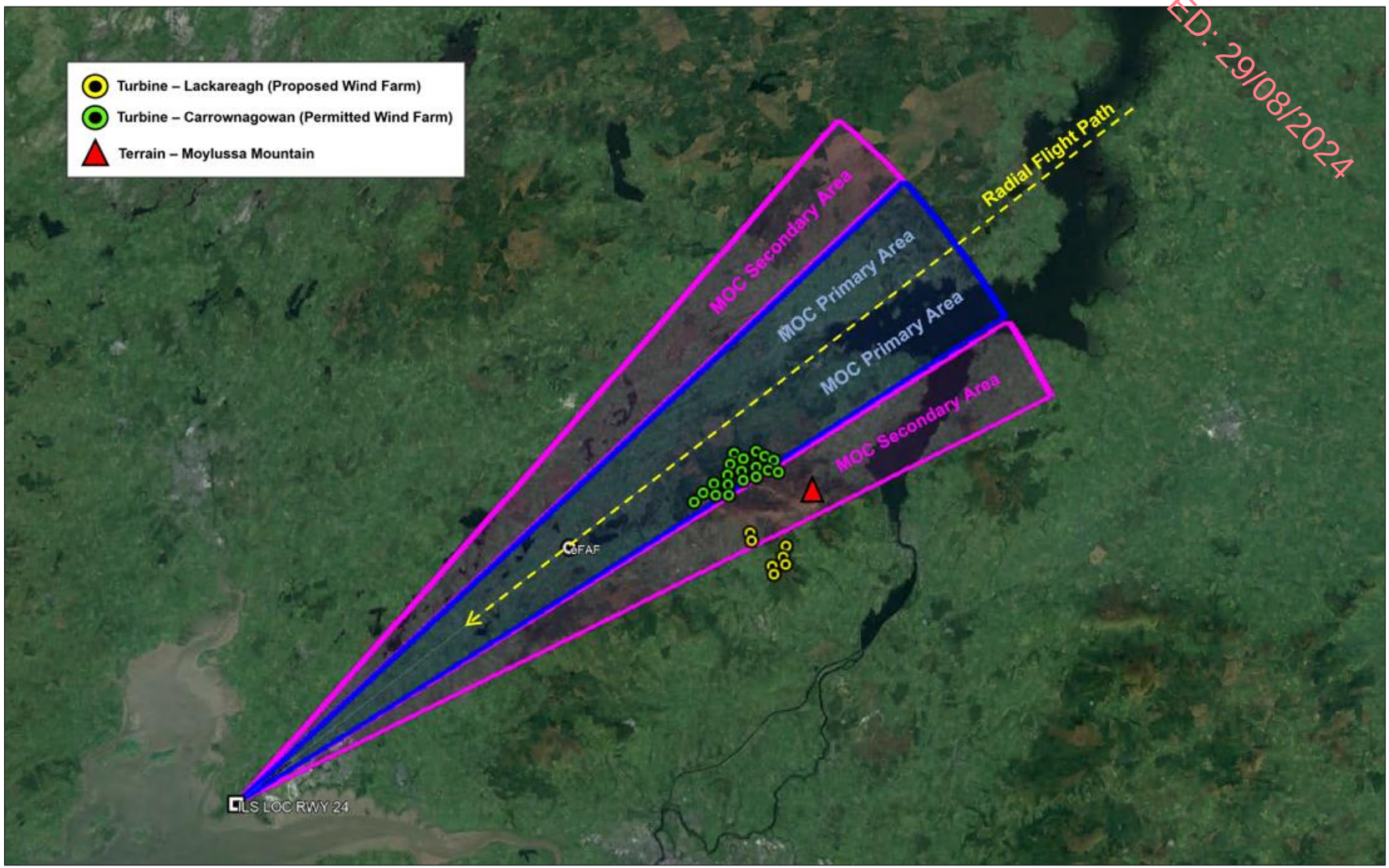


Figure 12. Lackareagh Wind Farm relative to Moylussa Mt, Carrownagowan Wind Farm and Primary and Secondary Flight Areas

2.8 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 safe-guarding 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

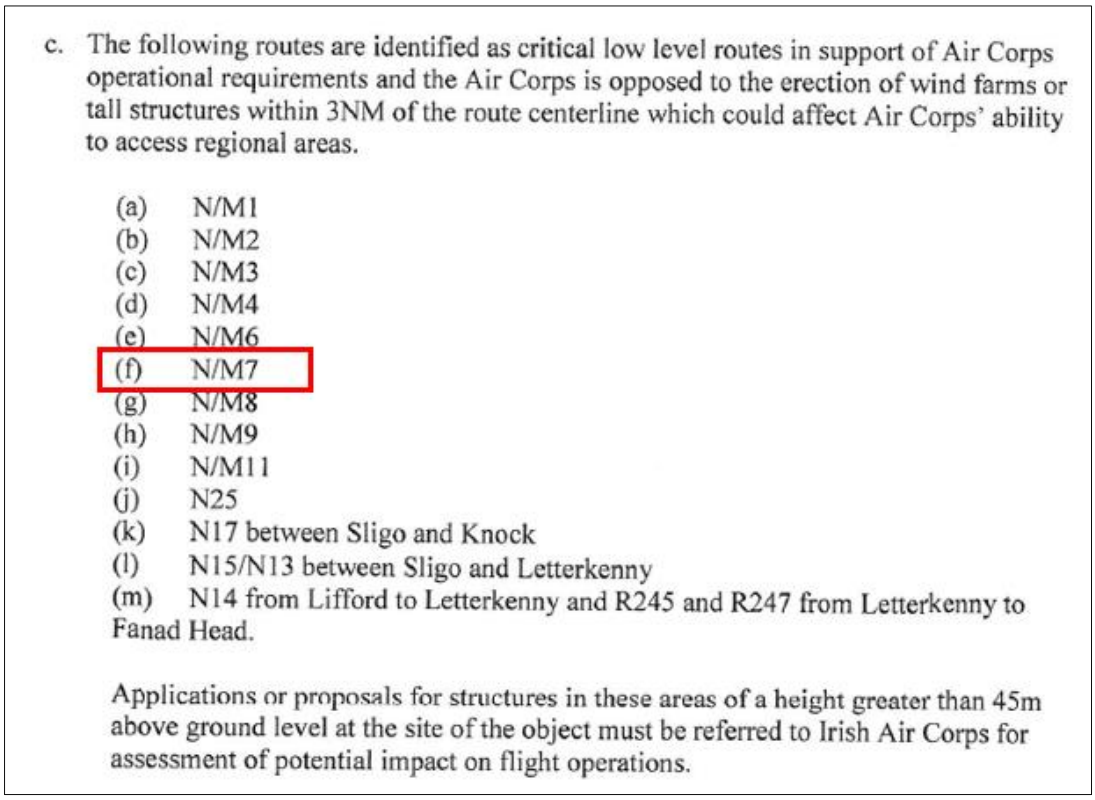
> *"Applicability: When considered as an obstacle a wind turbine should be marked and/or lighted."*

2.9 Irish Air Corps \ DoD Safeguarding

The Irish Air Corps Position Paper "*Air Corps Wind Farm/ Tall Structures Position Paper*" published on 08th August 2014, 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.
- Low Flying Area – LFTA WEST.
- A distance of 5NM or less from military installations.
- Critical low-level flying routes in support of Air Corps operation requirements.

The nearest of the Air Corps restricted areas to the proposed wind farm is the low-level flight route around the M7 motorway. The proposed wind farm site is 4.9 NM (9.1 km) from the M7 and is outside the 3 NM restricted area. As the proposed wind farm is located outside the restricted area, there should be no impacts on Irish Air Corps activities.



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 13. Irish Air Corps – Critical Low-Level Routes

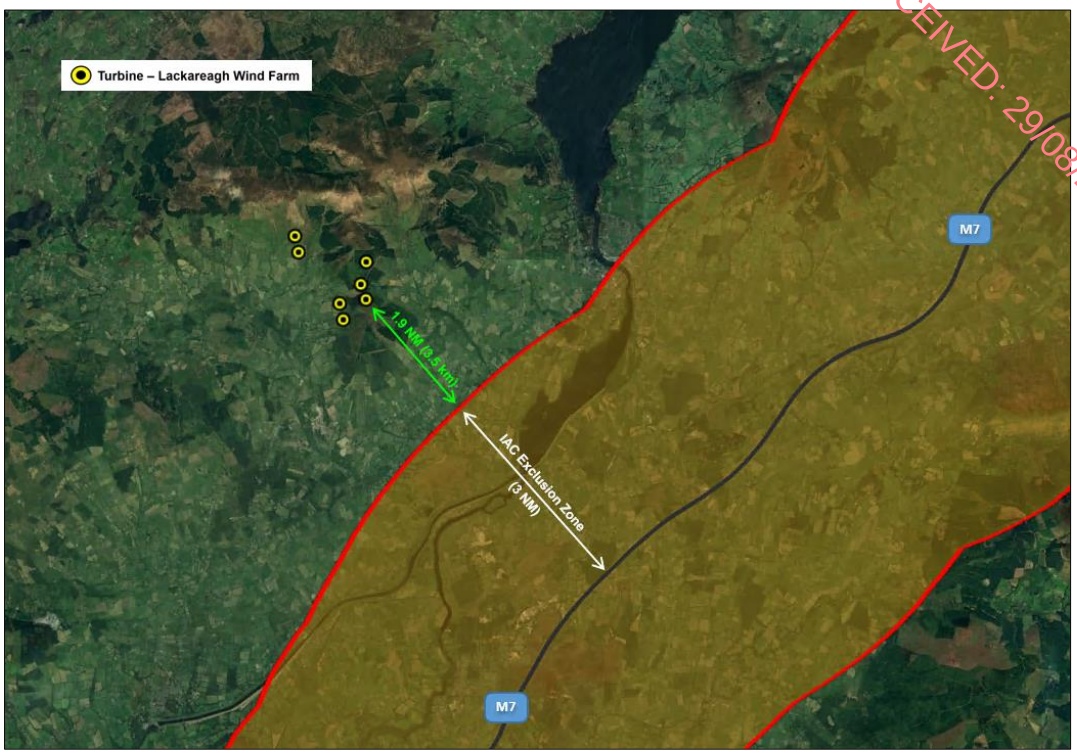


Figure 14. Proposed Wind Farm relative to Critical Low-Level Flight Route (M7)

3. Summary

A summary of the aviation review for the proposed wind farm is provided in Table 12 below.

Item	Impact	Summary
Annex 14 - Obstacle Limitation Surfaces (OLS)	None	The proposed wind farm site is located outside the Outer Horizontal Surfaces for Shannon Airport. Turbines at the proposed wind farm would be outside the take-off and approach surfaces for Shannon Airport
Annex 15 - Aerodrome Surfaces	Notification to IAA required	The proposed wind turbines would penetrate the ICAO Annex 15 Aerodrome Surface and should be included in the IAA Obstacle Data Set.
Minimum Sector Altitudes (MSA)	None	A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is within 25 nautical miles from the VOR/DME at Shannon Airport. The maximum allowable structure in the relevant Quadrant is 2400ft (AMSL). Turbines at the proposed wind farm would not exceed the 2400ft threshold, therefore the MSA of the Main Quadrant 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 site is sufficiently far from Shannon Airport that the instrument flight procedures (IFPs) for approach and departure flights to/from these airports are unlikely to be impacted for precision aircraft. The IAA have also stated that they do not anticipate any impacts to IFPs due to the proposed wind farm.
Communication and Navigation Systems	None	As the proposed wind farm is over 20km from the Localizers and transmitting antennas at Shannon Airport, it is very unlikely that the proposed development will have any impact on these ATS communications and radio navigational aids. The IAA have also stated that they do not anticipate any impacts to Navigational Aids due to the proposed wind farm.
Radar Surveillance Systems Safeguarding	None	For the MSSR at Woodcock Hill, the IAA have requested a further technical assessment. It should be noted that a technical assessment was carried out for the permitted wind farm at Carrownagowan and the IAA deemed that there would be no adverse impacts on the MSSR. No Radar Assessment was requested for the consented Fahybeg wind farm which is closer than the proposed Lackareagh development. A detailed Radar Safeguarding Assessment was conducted by Cyrrus Limited and it was concluded that there would be small shadow regions from the turbines are small and would be operationally tolerable and no mitigation measures are considered necessary for the Woodcock Hill MSSR
Flight Inspection and Calibration	None	The findings contained within this review statement document in relation to the impact assessment on ILS Flight Check Procedures should be presented to the IAA for their review noting that the obstacle terrain AMSL for Moylussa mountain is exceeds then AMSL for the highest of the proposed turbines.
Aeronautical Obstacle Warning Light Scheme	None	The IAA have stated that in the event of planning consent being granted, the wind farm should be fitted with Aeronautical Obstacle Warning Lights. It is recommended that an aeronautical obstacle lighting scheme be implemented and agreed with the IAA.
Irish Air Corps / DoD Safeguarding	None	The proposed wind farm is located outside the Irish Air Corps Restricted Areas.

Table 12. Lackareagh Wind Farm – Aviation Review Summary

4. Recommendations

From the findings of this report, the following recommendations hare presented

i) The findings contained within this review statement document in relation to the impact assessment on ILS Flight Check Procedures should be presented to the IAA for their review noting that the obstacle terrain AMSL for Moylussa Mountain exceeds the AMSL for the highest elevation of the proposed turbines.

ii) That the detailed Technical Safeguarding Assessment commissioned to investigate the possible impacts of the proposed Lackareagh Wind Farm development on the Secondary Surveillance Radar (SSR) at Woodcock Hill should be presented to the IAA for review.

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

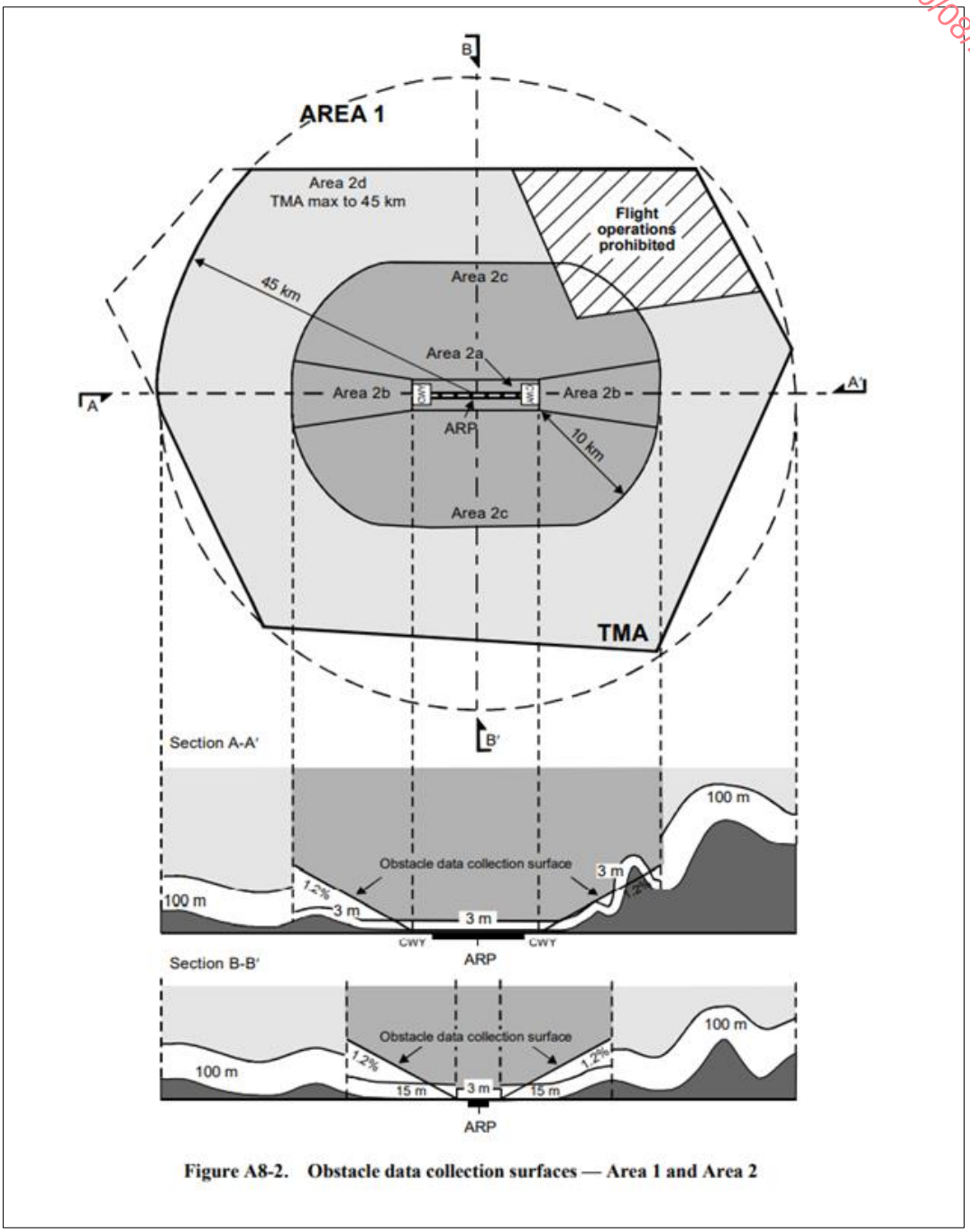


Figure A8-2. Obstacle data collection surfaces — Area 1 and Area 2

Figure B1. ICAO Annex 15 Area 1 and Area 2 Surfaces.

APPENDIX B – IAA Consultation Responses (December 2022)

The consultation responses received from the IAA (in December 2022) in relation to the proposed wind farm development at Lackareagh are shown below.

B.1 Email received from the IAA (Dated 08th December 2022)

Niamh McHugh

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 8 December 2022 14:59
To: Niamh McHugh
Cc: SYMMANS Terry; Paul Hennessy; comments@shannonairport.ie; Planning; DOYLE Fergal; OLOUGHLIN Charlie; CORRIGAN Gary; FLYNN Mark
Subject: 221208: 20245 - Proposed Lackareagh Wind Farm Scoping
Attachments: Lackareagh EIA SD F - 2022.12.05- 220245 Reduced.pdf; 220245 - Shannon Airport Scoping Letter - 2022.12.05.pdf; 20140909-impact-wind-turbines-sur-sensors-guid-v1.2 (1).pdf

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Niamh,

With thanks to Paul Hennessy from SAA for sending this data on, I have reviewed the attachments re. EIAR for the proposed Lackeragh Wind Farm.

I have no comments to add to your overall content in that it is consistent with what I would have previously seen in such EIAR. We normally use WGS84 co-ordinates (Latitude/Longitude) to ascertain positions. I have estimated the positioning of the centre of the proposed wind farm below:

1

Separately to an EIAR, the IAA Air Navigation Service Provider (ANSP) is responsible for safeguarding across a number of areas:

1. Instrument Flight Procedures (IFP): The elevation of the site in question is 296m Above Mean Sea Level. We add to this an estimated height for a wind turbine of c.175m = obstacle elevation 470m AMSL. This is sufficiently below the IFP surfaces such that I have no concerns here
2. Navigation Aids (Shannon Airport): The proposed location of the Wind Farm should be and adequate distance so as not to adversely affect these systems, but I'm asking technical colleagues(copied) in this area to confirm this
3. Surveillance(Radar): As you will see form the Google Earth extract, Woodcock Hill is the location of one of the IAA ANSP's Secondary Surveillance Radar stations. ***Given the estimated elevation of the Wind farm of 470m, this creates issues for these systems based on the proposed location***. I'm also copying relevant colleagues in this domain for comment, but I do need to caution that we have had numerous such requests for siting wind farms near our radar site, which in nearly all case are generating issues for us (see in the last attachment EUROCONTROL Guidance on impacts of Wind Turbines on Surveillance Sensors)

On the face of it, the IAA ANSP could not support the development based on the impact on our Surveillance systems, but I will defer to our experts in this in the first instance.

Please do feel free to call me if you need to discuss this further.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
cathal.maccriostail@iaa.ie
☎ +353 (0)1 6031173
+353 (0)86 0527130
www.iaa.ie
Do you *really* need to print this?

B.2 Letter No. 1 received from the IAA (Dated 16th December 2022)

Irish Aviation Authority
The Times Building
11–12 D'Olier Street
Dublin 2, D02 T449,
Ireland

Údarás Eitlíochta na hÉireann
Foirgneamh na hAmanna
11–12 Sráid D'Olier
Baile Átha Cliath 2, D02 T449,
Éire

T: +353 1 671 8655
F: +353 1 679 2934
www.iaa.ie

16th December 2022

Ms Niamh McHugh
McCarthy Keville O'Sullivan Ltd
Tuam Road
Galway
H91 VW84

Reference: ***220245***

Description: Proposed Lackareagh Wind Farm, Near Kilbane, Co. Clare.

Dear Ms McHugh

I refer to your letter/scoping report details of which were received by the Irish Aviation Authority by email on the 7th December in regard to the proposed wind farm development near Kilbane, Co. Clare.

This development has the potential to impact on Shannon ILS 24 Commissioning Flight Checks.

It's advisable the WF developer have the proposed development assessed by our flight commissioning company FCSL for any potential ILS 24 commissioning flight check infringements.

Please find FCSL Contact Details attached.

Your sincerely

P.P. G. O'Leary

Deirdre Forrest
Corporate Affairs

Flight Calibration Services Ltd.
Calibration House
17-19 Cecil Pashley Way, Shoreham Airport
Shoreham BN43 5FF

Telephone: +44 (0)1243 538245 **Fax:** +44 (0)20 8391 3391 *http://www.flight-cal.com*

Operations
Nick Whitehouse - Flight Inspection Manager
+44 (0)1243 538 245

operations@flight-cal.com

Sales / Enquiries
David Bartlett
+44 (0)20 8391 6880
david@flight-cal.com

B.2 Letter No. 2 received from the IAA (Dated 16th December 2022)

Irish Aviation Authority
The Times Building
11–12 D'Olier Street
Dublin 2, D02 T449,
Ireland

Údarás Eitlíochta na hÉireann
Foirgneamh na hAmanna
11–12 Sráid D'Olier
Baile Átha Cliath 2, D02 T449,
Éire

T: +353 1 671 8655
F: +353 1 679 2934
www.iaa.ie

16th December 2022

Ms Niamh McHugh
McCarthy Keville O'Sullivan Ltd
Tuam Road
Galway
H91 VW84

Reference: 220245
Description: Proposed Lackareagh Wind Farm, Near Kilbane, Co. Clare.

Dear Ms McHugh

Thank you for your letter/scoping report and request for comments in relation to the proposed Lackareagh Wind Farm, to comprise of approximately 7 no. wind turbines near Kilbane, Co. Clare.

The development appears to be approximately 25km East of Shannon Airport, as such, It is the observation of the Safety Regulation Division – Aerodromes, that even at this pre-planning stage, it would be prudent to engage as early as possible with Shannon airport and the IAA's Air Navigation Service Provider (ANSP) to undertake a preliminary screening assessment to confirm that the proposed wind farm and the associated cranes that would be utilised during its construction would have no impact on instrument flight procedures, communication and navigation aids or flight checking at Shannon Airport.

It is likely that the following general observations would be proffered by the Authority during a formal planning process: In the event of planning consent being granted, the applicant should be conditioned to contact the Irish Aviation Authority to: (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide as-constructed coordinates in WGS84 format together with ground and blade tip height elevations at each wind turbine location and (3) notify the Authority of intention to commence crane operations with at least 30 days prior notification of their erection.

Your sincerely

p.p. D. O'Leary

Deirdre Forrest
Corporate Affairs

APPENDIX C – IAA Radar Stations (Shannon Airport and Woodcock Hill)

The radar surveillance site at Shannon Airport consists of a PSR and a MSSR. The PSR and the MSSR antennas are co-located on the same structure at Shannon Airport as shown in Figure C1. The radar surveillance site at Woodcock Hill consists of a MSSR (Mono-pulse SSR) system housed in the dome-shaped structure shown below in Figure C2.

Figure C1. PSR / MSSR Radar Station at Shannon Airport

Figure C2. MSSR at Woodcock Hill

APPENDIX D – Letter from IAA, RFI to Item 3, Carrownagowan Wind Farm Appendix 4.

The Letter from the IAA in relation to the impact of Carrownagowan wind farm on Instrument Flight Procedures, Flight Check Procedures and Radar Surveillance Services is shown below.

https://carrownagowanplanning.ie/wp-content/uploads/2022/02/RFI%20Response%20Item%203.pdf

Appendix 4

Letter from the Irish Aviation Authority

rish Aviation Authority
The Times Building
11–12 D'Olier Street
Jublin 2, D02 T449
reland

Údarás Eitlíochta na hÉireann
Foirgneamh na hAmanna
11–12 Sráid D'Olier
Baile Átha Cliath 2, D02 T449,
Éire

T: +353 1 671 8655
F: +353 1 679 2934
www.iaa.ie

Operations
Directorate

An Stiúrthóireacht
Oibríochtaí

Malachy Walsh and Partners
Reen Point
Blennerville
Tralee
Co.Kerry

Ref. Pre-planning of Carrownagowan/Moylussa Clare East Wind Farm
(Updated correspondence following Meeting with Stakeholders 19th May 2021)

Dear Helen and to whom it may concern,

For the purposes of the referenced planning application process and in my capacity as IAA Air Navigation Service Provider (ANSP) Manager Airspace and Navigation, I am happy to revisit our position regarding this process, following our stakeholder meeting of 19th May 2021.

In my previous correspondence, I indicated that there were potential issues to be considered that might in turn impact on the acceptable turbine elevations as proposed in this application.

Following our meeting, I am satisfied that the issues highlighted can be appropriately managed, if and when planning permission is granted.

Specifically, to update my previously supplied comments:

1. '*The proposed Carrownagowan Wind Farm will therefore have no adverse effect on flight inspection procedures and profiles associated with the Runway 24 ILS*', but in 6.1.1 Horizontal Obstacle Clearances '*For a centreline approach profile, the flight inspection aircraft will be approximately 0.7 NM laterally from the nearest wind turbine (T19) at a point on the extended runway centreline closest to the wind farm.* ***This distance is less than the minimum clearance required from any object, as defined in FIP 23'***

   ANSP Comment Updated 19th May 2021: Flight Calibration Services Ltd (FCSL) confirmation, as an approved flight calibration service provider for Ireland, that they do not have a concern over this issue, is accepted by the IAA ANSP.
   Proposal: If and when planning permission is granted, I propose a re-engagement with stakeholders to review the timetable of construction, in order to ensure that this issue is considered in the context of planned calibration flight activity (for Shannon Airport).

2. **ANSP Comment Updated 19th May 2021:** The findings of the Technical Safeguarding Assessment are accepted as being that the proposal does not impact Surveillance (Radar) services provided by the ANSP. ***No further action required***.

3. **ANSP Comment Updated 19th May 2021:** The findings of the interim Instrument Flight Procedures (IFP) Safeguarding Report are accepted.
   Proposal: If and when planning permission is granted, I propose a re-engagement with Cyrrus and other affected stakeholders to consider the following:
   - An update to this IFP assessment to include an assessment of the Shannon Surveillance Minimum Altitude Chart and the non-standard (omni-directional) departures procedures
   - Assessment of any newly developed IFPs, currently in planning, to take account of the planned location of wind turbines associated with this proposal

On the basis of my updated comments and proposals, I wish to confirm that the IAA ANSP has no objections in regard to the planning process for the proposed Carrownagowan/ Moylussa Clare East Wind Farm.

I may be contacted for any queries or clarifications required as follows:

Email: cathal.maccriostail@iaa.ie

Mobile: +353 86 0527130

Yours Sincerely,

_____
Cathal Mac Criostail
IAA Manager Airspace & Navigation

19th May 2021

APPENDIX E – Technical Safeguarding Assessment

Technical Safeguarding Assessment

Lackareagh Wind Farm

Ai Bridges

14 May 2024

CL-6055-RPT-002 v1.0

www.cyrrus.co.uk

info@cyrrus.co.uk

Document Information	
Document title	Technical Safeguarding Assessment
Author	Luke Sissons
Reviewed by	Kevin Sissons
Produced by	Cyrrus Limited Cyrrus House Concept Business Court Allendale Road Thirsk North Yorkshire YO7 3NY T: +44 (0) 1845 522 585 F: +44 (0) 8707 622 325 E: info@cyrrus.co.uk W: www.cyrrus.co.uk
Document reference and Version	CL-6055-RPT-002 v1.0
Date of release	14 May 2024

Change History Record

Issue	Change Reference	Date	Details
1.0	Initial Issue	14/05/2024	1.0

Executive Summary

Cyrrus Limited has been engaged by Ai Brides to undertake a Technical Safeguarding Assessment, including a Radar Line of Sight (RLoS) Assessment for the proposed Lackereagh Wind Farm Development to the North West of Shannon Airport Ireland.

The assessment investigates the potential impact the proposed development will have on the Woodcock Hill Monopulse Secondary Surveillance Radar (MSSR).

Detailed radar modelling of the proposed layout against the MSSR at Woodcock Hill shows:

- Radar Line of Sight exists between all the Lackareagh Wind Farm Turbines and the Woodcock Hill MSSR.
- Calculations have shown that false targets due to bistatic reflections from the turbine towers will not occur from Woodcock Hill MSSR.
- The volumes of shadow regions from the turbines are relatively small and considered operationally tolerable.
- No mitigation measures are considered necessary for Woodcock Hill MSSR.
- No Operational impact due to the cumulative effect of nearby Wind Farms.

The full details of the investigation and findings are contained within the body of this report.

Abbreviations

AGL	Above Ground Level
AMSL	Above Mean Sea Level
ATCO	Air Traffic Control Officer
dB	Decibels
DTM	Digital Terrain Model
MSSR	Monopulse Secondary Surveillance Radar
PSR	Primary Surveillance Radar
RCS	Radar Cross Section
RLoS	Radar Line of Sight
Tx	Transmitter

References

[1] EUROCONTROL Guidelines on assessing the potential impact of wind turbines on surveillance sensors, EUROCONTROL 9 September 2014

Contents

List of figures

List of tables

1. Introduction

1.1. Background

1.1.1. Ai Bridges (the Client) has engaged Cyrrus to conduct a Technical Safeguarding Assessment including a Radar Line of Sight (RLoS) assessment for the proposed Lackareagh Wind Farm development comprising of 7-turbines to the North East of Shannon Airport.

1.2. Effects of Wind Turbines on Aviation

1.2.1. Wind turbines are an issue for aviation Primary Surveillance Radars (PSR) and Monopulse Secondary Surveillance Radars (MSSR) as the characteristics of a moving wind turbine blade are similar to that of an aircraft. The radar is unable to differentiate between wanted aircraft targets and unwanted clutter targets introduced by the presence of turbines.

1.2.2. The impact depends on airspace usage in the vicinity of the proposed development and the nature of the Air Traffic Service provided in that airspace.

1.3. Radar Modelling Tasks

1.3.1. The initial modelling tasks identified are to determine the radar visibility of the Lackareagh Wind Turbines to the Woodcock Hill MSSR.

1.3.2. Shannon Airport PSR / MSSR. No modelling was required as these systems fall outside the Eurocontrol assessment zone.

2. Evaluation Tools Used

2.1. Software

- ATDI HTZ Communications Version 2024.2;
- Global Mapper Geographic Information System (GIS) Software v21.1.1.

2.2. Terrain Data

- 20m ATDI Digital Terrain Model (DTM).

3. Development

3.1. Location – Proposed Lackareagh Wind Farm

3.1.1. The indicative 7-turbine layout used for modelling shown in Figure 1.

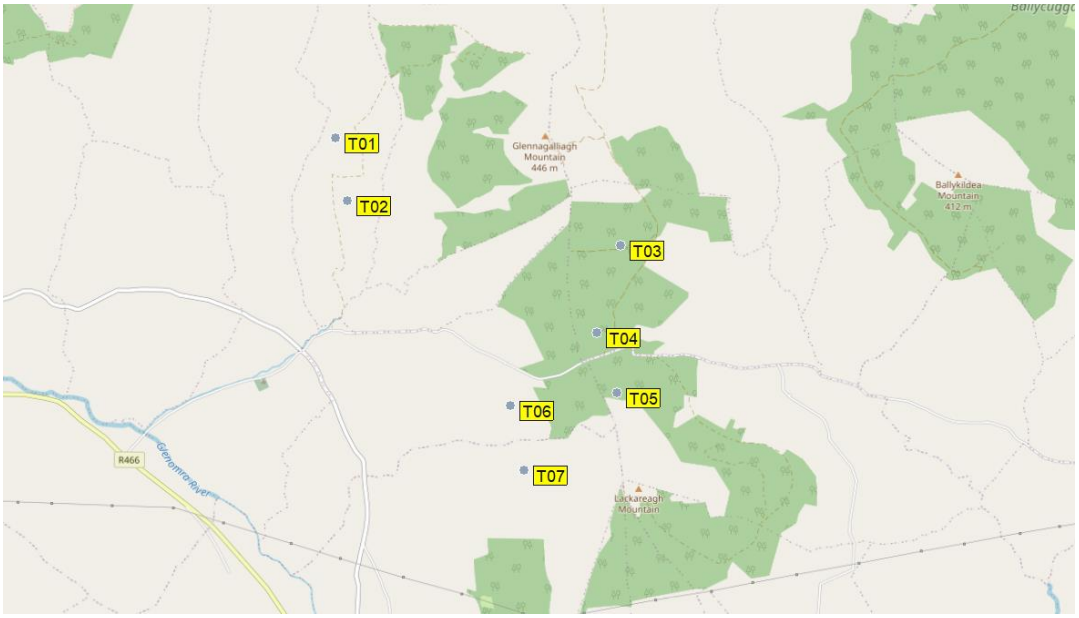


Figure 1: Indicative Windturbine Layout (Lackareagh Wind Farm)

3.2. Turbine Data

3.2.1. Each turbine has a planned tip height of 180m AGL and a rotor diameter of 150m. Turbine blade length is thus 75m and hub height is 105m AGL.

3.2.2. The WGS84 Coordinates for the proposed turbine layout used in the assessment, are listed in Table 1. These coordinates were supplied by the client.

Turbine	Latitude	Longitude	Heights
T01	52° 48' 55.94"N	08° 33' 38.30"W	230m
T02	52° 48' 43.02"N	08° 33' 34.08"W	187m
T03	52° 48' 34.29"N	08° 32' 01.48"W	366m
T04	52° 48' 16.40"N	08° 32' 9.27"W	291m
T05	52° 48' 4.16"N	08° 32' 2.45"W	295m
T06	52° 48' 1.28"N	08° 32' 38.45"W	201m
T07	52° 47' 48.10"N	08° 32' 33.64"W	202m

Table 1 - Turbine Coordinates

4. Radar Assessment

4.1. Potential Impact of Wind Turbines on MSSR

4.1.1. An MSSR is an 'active' system. It operated by the radar transmitting a coded pulse sequence which is received and decoded by suitably equipped aircraft. The aircraft responds with a coded pulse sequence on a different frequency which is received by the MSSR. The radar detects the range and azimuth of an aircraft based upon the difference in time between the transmission of pulses to the aircraft and the receipt of energy from the aircraft. Additional information in the coded reply allows the identification of a particular aircraft and its height. Other data may also be made available dependant on the mode of operation.

4.1.2. MSSR is immune to direct reflections (monostatic back scatter) from large objects such as wind turbines, because the transmitted and received frequencies differ and the message structure is different for transmit and receive paths.

4.1.3. Bistatic reflection is where the signal transmitted by the radar is 'forward' reflected to an aircraft and the aircraft reply is also reflected back to the radar. The effect of this is best understood by considering the following diagrams.

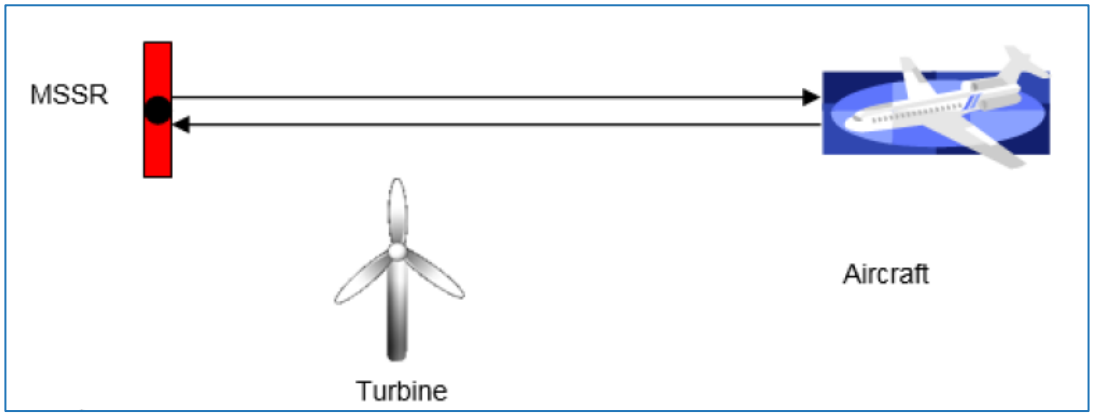


Figure 2 - Direct Interrogation and Reply Pulses

4.1.4. In Figure 2, the MSSR transmits an interrogation pulse sequence and the aircraft, on receiving the interrogation sequence, replies with a coded pulse sequence. The bearing of the aircraft is the physical bearing of the radar antenna.

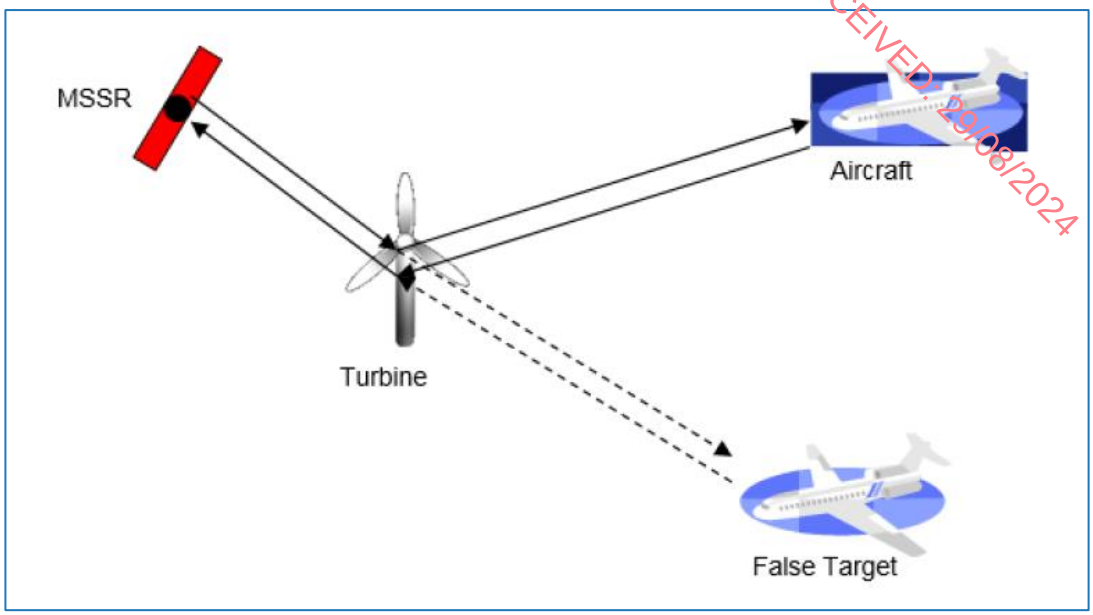


Figure 3 - Reflected Interrogation and Reply Pulses

4.1.5. In Figure 3, the MSSR beam illuminates a wind turbine which reflects the interrogation to an aircraft on a different bearing. The aircraft transponder replies, and this is received by the radar via the turbine. The radar processes this as a false target on the bearing of the wind turbine and at a distance proportional to the path length, which is slightly longer than the direct path length.

4.1.6. Objects can produce a radar shadow in the area behind the object. As a wind turbine is narrow compared to the radar beam width, assuming the turbine is more than 2 km away from the radar, the shadow will be relatively small, and will reduce with increasing distance behind the turbine. Shadowing effects are likely to be insignificant but, due to diffraction of the beam around the turbine tower, small azimuth angular errors may be introduced. Aircraft targets in this area can potentially be subject to track jitter causing the returns to meander from side to side. This can only occur when the turbine is in the direct RLoS between the radar and the aircraft target.

4.2. Woodcock Hill Radar

4.2.1. The radar at Woodcock Hill is a Thales RSM 970 S MSSR and housed in a polycarbonate radome.

Image © Google 2024

Figure 4 - Woodcock Hill MSSR

4.2.2. The radar ETRS89 coordinates are 52.72104722 N, 8.70743889 W.

4.2.3. The MSSR antenna height has been modelled at 10m AGL.

4.2.4. The MSSR position and relative location to the proposed development is shown in Figure 5 and Figure 6.

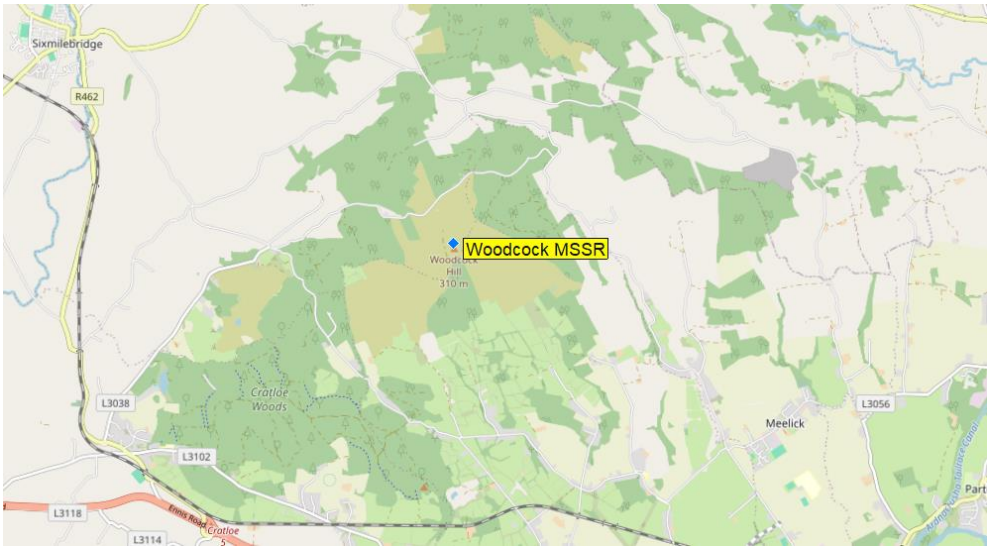


Figure 5 - Radar Position

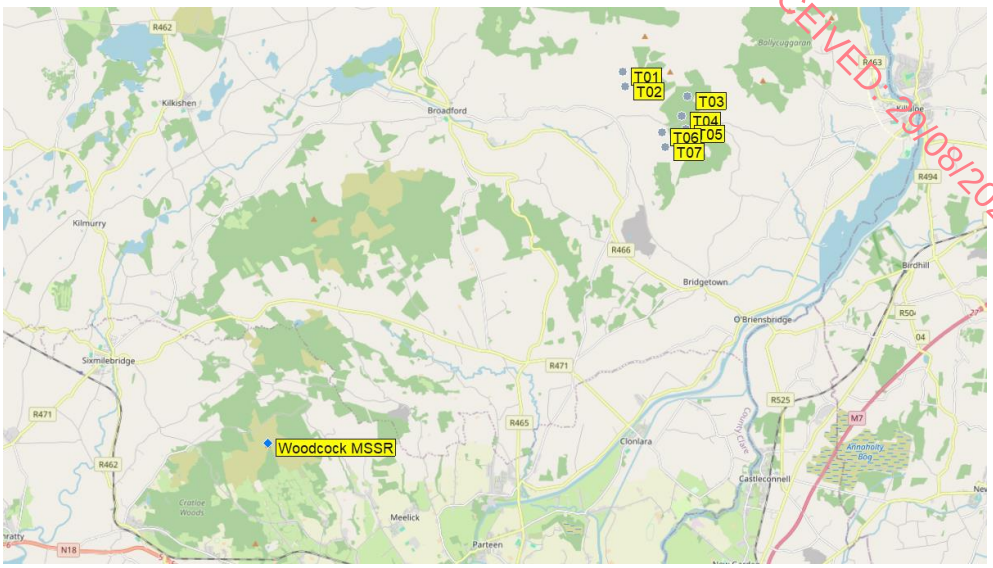


Figure 6 - Relative Location

4.3. Radar Line of Sight

4.3.1. RLoS is determined using a sight coverage map produced by ATDI's HTZ Communications modelling tool using 3D DTM data with a 20m resolution. Radar data is entered into the model and RLoS from the radar site to each turbine is then calculated.

4.3.2. In the case of MSSR, adverse effects are generated by the turbine towers, so for the scope of this study, RLoS is calculated using the maximum hub height of the turbines of 105m AGL.

4.3.3. The magenta shading in Figure 7 and Figure 8 illustrates the RLoS coverage from the Woodcock Hill MSSR to the turbines at a receiver height of 105m AGL.

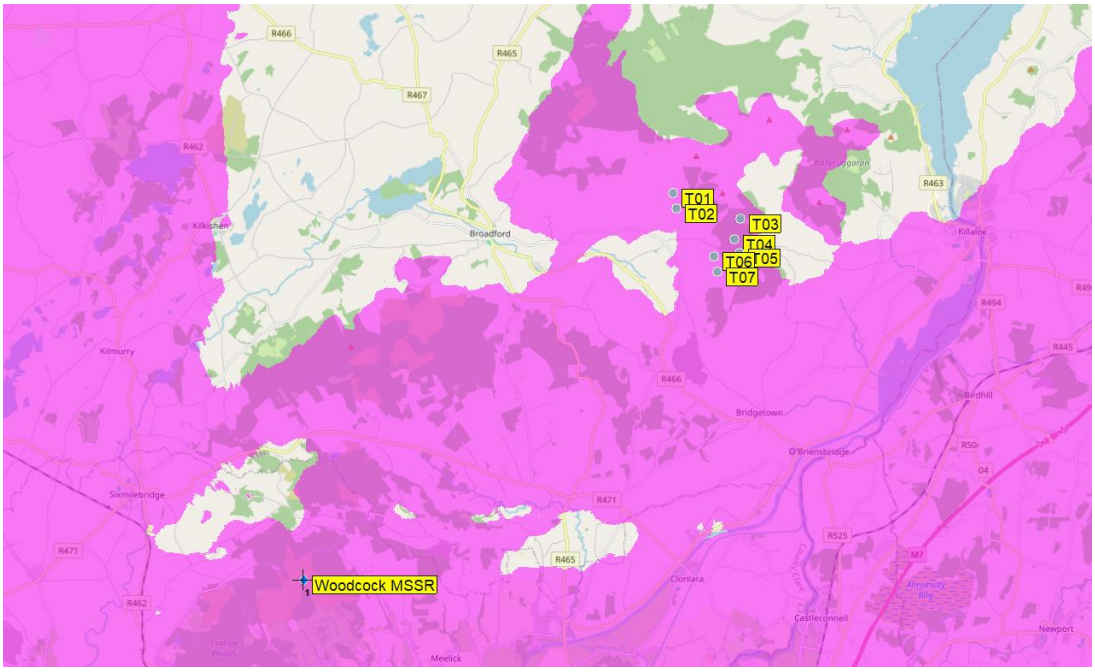


Figure 7 - RLoS from Woodcock Hill MSSR to Lackareagh Wind Farm at 105m AGL

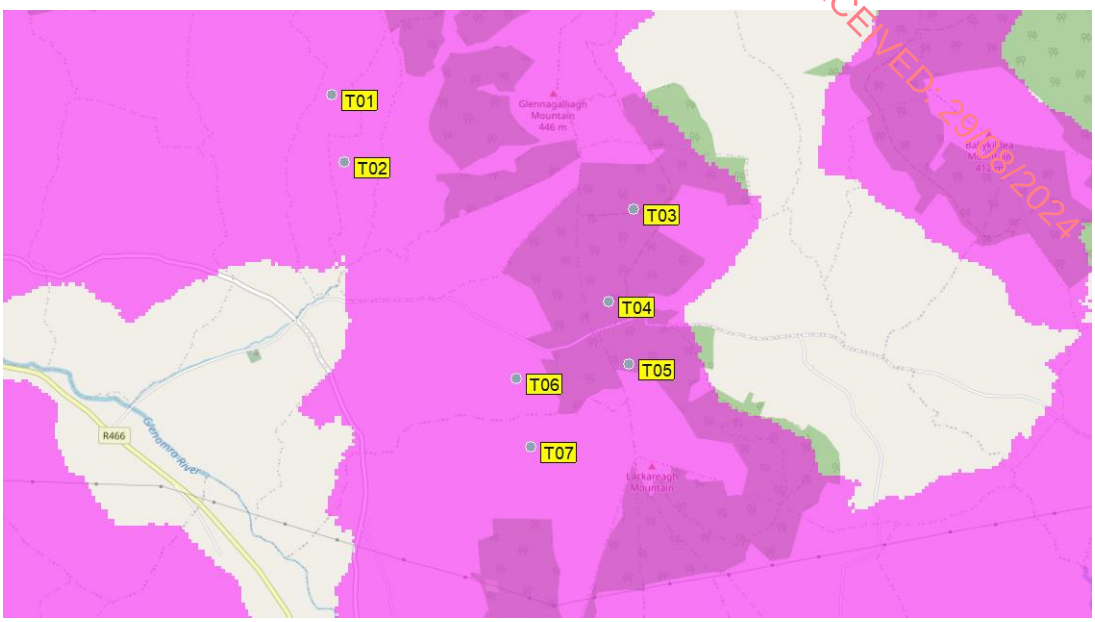


Figure 8 - RLoS from Woodcock Hill MSSR to Lackareagh Wind Farm at 105m AGL – Zoomed

4.3.4. RLoS exists between every turbine and Woodcock Hill MSSR at 105m AGL.

4.4. Woodcock Hill MSSR Path Loss

4.4.1. Using the radar propagation model the actual path loss between Woodcock Hill MSSR and the tops of the Lackareagh turbine towers can be determined.

4.4.2. An illustration of the path loss profile between the Woodcock Hill MSSR and Turbine 01 is shown in Figure 9.

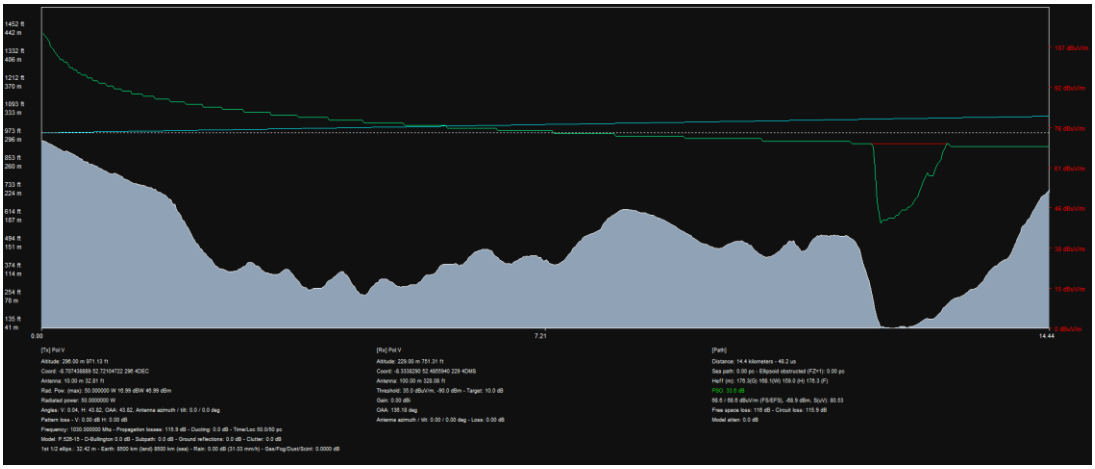


Figure 9 - Path loss profile between Woodcock Hill MSSR and T01

4.4.3. All of the path profiles between Woodcock Hill MSSR and the Lackareagh Turbines are shown in Annex A.

4.4.4. As explained in Section 4.1, multipath, or bistatic, reflections from turbine towers can potentially cause 'ghost' targets on MSSR. This occurs when an aircraft replies through a signal reflected from an obstruction; the radar attributes the response to the original signal and outputs a false target in the direction of the obstruction, which can lead to Air Traffic Control Officer (ATCO) deconflicting real traffic from targets that do not physically exist.

4.4.5. The likelihood of bistatic reflections can be determined by knowing the MSSR transmitter power, antenna gain, path loss to the turbine tower, Radar Cross Section (RCS) gain and aircraft receiver sensitivity.

4.4.6. The amount of signal reflected by a turbine tower is a function of the tower's RCS. A typical RCS value for a 100m steel tower of 8m diameter is 3,000,000m^2. However, a 0.5° taper of the tower can reduce this figure from millions to hundreds of square metres.

4.4.7. EUROCONTROL Guidelines[1] recommend an RCS value of $10^{3.5}$m^2 or 35dBm^2 for a turbine tower which equates to an RCS gain of 57dB at the MSSR uplink frequency of 1030MHz.

4.4.8. The following calculation can be used to determine the power of a radar signal reflected by a wind turbine tower:

	Tx Power	dBm
+	Antenna Gain	dB
-	Path Loss	dB
+	RCS Gain	dB
=	Reflected Power	dBm

4.4.9. Free Space Path Loss can be used to calculate the maximum distance from the reflecting obstacle an aircraft can be in order for the reflected signal to trigger a response from the aircraft transponder.

4.4.10. The maximum range at which a reflection can trigger a response is proportional to the reflected power of the signal. From the above calculation it can be seen that reflected power is greatest when the path loss between the MSSR and a turbine is the least.

4.4.11. Using the radar propagation model the actual path loss between the MSSR and the tops of the Lackareagh Turbine Towers can be determined.

4.4.12. The path loss results between Woodcock Hull MSSR and the Turbine Towers are shown in Table 2.

Turbine	Path Loss dB
T01	115.9
T02	115.8
T03	116.4
T04	116.1
T05	116.1
T06	115.7
T07	115.6

Table 2 - Woodcock Hill MSSR Path Loss

4.4.13. From Table 2 it can be seen that the worst-case or smallest path loss is 115.6dB at Turbine 07.

4.4.14. The Tx Power for a Thales RSM 970 S MSSR is 60.35 dBm at the antenna input. The MSSR antenna gain varies with elevation angle, with peak gain of 27dB at an elevation of between 8° and 9° above the horizontal, as shown in Figure 16.

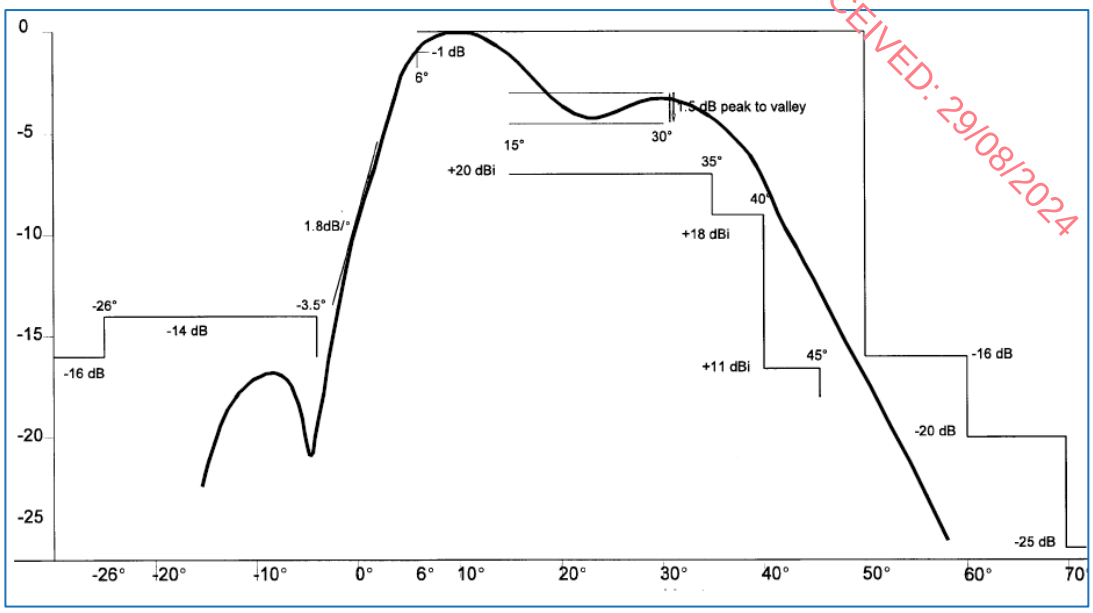


Figure 10 - Thales RSM 970 S VPD

4.4.15. The vertical angle from the MSSR to the hub of Turbine 07 is 0.06°. If a mechanical tilt of 0° is assumed, this means a reduction in gain of -9dB at this elevation.

4.4.16. Using these values results in a reflected power of 19.75dBm from Turbine 07.

4.4.17. If an aircraft receiver sensitivity of -77dBm is assumed, the reflected signal will not trigger a response if the Free Space Path Loss from the turbine to the aircraft is more than 77 + 19.75 = 96.75 dBm.

4.4.18. The Free Space Path Length for an MSSR frequency of 1030MHz and path loss of is 1594.3m. This means that aircraft beyond this distance from the turbine will not detect a reflected signal. Reflected signals from other Lackareagh Turbines will only be detected at ranges less than 1594.3m.

4.4.19. Annex D of the EUROCONTROL Guidelines[1] states that an airborne transponder will be insensitive for 35µs following reception of a radar interrogation. Thus, an aircraft closer than 5250m (half the distance corresponding to 35µs) to the source of a reflected interrogation will not reply to reflected interrogations because the path length between the direct and reflected signals will always be smaller than 35µs.

4.4.20. Aircraft will not respond to reflected MSSR interrogations as they will only be detected when the aircraft is within 5250m of the turbines.

4.4.21. An array of turbines can create a radar shadow in the space beyond it from the radar. The EUROCONTOL Guidelines provides a means of calculating the dimensions of this shadow region.

$$Dwr = dtw \,/\, [\lambda \frac{Dtw}{S^2}\left(1 - \sqrt{PL}\right)^2 - 1]$$

- Dwr = depth of shadow region;

- Dtw = distance of turbines (13.9km – 15.3km)
- Λ = wavelength (0.29)
- S = diameter of support structures (6m)
- PL = acceptable power loss (0.5/3dB as per guidelines)

4.4.22. The depth of the shadow region beyond each of the Lackareagh Turbines will vary between 1598.21m and 1615.21m.

4.4.23. The EUROCONTROL Guidelines[1] also provide equations for calculating the width and height of the shadow regions. For Woodcock Hill MSSR the shadow regions will vary between 43m and 44m wide and will vary in height between 957ft (291.69m) and 1607ft (489.81m) Above Mean Sea Level (AMSL).

4.4.24. The volumes of the Woodcock Hill MSSR shadow regions beyond the proposed turbines are considered sufficiently small to be operationally tolerable.

4.5. Conclusion

4.5.1. Analysis shows that RLoS does exist between the Lackareagh Wind Farm Turbines and the Woodcock Hill MSSR.

4.5.2. Calculations have shown that false targets due to bistatic reflections from the turbine towers will not occur from Woodcock Hill MSSR.

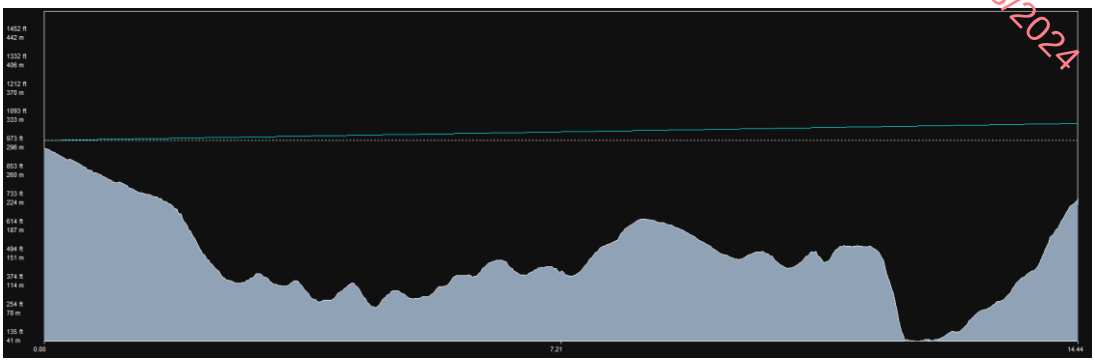
4.5.3. The volumes of shadow regions from the turbines are relatively small and considered operationally tolerable. No mitigation measures are considered necessary for the Woodcock Hill MSSR.

4.5.4. Carrownagowan and Fahybeg Windfarms are sited either side of the proposed Lackereagh Wind Farm, and have both been permitted. As Lackereagh Windfarm requires no mitigation measures it is highly likely that permission should be granted.

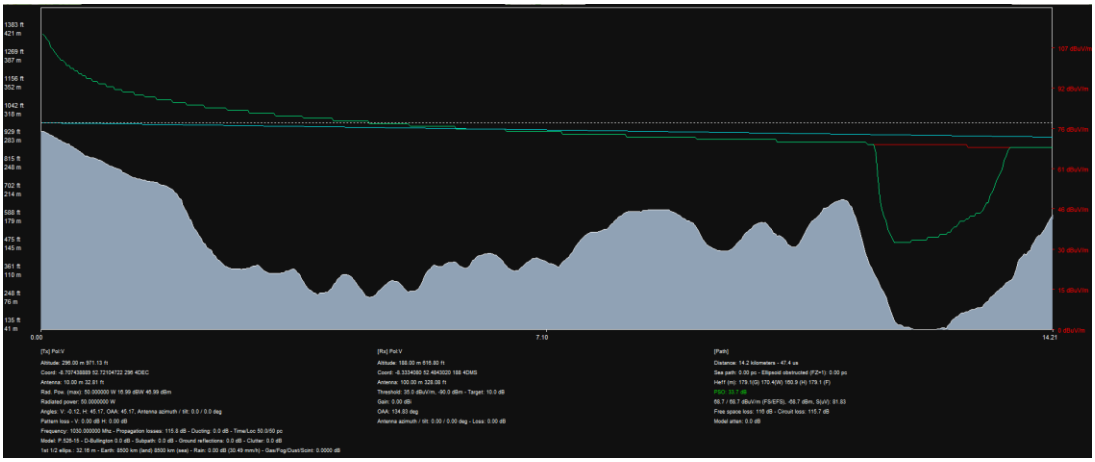
4.5.5. Due to the distance of Lackereagh Wind Farm from the Woodcock Hill radar, it is not foreseen that any operational problems will be caused through cumulative effects.

A. Annex A – Elevation Profiles

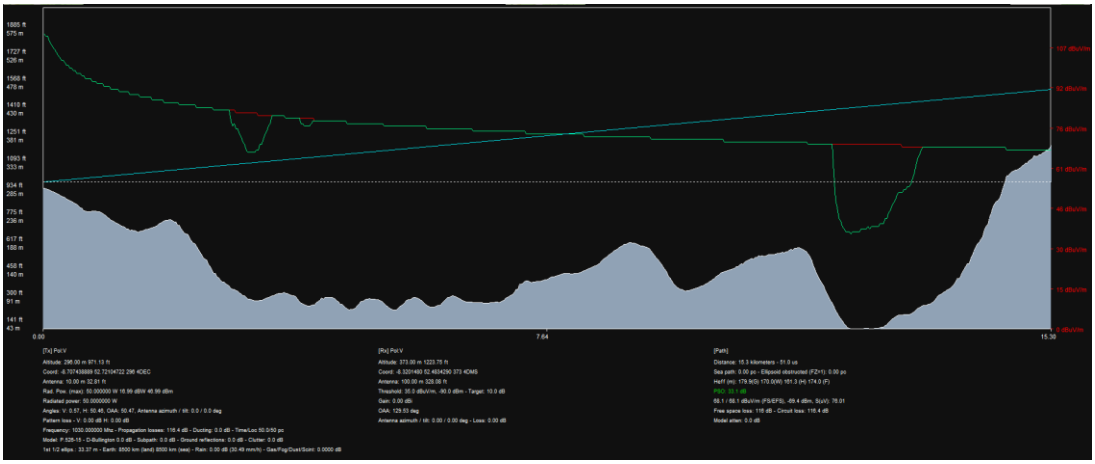
A.1. Turbine 01



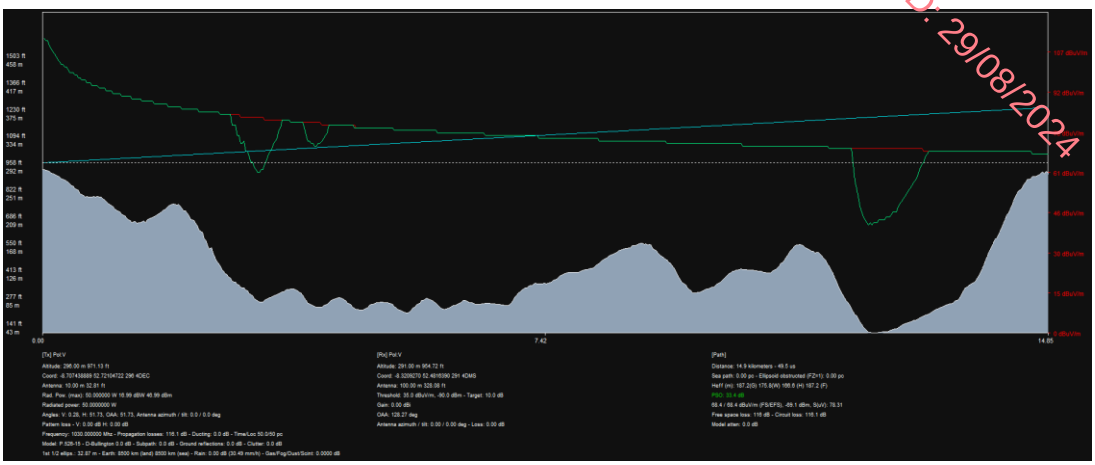
A.2. Turbine 02



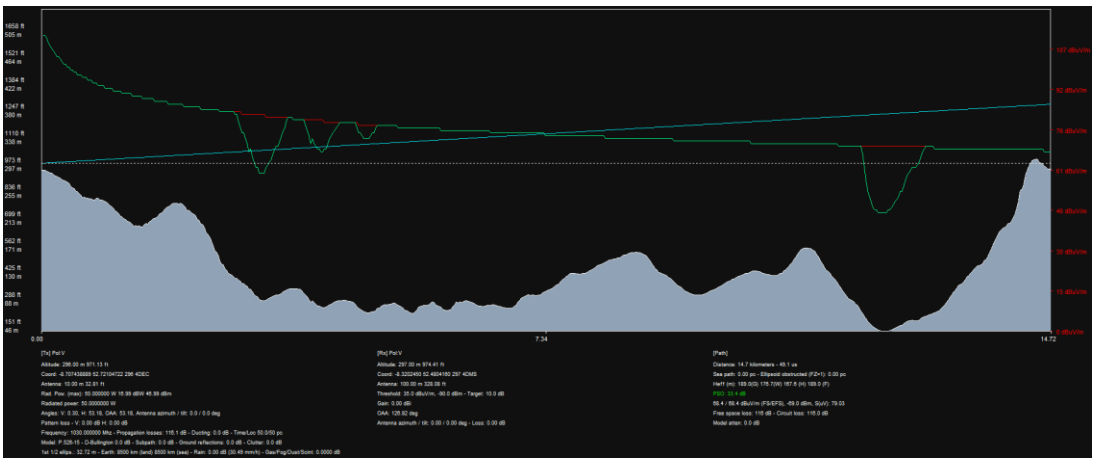
A.3. Turbine 03



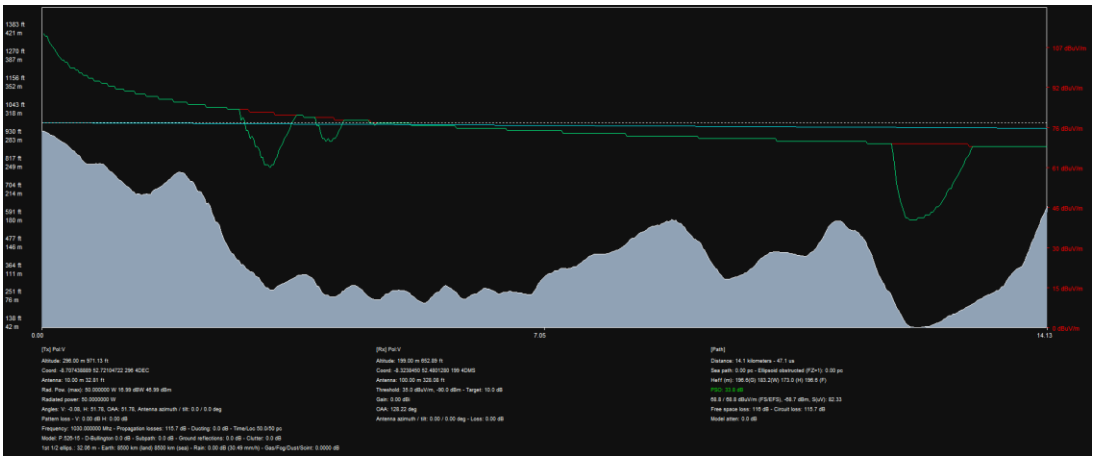
A.4. Turbine 04



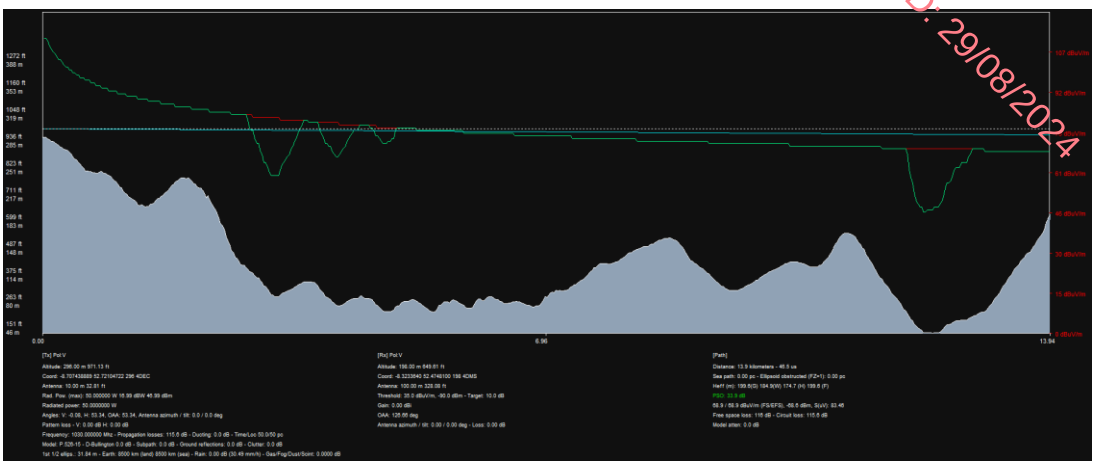
A.5. Turbine 05



A.6. Turbine 06



A.7. Turbine 07



This Page Is Intentionally Blank