


# **Appendix 10A**

## **AI BRIDGES AVIATION REPORT**

 <small>Total Communications Solutions</small>	Procedure: 001	Rev: 1.0
Brittas Wind Farm – Aviation Review Statement	Approved: KH	Date: 21/03/2023

# Report

## *Brittas Wind Farm Aviation Review Statement*

**Document Number:** 001/BS/0323


**Author:** PT\DMG

**Approved for Release:** Rev 1.0      KH      **Date:** 21/03/2023

**Document Filename:** *Brittas 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 Brittas. 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 Radar Surveillance Systems Safeguarding
- Flight Inspection and Calibration
- Aeronautical Obstacle Warning Light Scheme
- Irish Air Corps / Department of Defence (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 Airport, Waterford Airport and Moyne Airfield 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 Airport, Waterford Airport or Moyne Airfield.

### 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 an 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 wind farm be permitted, the turbines would be outside 45km of Shannon and Waterford Airport ARPs but would be greater than 100m in height. Therefore the turbines would be required to be included in the IAA Electronic Air Navigation Obstacle Dataset.

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### **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 sector of 25 nautical miles (46km) from the VOR/DME at Shannon Airport and the NDB at Waterford Airport. As the proposed wind farm is located outside the MSA Sectors for Shannon and Waterford Airports, there should be no impact on the published MSA altitudes.

### **Instrument Flight Procedures**

There are 13 published Instrument Flight Procedures for flights to/from Shannon and Waterford Airports. Due to the distance of the proposed wind farm from the airports, and as there are existing obstacles nearer to the airports than the proposed development, there should be no impacts to these flight procedures.

### **Communications, Navigation and Surveillance System Safeguarding**


As the proposed wind farm is more than 70km from the Localizer and transmitting antenna at Shannon and Waterford Airports, it is very unlikely that the proposed wind farm will have any impact on these ATS communications and radio navigational aids.

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 minimum distance of 60 km from the radar stations at Shannon Airport and Woodcock Hill 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 Shannon and Waterford Airports for calibration of instrument landing systems.

Flight Inspection Procedures will not 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).

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### **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.

### **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.


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# 1. Introduction

This section provides a brief summary of the proposed wind farm development at Brittas and of the nearest significant aviation installations at Shannon Airport, Waterford Airport and Moyne Aerodrome\*.

## 1.1 Wind Farm Site Information

The proposed wind farm development is located in County Tipperary approximately 4 km north of Thurles. Figure 1 shows the proposed wind farm site with respect to Shannon Airport, Waterford Airport, Moyne Aerodrome and the IAA radar stations at Woodcock Hill and Shannon.

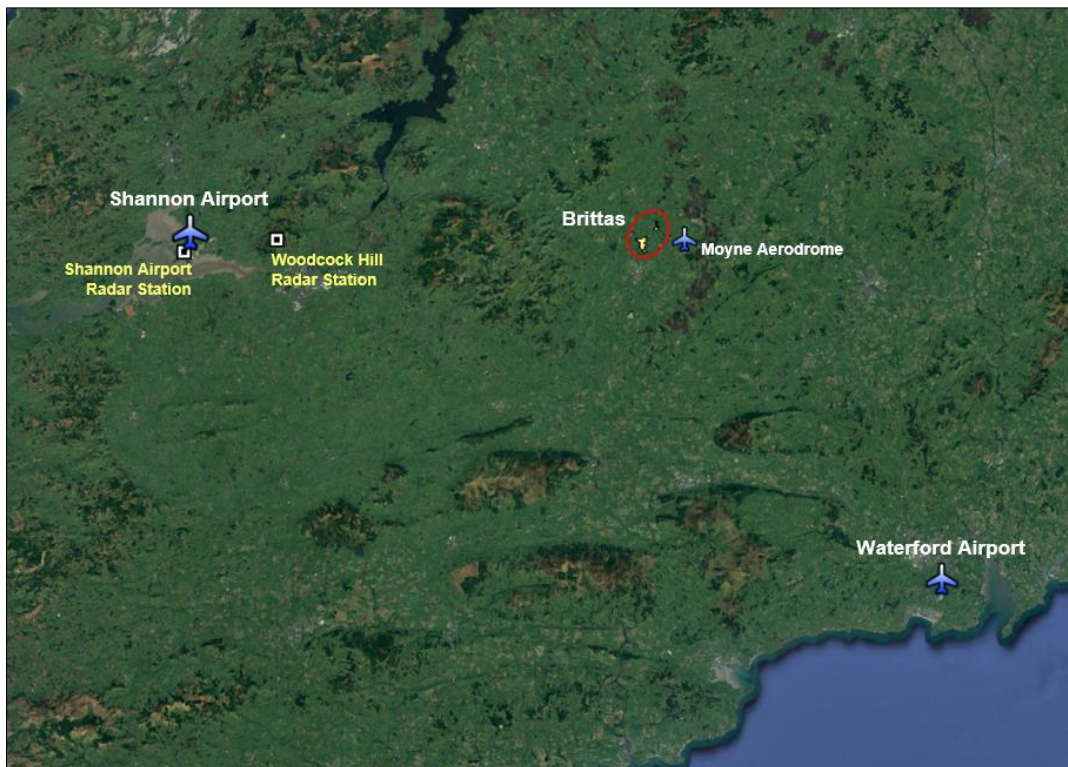


Figure 1. Location of proposed wind farm at Brittas

\* Field And Desktop Survey findings indicate that Moyne Aerodrome is no longer an operational Aerodrome. Although the aerodrome is unlikely to be still operational, it has been considered in this study for completeness.

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## 1.2 Shannon Airport

Table 2 below shows the co-ordinates of Shannon Airport and the distance from the Airport reference Point (ARP) to the proposed wind farm site. 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).	74 km

**Table 1. Shannon Airport Details**

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



**Figure 2. Shannon International Airport**



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### 1.3 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 06/24).	75 km

**Table 2. Waterford Airport Details**

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



**Figure 3. Waterford International Airport**

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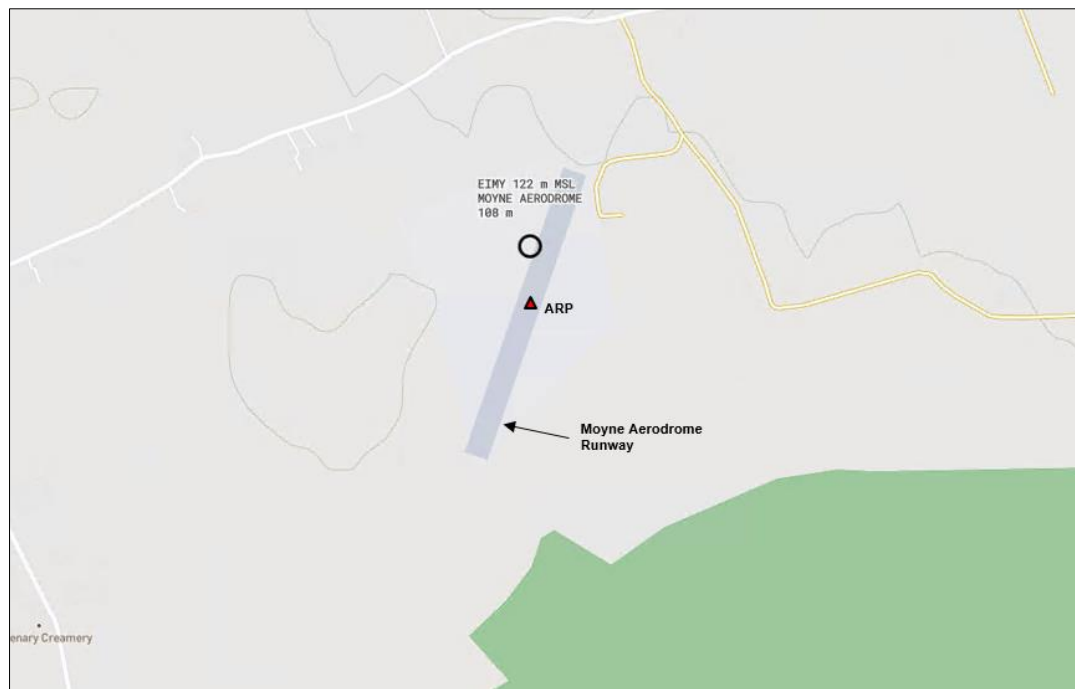
## 1.4 Moyne Aerodrome

Table 3 below shows the co-ordinates of Moyne Aerodrome and the distance from the Airport reference Point (ARP) to the proposed wind farm site. The aerodrome operates in Class G uncontrolled airspace.

This airstrip is not licensed by the IAA and contact details for the Airstrip operator are not publicly available. It should also be noted that the aerodrome at Moyne is probably no longer in use. Although the aerodrome is listed in some aeronautical material, satellite imagery shows no evidence of an existing runway (Figure 5). In addition, on the day of Field Survey, the aerodrome site was covered by a crop of grain (Figure 6).

Location	Installation	Description	Airport Ref. Point ARP	ARP Distance to Proposed Wind Farm
Moyne, Co Tipperary	Private Unlicensed Airstrip	Single Grass-strip Runway (Code 1) Airspace: Class G	52 42 10 N 07 42 19 W (Mid-point of Runway).	5.8 km

**Table 3. Moyne Aerodrome Details**



**Figure 4. Moyne Aerodrome**


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**Figure 5. Moyne Aerodrome – Satellite View (showing no evidence of existing runway)**




**Figure 6. Moyne Aerodrome – Roadside View (showing no evidence of existing runway)**

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## 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
- Minimum Sector Altitudes (MSA)
- Instrument Flight Procedures
- Permitted Wind Farms in vicinity of proposed Wind Farm
- Communications, Navigation and Radar Surveillance Systems Safeguarding
- Flight Inspection and Calibration
- Aeronautical Obstacle Warning Light Scheme
- Irish Air Corps / Department of Defence (DoD) Safeguarding

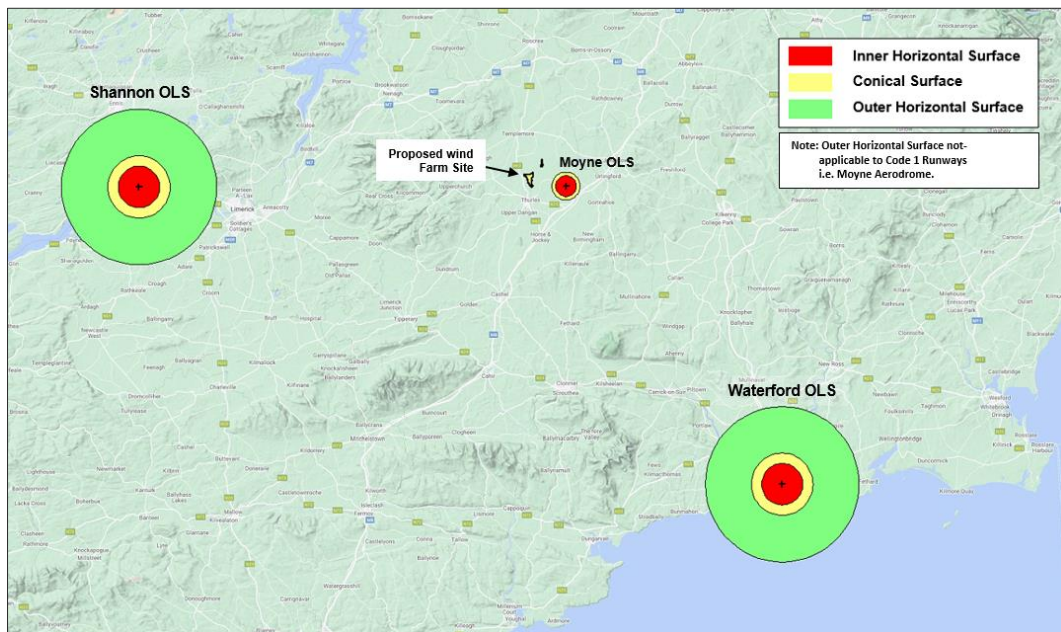
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## 2.1 Annex 14 Obstacle Limitation Surfaces (OLS)

A review of the Annex 14 Obstacles Limitation Surfaces (OLS) was first carried out by first plotting the proposed wind farm location and the airport obstacle surfaces. The obstacle limitation surfaces for aerodromes 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 7 below shows the Shannon, Waterford and Moyne OLS surfaces in relation to the proposed wind farm.




**Figure 7. Brittas Wind Farm in relation to Aerodrome OLS Surfaces.**

Aerodrome	Runway Code	Outer Horizontal Surface Applicable	Clearance Distance to Aerodrome OLS Surface
Shannon Airport	Runway Code 4	Y	59 km
Waterford Airport	Runway Code 4	Y	60 km
Moyne Airfield	Runway Code 1	N	3.1 km

**Table 4. Clearance Distances to Aerodrome OLS Surfaces**

For large aerodromes with Code 4 runways, the OLS consists of an Inner Horizontal Surface, a Conical Surface and an Outer Horizontal Surface which extend to 15km from the ARP.


For small aerodromes with Code 1 non-instrument runways, an Outer Horizontal Surface is not applicable. The Obstacle Free Zone for a Code 1 non-instrument runway extends 2.7km from the aerodrome’s ARP (Inner Horizontal Surface (2km) + Conical Surface (0.7km)). It should

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also be noted that the OLS constraints outlined above are IAA safeguarding limits to ensure safe aviation activities; however, from consultations with pilots who fly to/from small aerodromes, pilots use an area of approximately 1 mile (1.6km) around the runway to ascend and descend.

This 1 mile area is not limited to the take-off and approach surfaces, as pilots sometimes conduct a low-level flyover across the aerodrome to carry out a visual inspection of the wind-sock to assess wind conditions prior to landing. This flyover can occur from any direction relative to the runway (i.e. not just on the take-off and ascend surfaces). The proposed wind farm site is more than 1 mile from the airfield at Moyne.

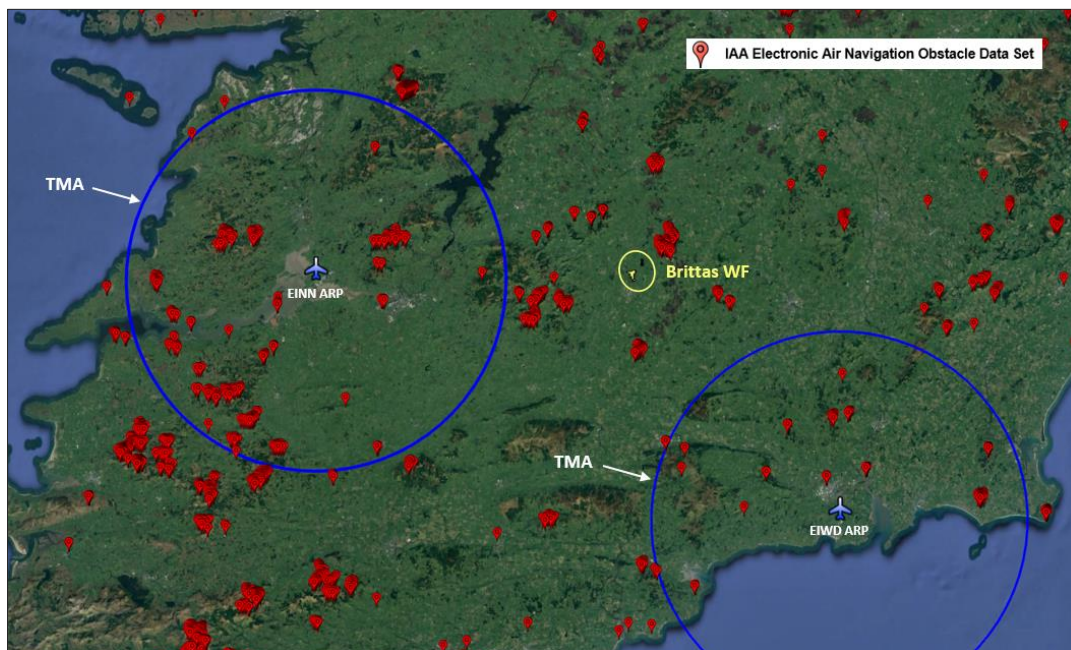
The analysis of the OLS plots indicate that turbines at the proposed wind farm would not penetrate the OLS surfaces of Shannon Airport, Waterford Airport or Moyne Airfield.

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## 2.2 Annex 15 Aerodrome Surfaces

Turbines at the proposed wind farm would not penetrate the ICAO Annex 15 Aerodrome Surface as shown in Figure 4. The “Terrain and Obstacle Requirements Area” is defined in ICAO Annex 15 as an area of up to 45km from the Aerodrome ARP. (An illustration of ICAO Annex 15 Area 1 and Area 2 Surface is provided in Appendix A).


As the nearest turbine at the proposed wind farm would be more than 45km from the ARP at Shannon and Waterford Airports, there will be no penetration of the Annex 15 surface for the Aerodromes. All obstacles, if they are more than 100 meters above terrain for a distance of up to 45km from the ARP, need to be registered in the IAA Air Navigation Obstacle Data Set. This area is known as the TMA area i.e. Terminal Maneuvering Area and is used for en-route circling and maneuvering and is shown in Figure 8.

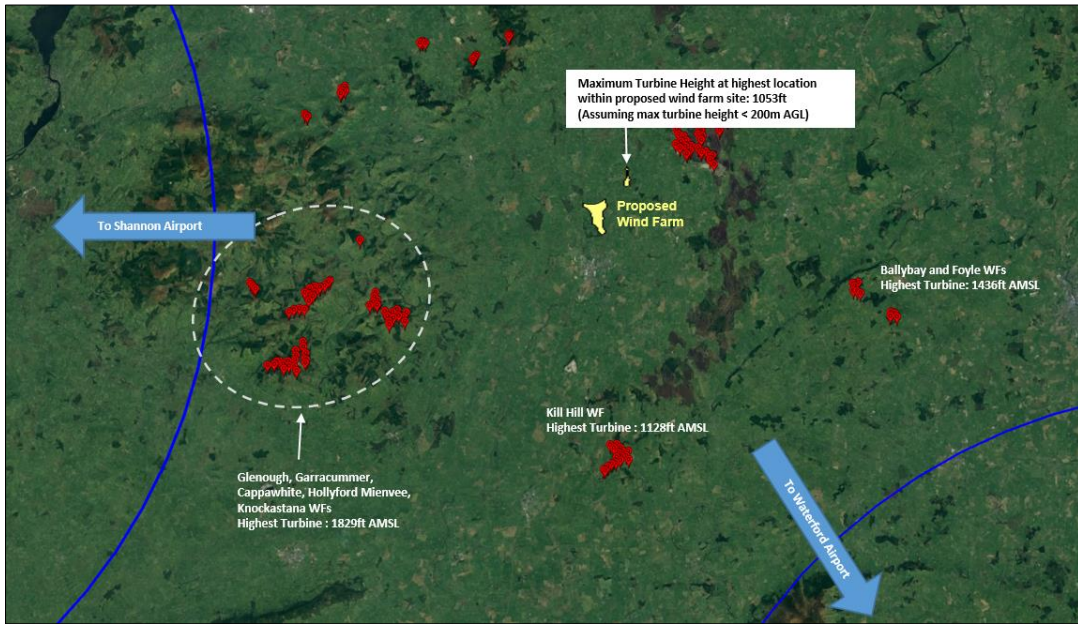


**Figure 8. Annex 15 Aerodrome Surface and IAA Electronic Air Navigation Obstacle Data Set**

It should also be noted that there are other existing tall structures (obstacles) nearer to the airports, e.g. the existing wind farms at Ballybay, Foyle, Kill Hill, Glenough, Garracummer, Cappawhite, Hollyford, Mienvee and Knockastanna.

These existing obstacles would shield any potential impacts from the proposed wind farm at Brittas. The IAA Electronic Air Navigation Obstacle Data Set permitted obstacles are shown relative to the proposed wind farm in Figure 9.


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**Figure 9. Permitted Obstacles in vicinity of Brittas Wind Farm**

Although there are other obstacles closer to the airport than 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.



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### 2.3 Minimum Sector Altitudes

A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is not within 25 nautical miles from the VOR/DME at Shannon, or 25 nautical miles from the NDB at Waterford. The MSA provides a minimum obstacle clearance of 1000 ft above the highest obstacle within specified quadrants

The proposed wind farm site is located more than 25NM from the VOR/DME/NDBs as shown in Figure 10. Therefore, the MSAs will not be affected and there will be no impact on the published MSA altitude figures.

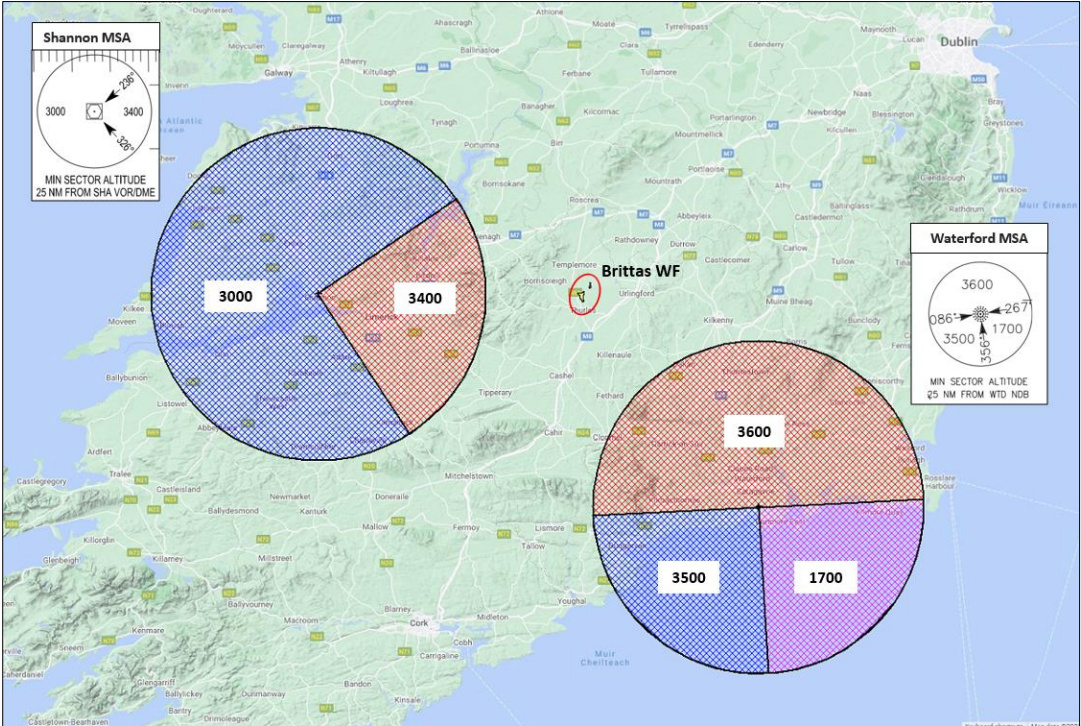



Figure 10. Minimum Sector Altitudes – Shannon, and Waterford Airports

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## 2.4 Instrument Flight Procedures

There are 13 published Instrument and Visual Flight Procedures for arrivals to and departures from Shannon and Waterford Airports.

Due to the distance of the proposed wind farm from Shannon and Waterford Airports (and as there are existing obstacles adjacent to the proposed wind farm, it is unlikely that there will be any impacts on the Instrument Flight Procedures for flights to/from Shannon and Waterford Airports. Table 5 below lists the Instrument Flight Procedures for Shannon and Waterford Airports.

Aerodrome	Aerodrome Procedure	Chart ID	Wind Farm Impacts
Shannon	RNAV Standard Instrument Departure Chart RWY 06	EINN AD 2.24-5	No Impacts.
Shannon	RNAV Standard Instrument Departure Chart RWY 24	EINN AD 2.24-6	No Impacts.
Shannon	RNAV Standard Arrival Chart RWY 06	EINN AD 2.24-7	No Impacts.
Shannon	RNAV Standard Arrival Chart RWY 24	EINN AD 2.24-8	No Impacts.
Shannon	Instrument Approach Chart ILS or LOC RWY 06	EINN AD 2.24-10	No Impacts.
Shannon	Instrument Approach Chart VOR RWY 06	EINN AD 2.24-11	No Impacts.
Shannon	Instrument Approach Chart ILS CAT I & II or LOC 24	EINN AD 2.24-13	No Impacts.
Shannon	Instrument Approach Chart VOR RWY 24	EINN AD 2.24-14	No Impacts.
Shannon	Visual Approach Chart – ICAO	EINN AD 2.24-15	No Impacts.
Waterford	Instrument Approach Chart ILS/NDB/DME RWY 21 – ICAO	EIWF AD 2.24-3.1	No Impacts.
Waterford	Instrument Approach Chart NDB/DME RWY 21 – ICAO	EIWF AD 2.24-5	No Impacts.
Waterford	Instrument Approach Chart NDB/DME RWY 03 – ICAO	EIWF AD 2.24-6.1	No Impacts.
Waterford	Visual Approach Chart – ICAO	EIWF AD 2.24-6.7	No Impacts.

**Table 5. Instrument and Visual Flight Procedures – Shannon and Waterford Airports**


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## 2.5 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 5. None of these wind farms required a Full Assessment of Instrument Flight Procedures.

Wind Farm	Planning Reference	Description
Ballybay	TBC	Operational Wind Farm
Foyle	TBC	Operational Wind Farm
Kill Hill	TBC	Operational Wind Farm
Glenough	TBC	Operational Wind Farm
Garracummer	TBC	Operational Wind Farm
Cappawhite	TBC	Operational Wind Farm
Hollyford	TBC	Operational Wind Farm
Mienvee	TBC	Operational Wind Farm
Knockastanna	TBC	Operational Wind Farm

**Table 6. Permitted Wind Farms in vicinity of Proposed Wind Farm**

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## 2.6 Communication Navigation and Surveillance Systems

In this section the possible impact of the proposed wind farm on the Communication, Navigation and Radar Surveillance Systems for the aerodrome at Shannon Airport is assessed.

### 2.6.1 Communications and Navigation Systems

The AIP documents EINN AD 2-18/19 and EIWF AD 2-18/19 provides the information for communication and navigation facilities for Shannon and Waterford Airports respectively. The table below shows the channel frequencies for the ATS communications Facilities and the Radio Navigation and Landing Aids for each 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
Shannon	118MHz –130MHz	339KHz – 330MHz	74 km	No impacts
Waterford	121MHz -130MHz	110KHz – 331MHz	75 km	No impacts

**Table 7. Impacts on Communications and Navigation Systems**

As the proposed wind farm is over 70km 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.

### 2.6.2 Radar Surveillance 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 8. 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 9. SSR Zone Arrangements**

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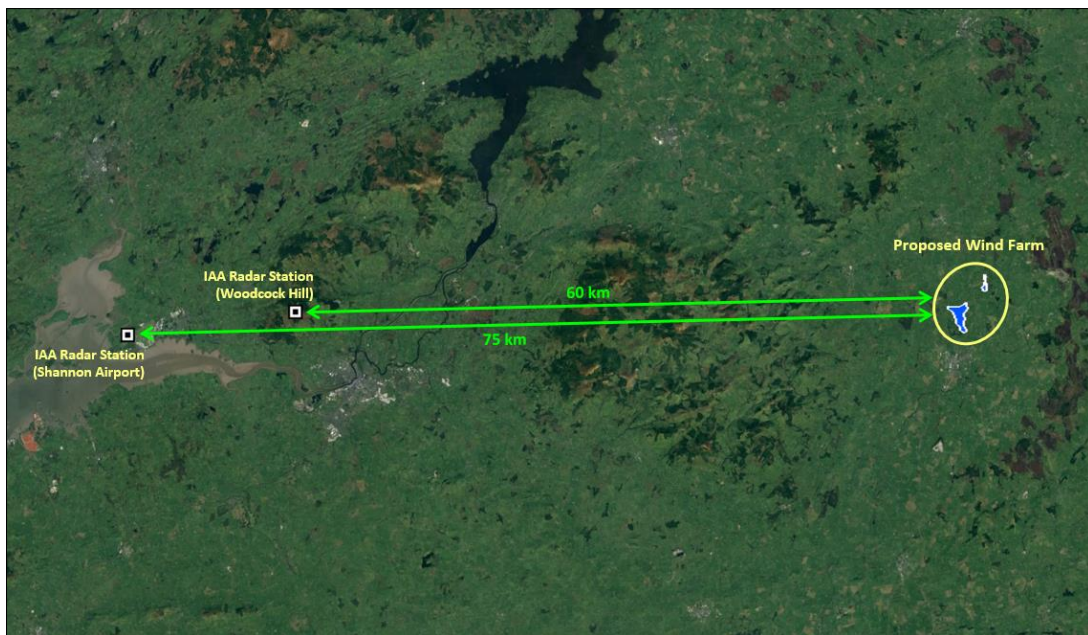
The EUROCONTROL Guidelines require a 16km safe distance for a “Zone 4 - No Assessment” condition and detailed assessments are required for any proposed wind within 16km of a secondary surveillance radar.

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.”*

### 2.6.2.1 Irish Aviation Authority (IAA) 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 at Shannon Airport and Woodcock Hill.



**Figure 11. Radar Surveillance Sites relative to Brittas Wind Farm.**

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### 2.6.2.1.1 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 12).



**Figure 12. Shannon Airport Radar Station**

Table 10 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)
Brittas	75 km	Detailed Assessment Not Required	Detailed Assessment Not Required

**Table 10. 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.

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### 2.6.2.1.2 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 13.




**Figure 13. Woodcock Hill Radar Station**

Table 11 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)
Brittas	60 km	Detailed Assessment Not Required	Detailed Assessment Not Required

**Table 11. EuroControl / UK Safeguarding Guidelines – Woodcock Hill Radar Station**

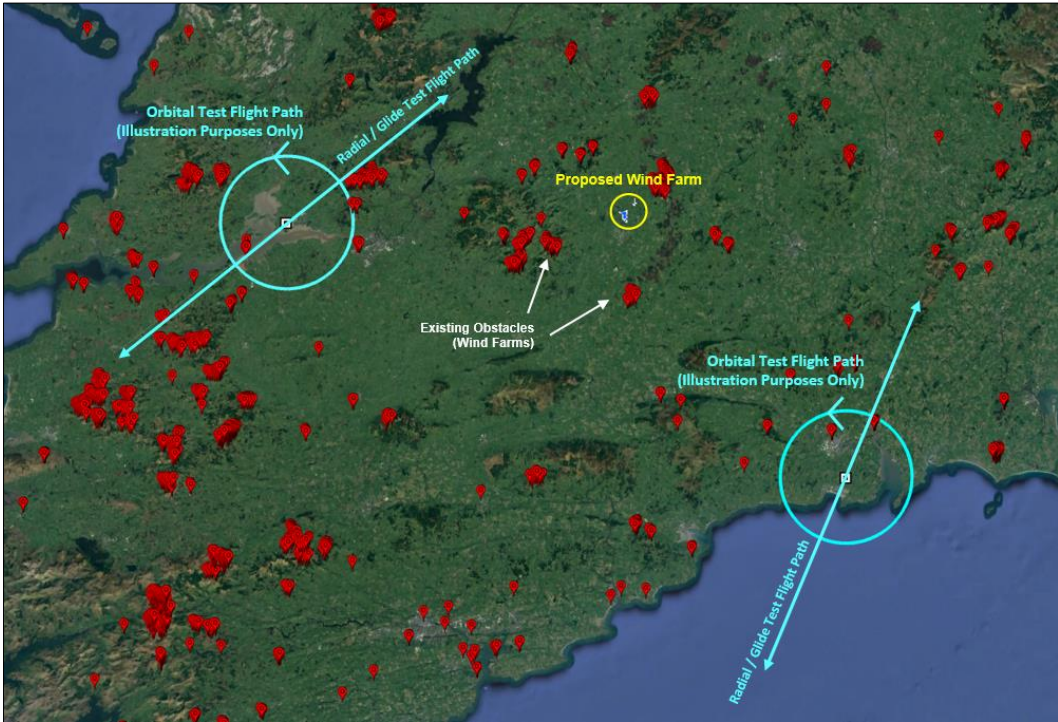
As the table above show, the proposed wind farm is within Assessment Zone 4 as specified by the EUROCONTROL guidelines, which would indicate that a detailed technical assessment would not be required for the impact on the SSR radar station at Woodcock Hill.

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## 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.

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



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## 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.”*

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## 2.9 Irish Air Corps / DoD Safeguarding

The Irish Air Corps Position Paper “*Air Corps Wind Farm/ Tall Structures Position Paper*” published on 08<sup>th</sup> 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 M8 motorway. The proposed wind farm site is 3.6 NM (6.6 km) from the M8 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.

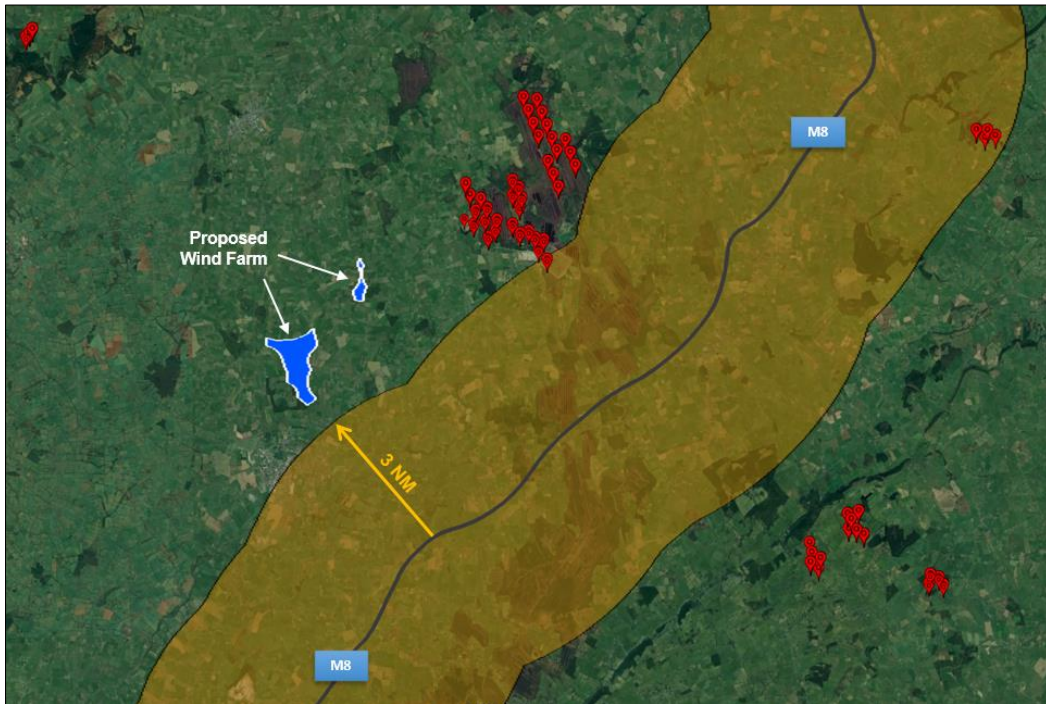
c. The following routes are identified as critical low level routes in support of Air Corps operational requirements and the Air Corps is opposed to the erection of wind farms or tall structures within 3NM of the route centerline which could affect Air Corps’ ability to access regional areas.

- (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 15. Irish Air Corps – Critical Low Level Routes**

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**Figure 16. Proposed Wind Farm relative to Critical Low Level Flight Route (M8)**


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### 3. Summary

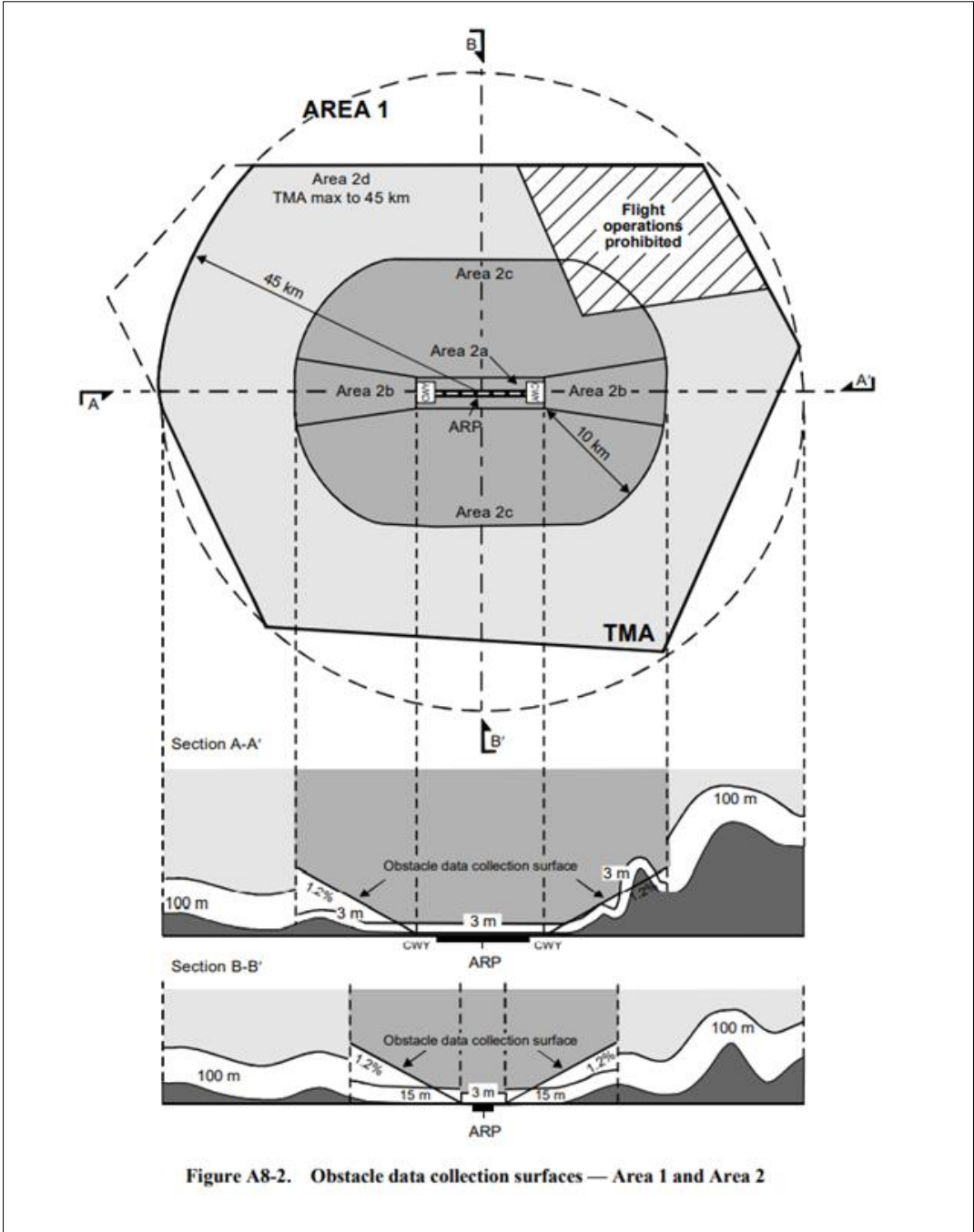
A summary of the aviation review for the proposed wind farm at Brittas is provided in Table 12 below.

Item	Impact	Summary
Annex 14 - Obstacle Limitation Surfaces (OLS)	None	Turbines at the proposed wind farm would be outside the Obstacle Limitation Surfaces for Shannon Airport, Waterford Airport and Moyne Airfield.
Annex 15 - Aerodrome Surfaces	None	<p>Turbines at the proposed wind farm would not penetrate the ICAO Annex 15 Aerodrome Surface for Shannon or Waterford Airports.</p> <p>All obstacles, if more than 100 meters above terrain for a distance of 45km from center point of Shannon Airport, need to be registered in the IAA Air Navigation Obstacle Data Set. The IAA may request that the turbines be included in the IAA Aeronautical Electronic Obstacle Data Sets.</p> <p>It should be noted that other existing tall structures nearer to Shannon and Waterford Airports (e.g. Ballybay, Foyle, Kill Hill, Glenough, Garracummer, Cappawhite, Hollyford etc.) are also located within the ICAO Annex 15 Aerodrome Surface and are already listed in the IAA Aeronautical Electronic Obstacle Data Sets.</p>
Minimum Sector Altitudes (MSA)	None	A review of the Minimum Sector Altitudes (MSA) shows that the proposed wind farm is outside 25 nautical miles from the VOR/DME at Shannon and Waterford Airports. Therefore the MSA of the relevant sectors 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 and Waterford Airports that the instrument flight procedures for approach and departure flights to/from the airports are unlikely to be impacted for precision aircraft
Communication and Navigation Systems	None	As the proposed wind farm is over 70 km from the Localizers and transmitting antennas at Shannon and Waterford Airports, it is very unlikely that the proposed development will have any impact on these ATS communications and radio navigational aids.
Radar Surveillance Systems Safeguarding	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	The annual Flight Inspection Procedures will not be impacted by the proposed wind farm as the proposed site is sufficiently far from the ARPs at Shannon and Waterford Airports that there would be no impacts.
Aeronautical Obstacle Warning Light Scheme	TBC	It is possible that the IAA may request that the wind farm, if permitted, would be fitted with Aeronautical Obstacle Warning Lights in accordance to industry standards. Subject to further consultation with the IAA.
Irish Air Corps / DoD Safeguarding	None	The proposed wind farm is located outside the Irish Air Corps Restricted Areas.

**Table 12. Brittas Wind Farm – Aviation Review Summary**

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



ICAO Annex 15 Area 1 and Area 2 Surfaces.

**Appendix 10B**  
**AI BRIDGES TELECOMMUNICATIONS REPORT**

	Procedure: 001	Rev: 5.0
Title: Brittas Telecommunications Impact Assessment	Approved: KH	Date: 20/06/24

# Report

## *Brittas Wind Farm Telecommunications Impact Assessment Report*

**Document Number:**

**Author:** DMG/PT

**Approved for Release:** Rev 5.0                      KH                      **Date:** 20/06/24

**Document Filename:** *Brittas Wind Farm Telecommunications Impact Assessment.*

	Procedure: 001	Rev: 5.0
Title: Brittas Telecommunications Impact Assessment	Approved: KH	Date: 20/06/24

## Executive Summary

Ai Bridges was commissioned to evaluate the possible impacts that the proposed wind farm at Brittas, Co Tipperary could have on existing telecommunications operator networks. The scope of work included field and desktop surveys to determine telecommunications network infrastructure that could be impacted by the proposed development. Consultations with telecom operators were also undertaken to assist in identifying network infrastructure that could be impacted by the proposed wind farm.

Telecommunications mast-sites with network infrastructure that could potentially be impacted by the development were identified and a field survey of each of these sites was carried out. During the field surveys, radio antennas with bearings in the direction of the wind farm were recorded. The findings of the field surveys are provided in Appendix B of this report.

During the consultation process, nineteen telecom operators were contacted. At the time of writing this report, seventeen of these operators have responded to the consultation request. The responses received from each of the telecom operators can be found in Section 3 of this report.

Using the information obtained during the field survey assessments and consultation process a desktop impact analysis was carried out and all of the telecommunication operator networks were analysed using radio planning \ modelling software. Results from the impact analysis indicate that there are five radio links that cross over the proposed development. The radio links that cross over the wind farm site are listed below in Table 1.

Operator	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance Distance to Blade-tip of Turbine.	Impact of proposed Turbine Layout
Enet	PTP microwave radio link from Urlingford to St Joseph's College.	T08	-85.78 m (Infringement into Fresnel Zone)	Potentially Impacted. (Viable Mitigation Measures Available)
Enet	PTP microwave radio link from Kilduff to Scoil Ruain.	T07	42.17 m	No impacts.
ESB	PTP microwave radio link from Kilduff to Thurles 110kV Substation	T04	-88.70 m (Infringement into Fresnel Zone)	Potentially Impacted. (Viable Mitigation Measures Available)
Three Ireland	PTP microwave radio link from Templemore Garda College to Brittas.	T01	38.60 m	No impacts.
Vodafone	PTP microwave radio link from Brittas to Templemore Garda College.	T01	37.98 m	No impacts.

**Table 1. Microwave radio links potentially impacted by proposed wind farm.**

Of the five radio links that cross over the proposed wind farm site, only two are potentially impacted by the proposed turbine layout; the Enet link from Urlingford to St Joseph's College and the ESB link from Kilduff to Thurles 110kV Substation.



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The impact to the Enet radio link could be mitigated by routing the Enet service into St Joseph's College from an alternative feeder site. The impact to the ESB link could be mitigated by relocating the monopole at the 110kV Substation at Thurles. These mitigation measures are outlined in Section 6 of this report.


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## Section 1 - Wind Farm Site Information

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# 1. Introduction

In this section a brief summary of the wind farm site is provided. Details regarding the site’s geographic location and the proposed wind turbine dimensions are presented.

## 1.1 Wind Farm Site Information

The proposed wind farm development is located approximately 4 km north of Thurles in County Tipperary. The development is in the pre-planning stage and exact details regarding the quantity, location and turbine dimension have yet to be finalized.

For the purpose of this study, a 10-turbine layout has been considered. The coordinates of the turbines assessed in this report are provided in Appendix A. The dimensions of the turbines assessed in this report are provided in Table 2 below.

Wind Farm	Number of Turbines	Turbine Tip-Height	Turbine Rotor Diameter
Brittas	10	180 m	155 m

**Table 2. Wind Farm Turbine Details**


The location of the proposed wind farm development is shown below in Figure 1.



**Figure 1. Location of proposed wind farm.**

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## Section 2 - Methodology

	Procedure: 001	Rev: 5.0
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## 2. Introduction

In this section a brief summary of the Telecommunication Impact Study Methodology is provided.

### 2.1 Methodology

There are four primary stages in preparing and compiling a communication impact study:

- Telecom Operator Consultations
- Field Surveys
- Desktop Survey Network Modelling and Analysis
- Report Generation

A summary of each of these stages is provided below:

#### Telecom Operator Consultations

Consultations are commenced with telecom operators who are requested to raise any concerns they have regarding the impact of the proposed wind farm on their networks. The consultation process is used to assist in identifying telecoms infrastructure that could be impacted by the proposed wind farm development.

#### Field Surveys

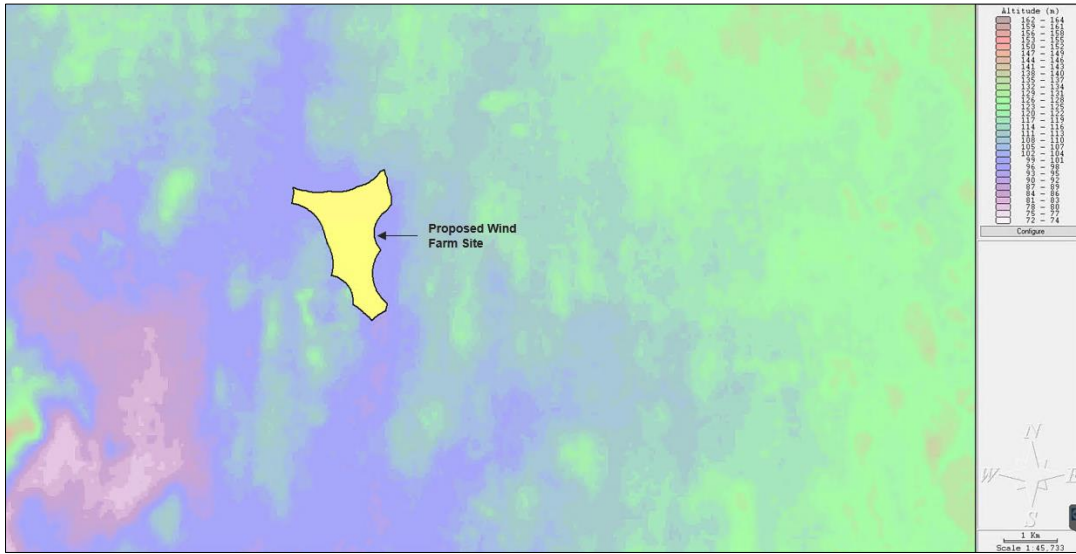
Field surveys are undertaken and the co-ordinates of communication masts are recorded. During the field surveys of the communication sites, approximations of antenna size, bearing and height are made for the antennas installed on each of the masts surveyed.

#### Desktop Survey and Analysis

A desktop survey is carried out to plot the wind turbines in a radio planning tool. The radio planning tool uses GIS and terrain mapping databases to enable accurate modelling. A selection of mast-site coordinates is then obtained and inputs from various operators \ service providers are converted from Irish National Grid (Easting and Northing in meters) to degrees minutes seconds format and then imported into the radio planning tool.

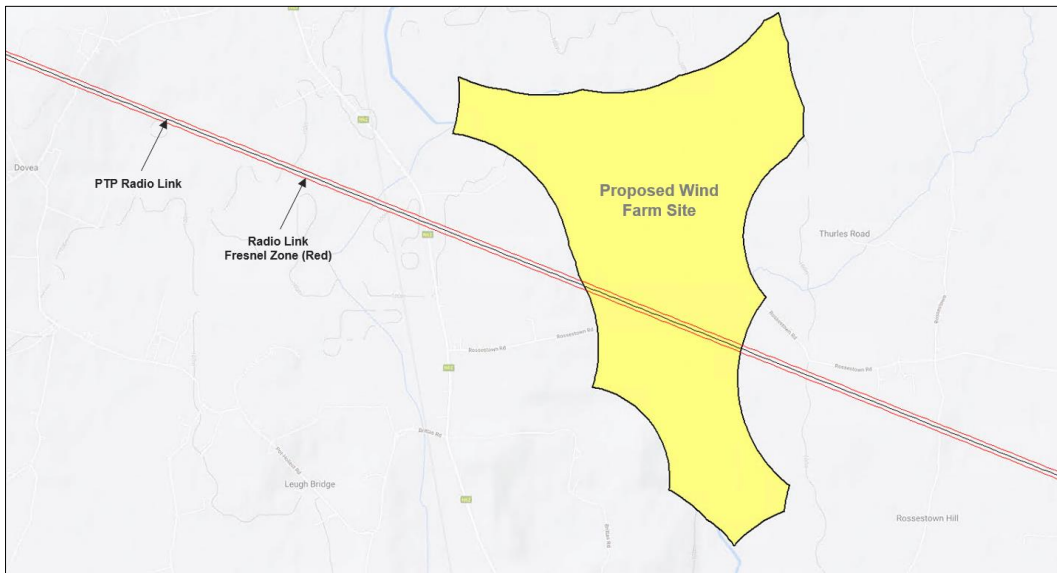
This provides a means of graphically showing telecommunications sites in the vicinity relative to the proposed wind farm at Brittas. Figure 2 below shows the proposed wind farm site boundary plotted in the radio planning tool.

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**Figure 2. Wind Farm Boundary plotted in Radio Planning Software**

The findings from the consultations and field surveys are collated and the communications networks requiring further analysis are identified. Network modeling is used to assess the impact of the turbines on the communications networks. The results from the network modeling are used to determine if mitigation measures are required. Figure 3 below shows an example of a microwave radio link that crosses over/near the wind farm boundary modelled in radio planning software.



**Figure 3. Example of microwave radio link crossing over/near the proposed wind farm boundary modelled in radio planning software.**

## Report Generation

The final stage of the communications impact study process is to collate the data and present the findings & analysis into a report for submission.

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## Section 3 - Telecom Operator Consultations



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### 3. Introduction

In this section the consultation process undertaken with telecom operators is described. The response received from each operator is also provided.

#### 3.1 Telecom Operator Consultations

Consultations beginning in February 2023 were undertaken with telecom network operators to assist in identifying telecommunication infrastructure that could be impacted by proposed wind farm. The operators were requested to raise any concerns they may have regarding impacts to their networks due to the proposed wind farm development. Table 3 lists the telecom operators contacted and the issues raised by the operators. The responses received from each of the Telecom Operators are provided in Sections 3.1.1 to 3.1.19.

ID	Operator	Response Received (Yes/No)	Issues raised by Operator \ Observations.
1	2RN	Yes	No issues regarding transmission links; however, 2RN have requested that a protocol document be signed should the wind farm go ahead (regarding the TV broadcast service in the area).
2	Airwave	Yes	No issues.
3	An Garda Síochána	No	No response. (No response expected.)
4	Broadcast Authority of Ireland (BAI)	Yes	No issues.
5	BT Ireland	Yes	No issues.
6	CIE/Irish Rail	Yes	No issues.
7	Dept. of Defence	Yes	The DoD have acknowledged receipt of the consultation request and have stated that would revert in due course.
8	Eir	Yes	No issues.
9	Enet	Yes	Enet have raised a concern regarding two Licensed PTP microwave radio links.
10	ESB Networks	Yes	ESB have raised a concern regarding one Licensed PTP microwave radio link.
11	Imagine Broadband	Yes	No issues.
12	Irish Aviation Authority (IAA)	Yes	No issues.
13	Irish Water	Yes	No issues.
14	Tipperary County Council	No	No response. (No response expected.)
15	Tetra Ireland (TI)	Yes	No issues.
16	Three Ireland	Yes	Three Ireland have raised a concern regarding one Licensed PTP microwave radio link.
17	Viatel	Yes	No issues.
18	Virgin Media	Yes	No issues.
19	Vodafone Ireland	Yes	Vodafone have raised a concern regarding one Licensed PTP microwave radio link.

**Table 3. Telecom Operators Consulted**

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### 3.1.1 2RN Response to Consultations

2RN provided the following email response to consultations:

*“The proposed windfarm will not affect 2rn’s fixed linking.  
There is a risk of interference to broadcast services in the area, we would request that a protocol be signed between the developer and 2rn should the site go ahead.”*

### 3.1.2 Airwave Response to Consultations

Airwave provided the following email response to consultations:

*“No infrastructure in this area.”*

### 3.1.3 An Garda Síochána Response to Consultations

To date no response has been received.

### 3.1.4 Broadcast Authority of Ireland (BAI) Response to Consultations

The BAI provided the following email response to consultations:

*“The BAI does not perform an in-depth analysis of the effect of wind turbines on FM networks. However, we are not aware of any issues from existing windfarms into existing FM networks. Also, the proposed windfarms are not located close to any existing or planned FM transmission sites.”*

### 3.1.5 BT Ireland Response to Consultations

BT provided the following email response to consultations:

*“I can confirm the planned development will have no impact on the BT Ireland microwave network.”*

### 3.1.6 CIE/Irish Rail Response to Consultations

CIE provided the following email response to consultations:

*“Please note that Iarnród Éireann have no wireless links transiting this area.”*

### 3.1.7 Department of Defence Response to Consultations


The Department of Defence provided the following email response to consultations:

*“The Department of Defence wishes to acknowledge receipt of your e-mail below.  
We will consider your request and revert in due course.”*

### 3.1.8 Eir Response to Consultations

Eir provided the following email response to consultations:

*“We have no transmission links within the proposed area and it has no risk to the network.”*

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### 3.1.9 Enet Response to Consultations

Enet provided the following email response to consultations:

*"We have the following links passing through this area:"*

Link Name / ID	Band MHz/GHz	Link Length	Site A					Site B				
			Lat	Long	Easting	Northing	Ant Height	Lat	Long	Easting	Northing	Ant Height
Cellnex Urlingford – St Josephs College	11GHz	31.3km	52.644696°	-7.529853°			15m	52.748875°	-7.960069°			7m
RTE Kilduff – Scoil Ruain	11GHz	33.3km	52.835214°	-7.909994°			15m	52.571472°	-7.677056°			7m

### 3.1.10 ESB Networks Response to Consultations

ESB provided the following email response to consultations:

*"Please see below details of links affected.*

*As per the Calculation of the Clearance Zone 3.1.doc by JRC, the buffer clearance zone is the 2nd Fresnel zone clearance plus 150m, a buffer zone to allow for location accuracy of the link ends, turbine construction and ellipsoid conversion anomalies, plus 100m for Turbine micrositing. Please provided accurate turbine details including coordinates of turbine, hub height, max blade length, and also the maximum micrositing distance allowed. This will allow us to carry out further detailed analysis once we have accurate turbine information."*

Link Name / ID	Band MHz/GHz	Link Length	Site A					Site B				
			Lat	Long	Easting	Northing	Ant Height	Lat	Long	Easting	Northing	Ant Height
Kilduff- Thurles	1.3/1.5	18.8	52.835145	-7.910544			15	52.691741	-7.765247			18

### 3.1.11 Imagine Broadband Response to Consultations

Imagine Broadband provided the following email response to consultations:

*"Imagine are not affected by this development."*

### 3.1.12 IAA Response to Consultations

The IAA provided the following email response to consultations:

*"No issue for Nav aids."*

### 3.1.13 Irish Water Response to Consultations

Irish Water provided the following email response to consultations:

*"I can confirm that Irish Water have no Telemetry links traversing the proposed wind farm site."*

### 3.1.14 Tipperary County Council Response to Consultations

To date no response has been received.

### 3.1.15 Tetra Ireland (TI) Response to Consultations

Tetra Ireland provided the following email response to consultations:

*"We anticipate no impact from the development as proposed. Can you ensure that the development is also reviewed by eir."*

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### 3.1.16 Three Ireland Response to Consultations

Three Ireland provided the following email response to consultations:

*"I've reviewed the proposed wind farm development at Brittas, Co Tipperary and it will have affect 1 link on the Three Ireland Microwave Transmission network."*

Link Name / ID	Band MHz\GHz	Link Length	Site A					Site B				
			Lat	Long	Easting	Northing	Ant Height	Lat	Long	Easting	Northing	Ant Height
20300	26	8.2km	52.7903	-7.8403	210825	171004	28.5	52.7181	-7.82263	212037	162974	35

### 3.1.17 Viatel Response to Consultations

Viatel provided the following email response to consultations:

*"No impact on Viatel network."*

### 3.1.18 Virgin Media Response to Consultations

Virgin Media provided the following email response to consultations:

*"Virgin Media Ireland DO NOT have any radio links in this area"*

### 3.1.19 Vodafone Ireland Response to Consultations

Vodafone provided the following email response to consultations:


*"I can confirm that the proposed windfarm development in Brittas, Co. Tipperary will impact the following microwave link on the Vodafone network. As you can see in the screenshot below, our link is passing over the most north-western point of the proposed development boundary. If you need any additional details please don't hesitate to get in touch."*



Link Name / ID	Band MHz\GHz	Link Length	Site A (TY080, Brittas)					Site B (TY054, Templemore Garda College)				
			Lat	Long	Easting	Northing	Ant Height	Lat	Long	Easting	Northing	Ant Height
TY080-TY054-SO	26GHz/56MHz	8.13km	52.71811712	-7.822607018	212037	162974	30m	52.79035248	-7.840367197	210819	171010	25.1m

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## Section 4 - Field Surveys

	Procedure: 001	Rev: 5.0
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## 4. Introduction

To assess the accuracy of the network information (radio link co-ordinates, antenna heights etc.) provided by the telecom operators, field surveys of the telecom-mast sites in the vicinity of the proposed wind farm were carried out. During the field surveys, radio antennas with bearings in the direction of the wind farm were recorded. The telecom mast-sites surveyed for this study (labelled Mast-Site A to Mast-Site F) are shown relative to the proposed wind farm site in Figure 4 below. The findings from the field surveys of the mast-sites are presented in Appendix B of this report.

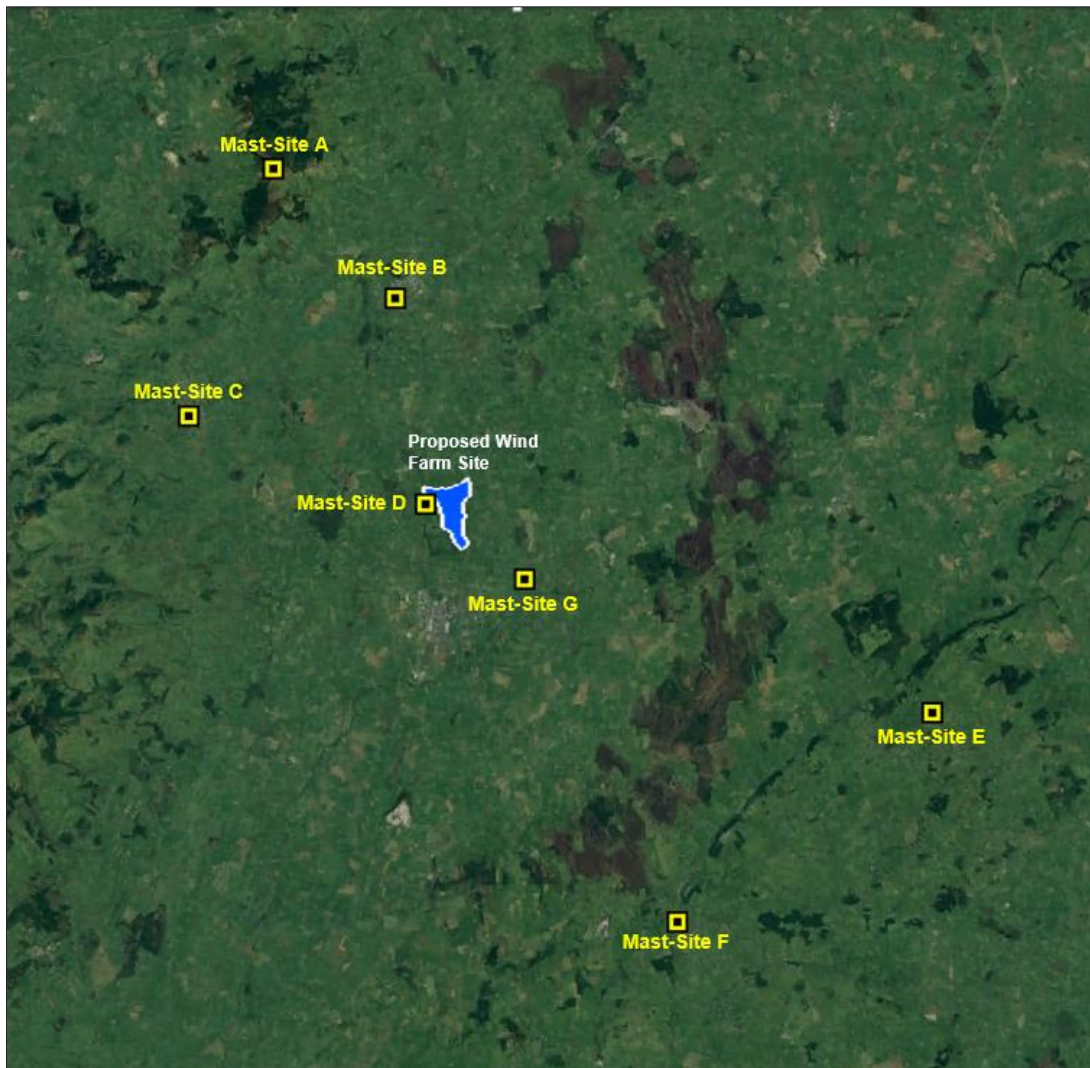


Figure 4. Telecom Mast-Sites Surveyed.

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## Section 5 - Desktop Survey Analysis

	Procedure: 001	Rev: 5.0
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## 5. Introduction

Based on the findings of the consultation process, there are three Telecom Operators with a network in the vicinity of the proposed development that requires a detailed technical analysis:

- Enet Network
- ESB Network
- Three Ireland Network
- Vodafone Network

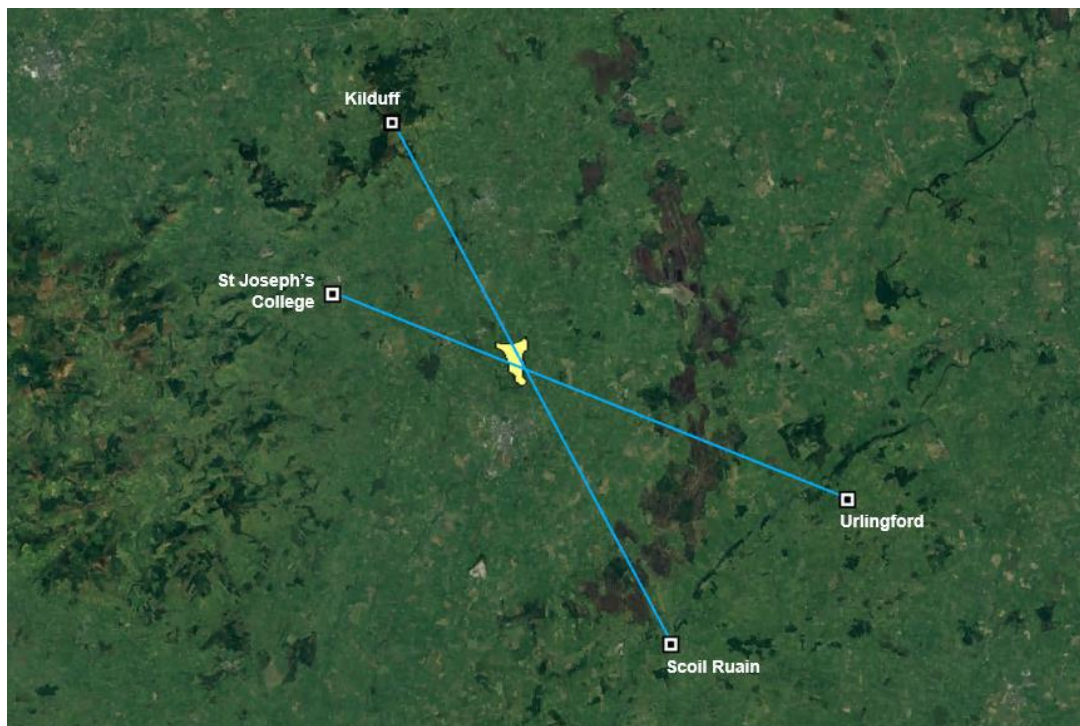
Sections 5.1 to 5.4 below outlines the desktop survey analysis findings\* for the Telecom Operator Networks listed above.

### 5.1 Enet Network Analysis

The Enet network in the vicinity of the proposed wind farm consists of two Point-to-Point (PTP) microwave radio links. The radio links are listed in Table 4 below and a Plan View of the Enet network is shown in Figure 5. The plan view indicates that both radio links are potentially impacted by the proposed wind farm development.

Link No.	Operator	Link Description
1	Enet	PTP microwave radio link from Urlingford to St Joseph's College.
2	Enet	PTP microwave radio link from Kilduff to Scoil Ruain


**Table 4. Enet Radio Links requiring Analysis**



**Figure 5. Enet Radio Network – Plan View**

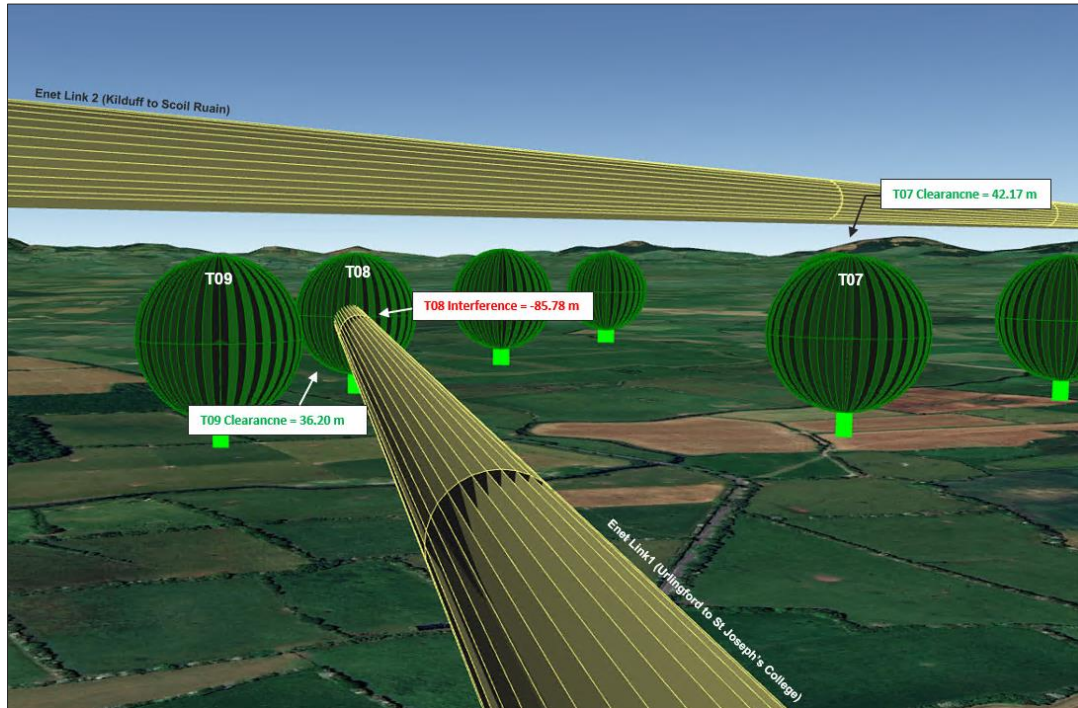
\* The Desktop Survey Analysis findings are subject to accuracy of the information (GPS co-ordinates, radio frequencies, etc.) provided to Ai Bridges.



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To further assess the potential impacts, the radio links were modelled in 3D and the Clearance Distances between the Fresnel Zones (F2) and the blade-tip of the turbines have been calculated. A 3D view of the microwave radio links relative to the proposed turbines is shown below in Figure 6.

The results of the 3D analysis indicate that Enet Link 1 would be impacted by turbine T08. Enet Link 2 would not be impacted as the radio link over-shoots the turbines at the proposed wind farm site.



**Figure 6. Enet Network – 3D View.**

Table 5 below provides a brief summary of the radio link interference analysis for the closest turbines to both of the Enet radio links. A detailed analysis showing the clearance distances from the 2<sup>nd</sup> Fresnel Zone of each radio link to the blade-tip of each of the proposed turbines can be found in Appendix C.

Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance/Interference	Wind Farm Impacts
Enet Link 1	Urlingford to St Joseph's College	T08	-85.78 m (Infringement into Fresnel Zone)	Interference Impact (Mitigation measures required)
		T09	36.20 m	No Impacts.
Enet Link 2	Kilduff to Scoil Ruain	T07	42.17 m	No Impacts.

**Table 5. Enet Network – Analysis Summary**

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## 5.2 ESB Network Analysis

The ESB network in the vicinity of the proposed wind farm consists of one Point-to-Point (PTP) microwave radio link. The radio link is listed below in Table 6 and a Plan View of the Three Ireland network is shown in Figure 7. The plan view indicates that the radio link is potentially impacted by the proposed wind farm development.


Link ID	Operator	Link Description
1	ESB	PTP microwave radio link from Kilduff to Thurles 110 kV Substation

**Table 6. ESB Radio Links requiring Analysis**

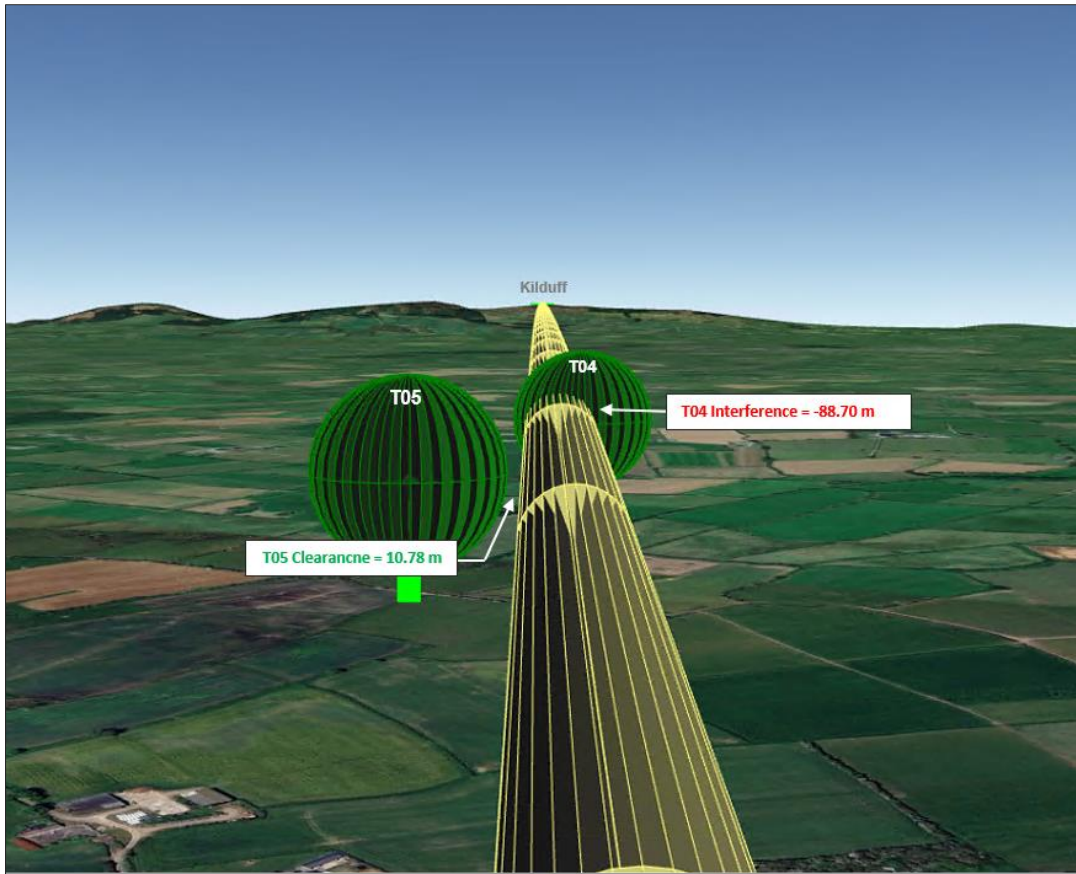


**Figure 7. ESB Radio Network – Plan View**

To further assess the potential impacts, the radio link has been modelled in 3D and the Clearance Distances between the Fresnel Zone and the blade-tip of the turbines have been calculated. A 3D view of the microwave radio link relative to the proposed turbines is shown below in Figure 8.

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The results of the 3D analysis indicate that T04 would obstruct the Fresnel Zone of the radio link (i.e. the operation of the ESB radio link would be impacted by T04).



**Figure 8. ESB Network – 3D View.**

Table 7 below provides a brief summary of the radio link interference analysis for the closest turbines to the ESB radio link. A detailed analysis showing the clearance distances from the 2<sup>nd</sup> Fresnel Zone of the radio link to the blade-tip of each of the proposed turbines can be found in Appendix C.

Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance/Interference	Wind Farm Impacts
ESB Link 1	Kilduff to Thurles 110 kV Substation	T04	-88.70 m (Infringement into Fresnel Zone)	Interference Impact (Mitigation measures required)
		T05	10.78 m	No Impacts.

**Table 7. ESB Network – Analysis Summary**

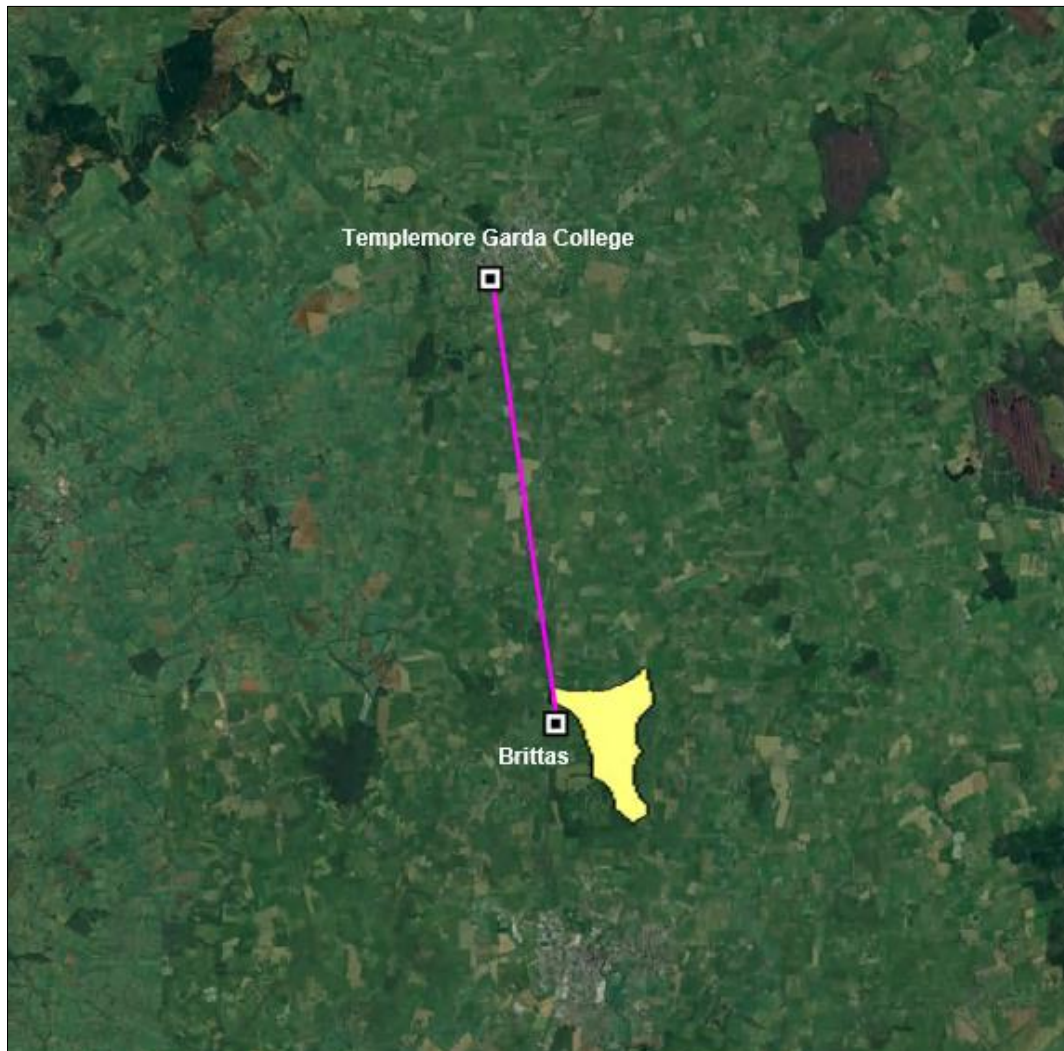
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### 5.3 Three Ireland Network Analysis

The Three Ireland network in the vicinity of the proposed wind farm consists of one Point-to-Point (PTP) microwave radio link. The radio link is listed below in Table 8 and a Plan View of the Three Ireland network is shown in Figure 9. The plan view indicates that the radio link is potentially impacted by the proposed wind farm development.

Link ID	Operator	Link Description
1	Three Ireland	PTP microwave radio link from Templemore Garda College to Brittas.

**Table 8. Three Ireland Radio Links requiring Analysis**

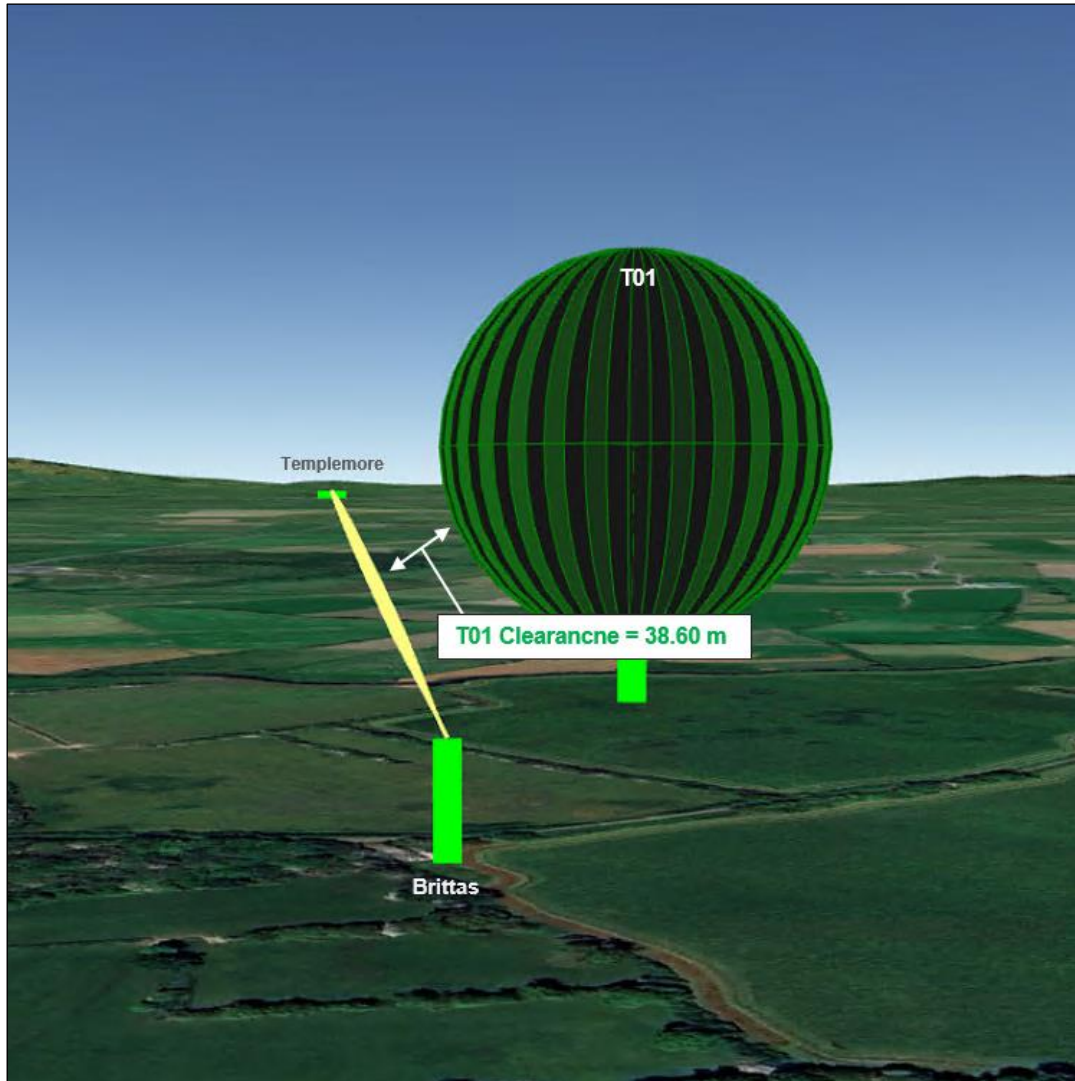


**Figure 9. Three Ireland Radio Network – Plan View**

To further assess the potential impacts, the radio link has been modelled in 3D and the Clearance Distances between the Fresnel Zone and the blade-tip of the turbines have been calculated. A 3D view of the microwave radio link relative to the proposed turbines is shown below in Figure 10.

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The results of the 3D analysis indicate that there would be a clearance distance of 38.60 m between the radio link and the nearest Turbine (T01). At this distance, there would be no impact to the Three Ireland radio link.




**Figure 10. Three Ireland Network – 3D View.**

Table 9 below provides a brief summary of the radio link interference analysis for the closest turbine (T01) to the Three Ireland radio link. A detailed analysis showing the clearance distances from the 2<sup>nd</sup> Fresnel Zone of the radio link to the blade-tip of each of the proposed turbines can be found in Appendix C.

Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance / Interference	Wind Farm Impacts
Three Ireland Link 1	Templemore Garda College to Brittas	T01	38.60 m	No Impacts

**Table 9. Three Ireland Network – Analysis Summary**

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## 5.4 Vodafone Ireland Network Analysis

The Vodafone network in the vicinity of the proposed wind farm consists of one Point-to-Point (PTP) microwave radio link. The radio link is listed below in Table 10 and a Plan View of the Vodafone network is shown in Figure 11. The plan view indicates that the radio link is potentially impacted by the proposed wind farm development.

Link ID	Operator	Link Description
1	Vodafone	PTP microwave radio link from Brittas to Templemore Garda College

**Table 10. Vodafone Radio Links requiring Analysis**



**Figure 11. Vodafone Radio Network – Plan View**

To further assess the potential impacts, the radio link has been modelled in 3D and the Clearance Distances between the Fresnel Zone and the blade-tip of the turbines have been calculated. A 3D view of the microwave radio link relative to the proposed turbines is shown below in Figure 12.

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The results of the 3D analysis indicate that there would be a clearance distance of 37.98 m between the radio link and the nearest Turbine (T01). At this distance, there would be no impact to the Vodafone radio link.

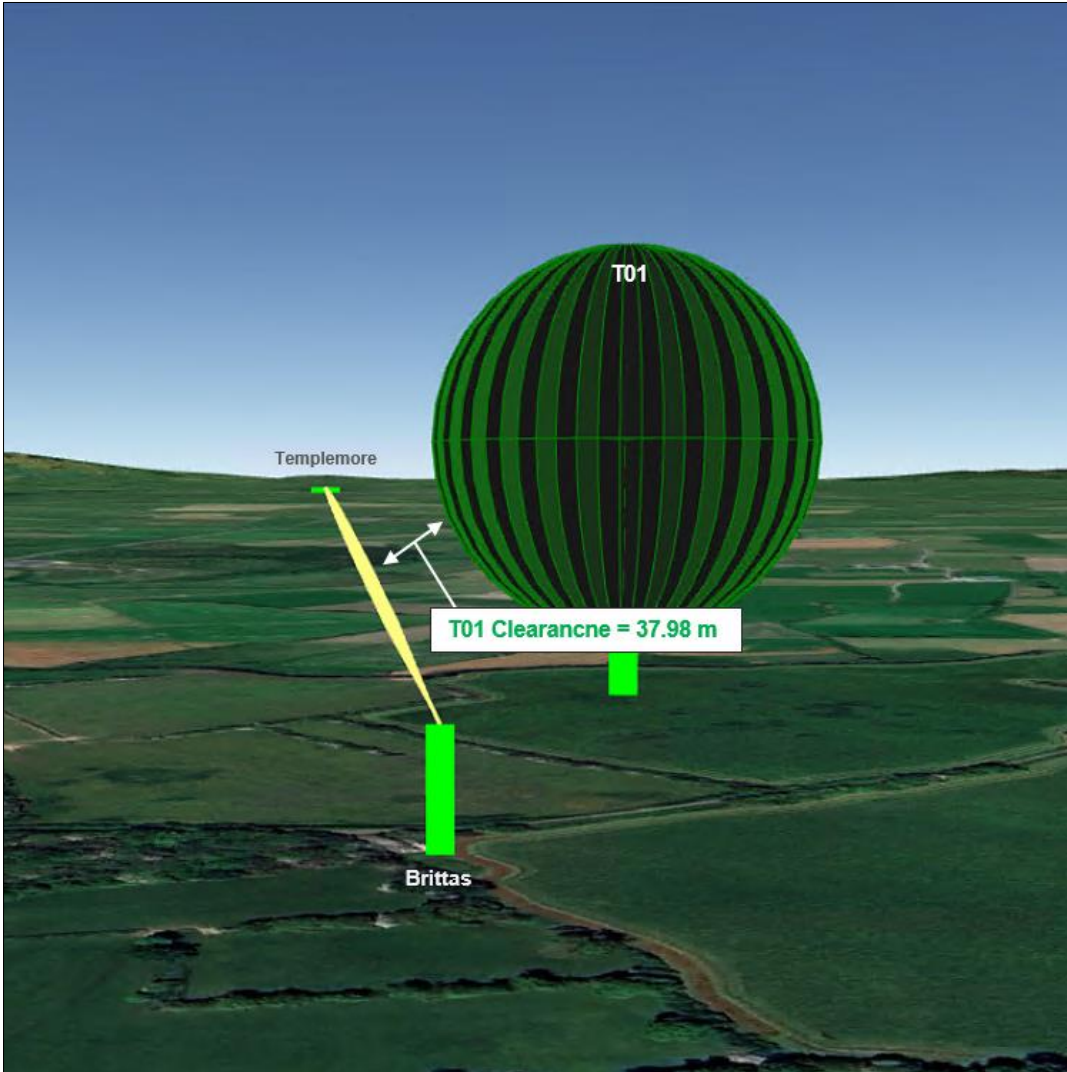


Figure 12. Vodafone Network – 3D View.

Table 11 below provides a brief summary of the radio link interference analysis for the closest turbine (T01) to the Vodafone radio link. A detailed analysis showing the clearance distances from the 2<sup>nd</sup> Fresnel Zone of the radio link to the blade-tip of each of the proposed turbines can be found in Appendix C.


Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance / Interference	Wind Farm Impacts
Vodafone Link 1	Brittas to Templemore Garda College	T01	37.98 m	No Impacts

Table 11. Vodafone Network – Analysis Summary

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## Section 6 - Mitigation Measures



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## 6. Mitigation Measures

Sections 6.1 to 6.2 that follow, describe the mitigation measures available to the wind farm developer to offset the potential impact of the proposed turbines on the Enet and ESB Networks.

### 6.1 Mitigation Measure Solutions – Enet Network

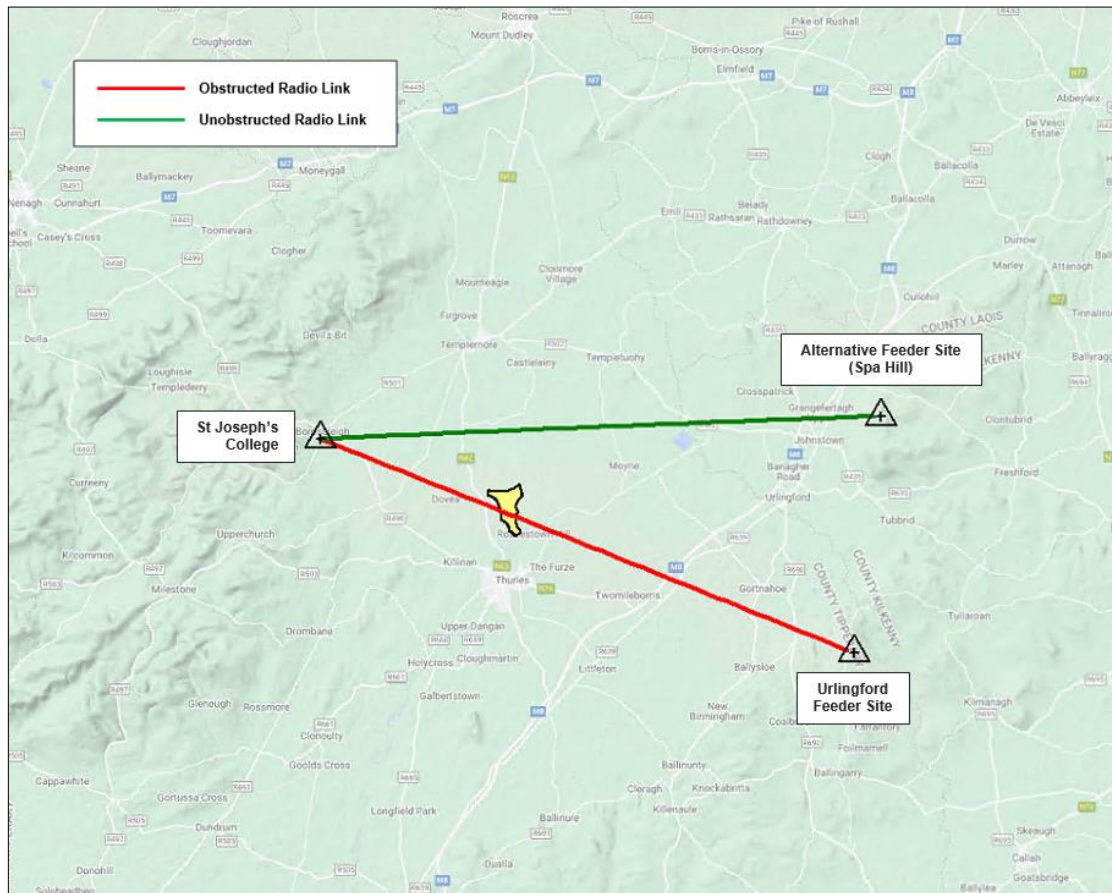
To offset the potential impact of T08 on the Enet radio link from Urlingford to St Joseph’s College the following mitigation solutions are available:

Option 1 – Relay the Enet radio link via an existing Telecoms Mast


This mitigation measure is described in Section 6.1.1 that follows.

#### 6.1.1 Option 1 - Route the Enet service into St Joseph’s College from an alternative Feeder Site.

An option to mitigate for the impact on the Enet radio link would be to use an alternative feeder-site to provide a service into St Joseph’s College. Figure 13 below illustrates how the telecoms mast-site at Spa Hill could be used as an alternative POP site to provide a service into St Joseph’s College.



**Figure 13. Example of how an alternative feeder-site could be used to mitigate against obstructing turbines.**

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To determine if the Telecoms Mast-site at Spa Hill could be used for a viable radio connection into St Joseph’s College, a radio link path profile was generated. The Radio Link Budget was also carried out to determine if the proposed radio link would meet the Radio Link Availability Criteria required by ComReg for radio licensing. The Radio Link Path Profile and Radio Link Budget are based on the following ITU-R Recommendations

- ITU-R P.525-2
- ITU-R P.526-11
- ITU-R P.676-8

The radio Path Profile is shown in Section 6.1.1.1 that follows. The Radio Link Budget can be found in Appendix D.

**6.1.1.1 Path Profile – Spa Hill to St Joseph’s College**

The radio link path profile shows clear Line-of-Sight (LOS) and the link budget results would pass the radio availability criteria required by ComReg.

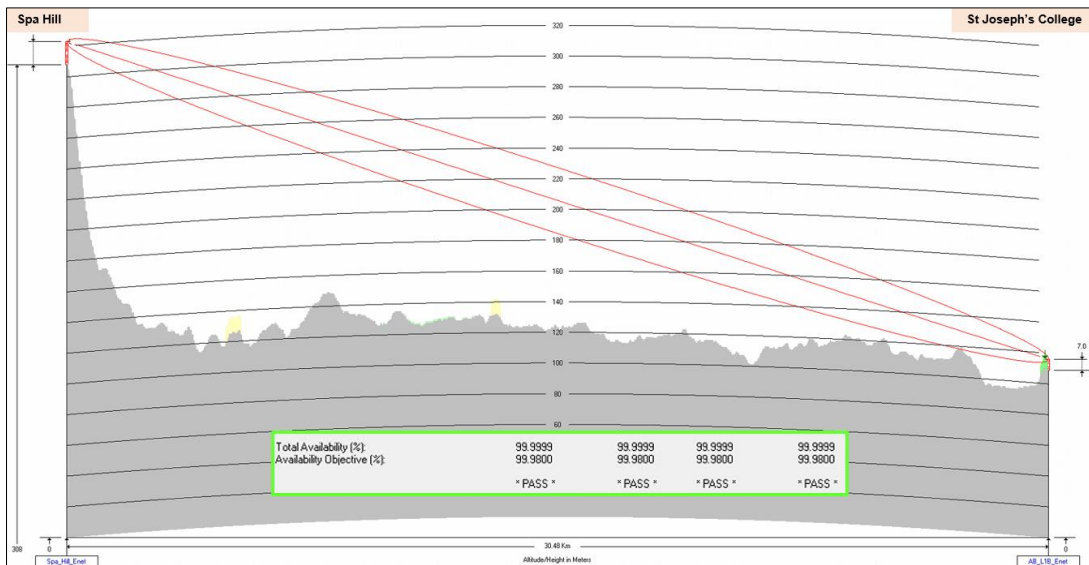



Figure 14. Path Profile – Spa Hill to St Joseph’s College

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## 6.2 Mitigation Measure Solutions – ESB Network

To offset the potential impact of T04 on the ESB radio link from Kilduff to the Thurles 110 kV Substation the following mitigation solutions are available:

Option 1 – Relocate the monopole at the Thurles 110 kV Substation

This mitigation measure is described in Sections 6.2.1 that follows.

### 6.2.1 Relocate the monopole at Thurles 110kV Substation.


An option to mitigate for the impact on the ESB radio link would be to relocate the radio antenna at the Thurles end of the radio link. The antenna at the Thurles 110 kV Substation is installed on a monopole as shown in Figure 15. Turbine T04 would have no impact on the radio link if the monopole (and antenna) was relocated to the northeastern corner of the ESB site.

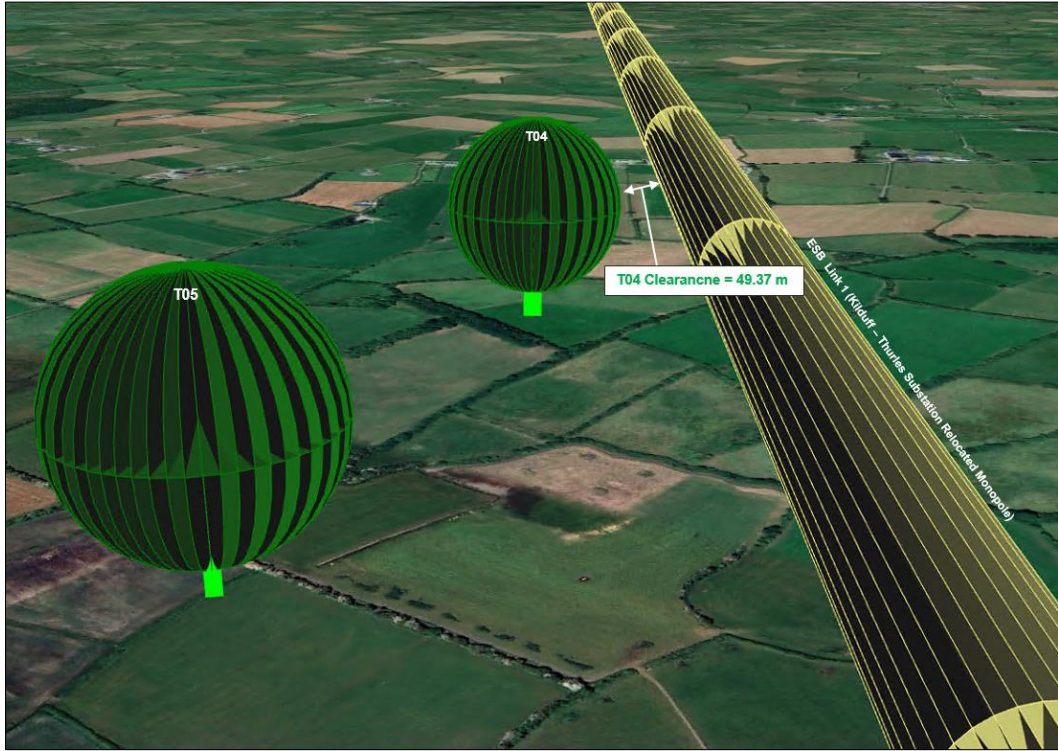


**Figure 15. Relocated Monopole – Thurles 110kV Substation**

3D analysis indicates that relocating the monopole to the new location as shown in Figure 16 would result in a clearance distance of 49.37 m between the 2<sup>nd</sup> Fresnel Zone of the radio link and the blade-tip of T04.

A further mitigation measure recommendation would be to use the 0.6 Fresnel Zone (0.6 F1) in the Clearance Calculations. (Radio links will operate provided that the 0.6 Fresnel Zone is free from obstructions). When the 0.6 F1 Fresnel is considered, the clearance distance to T04 is 66.56 m (i.e. using the relocated monopole location).


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**Figure 16. 3D View showing Clearance Condition when the ESB link uses the Relocated Monopole**

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## Section 7 - Conclusions

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## 7. Conclusions

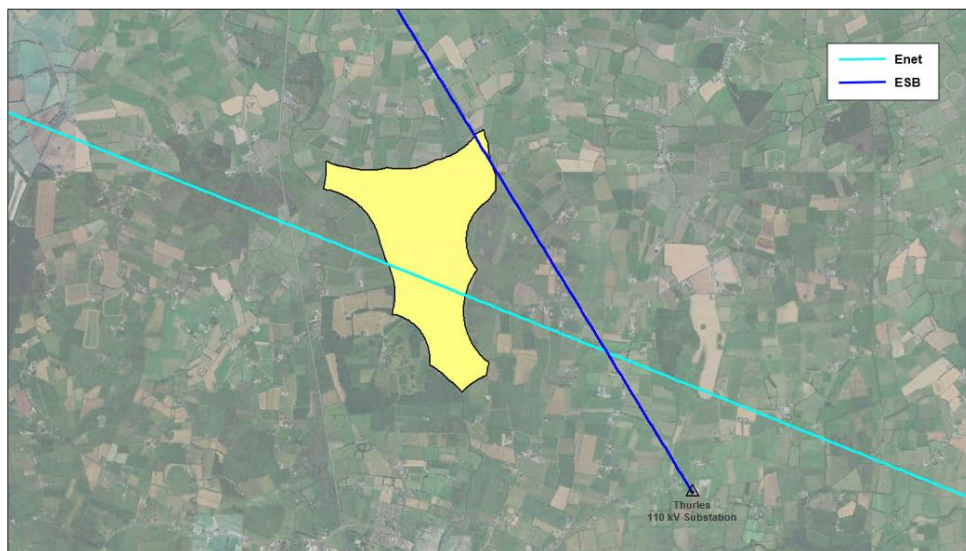
From the findings made in this report the following conclusions have been made:

- Results from the telecom operator consultations and desktop survey analysis indicate that there are five radio links that cross over the wind farm.
- Of the five radio links that cross over the proposed wind farm site, two are potentially impacted by the proposed turbine layout. i.e. the Enet link from Urlingford to St Joseph's College and the ESB link from Kilduff to Thurles 110kV Substation.

Operator	Radio Link Description	Impact of Wind Farm	Possible Mitigation Measure(s)
Enet	PTP microwave radio link from Urlingford to St Joseph's College.	Potentially Impacted. Viable Mitigation Measures Available	Route the Enet service into St Joseph's College using a microwave radio link from an alternative feeder-site.
Enet	PTP microwave radio link from Kilduff to Scoil Ruain.	No Impacts	N.A
ESB	PTP microwave radio link from Kilduff to Thurles.	Potentially Impacted. Viable Mitigation Measures Available	Relocate radio equipment to new Monopole at Thurles 110kV Substation.
Three Ireland	PTP microwave radio link from Templemore Garda College to Brittas.	No Impacts	N.A
Vodafone	PTP microwave radio link from Brittas to Templemore Garda College.	No Impacts	N.A

**Table 12. Radio Links that cross over the proposed wind farm site.**

- Figure 17 has been provided to illustrate the radio links that are potentially impacted by the proposed wind farm development.



**Figure 17. Radio links potentially impacted by the proposed wind farm development.**

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- The estimated costs associated with the mitigation measures proposed in this report are provided in the table below.

Operator	Impacted Radio Link	Mitigation Measure	Once-off Hardware & Installation Costs*
Enet	Urlingford - St Joseph's College.	Route the Enet service into St Joseph's College using a microwave radio link from an alternative feeder-site.	Based on previous projects the anticipated replacement link cost is circa €12K.
ESB	Kilduff – Thurles 110kV Substation.	Relocate radio equipment to new Monopole at Thurles 110kV Substation.	Based on previous projects the anticipated cost is circa €12K.

\* Details regarding the once-off hardware & installation costs for each of the proposed mitigation measures are provided below.

Enet Radio Link: Mitigation Measure

Installation of Microwave radio link equipment to be installed and maintained on behalf of Enet by a third party for duration of operation of the wind farm.

The Once-off Hardware & Installation Costs include provision for:

- Telecommunications Cabinet
- Electrical & Battery Pack Supply
- 1 no microwave radio link including radio, cabling, connectors & antenna equipment
- Design & Installation Costs

ESB Radio Link: Mitigation Measure

Installation of PMP UHF radio link equipment to be installed and maintained on behalf of ESB by a third party for duration of operation of the wind farm.


The Once-off Hardware & Installation Costs include provision for:

- 6m Monopole
- Telecommunications Cabinet
- Electrical & Battery Pack Supply
- 1 no UHF PMP telemetry link including radio, cabling, connectors & antenna equipment
- Design & Installation Costs

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# APPENDIX A – Wind Farm Turbine Coordinates




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## Appendix A – Wind Farm Turbine Co-ordinates


The development is in the pre-planning stage and the Final Turbine Layout is yet to be finalized. The turbine layout considered in this Telecommunications Impact Study is provided below.

Turbine ID	Co-ordinates (WGS 84)	
	Latitude	Longitude
T01	52 43 15.51 N	7 49 18.36 W
T02	52 43 17.27 N	7 48 48.24 W
T03	52 43 13.09 N	7 48 20.02 W
T04	52 43 33.01 N	7 47 57.28 W
T05	52 43 15.75 N	7 47 49.26 W
T06	52 42 59.81 N	7 48 55.51 W
T07	52 42 57.41 N	7 48 12.47 W
T08	52 42 48.43 N	7 48 42.72 W
T09	52 42 38.57 N	7 48 22.46 W
T10	52 42 18.60 N	7 48 18.61 W

**Table 13. Wind Farm Layout - Turbine Co-ordinates**

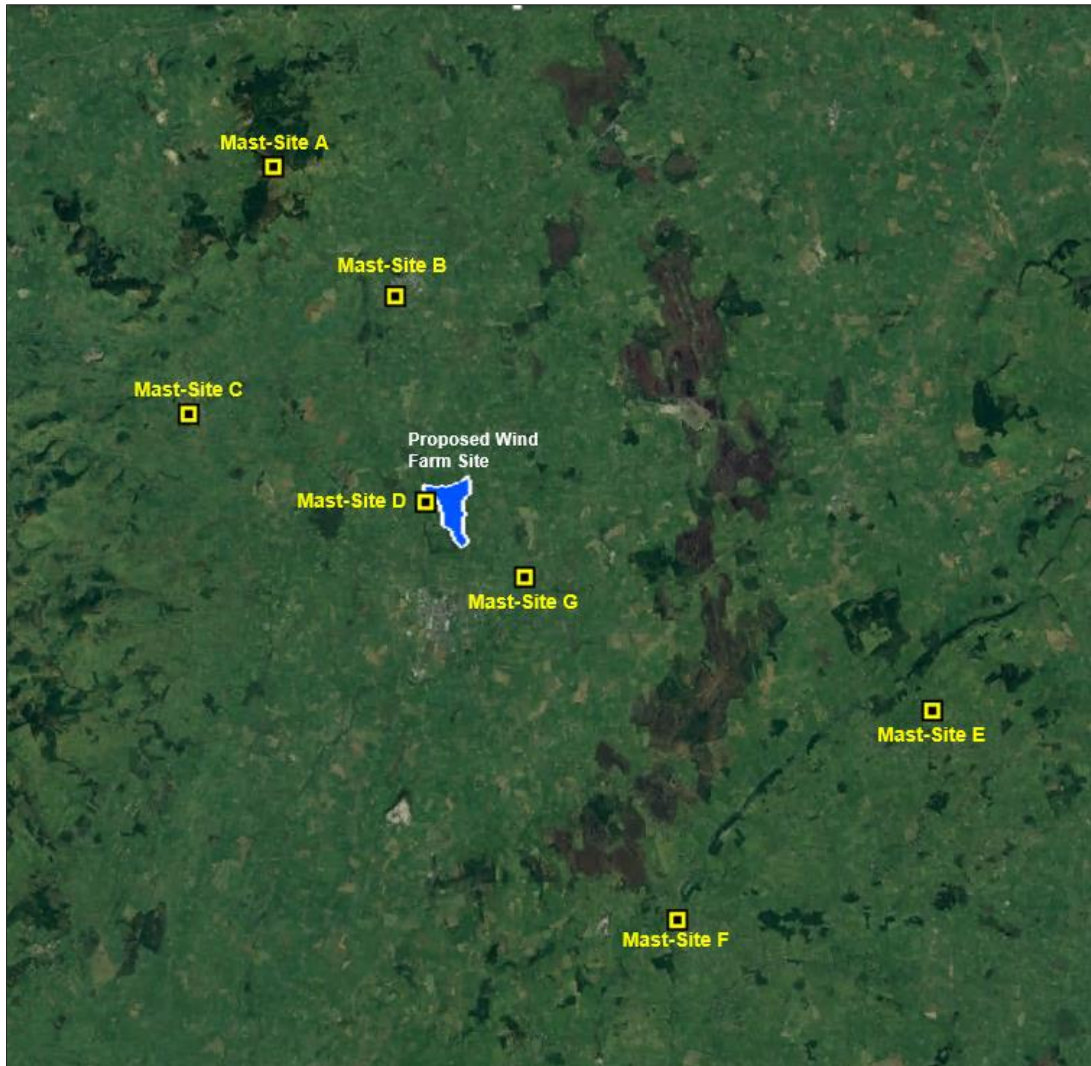
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## APPENDIX B – Field Survey Findings

	Procedure: 001	Rev: 5.0
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## Appendix B – Field Survey Findings

The telecom mast-sites surveyed for this Telecoms Impact Study are shown relative to the proposed wind farm site in Figure 18 below.



**Figure 18. Telecom Mast-Sites shown relative to proposed wind farm.**

The findings from the field surveys of each of the mast-sites are presented below.

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**Mast-Site A (RTE Kilduff)**

Telecommunications Mast-Site A is located on Kilduff Mountain, County Tipperary, and is approximately 14 km northwest of the proposed wind farm. A photo of the mast-structure at this location is shown below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 14.



**Figure 19. Mast A**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast A	Enet

**Table 14. Field Survey Summary – Mast-Site A**

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**Mast-Site B (Templemore)**


Telecommunications Mast-Site B is located at Templemore, Co Tipperary and is approximately 7 km north of the proposed wind farm. A photo of the mast at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 15.



**Figure 20. Mast B**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast B	Vodafone, Three Ireland

**Table 15. Field Survey Summary – Mast B**

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## **Mast-Site C (St Joseph’s Borrisoleigh)**

Telecommunications Mast-Site C is located within the grounds of St Joseph’s College, Borrisoleigh, Co Tipperary and is approximately 10 km northwest of the proposed wind farm. A photo of the mast-structure at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 16.



**Figure 21. Mast C**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast C	Enet

**Table 16. Field Survey Summary – Mast C**

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## **Mast-Site D (Brittas)**


Telecommunications Mast-Site D is located in the townland of Brittas, Co Tipperary and is less than 500 from the proposed wind farm site. A photo of the mast-structure at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 17.



**Figure 22. Mast D**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast D	Vodafone, Three Ireland

**Table 17. Field Survey Summary – Mast D**

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**Mast-Site E (Urlingford)**

Telecommunications Mast-Site E is located in the townland of Garransilly, near Urlingford in Co Tipperary and is approximately 19 km southeast of the proposed wind farm. A photo of the mast-structure at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 18.



**Figure 23. Mast E**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast E	Enet

**Table 18. Field Survey Summary – Mast E**



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## **Mast-Site F (Scoil Ruain)**


Telecommunications Mast-Site F is located within the grounds of Scoil Ruain, Killenaule, Co Tipperary and is approximately 17 km southeast of the proposed wind farm. A photo of the mast-structure at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 19.



**Figure 24. Mast F**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast F	Enet

**Table 19. Field Survey Summary – Mast F**

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**Mast-Site G (Thurles 110 kV Substation)**


Telecommunications Mast-Site G is located at the Thurles ESB 110kV Substation and is approximately 3 km southeast of the proposed wind farm. A photo of the mast-structure at this location is shown in the figure below. The Telecom Operators who have radio links operating from this mast-site in the direction of the wind farm are listed in Table 20.



**Figure 25. Mast-site G**

Mast ID	Telecom operators with radio links in direction of proposed wind farm
Mast G	ESB

**Table 20. Field Survey Summary – Mast-site G**

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# APPENDIX C – Radio Link Clearance Calculations Results

	Procedure: 001	Rev: 5.0
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## Appendix C – Radio Link Clearance Calculations Results

The Radio Link Clearance Calculations Results for each of the Telecom Operators with radio links in the vicinity of the proposed wind farm are presented below (i.e. Enet, ESB, Three Ireland, and Vodafone).


### Clearance Calculations – Enet Network

The Clearance Distances from the Radio Link Fresnel Zone (2<sup>nd</sup> Fresnel) to each of the proposed turbines have been calculated and are presented below.

#### Enet Link 1 – Urlingford to St Joseph’s College

Turbine ID	Clearance Distance from Radio Link 2 <sup>nd</sup> Fresnel Zone to Turbine Blade-tip Enet Link 1 (Urlingford to St Joseph’s College)
T01	> 100 m
T02	> 100 m
T03	> 100 m
T04	> 100 m
T05	> 100 m
T06	> 100 m
T07	> 100 m
T08*	-85.79 m
T09	36.20 m
T10	> 100 m


\* Nearest turbine to radio link.

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## Enet Link 2 – Kilduff to Scoil Ruain

Turbine ID	Clearance Distance from Radio Link 2 <sup>nd</sup> Fresnel Zone to Turbine Blade-tip Enet Link 2 (Kilduff to Scoil Ruain)
T01	> 100 m
T02	> 100 m
T03	> 100 m
T04	> 100 m
T05	> 100 m
T06	> 100 m
T07*	42.17 m
T08	> 100 m
T09	> 100 m
T10	> 100 m

\* Nearest turbine to radio link.

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## Clearance Calculations – ESB Network

The Clearance Distances from the Radio Link Fresnel Zone (2<sup>nd</sup> Fresnel) to each of the proposed turbines have been calculated and are presented below.

### ESB Link 1 – Kilduff to Thurles

Turbine ID	Clearance Distance from Radio Link 2 <sup>nd</sup> Fresnel Zone to Turbine Blade-tip ESB Link 1 (Kilduff to Thurles)
T01	> 100 m
T02	> 100 m
T03	> 100 m
T04*	-88.70 m
T05	10.78 m
T06	> 100 m
T07	> 100 m
T08	> 100 m
T09	> 100 m
T10	> 100 m

\* Nearest turbine to radio link.

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## **Clearance Calculations – Three Ireland Network**

The Clearance Distances from the Radio Link Fresnel Zone (2<sup>nd</sup> Fresnel) to each of the proposed turbines have been calculated and are presented below.

### **Three Ireland Link 1 – Templemore Garda College to Brittas**

<b>Turbine ID</b>	<b>Clearance Distance from Radio Link 2<sup>nd</sup> Fresnel Zone to Turbine Blade-tip Three Ireland Link 1 (Templemore Garda College to Brittas)</b>
T01*	38.60 m
T02	> 100 m
T03	> 100 m
T04	> 100 m
T05	> 100 m
T06	> 100 m
T07	> 100 m
T08	> 100 m
T09	> 100 m
T10	> 100 m

\* Nearest turbine to radio link.

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## **Clearance Calculations – Vodafone Network**

The Clearance Distances from the Radio Link Fresnel Zone (2<sup>nd</sup> Fresnel) to each of the proposed turbines have been calculated and are presented below.

### **Vodafone Link 1 – Brittas to Templemore Garda College**

<b>Turbine ID</b>	<b>Clearance Distance from Radio Link 2<sup>nd</sup> Fresnel Zone to Turbine Blade-tip Vodafone Link 1 (Brittas to Templemore Garda College)</b>
T01*	37.98 m
T02	> 100 m
T03	> 100 m
T04	> 100 m
T05	> 100 m
T06	> 100 m
T07	> 100 m
T08	> 100 m
T09	> 100 m
T10	> 100 m

\* Nearest turbine to radio link.



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## APPENDIX D – Radio Link Budget Reports

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## Appendix D – Radio Link Budget Reports

### D.1 Radio Link Budget Report (Spa Hill – St Joseph’s College)


#### Link Budget Report

Site: Spa\_Hill\_Enet AB\_L1B\_Enet (St Joseph’s College)  
Name:  
Type: Cell Cell  
Latitude: 52°45’36.4”N 52°44’56.4”N  
Longitude: 7°30’29.3”W 7°57’34.9”W  
Altitude (m): 308.0 109.0


UserData1: User Data

Datum: World Geodetic System 1984 (WGS 84)

	Forward Link	Reverse Link				
Transmission Site:	Spa_Hill_Enet	AB_L1B_Enet				
Reception Site:	AB_L1B_Enet	Spa_Hill_Enet				
Radio Type:	NetRadio0001	NetRadio0001				
Modulation Scheme:	4-QAM	4-QAM				
Bandwidth (MHz):	2	2				
Roll-Off Factor:	0.2	0.2				
Coding Gain (dB):	0	0				
System Gains (dB):	0	0				
Channel Overhead (%):	20	20				
FEC Overhead (%):	0	0				
Reference Temperature (°K):	290	290				
Receiver Noise Figure (dB):	5	5				
Maximum Data Rate (Mbps):	2.667	2.667				
Maximum Bit Rate (Mbps):	3.333	3.333				
Required Bit Error Rate:	BER 10-3 BER 10-6	BER 10-3 BER 10-6				
Service Threshold (dBm):	-91 -90	-91 -90				
Carrier to Noise Ratio (dB):	14.965 15.965	14.965 15.965				
Cross Polarization Improvement Factor (dB):	20	20	20	20		
Rx Equalization Sig Norm Parameter (Kn,M):	0.1	0.1	0.1	0.1		
Rx Equalization Sig Norm Parameter (Kn,NM):	0.1	0.1	0.1	0.1		
UserData1:	User Data	User Data				
Center Frequency (MHz):	11000	11000				
Channel Bandwidth (MHz):	28	28				
Transmission Power (dBm):	30	30				
Transmission Gains (dB):	0	0				
Transmission System Loss (dB):	0	0				
Transmission Line Loss (dB/100 m):	4	4				
Transmission Line Length (m):	10	10				
Transmission Connection Loss (dB):	0.3	0.3				
Transmission Number of Connections:	2	2				
Transmission Additional Loss (dB):	0	0				
Transmission Losses (dB):	1	1				
Transmission Antenna:	HP2-11-NSMA	HP2-11-NSMA				
Transmission Antenna Size (m):	0.6	0.6				
Transmission Antenna Height (m):	15	7				
Transmission Antenna Gain (dBd):	32.36	32.36				
Transmission Antenna Gain (dBi):	34.5	34.5				
Transmission Power EIRP (dBm):	63.5	63.5				
Reception Gains (dB):	0	0				
Reception System Loss (dB):	0	0				
Reception Line Loss (dB/100 m):	4	4				
Reception Line Length (m):	10	10				
Reception Connection Loss (dB):	0.3	0.3				
Reception Number of Connections:	2	2				
Reception Additional Loss (dB):	0	0				
Reception Losses (dB):	1	1				

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Reception Antenna: HP2-11-NSMA		HP2-11-NSMA	
Reception Antenna Size (m): 0.6		0.6	
Reception Antenna Height (m):	7	15	
Reception Antenna Gain (dBd):	32.36	32.36	
Reception Antenna Gain (dBi):	34.5	34.5	
Link Polarization: Vertical	Vertical		
Cross Polarization Factor (dB):	26.667	26.667	
Link Distance (m): 30475.033		30475.033	
Azimuth - True (°): 267.849	87.49		
Azimuth - Magnetic (°):	269.954	89.769	
Transmission Inclination (°):	0.389	-0.389	
Reception Inclination (°):	0.389	-0.389	
ITU Recommendation:	ITU-R P.525-2		
Free Space Distance (m):	30475.736	30475.736	
Center Frequency (MHz):	11000	11000	
Free Space Loss (dB):	142.947	142.947	
Max Fresnel Radius (m):	14.415	14.415	
Max 2nd Fresnel Radius (m):	20.385	20.385	
Earth Radius Factor (K):	4/3		
Effective Radius (m):	8502056.000		
ITU Recommendation:	ITU-R P.526-11		
Diffraction Model: Cascade Knife Edge			
Diffraction: No LOS Diffraction	No LOS Diffraction	No LOS Diffraction	
Diffraction Loss (dB):	6.194	6.194	
Clearance Target (%):	60		
Minimum Clearance (m):	-0.488	-0.488	
Minimum Clearance Point (m):	30371.95	30371.95	
Terrain Reflection Dispersion (°):	0.5		
Reflection Area 1 (m):	871.5 - 890.3	871.5 - 890.3	
Reflection Area 2 (m):	965.23	965.23	
Reflection Area 3 (m):	1415 - 1433.8	1415 - 1433.8	
Reflection Area 4 (m):	1565.0 - 1583.7	1565.0 - 1583.7	
Reflection Area 5 (m):	1677.4 - 1696.2	1677.4 - 1696.2	
Reflection Area 6 (m):	3289.279	3289.279	
Reflection Area 7 (m):	3326.8 - 3383	3326.8 - 3383	
Reflection Area 8 (m):	3476.7 - 3495.4	3476.7 - 3495.4	
Reflection Area 9 (m):	4076.457	4076.457	
Reflection Area 10 (m):	4113.942	4113.942	
Reflection Area 11 (m):	20907 - 21000.8	20907 - 21000.8	
Reflection Area 12 (m):	21169.465	21169.465	
Reflection Area 13 (m):	21225.7 - 21300.7	21225.7 - 21300.7	
Reflection Area 14 (m):	21394.373	21394.373	
Reflection Area 15 (m):	21694.2 - 21788.0	21694.2 - 21788.0	
Reflection Area 16 (m):	21844.2 - 21900.4	21844.2 - 21900.4	
ITU Recommendation:	ITU-R P.676-8		
Atmospheric Pressure (hPa):	1013	1013	
Standard Temperature (°C):	15	15	
Water Vapor Density (g/m³):	7.5	7.5	
Atmospheric Gases Loss (dB):	0.503	0.503	
Total Path Loss (dB):	149.644	149.644	
Reception Signal Level (dBm):	-52.644	-52.644	
BER 10-3	BER 10-6	BER 10-3	BER 10-6
Service Threshold (dBm):	-91	-90	-91
Link Gross Margin (dB):	38.356	37.356	38.356
ITU Recommendation:	ITU-R F.1703-0 / ITU-T G.827		
Objective ITU Quality Grade:	Short Haul SDH Networks		
Unavailability Objective (%):	2.00E-02		
Availability Objective (%):	99.9800		

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ITU Recommendation: ITU-R F.1668-1 / ITU-T G.826  
Error Performance Objective BBER (%): 1.60E-05 1.60E-05  
Error Performance Objective BBER (s/Month): 0.42 0.42  
SESR ESR SESR ESR  
Error Performance Objective (%): 1.60E-04 3.20E-03 1.60E-04 3.20E-03  
Error Performance Objective (s/Month): 4.205 84.096 4.205 84.096

ITU Recommendation: ITU-R F.1668-1 / ITU-T G.828  
Error Performance Objective BBER (%): 4.00E-06 4.00E-06  
Error Performance Objective BBER (s/Month): 0.105 0.105  
SESR ESR SESR ESR  
Error Performance Objective (%): 1.60E-04 8.00E-04 1.60E-04 8.00E-04  
Error Performance Objective (s/Month): 4.205 21.024 4.205 21.024

Multipath Model: ITU-R P.530-15  
Multipath Planning Type: Quick Planning  
Multipath Time Frame: Average annual distribution  
ITU Recommendation: ITU-R P.453-9  
Point Refractivity Gradient (dN1): -76.7  
Geoclimatic Factor: 4.05E-05 4.05E-05  
Multipath Occurrence Factor (%): 6.12E-01 6.12E-01

Precipitation Model: ITU-R P.530-15  
ITU Recommendation: ITU-R P.837-5 / ITU-R P.841-4  
Precipitation Time Frame: Average annual distribution  
Precipitation Rate @ 0.01% (mm/h): 22  
ITU Recommendation: ITU-R P.838-3  
Specific Attenuation (dB/km): 0.627671 0.627671  
Rainfall Attenuation (dB): 10.913 10.913

BER 10-3 BER 10-6 BER 10-3 BER 10-6  
Fading Outage (%): 1.16E-05 1.46E-05 1.16E-05 1.46E-05  
Selective Fading Outage (%): 7.06E-08 7.06E-08 7.06E-08 7.06E-08  
Composite Fading Outage (%): 1.17E-05 1.47E-05 1.17E-05 1.47E-05

Fading Outage (s/Month): 0.305 0.384 0.305 0.384  
Selective Fading Outage (s/Month): 0.002 0.002 0.002 0.002  
Composite Fading Outage (s/Month): 0.307 0.386 0.307 0.386

BER 10-3 BER 10-6 BER 10-3 BER 10-6  
Unavailability due to Rain (%): 4.53E-05 5.78E-05 4.53E-05 5.78E-05  
Unavailability due to Rain (s/Year): 14.275 18.217 14.275 18.217

BER 10-3 BER 10-6 BER 10-3 BER 10-6  
Unavailability due to Fading (%): 1.17E-05 1.47E-05 1.17E-05 1.47E-05  
Unavailability due to Rain (%): 4.53E-05 5.78E-05 4.53E-05 5.78E-05  
Total Unavailability (%): 5.69E-05 7.24E-05 5.69E-05 7.24E-05  
Unavailability Objective (%): 2.00E-02 2.00E-02 2.00E-02 2.00E-02

Unavailability due to Fading (s/Year): 3.683 4.63 3.683 4.63  
Unavailability due to Rain (s/Year): 14.275 18.217 14.275 18.217  
Total Unavailability (s/Year): 17.957 22.847 17.957 22.847  
Unavailability Objective (s/Year): 6307.2 6307.2 6307.2 6307.2

Total Availability (%): 99.9999 99.9999 99.9999 99.9999  
Availability Objective (%): 99.9800 99.9800 99.9800 99.9800

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