



APPENDIX 15-4

TELECOMMUNICATIONS IMPACT ASSESSMENT

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Report

Cooloo Wind Farm Telecommunications Impact Study

Document Number:

Author: DM/KH

Approved for Release: Rev 2.0 KH **Date:** 24/04/24

Document Filename: *Cooloo Wind Farm Telecommunications Impact Assessment Study*

© copyright Ai Bridges Ltd. 2024

Copyright of this document is vested in Ai Bridges Limited. Ai Bridges Limited shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. No part of this document may be photocopied, reproduced, or translated to another language, without prior written permission of Ai Bridges Limited.

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Executive Summary

Following consultations between McCarthy Keville O'Sullivan (MKO) and ESB Services it was found that:

- ESB have four UHF Point-to-Point (PMP) telemetry radio links in the vicinity of the proposed wind farm.
- Three Ireland have one Point-to-Point (PTP) microwave radio links in the vicinity of the proposed wind farm.

Ai Bridges Ltd were subsequently commissioned to assess the potential impact of the proposed wind turbines on the ESB and Three Ireland radio links and to proposed possible mitigation measures. The scope of work included field surveys and a detailed network 3D analysis. Each of the four radio links were surveyed to assess/verify the accuracy of the radio link details (antenna co-ordinates, antenna installation heights, etc). The findings of the field surveys can be found in Section 4 of this report.

Network analysis was carried out to model the radio links in 3D and to show the links relative to the proposed turbines. The findings of the network analysis indicate that one of the proposed turbines, T07, would cause an Interference Condition of 11.4m to the 0.6 Fresnel of the ESB radio link from Abbeyknockmoy to Glenamaddy 38kV and an Interference Condition of 4.5m to the 0.6 Fresnel of the ESB radio link from Abbeyknockmoy to Castlerea 38kV. The findings of the ESB network analysis can be found in Section 6 of this report.

Network Analysis also found that T07 is more than 75m from the Three Ireland microwave radio link between Cloonriddia and Moylough, however if the location of T07 is revised (i.e. to mitigate for the Interference Condition on the ESB PMP links) this clearance distance may be reduced.

Should mitigation be required for the ESB network, a number of possible mitigation measures are available to offset the possible impact of Turbine T07 on the ESB UHF radio links and these measures are outlined in Section 7. Ai Bridges Ltd have contacted ESB Networks in relation to mitigation measures regarding other 3rd party wind farms, but there has been no engagement from ESB for mitigation measures. To-date no response has been received from ESB in response to the multiple consultation attempts. Ai Bridges is also seeking to engage with ESB on other third party projects and also awaiting consultation responses.

Although there is a small interference condition on two of ESB's Telemetry radio links, it should be noted that ESB are presently undertaking a pre-qualification for a Tender process to replace their existing UHF SCADA Telemetry network using an alternative technology. If this tender process is to proceed and a successful tender bid is granted it is expected that the UHF Telemetry network operated by ESB may be replaced.

It should be also be noted that in this report a micro-sited location for T07 has been specified that would minimize the impact on the ESB PMP radio links. However, micro-siting T07 would reduce the clearance distance between the turbine and the Three Ireland PTP radio link to 11.38m. Additional consultations would be required with Three Ireland to confirm that a clearance distance of 11.38m from the 2nd Fresnel Zone of their radio link is acceptable to them. If mitigation is required for the Three Ireland radio link (to accommodate micro-siting T07), a possible solution would be to relay the PTP radio link via an existing Telecoms Mast (e.g. the telecoms mast at Creevagh). This mitigation measure is described in Section 7.2 of this report.

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Sections

Section 1 - Wind Farm Site Information	4
Section 2 - Methodology	6
Section 3 - Telecom Operator Consultations	8
Section 4 - Field Surveys	15
Section 5 - Solar Farm Planning References	22
Section 6 - Desktop Survey Analysis	25
Section 7 - Mitigation Measures	31
Section 8 - Conclusions	38
Section 9 - References	41

Appendix

Appendix A – Cooloo Wind Farm Turbine Coordinates	43
Appendix B – Field Survey of Three Ireland Network	45
Appendix C – Radio Link Budget Reports	49

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 1 - Wind Farm Site Information

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

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 wind farm development is located in County Galway approximately 13 km southeast of Tuam. The wind farm proposal consists of 9 turbines with a maximum turbine tip-height of 180 meters. The proposed turbine co-ordinates are provided in Appendix A.

Wind Farm	Number of Turbines	Hub Height	Blade Length
Cooloo	9	99m	81m

Table 1. Cooloo Wind Farm Turbine Details

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

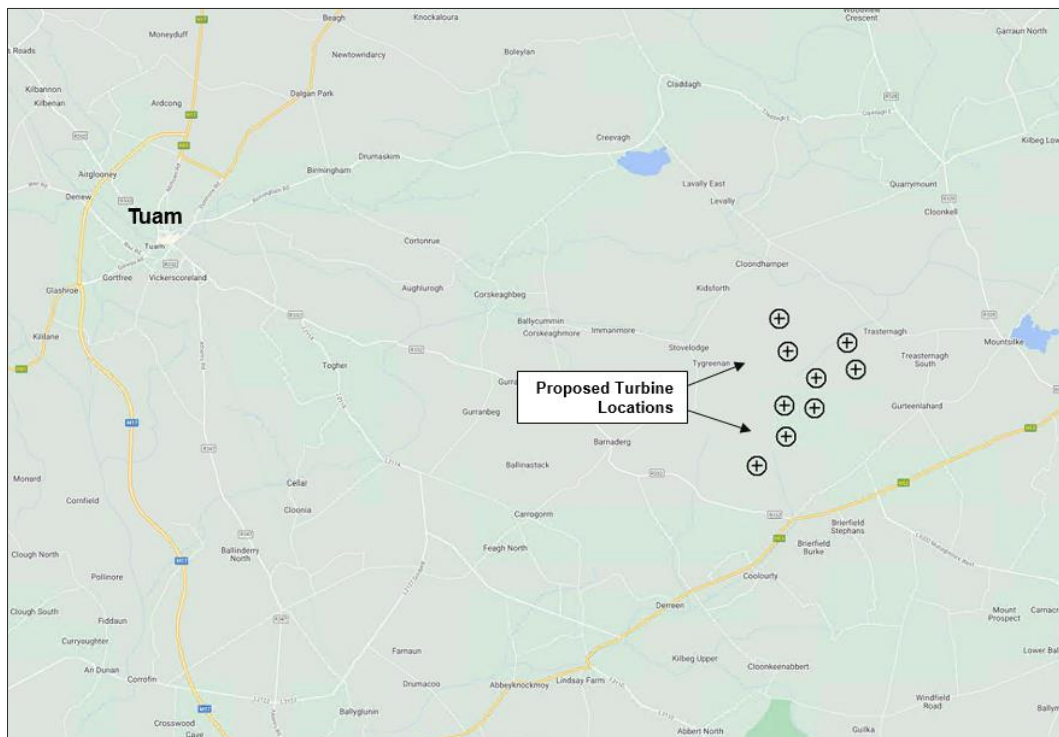


Figure 1. Location of Cooloo Wind Farm, County Galway.

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 2 - Methodology

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

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
- Mitigation Measures
- 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 Network Analysis

A desktop survey is carried out to plot and model the proposed wind turbines in a radio planning tool. The radio planning tool uses GIS and terrain mapping databases to enable accurate modelling. This provides a means of graphically showing the turbines in 3D relative to the existing radio link(s). The radio planning tool is then used to calculate the Clearance or Interference Condition distance between the relevant radio link and the nearest turbine(s).

Mitigation Measures

A range of Mitigation Measures are assessed and proposed to offset the potential impact of the proposed turbines on existing radio link(s).

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.

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 3 - Telecom Operator Consultations

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

3. Introduction

Consultations beginning in November 2021 were undertaken by the EIAR consultants (MKO) with relevant telecom network operators. 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 who raised concerns during the consultation process. The responses received from each of the Telecom Operators (ESB and Three Ireland) are provided in Section 3.1 and Section 3.2.

ID	Operator	Response Received (Yes/No)	Issues raised by Operator \ Observations.
1	ESB Services	Yes	ESB raised a concern regarding four Point-to-Point (PMP) UHF radio links.
2	Three Ireland	Yes	Three Ireland raised a concern regarding one Licensed PTP microwave radio link.

Table 2. Telecom Operators who raised concerns during Consultations

3.1 ESB Services Response to Consultations

In Section 3.1.1 the correspondences between the EIAR consultants (MKO) and ESB are provided. The correspondences between Ai Bridges and ESB Services are provided in Section 3.1.2

3.1.1 Consultations between ESB Services and EIAR Consultant

The correspondences between the EIAR consultants and ESB are provided below.

02/11/21 – ESB response to EIAR Consultations

"Hi Lorna,

Can you please forward on a PDF of the site boundary please? I am currently having issues opening the KMZ file on Google Earth.

*Regards,
Myles"*

02/11/21 – MKO Response

"Hi Myles,

Please see attached site boundary PDF and shapefile.

*Kind Regards,
Lorna"*

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

02/11/21 – ESB Response

"Hi Lorna,

I have carried out an initial impact analysis of proposed Windfarm development and can confirm we do have Point to Multipoint radio links crossing the outlined site boundary as listed below.

Link	Site A	Lat	Long	Height (m)	Frequency	Site B	Lat	Long	Height (m)
1	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Glenamaddy 38kV	53.605614	-8.574209	18
2	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Castlereagh 38kV	53.7575	-8.45286	15
3	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Shannagh Beg Solar	53.59236014	8.577466443	6
4	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Rathleg Solar	53.764841	-8.447302	6

Once the turbine locations have been determined, please let me know so that a detailed analysis can be carried out.

Regards,
Myles"

11/03/22 – MKO Response

"Hi Myles,

I have inherited the Cooloo Wind Farm project from Lorna and am following up on her last exchange. We still do not have a definite turbine layout as the constraints study is ongoing and will ultimately be informed by it. As you pointed out in the email below, there are radio links through the area. It would be helpful to know if these necessitate a buffer, and if so, of what dimensions. Could you please pass the information on if available.

Thank you, and please do not hesitate to come back to me if you have any queries,

Kind Regards,
Sanghamitra"

11/03/22 – ESB Response

"Hi Sanghamitra,

As per the Calculation of the Clearance Zone 3.1.doc by JRC, the buffer clearance zone recommended 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 micro siting.

The 2nd Fresnel Zone Clearance zone varies with the Frequency but also the link length and the distance of the turbine from Site A and to Site B. For the calculations below, I have calculated the link length was 42km, with the turbine at 10km from site A and 32km to site B.

For the Point to Multipoint Polling radio link which operate at 458MHz, This would be 97m + 150 + 100 = approx. 347m outside the blade tips on both sides of the Castlereagh 38kV station link as an example.

Regards,
Myles"

16/03/22 – MKO Response

"Hi Myles,

Many thanks for your assistance to date. Further to your email to Sanghamitra below, could you please advise on the buffer requirements for the all links.

We do not have specific turbine locations yet and are working off a viable area which will be informed by the information provide by yourself.

To inform your examination, I can confirm the following from our mapping:

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Link	Site A	Lat	Long	Height (m)	Frequency	Site B	Lat	Long	Height (m)
1	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Glenamaddy 38kV	53.605614	-8.574209	18
2	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Castlerea 38kV	53.7575	-8.45286	15
3	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Shannagh Beg Solar	53.59236014	8.577466443	6
4	Abbeyknockmoy	53.420236	-8.742158	36	458 MHz	Rathleg Solar	53.764841	-8.447302	6

Would you please be able to populate the column Buffer Required in the table above. I have included the number previously provided but if this changes based on the other parameters I have provided, please update.

Regards,
Owen Cahill."

25/03/22 – MKO Email to ESB

"Hi Myles,

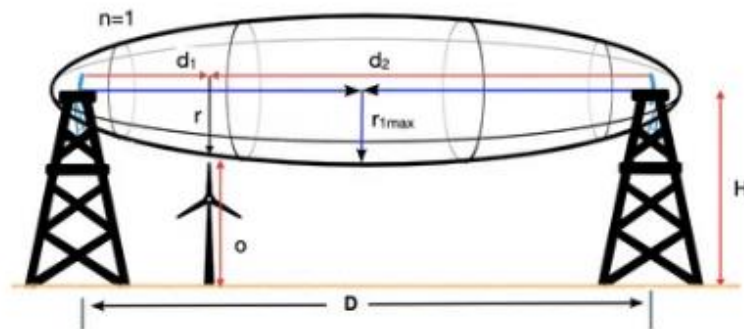
I'm following up on Owen's email below. Could you let us know if you have any updates for us. Thank you for your time and attention to this matter,

Kind Regards,
Sanghamitra."

25/04/22 – ESB Response

"Hi Sanghamitra, Owen,

Apologies about the delay in my response on your query. Below is the table as requested. It is hard to calculate the exact 2nd Fresnel zone distance until the turbine locations have been determined. Some developers will use the maximum 2nd Fresnel Zone which is the midway point between A & B (R max in the diagram below) and extrapolate this buffer zone for the full length of the link, this may be easiest way of plotting on your constraint maps.



Please note the buffer zone is from both side from the centre of the radio link.

Link	Site A	Site B	Link Length	Distance from Site A to Turbine Viable Area	Distance from Site B to Turbine Viable Area	Buffer Required both sides of the centre point of the link
1	Abbeyknockmoy	Glenamaddy 38kV	23.4km	7 - 10km	13 - 16km	334m
2	Abbeyknockmoy	Castlerea 38kV	42km	7 - 10km	32 - 35km	347m
3	Abbeyknockmoy	Shannagh Beg Solar	22km	7 - 10km	12 - 15km	333m
4	Abbeyknockmoy	Rathleg Solar	42.8km	7 - 10km	33 - 36km	347m

Please let me know if you require further information.

Regards,
Myles"

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

3.1.1.1 Consultations between ESB Services and Ai Bridges Ltd

The correspondences between the Ai Bridges and ESB are provided below.

15/08/22 – Ai Bridges Email to ESB Services

Myles,

I am re-sending this email to you which was sent earlier in June this year.

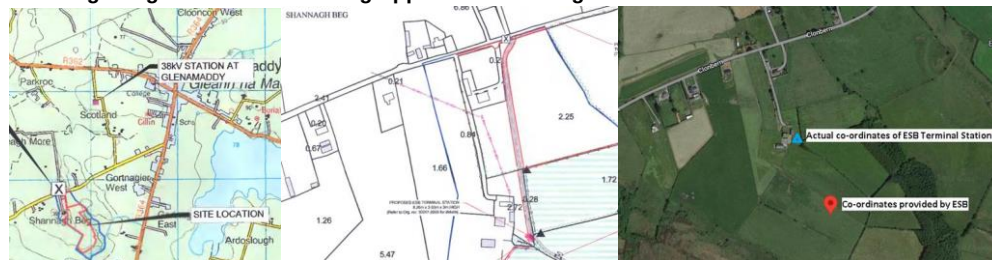
We are following up with you in relation to the correspondences that you have had with MKO in relation to proposed Cooloo Wind Farm Development. We have been commissioned to conduct a detailed technical analysis as part of the Environmental Impact Assessment

Our engineers have surveyed the 38kV sub-stations at both Glenamaddy and Castlerea 38kV sub-stations and have recorded the correct UHF antenna bearings to Abbeyknockmoy. From the field survey conducted it would appear that the antenna are mis-aligned.

Also our engineers have conducted an initial due diligence survey, by referring to the online planning references, which has shown that the Shannagh and Rathbeg solar farms have not been constructed. Please note that we are not obliged to consider telecommunications infrastructure that does not exist at the time of submission of a planning application and there is a previous precedent in this regard.

However for the purpose of this technical analysis our engineers conducted a field survey which showed that the co-ordinates provided for the Shannagh Beg and Rathbeg Solar Farms, during the consultation process, did not reflect the locations of the “ESB Remote Station” in the submitted planning application drawings, see attached. Our engineers have used the correct co-ordinates as part of their technical analysis and considered the ESB telecommunication infrastructure which are both non-existent.

Shannagh Beg Solar Farm Planning Application Drawings – Co-ordinate Check :



Rathleg Solar Farm Planning Application Drawings – Co-ordinate Check :



For your reference please see the attached analysis summary below that our engineers completed in relation to the proposed Cooloo Wind Farm development. Our engineers incorporated the correct co-ordinates in their analysis which shows no impacts from T06 on the 0.6F1 Fresnel Zone.

Please note that our engineers have used the reference provided as a basis for the 0.6F1 Fresnel Zone analysis “Calculation of the Clearance Zone 3.1.doc by JRC”. Thus our engineers have not observed request for “the buffer clearance zone recommended 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 micro siting.”

There is no basis in Irish Telecommunications Licensing to observe this exclusion distances. ComReg have confirmed that that can only deal with a matter of harmful interference due to radio equipment and not by physical structures.

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

As part of our technical analysis a “micro-sited” location for T07, in the viable wind farm development area, has been selected and while it reduces the interference impact on the Glenamaddy 38kV link there may be a possible interference impact on the Castlerea 38kV to Abbeyknockmoy Radio Link.

We will use this analysis, as shown in the summary below, as a basis to propose suitable mitigation measures which could be used to remediate the potential interference impacts of the proposed wind farm development. The mitigation measures that we are proposing are:

1. Micro siting the telecommunications timber poles at both Glanamaddy and Castlerea 38kV sub-stations to eliminate possible interference impacts on the 0.6F1 Fresnel Zone.
2. Installation of High Gain antenna system and use of optional radio frequency spectrum.
3. Using a relay mast , on the ESB existing Telecommunications network, relay the signal around the proposed development

Noting : that all remediate measure costs would be covered by the wind farm developer.

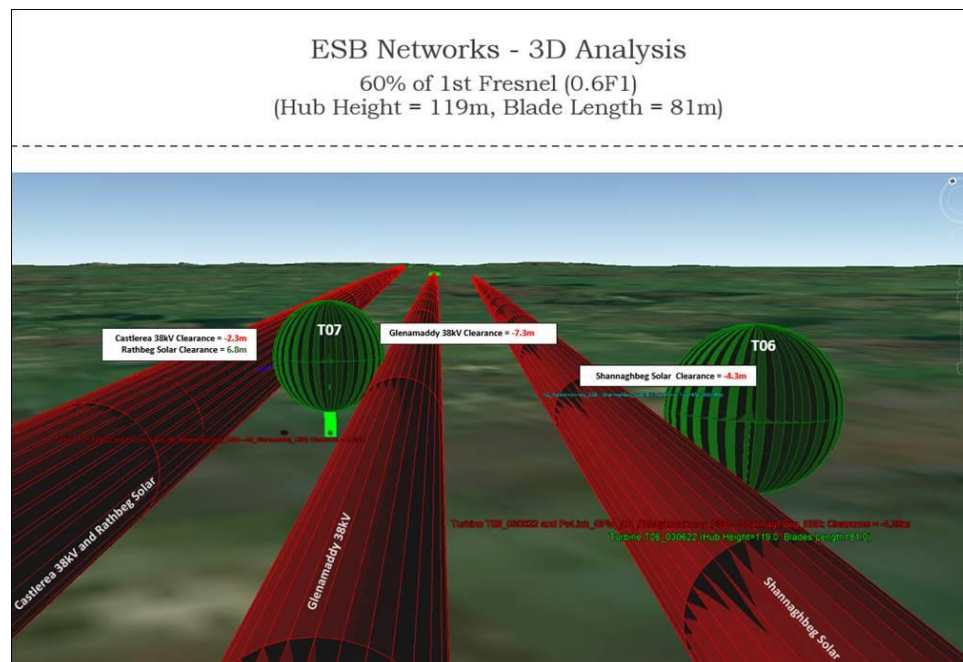
We will also be highlighting that there are many precedents where there is already wind farm interference impacts on the ESB UHF Telemetry networks and where these links are “operational” and continue to be operated

We will also be highlighting the PQQ process that ESB are engaging in, in relation a call to the market for an alternative technology to replace the UHF Telemetry network currently in use and that in all likelihood the current network will be replaced before a wind farm development would be constructed at the proposed site i.e. in the event of a successful planning application.

We will be submitting our analysis on the basis that viable mitigation measures can be implemented to remediate any potential wind farm impacts on existing telecommunications infrastructure. We will also be stating that is not acceptable for ESB, in our view, to impose restrictions which have no basis in Irish Telecommunications Licensing laws.

We will be recommending that a meaningful consultation process in a spirit of co-operation should be arranged with ESB , to agree a mitigation measure, in the same way as all other state agencies and licensed telecommunications operators have been engaged to agree mitigation measures.

We will provide a Letter Of Reliance as to the findings of our detailed technical analysis which will include our proposed Mitigation Measures



 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

3.2 Three Ireland Consultations

The correspondences between the EIAR consultants and Three Ireland are provided below.

3.2.1 Consultations between Three Ireland and EIAR Consultant

The correspondences between Three Ireland and the EIAR consultants are provided below.

Date (TBC) – Three Ireland response to EIAR Consultations

During consultations Three Ireland raised a concern regarding one PTP (Point-to-Point) microwave radio link. The details regarding the microwave radio link are shown in the table below which was provide by Three Ireland.

Link no.	Link Ref	Freq.	Length	Site A	X	Y	Dish Height	Site B	X	Y	Dish Height
1	ML020355	26GHz	10.3km	GA0064 - Clonriddia Forestry	153,147	250,825	30m	GA0313 - Moylough	163,430	249,594	30m

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 4 - Field Surveys

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4. Introduction

To assess/verify the accuracy of the radio link details (antenna co-ordinates, antenna installation heights, etc.), field surveys of the ESB radio links were carried out.

Figure 2 below shows the ESB radio link sites relative to the proposed wind farm. A summary of the findings of the field surveys of these sites are provided in Section 4.1 to Section 4.4 that follow.

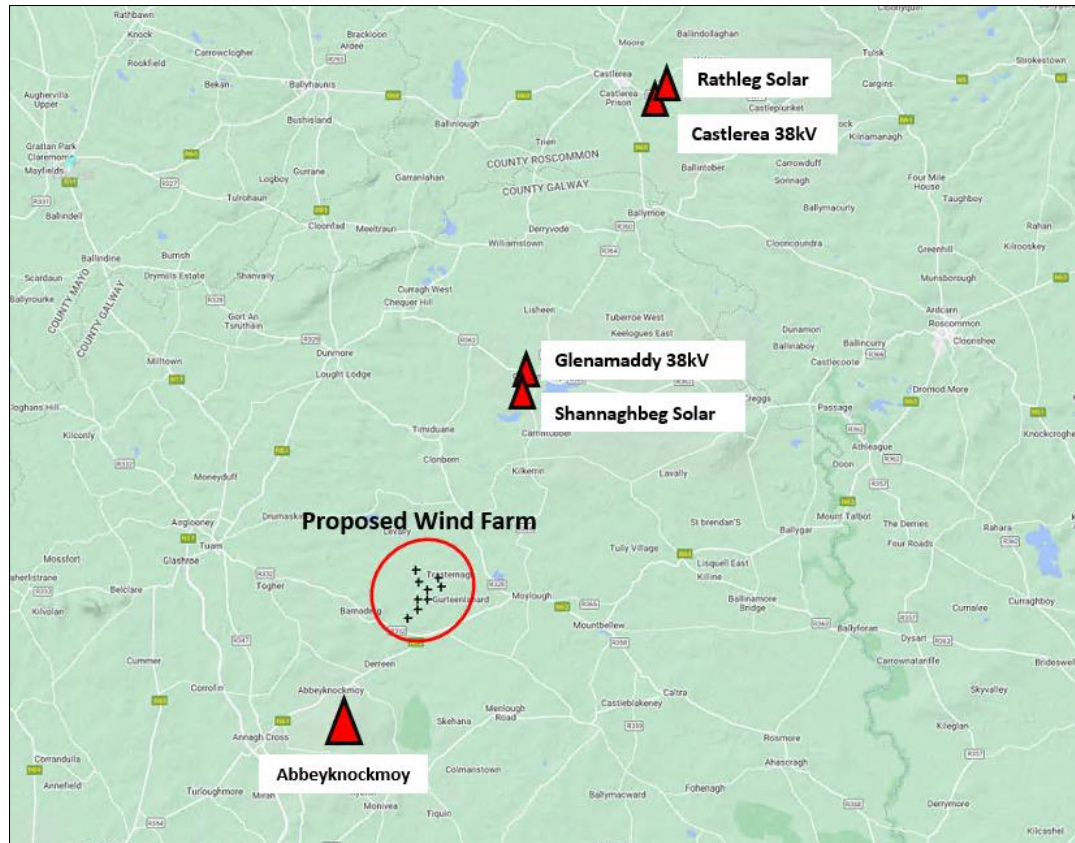


Figure 2. ESB Radio Link Sites relative to proposed wind farm.

Note: Field Surveys of the Three Ireland Radio network were also undertaken. The survey findings of the Three Ireland network are presented in Appendix B.

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4.1 Abbeyknockmoy

The survey of this site found that the ESB antennas are installed on the apex of the Telecoms Mast shown below in Figure 3. The antennas is installed at an approximate height of 36m AGL. A summary of the Abbeyknockmoy Field Survey is provided below in Table 4.



Figure 3. ESB Antenna at Abbeyknockmoy Telecoms Mast Site

Site	Operator	Co-ordinates	Antenna Type	Antenna Install Height (AGL) *
Abbeyknockmoy	ESB	53 25 12.85 N 08 44 31.82 W	<i>UHF Omni Directional</i>	36m

Table 3. Abbeyknockmoy – Field Survey Summary

* Approximate Height recorded from ground level during field survey.

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4.2 Glenamaddy 38kV

The survey of this site found that the ESB antenna is installed on the telecoms pole as shown below in Figure 4. The antenna is installed at an approximate height of 15m AGL. A summary of the Glenamaddy 38kV Field Survey is provided below in Table 4.



Figure 4. ESB Antenna at Glenamaddy 38kV Station

Site	Operator	Co-ordinates	Antenna Type	Antenna Install Height (AGL) *
Glenamaddy 38kV	ESB	53 36 20.21 N 08 34 27.18 W	UHF Directional Yagi	15m

Table 4. Glenamaddy 38kV – Field Survey Summary

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4.3 Castlerea 38kV

The survey of this site found that the ESB antenna is installed on the telecoms pole as shown below in Figure 4. The antenna is installed at an approximate height of 15m AGL. A summary of the Castlerea 38kV Field Survey is provided below in Table 4.



Figure 5. ESB Antenna at Glenamaddy 38kV Station

Site	Operator	Co-ordinates	Antenna Type	Antenna Install Height (AGL) *
Castlerea 38kV	ESB	53 45 27.06 N 08 27 10.78 W	UHF Directional Yagi	15m

Table 5. Castlerea 38kV – Field Survey Summary

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4.4 Shannagh Beg Solar

The survey of this site found that the Solar Farm is yet to be constructed. The coordinates for the radio antenna for this site provided by ESB appear to be chosen arbitrarily within the site boundary.

A summary of the Shannagh Beg Solar Field Survey is provided below in Table 5.



Figure 6. Shannagh Beg Solar - Proposed Site

Site	Operator	Radio Antenna Co-ordinates	Antenna Type	Antenna Install Height (AGL)
Shannagh Beg Solar	ESB	Antenna not installed	N/A	N/A

Table 6. Shannaghbeg Solar – Field Survey Summary

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

4.5 Rathleg Solar

The survey of this site found that the Solar Farm is yet to be constructed. The coordinates for the radio antenna for this site provided by ESB appear to be chosen arbitrarily within the site boundary.

A summary of the Rathleg Solar Field Survey is provided below in Table 6.



Figure 7. Rathleg Solar Site

Figure 8. Rathleg Solar - ESB Terminal Station Location

Site	Operator	Radio Antenna Co-ordinates	Antenna Type	Antenna Install Height (AGL)
Rathleg Solar	ESB	Antenna not installed	N/A	N/A

Table 7. Rathleg Solar – Field Survey Summary

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 5 – Solar Farm Planning References

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

5. Introduction

The Planning References for the proposed Solar Farms in the vicinity of the proposed wind farm are shown below in Table 3.

Wind Farm	Planning Reference(s)	Description
Shannagh Beg	https://www.eplanning.ie/GalwayC/AppFileRefDetails/171195/0	Planned Solar Farm – not yet constructed. Proposed development on 9.68 hectares will include a 4.2MVA solar farm comprising photovoltaic panels on ground mounted frames, 4 no. single storey inverter/transformer stations, 1 no. single storey ESB MV substation, security fencing, CCTV, and all associated ancillary development works. Gross floor space of proposed works 102.46sqm.
Rathleg	https://www.eplanning.ie/RoscommonCC/AppFileRefDetails/17295/0	Planned Solar Farm – not yet constructed. Development at a site within the townland of Rathleg, Castlerea, Co. Roscommon. The application is for a 10 year planning permission. The development will consist of A Solar Farm with an export capacity of approximately 4.2 MVA comprising Photovoltaic Panels on ground mounted frames, an enclosed single storey ESB Terminal Station, a single storey switchgear enclosure with storage contained, 4 No. single storey inverter stations, ducting & underground electrical cabling, perimeter fencing mounted CCTV cameras, provision of new access to public road as well as internal access track, and all associated site development and landscaping works.

Table 8. Permitted Wind Farms in vicinity of proposed Wind Farm

From the details contained within the Planning documents, the coordinates for the radio antennas at Shannagh Beg and Rathleg appear to be chosen arbitrarily by ESB. Sections 5.1 and 5.2 that follow show the differences between the radio coordinates provided by ESB (in consultations with MKO) relative to the actual (Terminal Station) coordinates in the Planning documents.

5.1 Shannagh Beg Terminal Station Coordinates

Figure 9 below shows the actual coordinates of the Terminal station at Shannagh Beg, as per the Planning documentation.

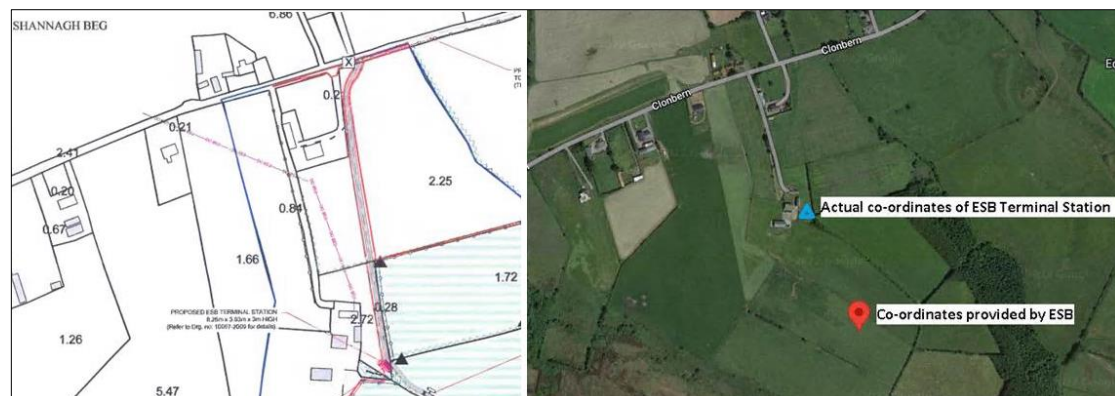


Figure 9. Actual location of ESB Terminal Station – Shannagh Beg Solar

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

5.2 Rathleg Terminal Station Coordinates

Figure 9 below shows the actual coordinates of the Terminal station at Shannagh Beg, as per the Planning documentation.



Figure 10. Actual location of ESB Terminal Station – Rathleg Solar

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 6 - Desktop Survey Analysis

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

6. Introduction

Based on the findings of the consultation process, there are two Telecom Operators with networks in the vicinity of the proposed development that require a detailed technical analysis:

- ESB Services Network
- Three Ireland Network

Sections 6.1 to 6.2 below outlines the desktop survey analysis findings* for the Telecom Operator Networks listed above.

6.1 ESB Services Network Analysis

The ESB network in the vicinity of the proposed wind farm consists of four PMP UHF radio links. The radio links are listed in Table 9 below and a Plan View of the ESB network is shown in Figure 11.

Link ID	Operator	Link Description
1	ESB	PMP radio link from Abbeyknockmoy to Glenamaddy 38kV
2	ESB	PMP radio link from Abbeyknockmoy to Glenamaddy 38kV
3	ESB	PMP radio link from Abbeyknockmoy to Shannagh Beg Solar
4	ESB	PMP radio link from Abbeyknockmoy to Rathleg Solar

Table 9. Radio Links requiring Analysis

Figure 11 below shows a Plan View of the ESB PMP radio links in the vicinity of the proposed wind farm.

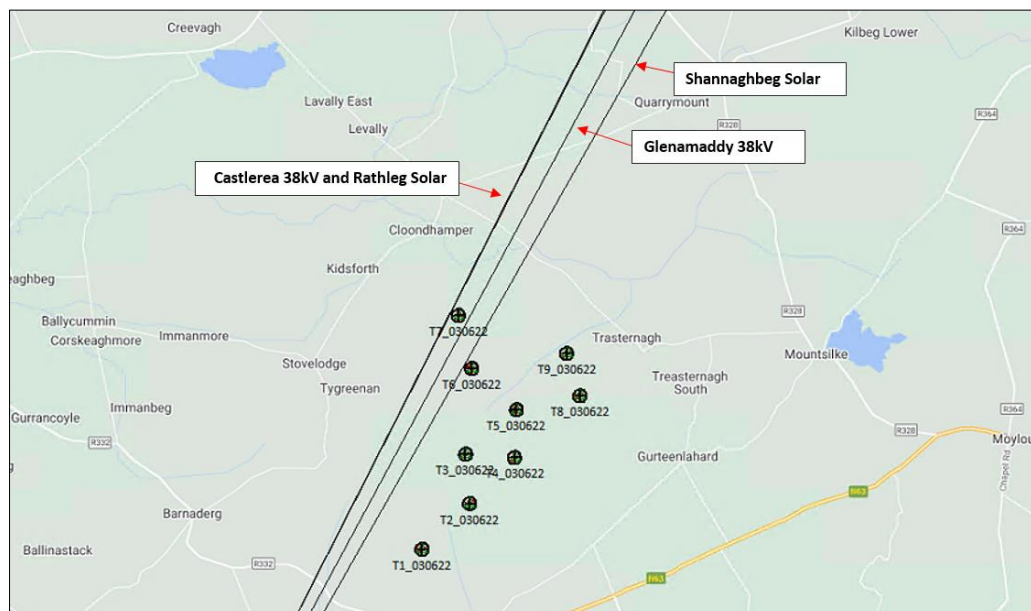


Figure 11. Plan View of ESB's PMP radio link in vicinity of proposed wind farm.

To assess the potential impact of the proposed turbines on these radio links, a 3D analysis of the radio link was carried out. Topology and Morphology layers were modelled for the 3D analysis and the International Telecommunication Union - Radio Communication (ITU-R) Rec. 526-11/Cascade Knife Edge method was used for calculations.

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Note: When assessing impacts on radio links most Telecom Operators including statutory bodies accept the Radio Diffraction Theory that states that low frequency links (< 1GHz) will not be impacted if the obstruction (e.g. turbine or terrain) is outside the 0.6 Fresnel Zone of the radio link. ESB's own radio consultants, JRC, also use 0.6 F1 for sub 1GHz radio links*. JRC do include a buffer for location uncertainties, however as Ai Bridges have conducted due diligence field surveys, these location uncertainties are not applicable.

The analysis findings when considering the Critical 0.6 Fresnel Zone are provided below.

* Ref: "Calculation of Wind Turbine clearance zones for JRC managed fixed services with particular reference to UHF (460MHz) Telemetry Systems when turbine sizes and locations are accurately known. Issue 4.2 December 2014

6.1.1 3D Radio Link Analysis – ESB Network

Network analysis calculations indicate that (in the current turbine layout) turbines T01, T02, T03, T04, T05, T06, T08, T09 are more than 50m from the ESB links and they will have no impacts.

In its current location, there would be a relatively small incursion into the 0.6 Fresnel Zone of the Glenamaddy and Castlerea radio links by Turbine T07 (11.4m and 4.5m respectively).

As the Solar Farms at Shannagh Beg and Rathleg are not constructed there is no current impacts due to the proposed wind farms. (The Solar Farm radio links are shown in the figure below for illustration purposes only).

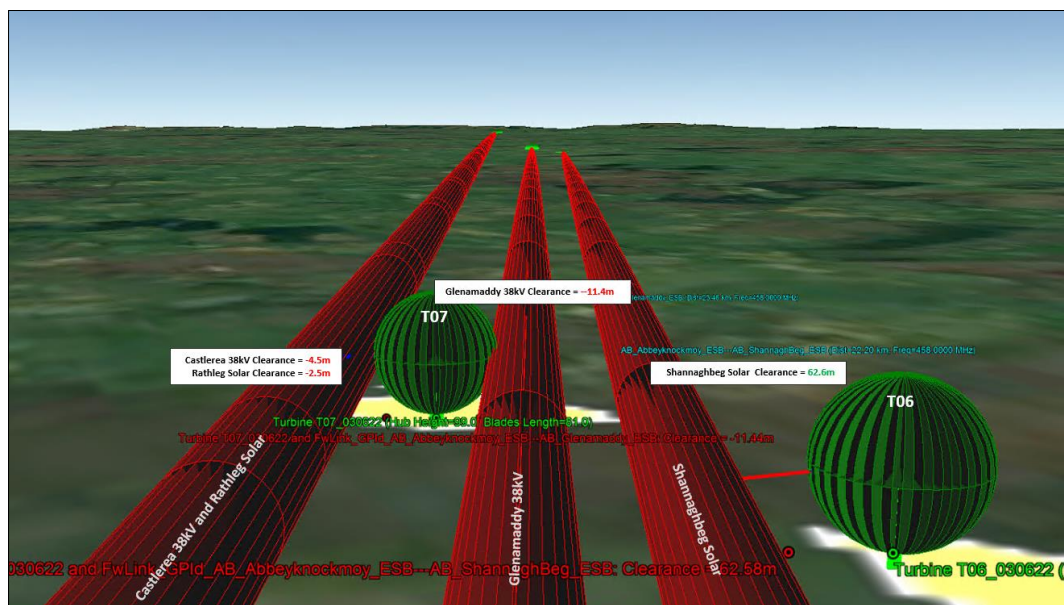


Figure 12. 3D Model showing proposed turbines relative to ESB radio link – 0.6 Fresnel Zones

Although network analysis indicates that Turbine T07 will obstruct the 0.6 Fresnel Zone of the Glenamaddy and Castlerea links, it should be noted that the 0.6 Fresnel Zone of these radio links is already significantly impeded by existing terrain, as shown below in Figure 13.

The analysis indicates that any impacts due to turbine T07 would be relatively small when compared the existing impact of the obstruction due to terrain.

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

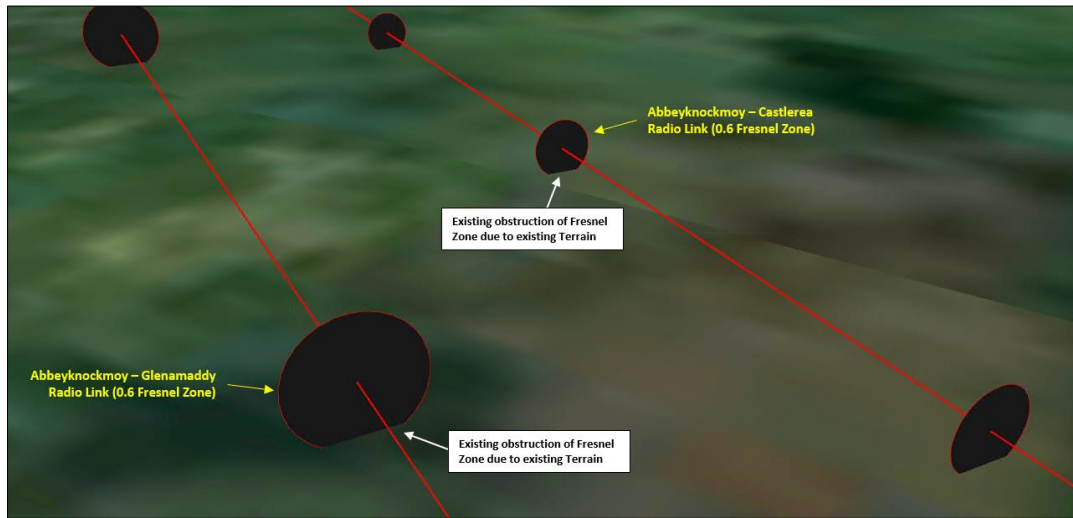


Figure 13. 3D Model showing 0.6 Fresnel of ESB radio links are already obstructed by terrain.

A summary of the results of the Proposed Turbines Impact Analysis is provided in the table below.

Turbine	UHF PMP Radio Link (from Abbeyknockmoy)			
	Glenamaddy 38kV	Castlerea 38kV	Shannagh Beg Solar	Rathleg Solar
T01	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T02	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T03	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T04	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T05	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T06	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T07	Fail - Turbine obstructs the 0.6 Fresnel Zone by a distance of 11.4m.	Fail - Turbine obstructs the 0.6 Fresnel Zone by a distance of 4.5m.	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T08	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed
T09	Pass	Pass	Pass – Solar Farm not constructed	Pass – Solar Farm not constructed

Table 10. Proposed Turbine(s) Impact Analysis - Calculation Results – ESB Network

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

6.2 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 11 and a Plan View of the Three Ireland network is shown in Figure 14.

Link ID	Operator	Link Description
1	Three Ireland	PTP microwave radio link between Cloonriddia and Moylough.

Table 11. Three Ireland Radio Links requiring Analysis

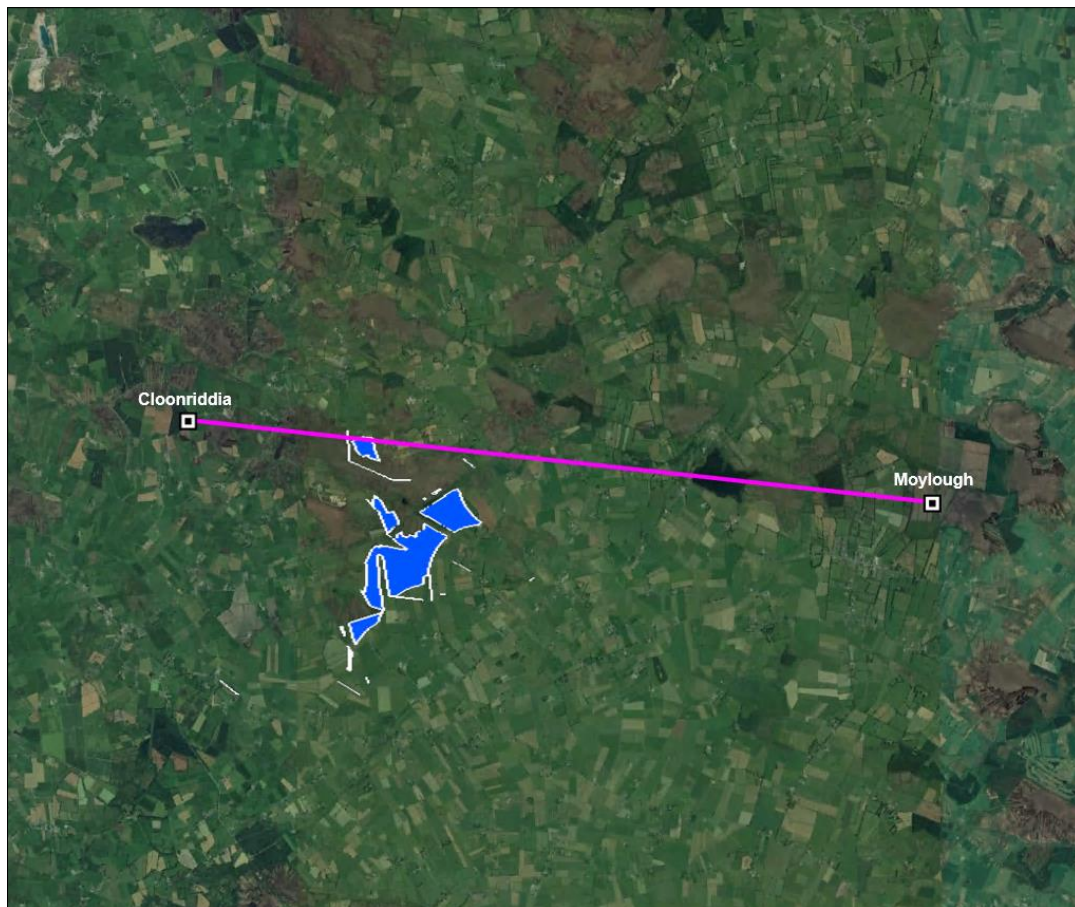


Figure 14. Three Ireland Radio Network – Plan View

To assess the potential impact of the proposed turbine layout, the Three Ireland radio network has been modelled in 3D and the Clearance Distances between the Fresnel Zone(s) of the radio link(s) and the blade-tip of the nearest turbine(s) have been calculated. The results of this 3D network analysis are presented in Section 6.2.1 that follows.

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

6.2.1 3D Radio Link Analysis – Three Ireland

The findings of the 3D analysis indicate that there would be a clearance distance of more than 75m between the blade-tip of T07 and the 2nd Fresnel Zone of the radio link between Cloonriddia and Moylough. At this distance there would be no impact on the Three Ireland radio link due to the proposed turbines.

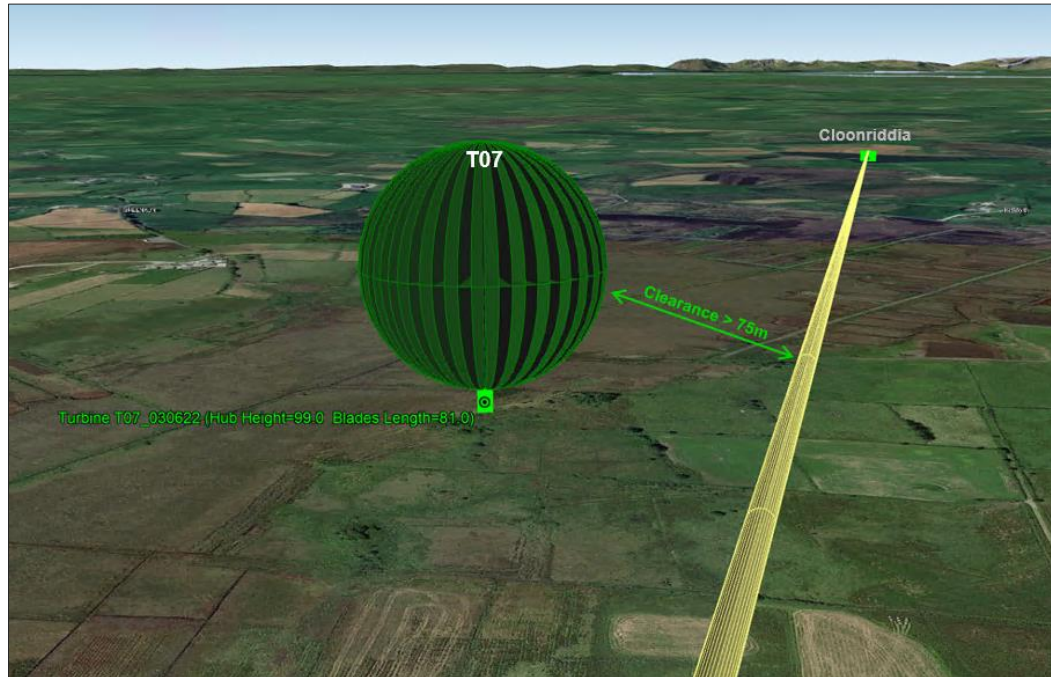


Figure 15. Three Ireland Network – 3D View

Table 9 below provides a brief summary of the radio link interference analysis for the closest turbine (T07) to the Three Ireland radio link.

Radio Link ID	Link Description	Nearest Turbine	Fresnel Zone (F2) Clearance/Interference	Wind Farm Impacts
Three Ireland Link 1	Cloonriddia to Moylough	T07	> 75 m	No Impacts.

Table 12. Three Ireland Network – Analysis Summary

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 7 - Mitigation Measures

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

7 Introduction

Sections 7.1 and 7.2 that follow, describe the mitigation measures available to the wind farm developer to offset the potential impact of the proposed turbines on the ESB and Three Ireland Networks.

Note: Although the Three Ireland radio link between Cloonriddia and Moylough would not be impacted by the original 2022 Turbine Layout, there is potential for this link to be impacted if the location of T07 is revised. For this reason possible mitigation measures for the Three Ireland network are provided.

7.1 Mitigation Measure Solutions – ESB Network

To offset the potential impact of the turbines on the ESB radio links the following mitigation solutions are available:

- i) Microsite T07 to minimize obstruction into Glenamaddy and Castlerea Radio Link Fresnel Zones.
- ii) Relocate the monopoles at the Glenamaddy and Castlerea 38kV stations.

These mitigation measures are described in more detail in Section 7.1.1 and Section 7.1.2 that follow.

7.1.1 Microsite T07 to minimize obstruction into Radio Link Fresnel Zones.

An option of minimize any potential impact of T07 on the ESB communications link would be to microsite the turbine northeast of its current position. Moving T07 by 150m northeast of its current location could reduce the interference distance into the Fresnel Zone of the Glenamaddy 38kV link from 11.4m to 8.4m. The interference distance on the Castlerea 38kV link would also be reduced (4.5m to 4.4m).

Figure 16 below shows an example of a micro-sited location for turbine T07. A 3D model showing the micro-sited T07 relative to the ESB links is shown in Figure 17.

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

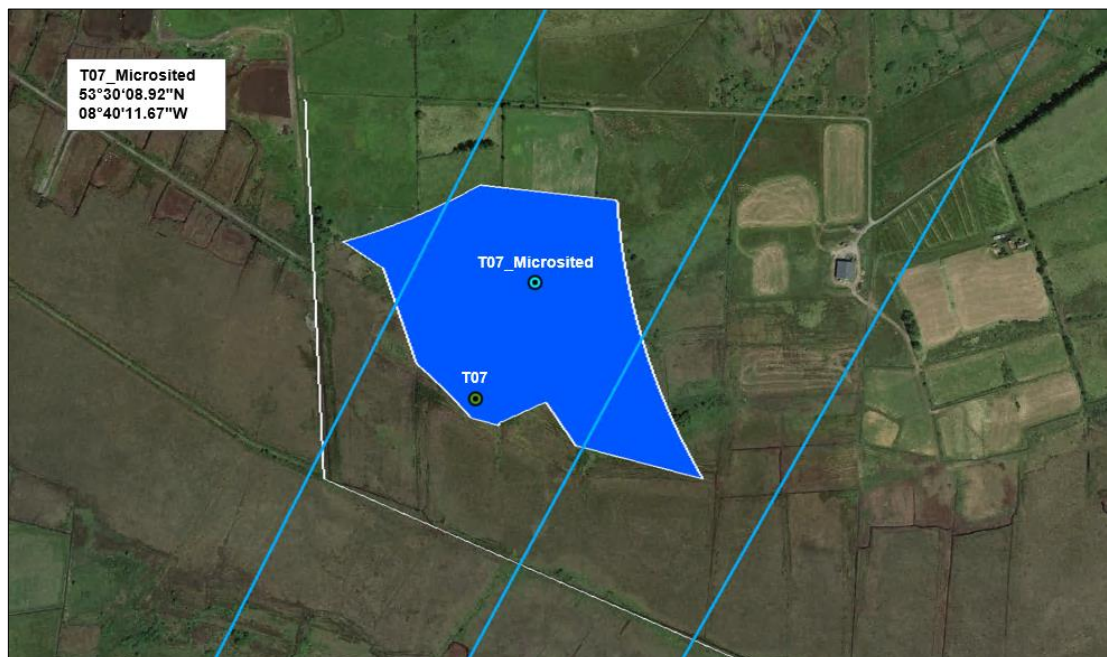


Figure 16. Turbine T07 Micro-sited to Northeast.

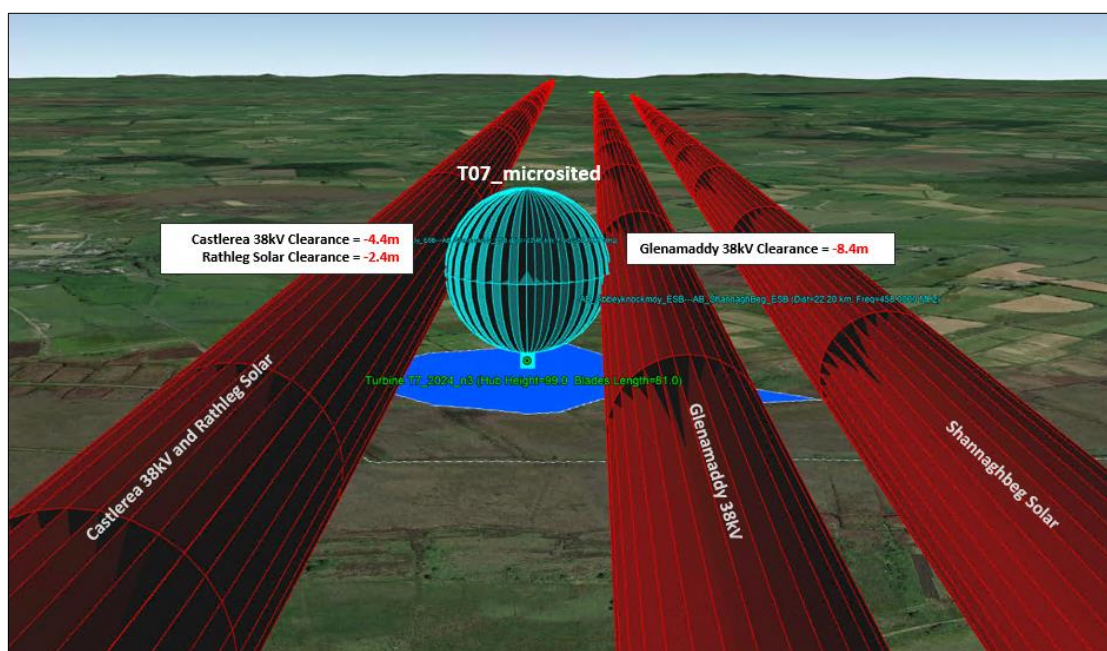


Figure 17. 3D Model showing a sample micro-sited location for T07 shown relative to the ESB radio links

Although micro-siting T07 to the northeast minimizes the impact on the ESB PMP network, it does move the turbine closer to the Three Ireland PTP microwave radio. 3D analysis indicates that there would be 11.4 m between the 2nd Fresnel Zone of the Three Ireland Radio link and the blade-tip of “T07_microsited”.

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

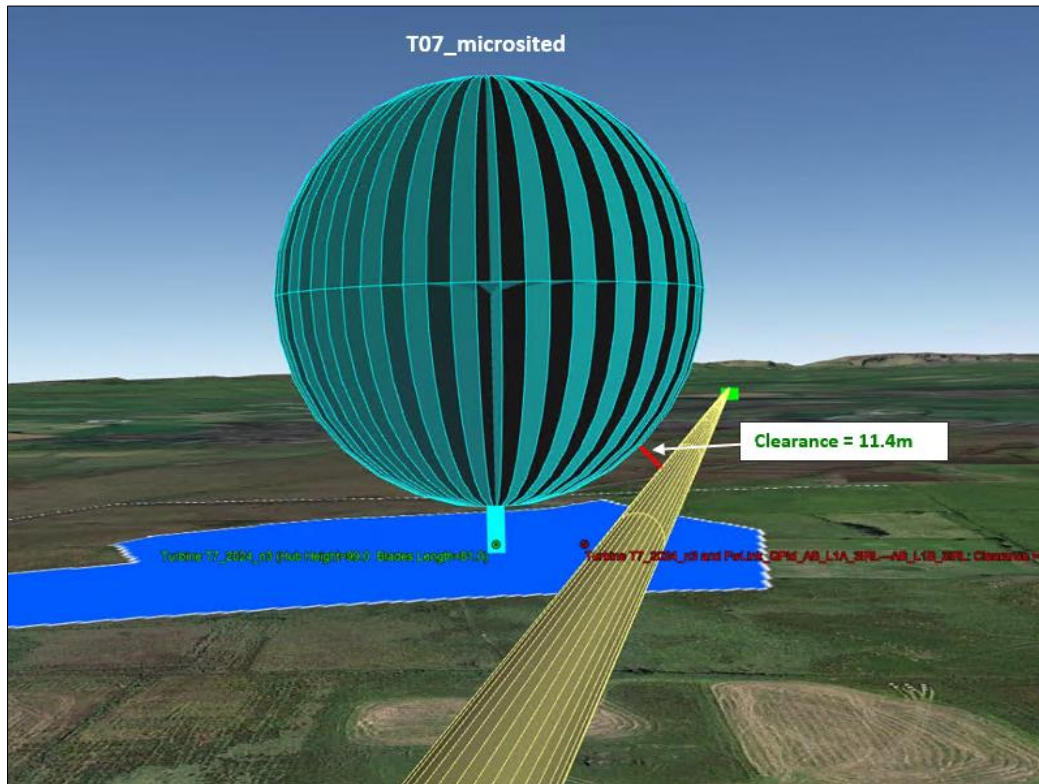


Figure 18. 3D Model showing a sample micro-sited location for T07 shown relative to the Three Ireland radio link

Note: Further consultations with Three Ireland would be required to confirm that clearance distance of 11.4m from the 2nd Fresnel Zone of the radio link is acceptable to them.

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

7.1.2 Relocate monopoles at Glenamaddy and Castlerea 38kV stations.

To increase the distance between the 0.6 Fresnel of the radio links and turbine T07, the B-ends of the radio links (i.e. the monopoles at Glenamaddy and Castlerea) could potentially be relocated. Figures 16 and 17 below illustrate how moving the monopoles at Glenamaddy and Castlerea could increase the distance between T07 and the radio links.

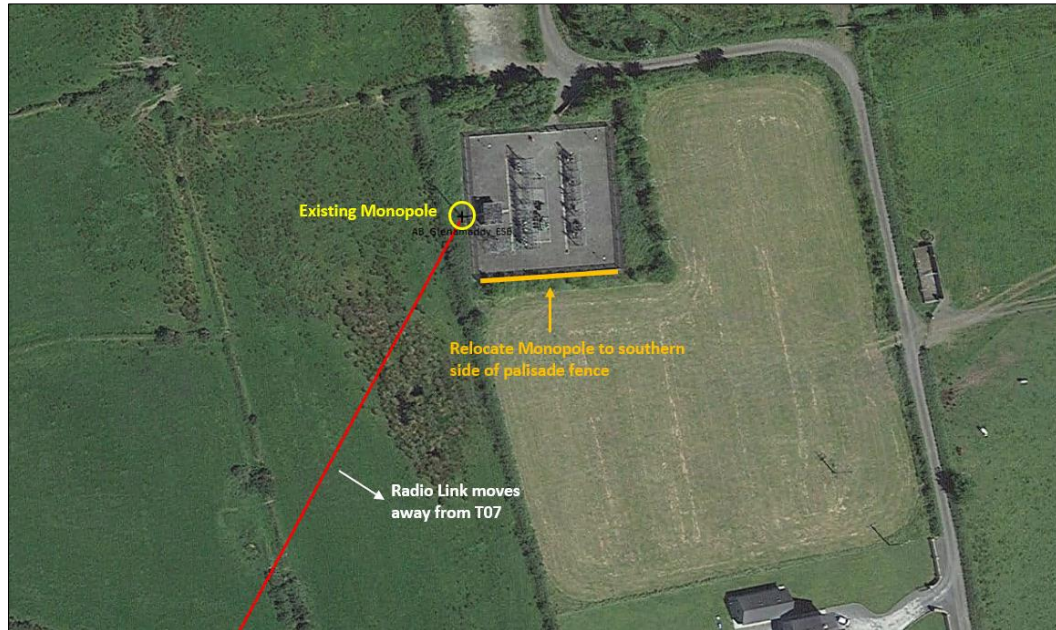


Figure 19. Relocated Monopole - Glenamaddy 38kV



Figure 20. Relocated Monopole - Castlerea 38kV

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

7.2 Mitigation Measure Solutions – Three Ireland Network

To offset the potential impact of (micro-siting) T07 on the Three Ireland radio link between Cloonriddia and Moylough the following mitigation solutions are available:

- i) Relay the Three Ireland radio link via an existing Telecoms Mast.

This mitigation measure is described in more detail in Section 7.2.1 that follows

7.2.1 Relay the Three Ireland radio link via an existing Telecoms Mast.

An alternative option to mitigate for the impact on the radio link to between Cloonriddia and Moylough would be to use an existing telecoms mast to relay the radio link.

Figure 21 below illustrates how the existing telecoms mast-site at Creevagh could be used to relay a radio link between Cloonriddia and Moylough.

Note: A database of telecommunications mast-sites indicates that Three Ireland have an existing presence at the Creevagh mast-site.

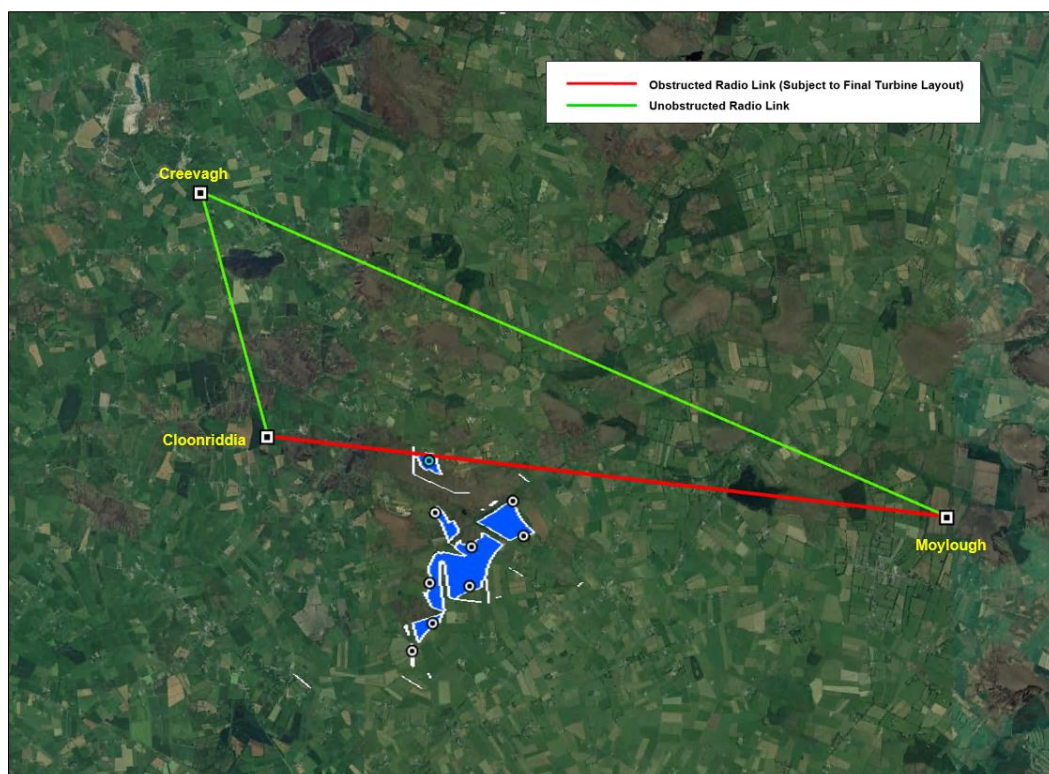


Figure 21. Example of how an existing telecoms mast could be relay the radio link between Cloonriddia and Moylough.

To determine if Creevagh could be used as a viable relay-mast, radio link path profiles were generated. Radio Link Budgets were also carried out to determine if the proposed links would meet the Radio Link Availability Criteria required by ComReg for radio licensing. The Radio Link Path Profiles and Radio Link Budgets are based on the following ITU-R Recommendations:

AiBridges Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

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

The radio Path Profiles are shown in Sections 7.2.1.1 and 7.2.1.2 that follows. The Radio Link Budgets can be found in Appendix C.

7.2.1.1 Path Profile – Cloonriddia to Creevagh

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.

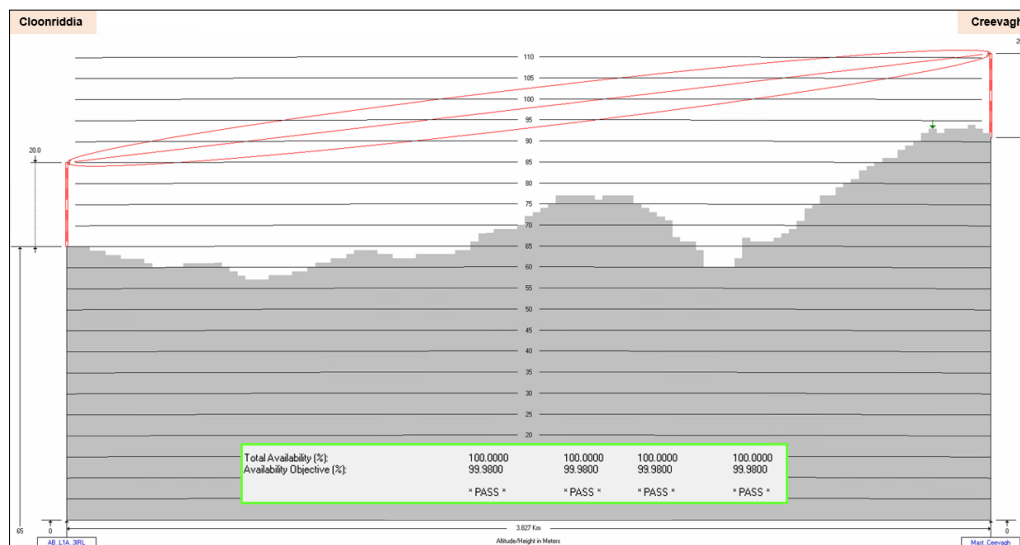


Figure 22. Path Profile – Cloonriddia to Creevagh

7.2.1.2 Path Profile – Creevagh to Moylough

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.

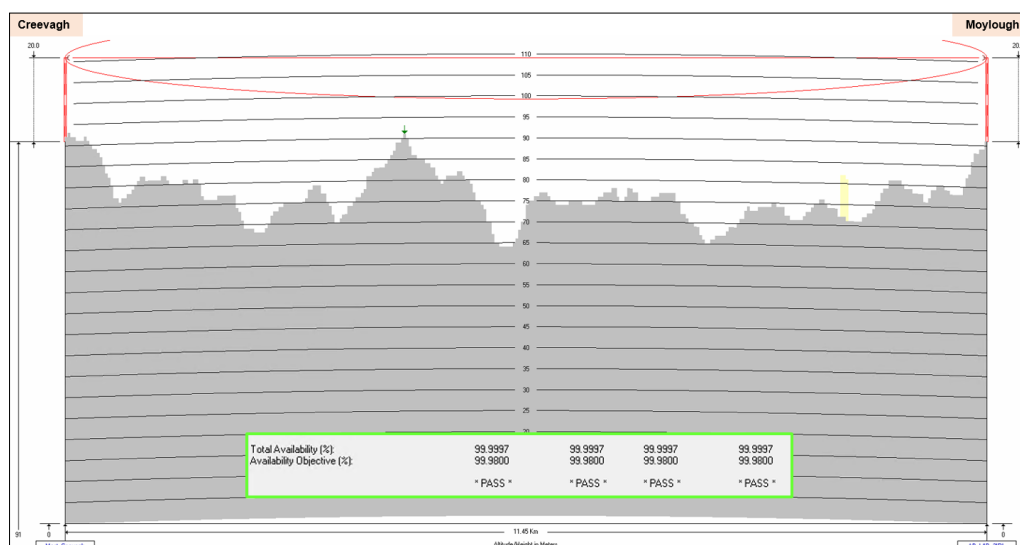


Figure 23. Path Profile – Creevagh to Moylough

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 8 - Conclusions

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

8. Conclusions

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

- The Solar Farms at Shannagh Beg and Rathleg are not constructed and there are no existing radio links to these sites.
- When using the radio diffraction theory, the accepted 0.6F1 Fresnel Zone Radio Link Clearance Calculations, Turbine T07 would fail the clearance criteria to the PMP radio links to Glenamaddy and Castlerea 38kV stations by a relatively small distance. (Glenamaddy Clearance : -11.4m Castlerea Clearance: -4.5m)
- A number of mitigation measures have been proposed to offset/minimize the potential impact of Turbine T07 on the ESB telemetry links and are presented in Section 7.1 of this report. The associated mitigation measure costs of remediating the impacts on the ESB Telemetry links are presented below ...

ESB Mast Relay Site Mitigation Measure Proposal:

- Installation of UHF PMP telemetry link equipment to be installed and maintained by ESB Networks for duration of operation of the wind farm
- Civil Construction by the wind farm developer of a concrete plinth, outdoor street side telecommunication cabinet, palisade fencing and a 6m monopole.

ESB Mast Relay Site Mitigation Measure Costs :

- Once-off Civil Construction costs including concrete plinth palisade construction and monopole construction to be covered by the wind farm developer are estimated to be in the order of €15,000
- The proposed mitigation measure would involve supply and provisioning of the
 - Street side Telecommunications Cabinet
 - Electrical & Battery Pack Supply
 - 2 no UHF Links including radio and antenna equipment :
 - Design & Commissioning Services :
- If it is decided to micro-site T07 (i.e. to minimize the impact on the ESB network), this would reduce the clearance distance between the turbine and the Three Ireland PTP radio link to 11.4m. Additional consultations would be required with Three Ireland to confirm that a clearance distance of 11.4m from the 2nd Fresnel Zone of their radio link is acceptable to them.
- If mitigation is required for the Three Ireland radio link, a possible solution would be to relay the PTP radio link via an existing Telecoms Mast (e.g. telecoms mast at Creevagh). This mitigation measure is described in Section 7.2 of this report. The associated mitigation measure costs of remediating the impacts on the Three Ireland radio link are presented below ...

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Three Ireland Mitigation Measure Proposal:

- Relay the Three Ireland radio link between Cloonriddia and Moylough via an existing Telecoms Mast (i.e. Creevagh). This would involve the installation of two microwave radio links:
 - PTP radio between Cloonriddia and Creevagh
 - PTP radio between Creevagh and Moylough

Three Ireland Mitigation Measure Costs :

- Once-off installation of two microwave radio links to be covered by the wind farm developer are estimated to be in the order of €10,000 - €15,000
- The proposed mitigation measure would involve supply and provisioning of the
 - 2 no microwave radio links including radio antennas, cables connectors, etc.
 - Rigging and Installation Services
 - Design & Commissioning Services

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Section 9 - References

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

9.1 References

- (i) International Telecommunications Union Recommendation: ITU-R P.525 “International Telecommunications Union radio communications standard for the calculation of free-space attenuation.”
- (ii) International Telecommunications Union Recommendation: ITU-R P.526 “*International Telecommunications Union radio communications standard for the Propagation by diffraction.*”
- (iii) OFCOM Report: “*OfW 49 Fixed Point-to-Point and Point-to-Multipoint Scanning Telemetry Radio Services Operating in the Frequency Ranges 457.5 to 458.5 MHz paired with 463.0 to 464.0 MHz*” Published May 2017 Version 3.0
- (iv) AEGIS Report: “*RF Measurement Assessment of Potential Wind Farm Interference to Fixed Links and Scanning Telemetry Devices*” Published March 2009 Issue 3
- (v) JRC Report “*Calculation of Wind Turbine clearance zones for JRC managed fixed services with particular reference to UHF (460MHz) Telemetry Systems when turbine sizes and locations are accurately known.*” Issue 4.2 December 2014

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

APPENDIX A – Cooloo Wind Farm Turbine Co-ordinates

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Appendix A – Cooloo Wind Farm Turbine Co-ordinates

The co-ordinates of the turbines studied in this report are shown below in Table A1.

Cooloo Wind Farm Co. Galway		
Turbine No.	ITM Latitude	Longitude
T1	53° 28' 31.258"N	8° 40' 39.724"W
T2	53° 28' 49.533"N	8° 40' 7.647"W
T3	53° 29' 9.242"N	8° 40' 10.358"W
T4	53° 29' 7.861"N	8° 39' 37.566"W
T5	53° 29' 27.006"N	8° 39' 36.190"W
T6	53° 29' 43.534"N	8° 40' 6.317"W
T7	53° 30' 4.667"N	8° 40' 15.322"W
T8	53° 29' 32.580"N	8° 38' 53.552"W
T9	53° 29' 49.527"N	8° 39' 2.559"W

Table A1 - Cooloo Wind Farm Turbine Co-ordinates (2022 Turbine Layout)

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

APPENDIX B – Field Survey of Three Ireland Network

	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Appendix B – Field Survey of Three Ireland Network

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

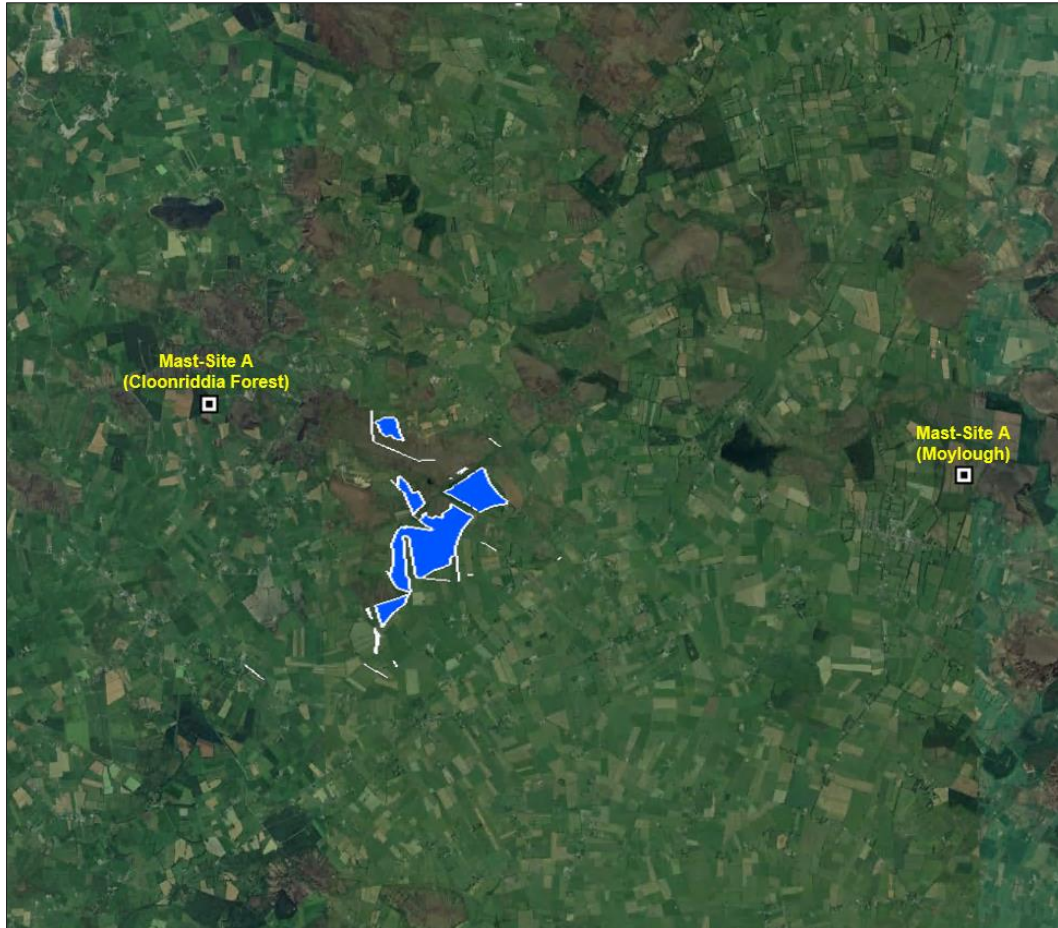


Figure 24. Three Ireland Telecom Mast-Sites shown relative to proposed wind farm.

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Mast-Site A (Cloonriddia Forest)

Telecommunications Mast-Site A is located in Cloonriddia Forest, Co. Galway and is approximately 3 km west of the proposed wind farm. A photo of the mast-structure at this location is shown below.



Figure 25. Mast-Site A

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

Table 13. Field Survey Summary – Mast-Site A

AiBridges <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Mast-Site B (Moylough)

Telecommunications Mast-Site B is located in the townland of Tomree, Moylough, Co. Galway, and is approximately 7 km east of the proposed wind farm. A photo of the mast-structure at this location is shown below.



Figure 26. Mast-Site B

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

Table 14. Field Survey Summary – Mast-Site B

 <i>Total Broadband Solutions</i>	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

APPENDIX C – Radio Link Budget Reports

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Appendix C – Radio Link Budget Reports

C.1 Radio Link Budget Report (Cloonriddia – Creevagh)

Link Budget Report

Site:	Cloonriddia	Creevagh
Name:		
Type:	Cell	Cell
Latitude:	53°30'19.8"N	53°32'18.8"N
Longitude:	8°42'24.7"W	8°43'21.0"W
Altitude (m):	65.0	91.0
UserData1:	User Data	
Datum:	World Geodetic System 1984 (WGS 84)	
	Forward Link	Reverse Link
Transmission Site:	AB_L1A_3IRL	Mast_Ceevagh
Reception Site:	Mast_Ceevagh	AB_L1A_3IRL
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
Service Threshold (dBm):	-91	-91
Carrier to Noise Ratio (dB):	14.965	15.965
Cross Polarization Improvement Factor (dB):	20	20
Rx Equalization Sig Norm Parameter (Kn,M):	0.1	0.1
Rx Equalization Sig Norm Parameter (Kn,NM):	0.1	0.1
UserData1:	User Data	User Data
Center Frequency (MHz):	26000	26000
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:	HP2-26	HP2-26
Transmission Antenna Size (m):	0.6	0.6
Transmission Antenna Height (m):	20	20
Transmission Antenna Gain (dBd):	38.96	38.96
Transmission Antenna Gain (dBi):	41.1	41.1
Transmission Power EIRP (dBm):	70.1	70.1
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

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Reception Losses (dB): 1 1
 Reception Antenna: HP2-26 HP2-26
 Reception Antenna Size (m): 0.6 0.6
 Reception Antenna Height (m): 20 20
 Reception Antenna Gain (dBd): 38.96 38.96
 Reception Antenna Gain (dBi): 41.1 41.1

Link Polarization: Vertical Vertical
 Cross Polarization Factor (dB): 30 30

Link Distance (m): 3827.053 3827.053
 Azimuth - True (°): 344.306 164.293
 Azimuth - Magnetic (°): 346.881 166.88
 Transmission Inclination (°): -0.389 0.389
 Reception Inclination (°): -0.389 0.389

ITU Recommendation: ITU-R P.525-2
 Free Space Distance (m): 3827.142 3827.142
 Center Frequency (MHz): 26000 26000
 Free Space Loss (dB): 132.397 132.397

Max Fresnel Radius (m): 3.323 3.323
 Max 2nd Fresnel Radius (m): 4.699 4.699

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
 Diffraction Loss (dB): 0 0

Clearance Target (%): 60
 Minimum Clearance (m): 15.342 15.342
 Minimum Clearance Point (m): 3585.852 3585.852

Terrain Reflection Dispersion (°): 0.5
 Reflection Area 1 (m): 337.681 337.681
 Reflection Area 2 (m): 627.122 627.122
 Reflection Area 3 (m): 1238.164 1238.164
 Reflection Area 4 (m): 1398.965 1398.965
 Reflection Area 5 (m): 1495.4 - 1559.8 1495.4 - 1559.8
 Reflection Area 6 (m): 3328.6 - 3360.7 3328.6 - 3360.7
 Reflection Area 7 (m): 3425.052 3425.052
 Reflection Area 8 (m): 3489.372 3489.372

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): 0.506 0.506

Total Path Loss (dB): 132.903 132.903

Reception Signal Level (dBm): -22.703 -22.703

BER 10-3 BER 10-6 BER 10-3 BER 10-6
 Service Threshold (dBm): -91 -90 -91 -90
 Link Gross Margin (dB): 68.297 67.297 68.297 67.297

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

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

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

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 (%): 2.09E-03 2.09E-03

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): 3.069491 3.069491
Rainfall Attenuation (dB): 10.382 10.382

BER 10-3 BER 10-6 BER 10-3 BER 10-6
Fading Outage (%): 2.24E-11 2.83E-11 2.24E-11 2.83E-11
Selective Fading Outage (%): 4.53E-12 4.53E-12 4.53E-12 4.53E-12
Composite Fading Outage (%): 2.70E-11 3.28E-11 2.70E-11 3.28E-11

Fading Outage (s/Month): 0 0 0 0
Selective Fading Outage (s/Month): 0 0 0 0
Composite Fading Outage (s/Month): 0 0 0 0

BER 10-3 BER 10-6 BER 10-3 BER 10-6
Unavailability due to Rain (%): 0.00E+00 0.00E+00 0.00E+00 0.00E+00
Unavailability due to Rain (s/Year): 0 0 0 0

BER 10-3 BER 10-6 BER 10-3 BER 10-6
Unavailability due to Fading (%): 2.70E-11 3.28E-11 2.70E-11 3.28E-11
Unavailability due to Rain (%): 0.00E+00 0.00E+00 0.00E+00 0.00E+00
Total Unavailability (%): 2.70E-11 3.28E-11 2.70E-11 3.28E-11
Unavailability Objective (%): 2.00E-02 2.00E-02 2.00E-02 2.00E-02

Unavailability due to Fading (s/Year): 0 0 0 0
Unavailability due to Rain (s/Year): 0 0 0 0
Total Unavailability (s/Year): 0 0 0 0
Unavailability Objective (s/Year): 6307.2 6307.2 6307.2 6307.2

Total Availability (%): 100.0000 100.0000 100.0000 100.0000
Availability Objective (%): 99.9800 99.9800 99.9800 99.9800

* PASS * * PASS * * PASS * * PASS *

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

C.2 Radio Link Budget Report (Creevagh – Moylough)

Link Budget Report

Site: Creevagh_Mast AB_L1B_3IRL (Moylough)
Name:
Type: Cell Cell
Latitude: 53°32'18.8"N 53°29'43.0"N
Longitude: 8°43'20.9"W 8°33'06.5"W
Altitude (m): 91.0 87.0

UserData1: User Data

Datum: World Geodetic System 1984 (WGS 84)

Forward Link		Reverse Link	
Transmission Site:	Creevagh_Mast	AB_L1B_3IRL	
Reception Site:	AB_L1B_3IRL	Creevagh_Mast	
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
Rx Equalization Sig Norm Parameter (Kn,M):	0.1	0.1	0.1
Rx Equalization Sig Norm Parameter (Kn,NM):	0.1	0.1	0.1
UserData1:	User Data	User Data	
Center Frequency (MHz):	26000	26000	
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:	HP2-26	HP2-26	
Transmission Antenna Size (m):	0.6	0.6	
Transmission Antenna Height (m):	20	20	
Transmission Antenna Gain (dBd):	38.96	38.96	
Transmission Antenna Gain (dBi):	41.1	41.1	
Transmission Power EIRP (dBm):	70.1	70.1	
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	
Reception Antenna:	HP2-26	HP2-26	
Reception Antenna Size (m):	0.6	0.6	
Reception Antenna Height (m):	20	20	

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

Reception Antenna Gain (dBd):	38.96	38.96
Reception Antenna Gain (dBi):	41.1	41.1
Link Polarization: Vertical	Vertical	
Cross Polarization Factor (dB):	30	30
Link Distance (m):	12292.451	12292.451
Azimuth - True (°):	113.026	293.163
Azimuth - Magnetic (°):	115.583	295.644
Transmission Inclination (°):	0.019	-0.019
Reception Inclination (°):	0.019	-0.019
ITU Recommendation:	ITU-R P.525-2	
Free Space Distance (m):	12292.452	12292.452
Center Frequency (MHz):	26000	26000
Free Space Loss (dB):	142.532	142.532
Max Fresnel Radius (m):	5.955	5.955
Max 2nd Fresnel Radius (m):	8.421	8.421
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
Diffraction Loss (dB):	0	0
Clearance Target (%):	60	
Minimum Clearance (m):	7.434	7.434
Minimum Clearance Point (m):	12222.38	12222.38
Terrain Reflection Dispersion (°):	0.5	
Reflection Area 1 (m):	330.3 - 390.4	330.3 - 390.4
Reflection Area 2 (m):	3573.62	3573.62
Reflection Area 3 (m):	3653.7 - 3793.8	3653.7 - 3793.8
Reflection Area 4 (m):	3833.883	3833.883
Reflection Area 5 (m):	4034 - 4234.3	4034 - 4234.3
Reflection Area 6 (m):	4294.35	4294.35
Reflection Area 7 (m):	4354.4 - 4394.5	4354.4 - 4394.5
Reflection Area 8 (m):	4454.5 - 4574.6	4454.5 - 4574.6
Reflection Area 9 (m):	4634.7 - 4734.8	4634.7 - 4734.8
Reflection Area 10 (m):	4874.938	4874.938
Reflection Area 11 (m):	4935 - 4955	4935 - 4955
Reflection Area 12 (m):	5055.12	5055.12
Reflection Area 13 (m):	5155.2 - 5175.2	5155.2 - 5175.2
Reflection Area 14 (m):	5275.343	5275.343
Reflection Area 15 (m):	5335.4 - 5355.4	5335.4 - 5355.4
Reflection Area 16 (m):	5415.5 - 5455.5	5415.5 - 5455.5
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):	1.627	1.627
Total Path Loss (dB):	144.159	144.159
Reception Signal Level (dBm):	-33.959	-33.959
BER 10-3 BER 10-6 BER 10-3 BER 10-6		
Service Threshold (dBm):	-91	-90
Link Gross Margin (dB):	57.041	56.041
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	
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

 Total Broadband Solutions	Procedure: 001	Rev: 2.0
Title: Cooloo Wind Farm Telecommunications Impact Assessment Study	Approved: KH	Date: 24/04/24

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 (%): 7.31E-01 7.31E-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): 3.069478 3.069478
 Rainfall Attenuation (dB): 23.455 23.455

BER 10-3 BER 10-6 BER 10-3 BER 10-6
 Fading Outage (%): 1.94E-07 2.44E-07 1.94E-07 2.44E-07
 Selective Fading Outage (%): 7.60E-09 7.60E-09 7.60E-09 7.60E-09
 Composite Fading Outage (%): 2.02E-07 2.52E-07 2.02E-07 2.52E-07

Fading Outage (s/Month): 0.005 0.006 0.005 0.006
 Selective Fading Outage (s/Month): 0 0 0 0
 Composite Fading Outage (s/Month): 0.005 0.007 0.005 0.007

BER 10-3 BER 10-6 BER 10-3 BER 10-6
 Unavailability due to Rain (%): 2.90E-04 3.26E-04 2.90E-04 3.26E-04
 Unavailability due to Rain (s/Year): 91.565 102.891 91.565 102.891

BER 10-3 BER 10-6 BER 10-3 BER 10-6
 Unavailability due to Fading (%): 2.02E-07 2.52E-07 2.02E-07 2.52E-07
 Unavailability due to Rain (%): 2.90E-04 3.26E-04 2.90E-04 3.26E-04
 Total Unavailability (%): 2.91E-04 3.27E-04 2.91E-04 3.27E-04
 Unavailability Objective (%): 2.00E-02 2.00E-02 2.00E-02 2.00E-02

Unavailability due to Fading (s/Year): 0.064 0.079 0.064 0.079
 Unavailability due to Rain (s/Year): 91.565 102.891 91.565 102.891
 Total Unavailability (s/Year): 91.629 102.971 91.629 102.971
 Unavailability Objective (s/Year): 6307.2 6307.2 6307.2 6307.2

Total Availability (%): 99.9997 99.9997 99.9997 99.9997
 Availability Objective (%): 99.9800 99.9800 99.9800 99.9800

* PASS * * PASS * * PASS * * PASS *