Report

Seskin Wind Farm
Telecommunications Impact Assessment Report

Document Number:

Author: DMG/PT

Approved for Release: Rev 1.0 KH **Date:** 07/05/24

Document Filename: *Seskin Wind Farm EMI Impact Assessment.*

Executive Summary

Ai Bridges was commissioned to evaluate the possible impacts that the proposed wind farm at Seskin, Co Kilkenny could have on the Enet and Vodafone telecommunications networks.

The scope of work included field and desktop surveys to determine if the Enet and Vodafone networks could be impacted by the proposed development. Using the information obtained during the field survey assessments and the consultation responses, a desktop impact analysis was carried out and the radio links were analysed (in 2D and 3D) using radio planning \ modelling software.

Results from the impact analysis show that there is a clearance distance of over 50 m between the Fresnel Zone of the Enet link and the blade-tip of the nearest of the proposed turbines (T03). At this distance there would be no impact to the Enet microwave radio link.

Results from 3D network analysis indicate that the Vodafone radio link over-shoots the proposed development and that there would be a clearance distance of over 10m between the Fresnel Zone of the radio link and the blade-tip of the nearest of the proposed turbines (T08). Although the analysis indicates that the proposed turbine layout will not obstruct the radio link, a clearance distance of less than 15 meters may not be sufficient for Vodafone and they may request mitigation measures.

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 between Tinnaslatty and Ballyouskill Parish Hall.	T03	51.8 m	No impacts.
Vodafone	PTP microwave radio link between Ballyspellan and Ballyoscail.	T08	10.2 m (Clearance Distance < 15 m)	No impacts. (Optional Mitigation Measures have been provided.)

Table 1. Microwave radio links that cross over the proposed wind farm development at Seskin.

Mitigation measures to offset the potential impacts of the proposed turbine layout on the Vodafone radio link including : turbine micro-siting and/or re-routing the radio link via an existing telecoms mast have been presented in Section 6 of this report.

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Section 1 - Wind Farm Site Information

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 10 km west of Castlecomer, Co. Kilkenny. 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 Hub Height	Turbine Rotor Diameter
Seskin	8	100 m	150 m

Table 2. Wind Farm Turbine Details

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

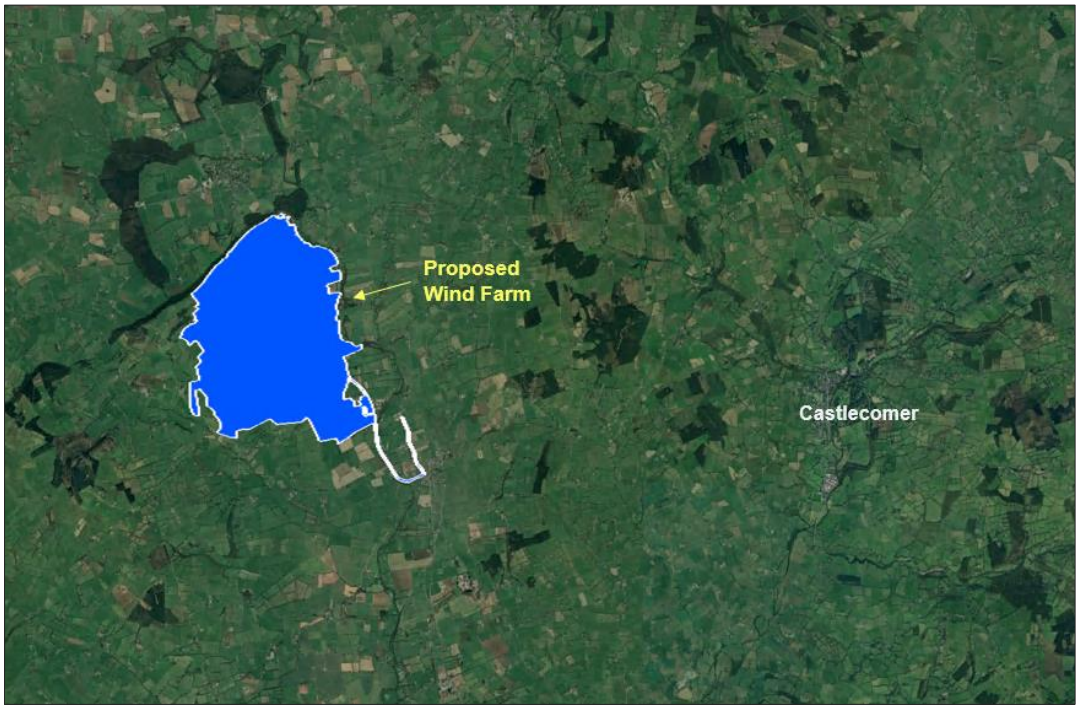

Figure 1. Location of proposed wind farm.

Section 2 - Methodology

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. Mast-site coordinates are then obtained and inputs from relevant 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 Seskin. Figure 2 below shows the proposed wind farm site boundary plotted in the radio planning tool.

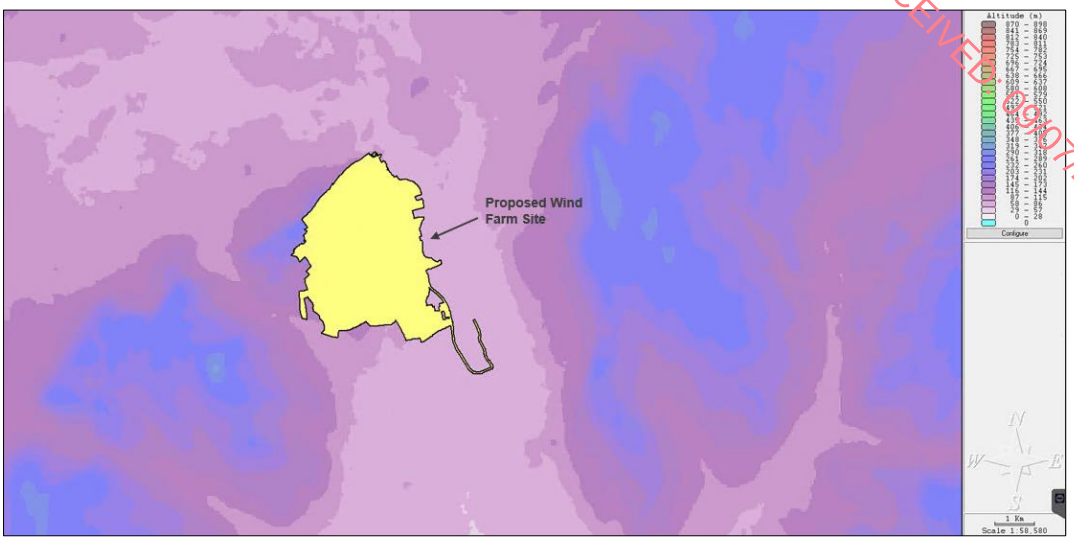

Figure 2. Wind Farm Boundary plotted in Radio Planning Software

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.

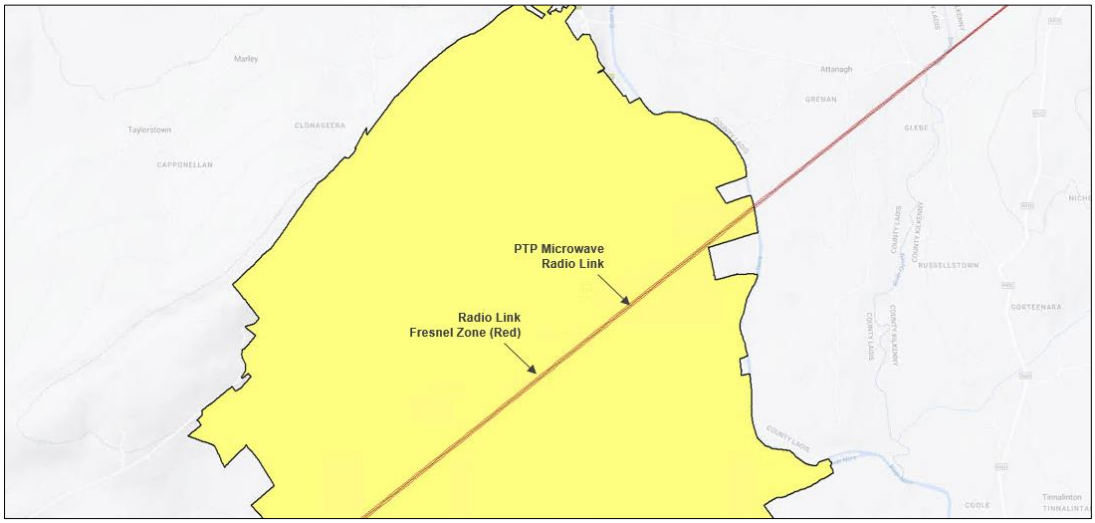

Figure 3. Example of a microwave radio link crossing over/near the proposed wind farm boundary modelled in radio planning software.

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.

Section 3 - Telecom Operator Consultations

3. Introduction

Consultations beginning in April 2023 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 (Enet and Vodafone) are provided in Section 3.1 and Section 3.2.

ID	Operator	Response Received (Yes/No)	Issues raised by Operator \ Observations.
1	Enet	Yes	Enet have raised a concern regarding one Licensed PTP microwave radio link.
2	Vodafone	Yes	Vodafone have raised a concern regarding one Licensed PTP microwave radio link.

Table 3. Telecom Operators Consulted

3.1 Enet Response to Consultations

The correspondences between the EIAR consultants (MKO) and Enet are provided below.

06.04.23 - Email from MKO to Enet

"I am undertaking an early stage feasibility study for a proposed wind farm development at Seskin, Co. Laois/Kilkenny. Please see location map and kml attached and the site centre coordinates below. Can you please let me know if any telecommunication operators have links in the area?

Centre coordinates for the Seskin site is:
ITM – 641755, 673839
Irish Grid – 241813, 173799"

11/04/23 – Enet response to MKO

"We have one link passing through this area:"

Link Name	A-End Coordinates	A-End Antenna Height	B-End Coordinates	B-End Antenna Heights	Frequency
Cignal Tinnaslatty - SCP0092 Ballyouskill Parish Hall	52.788086 -7.439000	15m	52.842325 -7.326397	7m	18GHz

05.05.23 - Email from MKO to Enet

"Regarding the link below.

Link Name	A-End Coordinates	A-End Antenna Height	B-End Coordinates	B-End Antenna Heights	Frequency
Cignal Tinnaslatty - SCP0092 Ballyouskill Parish Hall	52.788086 -7.439000	15m	52.842325 -7.326397	7m	18GHz

Could you please provide a setback distance you would recommend for your link, thank you. If you have any questions, please let me know. "

10.07.23 - Email from MKO to Enet

"I messaged a few weeks ago regarding the link attached in the email below. Could you please provide a setback distance you would recommend for your link, thank you. If you have any questions, please let me know."

11/07/23 – Enet response to MKO

"About 50m should be ok,"

3.2 Vodafone Response to Consultations

The correspondences between the EIAR consultants (MKO) and Vodafone are provided below.

06.04.23 - Email from MKO to Vodafone

"I am undertaking an early stage feasibility study for a proposed wind farm development at Seskin, Co. Laois/Kilkenny. Please see location map and kml attached and the site centre coordinates below. Can you please let me know if any telecommunication operators have links in the area?

Centre coordinates for the Seskin site is:

ITM – 641755, 673839

Irish Grid – 241813, 173799"

20.04.23 - Email from MKO to Vodafone

"This is a follow up from a previous email.

I am undertaking an early stage feasibility study for a proposed wind farm development at Seskin, Co. Laois/Kilkenny. Please see location map and kml attached and the site centre coordinates below. Can you please let me know if any telecommunication operators have links in the area?

Centre coordinates for the Seskin site is:
ITM – 641755, 673839
Irish Grid – 241813, 173799"

21/04/23 – Vodafone response to MKO

"There is one link passing directly through the proposed area. Detail below. A clearance of 30m from the first Fresnel zone is desired.
If you require any additional information please let me know,"

Site Name	Easting	Northing	Site Name Rel	Easting Rel	Northing Rel	Site Height	Ant. Height	Site Height Rel	Ant. Height Rel	Distance
KKBAP Ballyspellan	233230	167740	KK114 Ballyoscail 02	247750	175720	302	15	300	15	16571

21.04.23 - Email from MKO to Vodafone

"Thank you for your reply. Could you please let me know the GHZ produced by the link."

21/04/23 – Vodafone response to MKO

"Apologies, I thought I had included it. It a 13GHz link,"

Section 4 - Field Surveys

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 are shown relative to the proposed wind farm site in Figure 4 below. The findings from the field surveys of each of the mast-sites are presented in Section 4.1 to Section 4.4

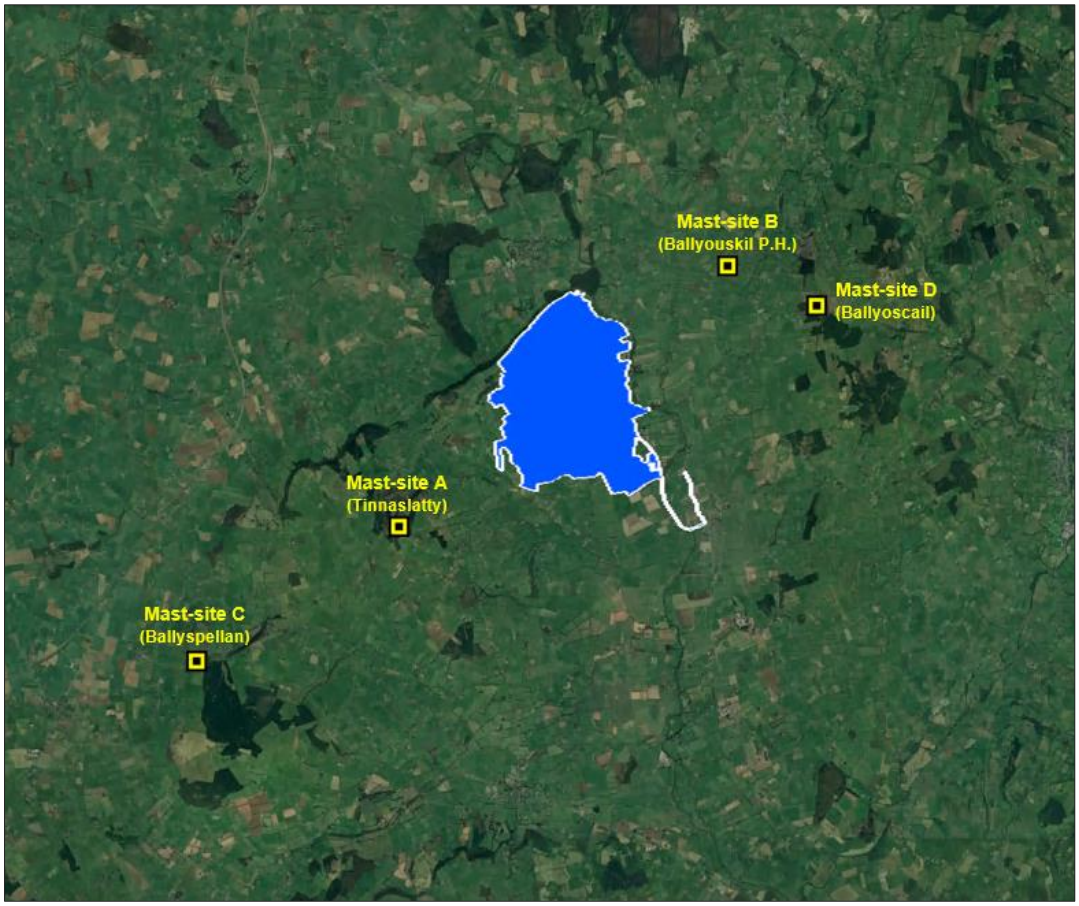

Figure 4. Telecom Mast-Sites Surveyed.

4.1 Mast-Site A (Tinnaslatty)

Telecommunications Mast-Site A is located in the townland of Tinnaslatty, County Kilkenny, and is approximately 5 km southwest of the proposed turbines at Seskin. 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 4.

Figure 5. Mast-Site A

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

Table 4. Field Survey Summary – Mast-Site A

4.2 Mast-Site B (Ballyouskill Parish Hall)

Telecommunications Mast-Site B is located in the townland of Ballyouskill, County Kilkenny, and is approximately 4 km northeast of the proposed turbines at Seskin. 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 5.

Figure 6. Mast B

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

Table 5. Field Survey Summary – Mast-Site B

4.3 Mast-Site C (Ballyspellan)

Telecommunications Mast-Site C is located at Spa Hill in the townland of Ballyspellan, County Kilkenny, and is approximately 10 km southwest of the proposed turbines at Seskin. 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 6.

Figure 7. Mast C

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

Table 6. Field Survey Summary – Mast-Site C

4.4 Mast-Site D (Ballyoscail)

Telecommunications Mast-Site D is located in the townland of Ballyoscail, County Kilkenny, and is approximately 6 km northeast of the proposed turbines at Seskin. 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 7.

Figure 8. Mast D

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

Table 7. Field Survey Summary – Mast-Site D

Section 5 - Desktop Survey Analysis

5. Introduction

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

- Enet Network
- Vodafone Network

Sections 5.1 to 5.2 below outline 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 one Point-to-Point (PTP) microwave radio link. The radio link is listed in Table 8 below and a Plan View of the Enet network is shown in Figure 9.

Link No.	Operator	Link Description
1	Enet	PTP microwave radio link between Tinnaslatty and Ballyouskill Parish Hall.

Table 8. Enet Radio Links requiring Analysis

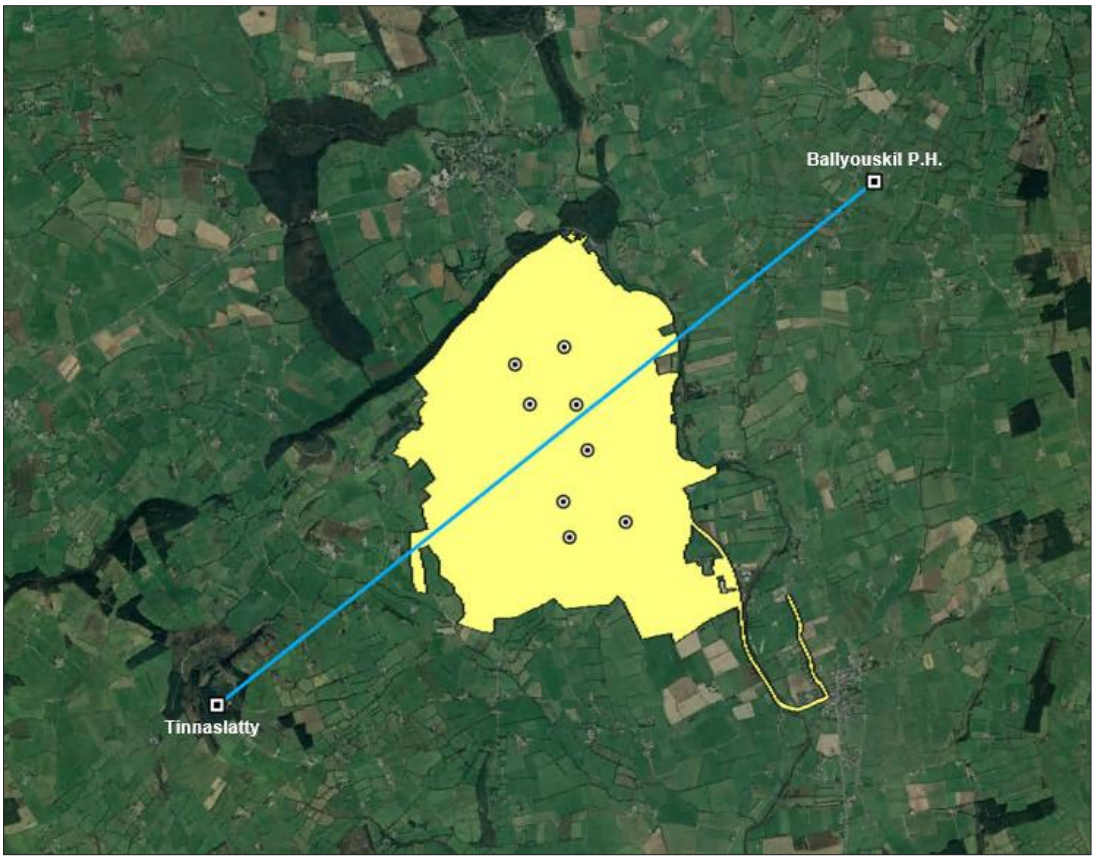

Figure 9. Enet Radio Network – Plan View

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

Figure 10 below shows a close-up plan view of the Enet microwave radio link relative to the proposed turbine layout. The plan view indicates that the radio link is relatively near turbine T04.

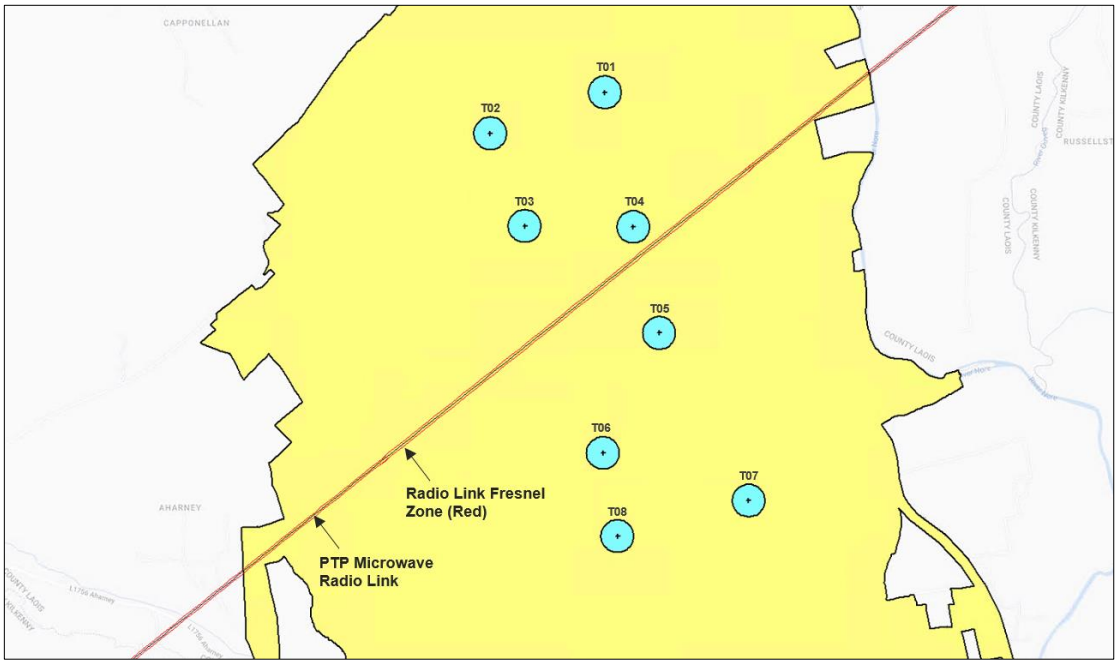

Figure 10. Enet Network – Close-up Plan View.

To further assess the potential impacts, the radio link has been modelled in 3D and the Clearance Distance between the Fresnel Zone (F2) and the blade-tip of the nearest turbine (T04) has been calculated. A 3D view of the microwave radio link relative to the proposed turbine layout is shown below in Figure 11.

The results of the 3D analysis indicate that there is a clearance distance of over 50 m between the blade-tip of T04 and the Fresnel Zone of the Enet radio link. At this distance, there will be no impact on the microwave radio link.

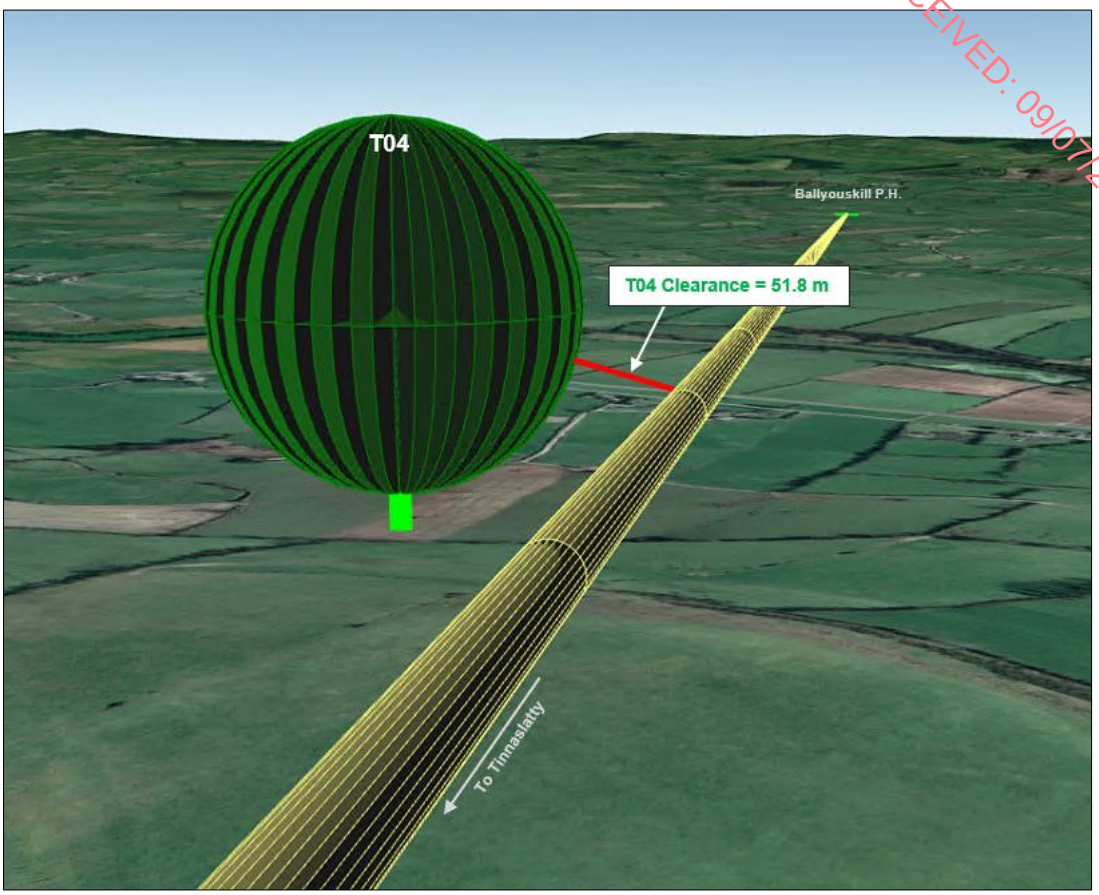

Figure 11. Enet Network – 3D View.

Table 9 below provides a summary of the radio link interference analysis for the closest turbines to the Enet radio link.

Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance/Interference	Wind Farm Impacts
Enet Link 1	Tinnaslatty - Ballyouskill Parish Hall	T04	51.8 m	No impacts.

Table 9. Enet Network – Analysis Summary

5.2 Vodafone 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 in Table 10 below and a Plan View of the Vodafone network is shown in Figure 12.

Link No.	Operator	Link Description
1	Vodafone	PTP microwave radio link between Ballyspellan and Ballyoscail.

Table 10. Vodafone Radio Links requiring Analysis

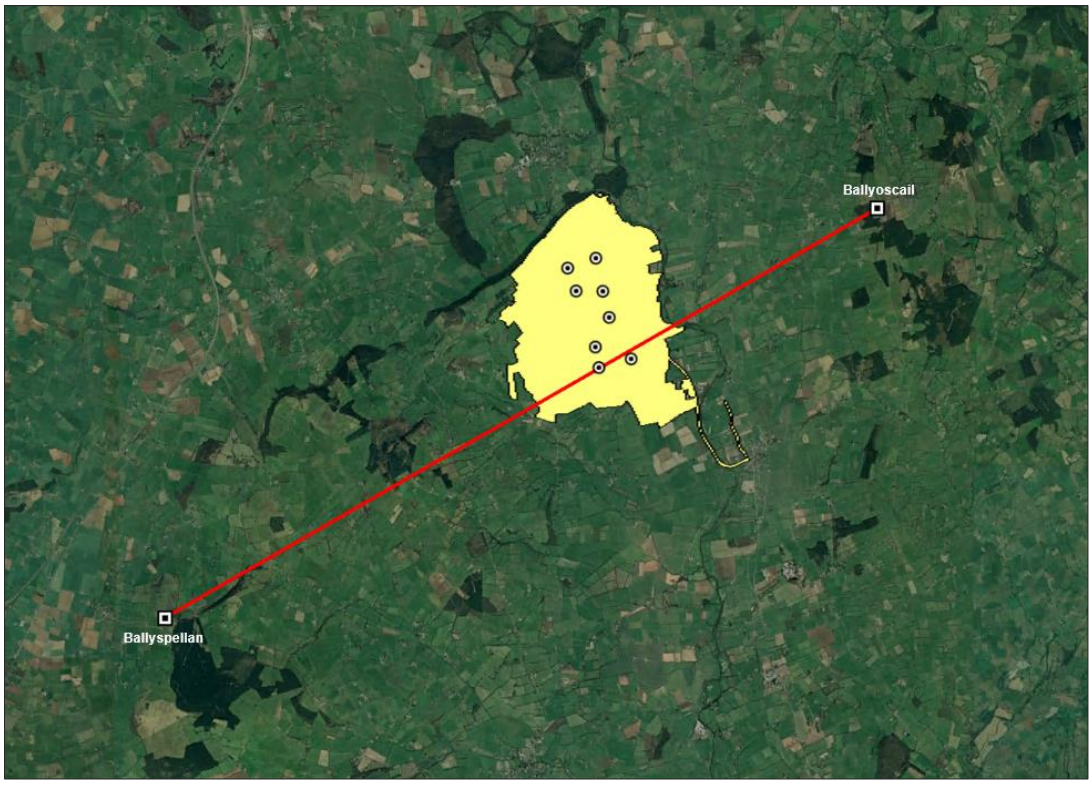

Figure 12. Vodafone Radio Network – Plan View

Figure 13 below shows a close-up plan view of the Vodafone microwave radio link relative to the proposed wind farm site. The plan view indicates that the radio link is potentially impacted by turbine T08.

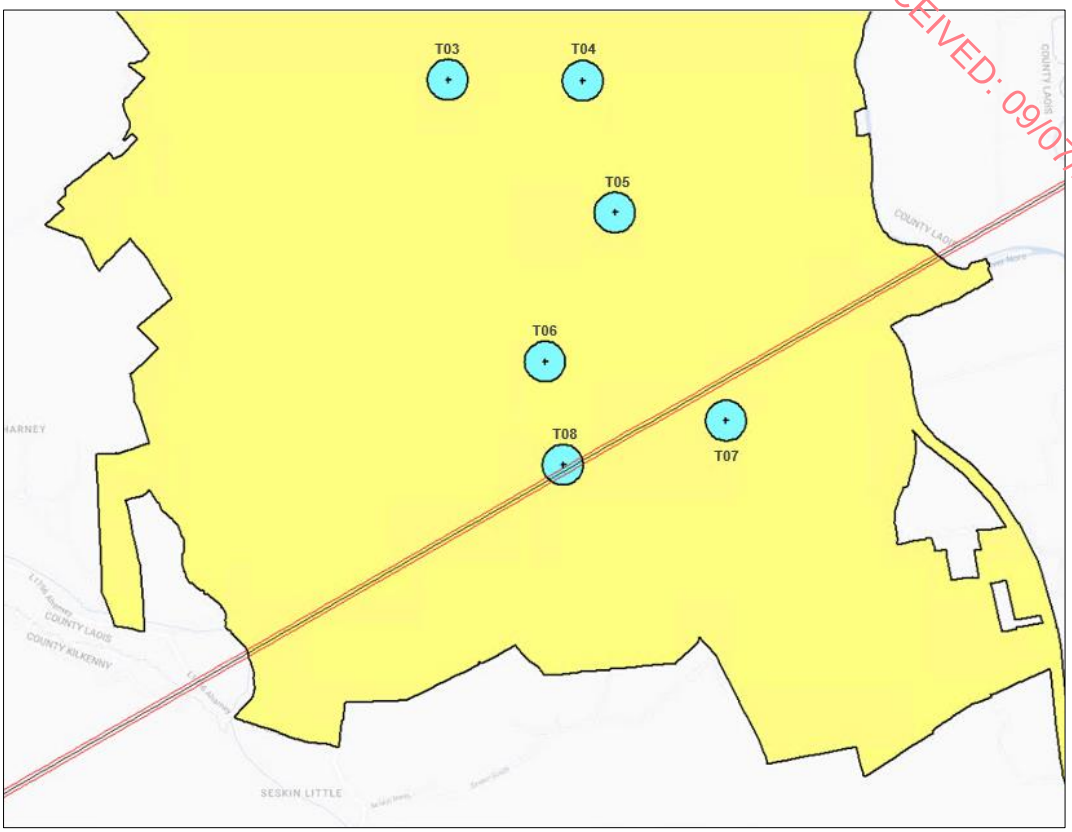

Figure 13. Vodafone Network – Close-up Plan View.

To further assess the potential impact, the Vodafone radio link* has modelled in 3D and the Clearance Distances between the Fresnel Zone (F2) and the blade-tip of the nearest turbine (T08) has been calculated. A 3D view of the microwave radio link relative to the proposed turbine layout is shown below in Figure 14.

The results of the 3D analysis indicate that there is a clearance distance of 10.2 m between the blade-tip of T08 and the 2nd Fresnel Zone of the Vodafone radio link.

The Huygens-Kirchoff radio wave propagation theory states that as long as 60%of the 1st Fresnel Zone is not obstructed then free space propagation can be considered between transmitter and receiver. This analysis allows for 2nd Fresnel Zone clearance thus there will be less of an impact to the critical 0.6F1 Fresnel Zone Clearance

Although the 3D modelling analysis indicates that the radio link will not be impacted, optional mitigation measure solutions having been provided to account for any potential impacts that may be reported during the operational phase of the proposed development.

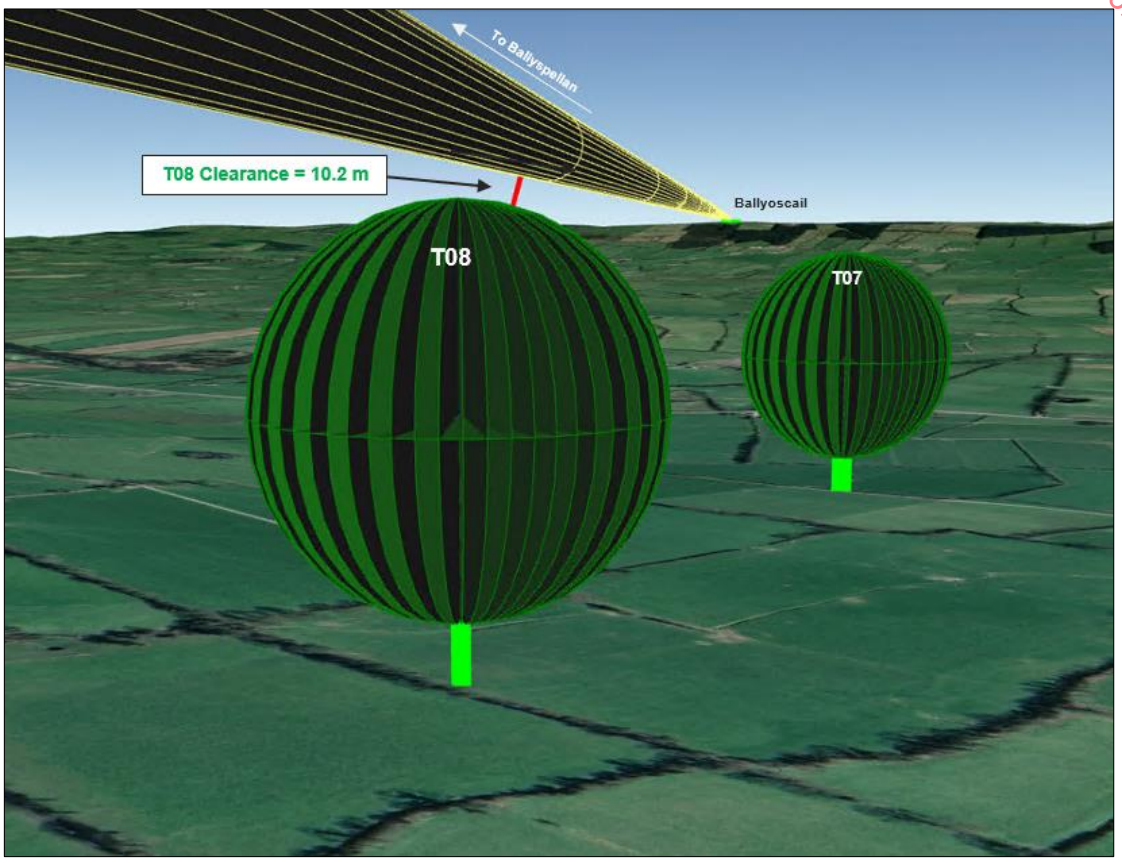

Figure 14. Vodafone Network – 3D View.

Table 11 below provides a summary of the radio link interference analysis for the closest turbine(s) to the Vodafone radio link.

Radio Link ID	Link Description	Nearest Turbine(s)	Fresnel Zone (F2) Clearance/Interference	Wind Farm Impacts
Vodafone Link 1	Ballyspellan - Ballyoscail	T08	10.2 m (Clearance Distance < 15 m)	No impacts (Optional Mitigation Measures have been provided in Section 6)

Table 11. Vodafone Network – Analysis Summary

Section 6 - Mitigation Measures

6. Mitigation Measures

Section 6.1 that follow, describe the mitigation measures available to the wind farm developer to offset the potential impact of the T08 on the Vodafone Network.

6.1 Mitigation Measure Solutions – Vodafone Network

Although the analysis shows that there will be no impacts to the 0.6F1 Fresnel Zone Clearance a number of optional mitigation measure solutions have been provided should there be any reports of potential impact on the radio link from Ballyspellan to Ballyoscail the following mitigation solutions are available:

Option 1 – Micro-site Turbines T08

Option 2 – Increase Radio Antenna Installation Heights

Option 3 – Relay the Vodafone radio link via an existing Telecoms Mast

These mitigation measures are described in Sections 6.1.1 and 6.1.2 that follow.

6.1.1 Option 1 – Micro-site Turbine T08

An option of offset the potential impact of T08 on the Vodafone radio link between Ballyspellan and Ballyoscail would be to micro-site the turbine away from the radio link.

Figure 15 below illustrates how micro-siting T08 to the northwest would increase the Clearance Condition between the turbine and the 2nd Fresnel Zone of the radio link.

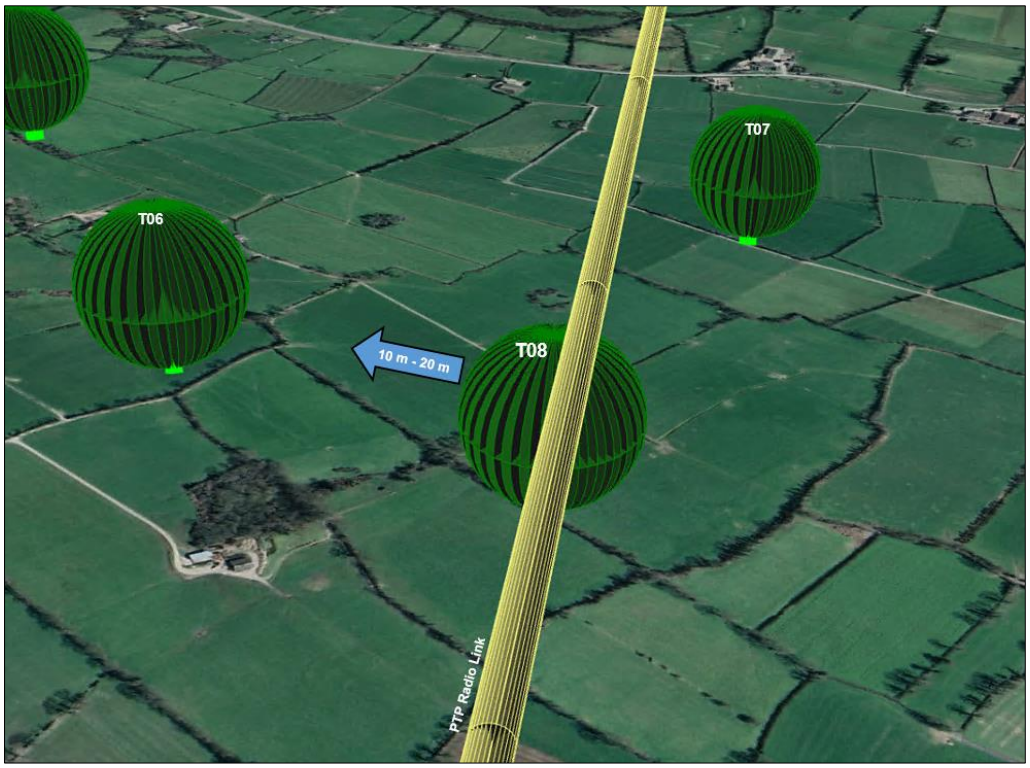

Figure 15. Micro-siting Turbine T08

6.1.2 Option 2 – Increase Radio Antenna Installation Heights

Another option of offset the potential impact of T08 on the Vodafone radio link between Ballyspellan and Ballyoscail would be to increase the radio antenna installations heights. Vodafone have specified that the current installation heights are 15m AGL (Ref Section 3.2), however, findings from field surveys indicate that the radio antenna installation heights could be increased to 25m AGL on both ends (Ballyoscail and Ballyspellan) of the radio link. See Figure 16 below.

Increasing the antenna installation heights would result in an increased clearance distance between the Fresnel Zone and the blade-tip of T08. 3D analysis (Figure 17) indicates that moving the antennas to 25m AGL would result in a Clearance Distance of 20m which may be acceptable to Vodafone.

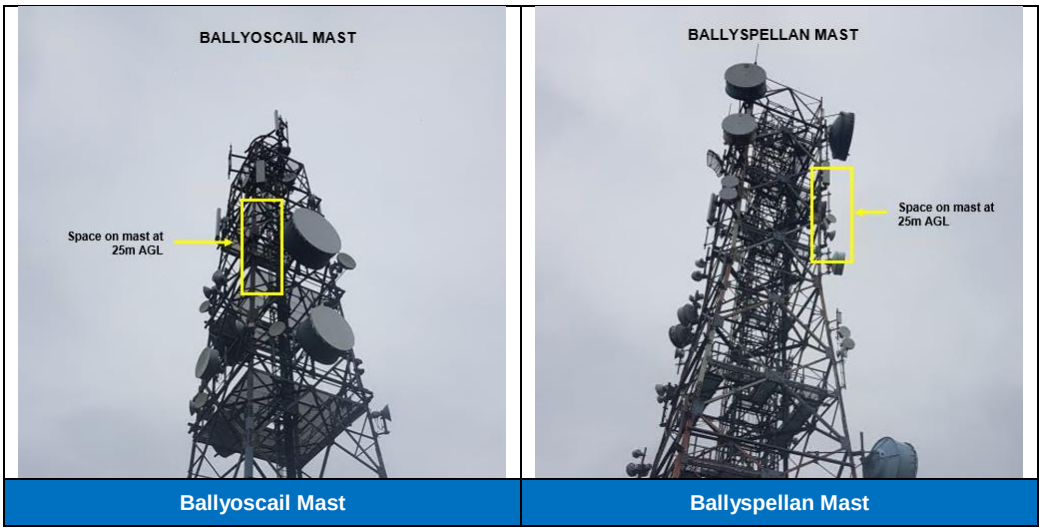

Figure 16. Free Space on Telecom Masts at 25M AGL

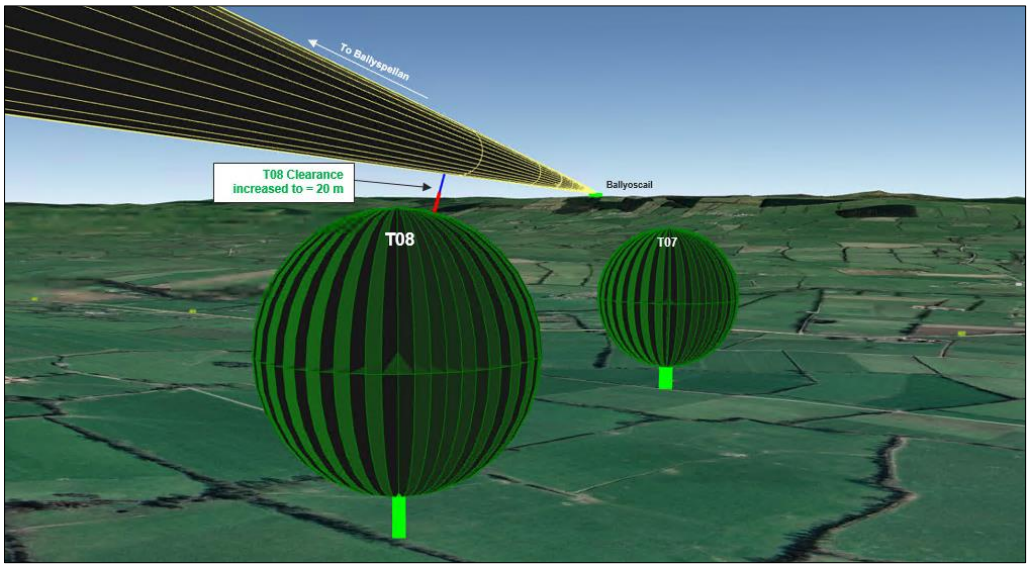

Figure 17. Vodafone Network – 3D View with Antennas Modelled at 25M AGL.

6.1.3 Option 3 - Relay the Vodafone radio link via an existing Telecoms Mast.

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

Figure 18 below illustrates how the existing telecoms mast-site at Oldglass, Co Laois could be used to relay a radio link between Ballyspellan and Ballyoscail.

Note: A database of telecommunications mast-sites indicates that Vodafone have an existing presence at the Oldglass mast-site.

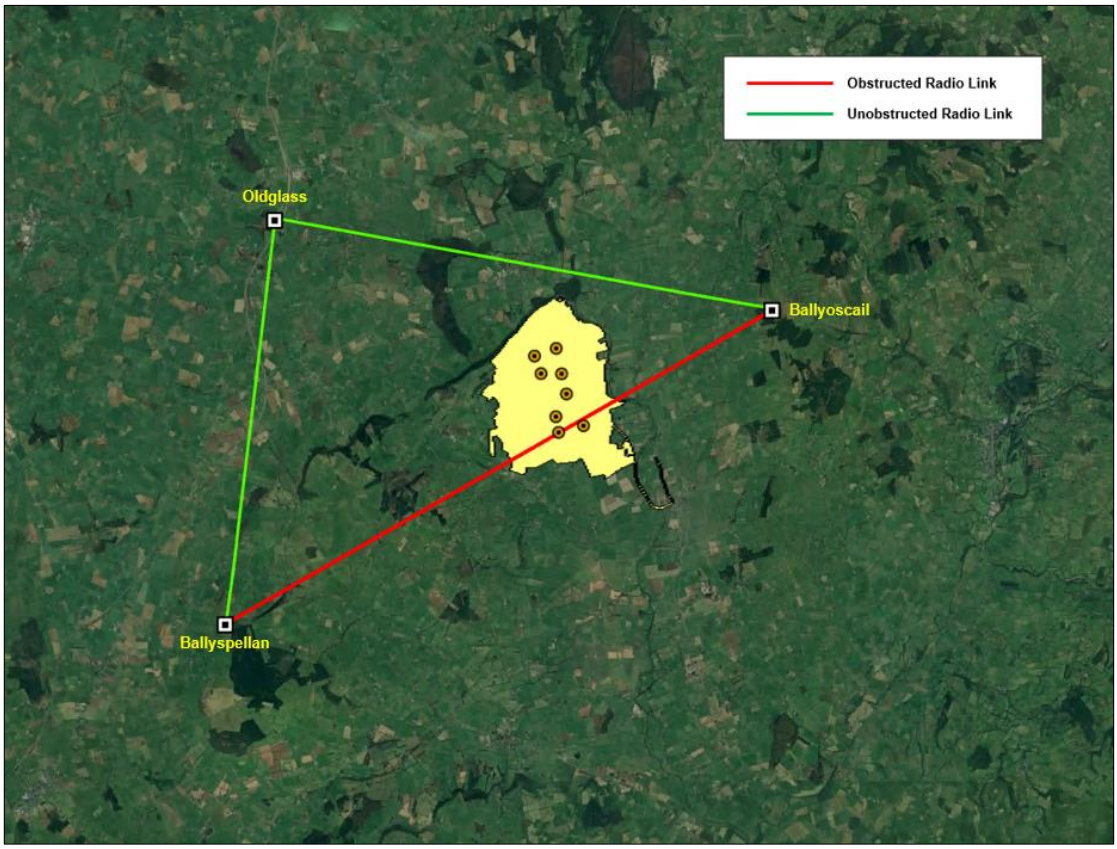

Figure 18. Example of how an existing telecoms mast could be relay the radio link between Ballyspellan and Ballyoscail.

To determine if Oldglass 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:

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

The radio Path Profile is shown in Section 6.1.2.1 that follows. The Radio Link Budget can be found in Appendix B.

6.1.3.1 Path Profile – Ballyspellan to Oldglass

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.

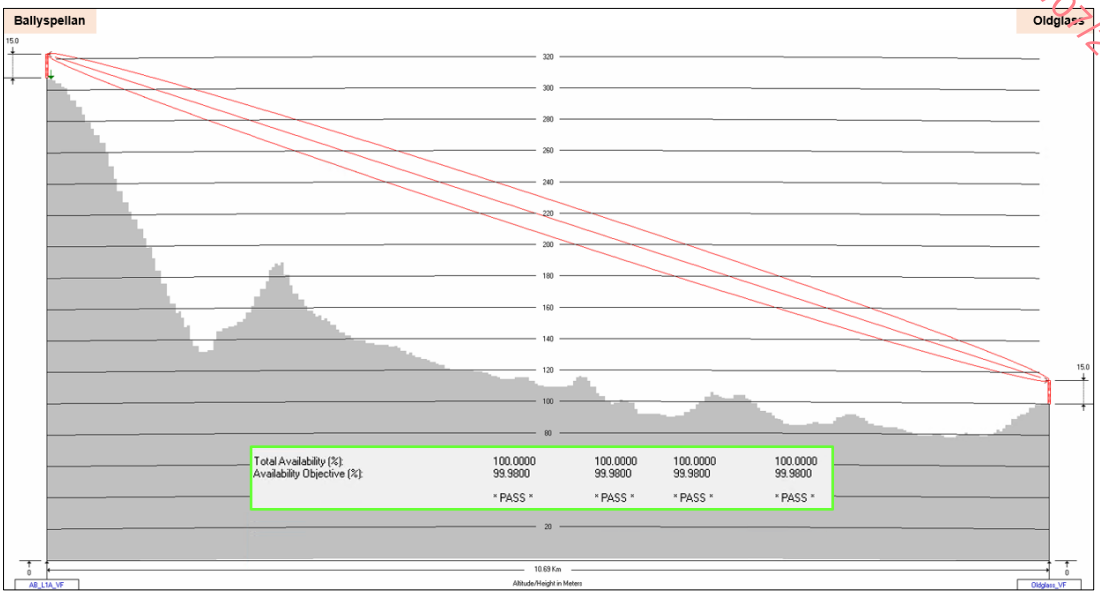

Figure 19. Path Profile – Ballyspellan to Oldglass

6.1.3.2 Path Profile – Oldglass to Ballyoscail

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.

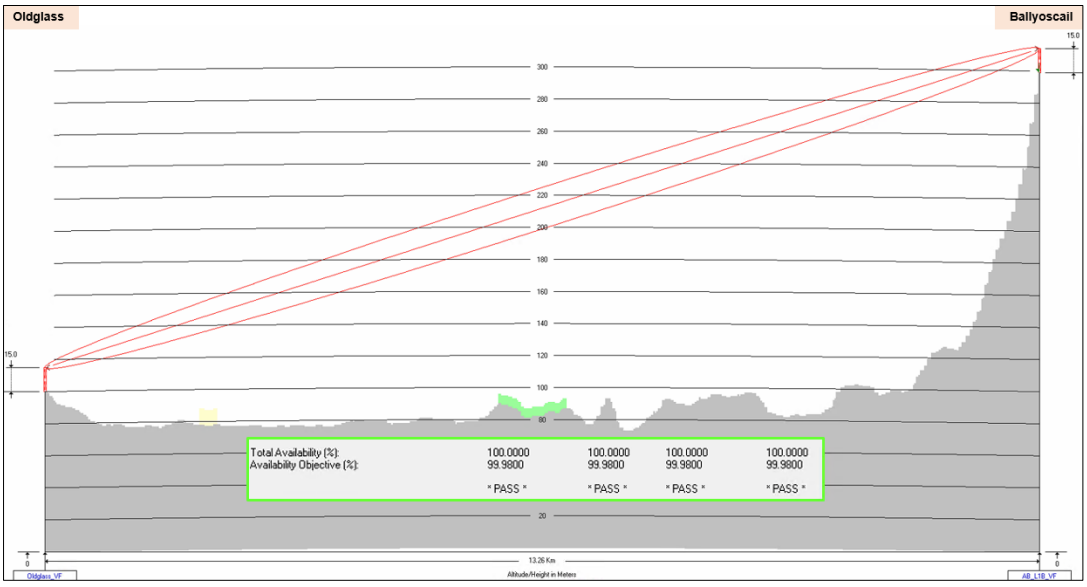

Figure 20. Path Profile – Oldglass to Ballyoscail

Section 7 - Conclusions

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 the Enet Radio link between Tinnaslatty and Ballyouskill Parish Hall would be not impacted by the proposed turbine layout.

- Results from the telecom operator consultations and desktop survey analysis indicate that the Vodafone radio link between Ballyspellan and Ballyoscail would be not obstructed by the proposed turbine layout. However, the 3D analysis indicates that the clearance distance between the blade-tip of T08 and the Fresnel Zone of the radio link is less than 15m. The clearance distance (10.2m) may not be sufficient for Vodafone and mitigation measures may be required.

- Table 12 below lists the radio links that would be impacted by the proposed turbine layout, along with potential mitigation measures.

Operator	Impacted PTP Link	Impact of Proposed Turbine Layout	Possible Mitigation Measure(s)
Enet	PTP microwave radio links between Tinnaslatty and Ballyouskill Parish Hall	None	N.A.
Vodafone	PTP microwave radio links between Ballyspellan and Ballyoscail.	No impacts (Optional Mitigation Measures have been provided in Section 6)	**Option 1:** Micro-site T08. **Option 2:** Increase Radio Antenna Installation Heights. **Option 3:** Relay the Vodafone radio link via the existing Telecoms Mast at Oldglass.

Table 12. Mitigation Measures Summary

APPENDIX A – Wind Farm Turbine Coordinates

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° 49' 30.574"N	7° 22' 47.662"W
T02	52° 49' 23.985"N	7° 23' 18.087"W
T03	52° 49' 8.964"N	7° 22' 40.112"W
T04	52° 49' 9.102"N	7° 23' 8.959"W
T05	52° 48' 51.916"N	7° 22' 33.253"W
T06	52° 48' 32.656"N	7° 22' 48.182"W
T07	52° 48' 24.997"N	7° 22' 9.468"W
T08	52° 48' 19.303"N	7° 22' 44.347"W

Table 13. Wind Farm Layout - Turbine Co-ordinates

APPENDIX B – Radio Link Budget Reports

Appendix B – Radio Link Budget Reports

B.1 Radio Link Budget Report (Ballyspellan – Oldglass)

Link Budget Report

Site Name:	AB_L1A_VF (Ballyspellan)			Oldglass_VF			
Type:	Cell	Cell					
Latitude:	52°45'36.4"N		52°51'19.5"N				
Longitude:	7°30'29.4"W			7°29'23.2"W			
Altitude (m):	308.0		100.0				
UserData1:	User Data						
Datum:	World Geodetic System 1984 (WGS 84)						
	Forward Link		Reverse Link				
Transmission Site:	AB_L1A_VF			Oldglass_VF			
Reception Site:	Oldglass_VF			AB_L1A_VF			
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):		13000		13000			
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:		HP2-13-NSMA			HP2-13-NSMA		
Transmission Antenna Size (m):			0.6		0.6		
Transmission Antenna Height (m):			15		15		
Transmission Antenna Gain (dBd):			33.76		33.76		
Transmission Antenna Gain (dBi):			35.9		35.9		
Transmission Power EIRP (dBm):			64.9		64.9		
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:	HP2-13-NSMA		HP2-13-NSMA	
Reception Antenna Size (m):	0.6		0.6	
Reception Antenna Height (m):		15		15
Reception Antenna Gain (dBd):		33.76		33.76
Reception Antenna Gain (dBi):		35.9		35.9
Link Polarization:	Vertical	Vertical		
Cross Polarization Factor (dB):		30		30
Link Distance (m):	10690.141		10690.141	
Azimuth - True (°):	6.654	186.668		
Azimuth - Magnetic (°):	8.59		188.613	
Transmission Inclination (°):	1.115		-1.115	
Reception Inclination (°):	1.115		-1.115	
ITU Recommendation:	ITU-R P.525-2			
Free Space Distance (m):	10692.164			10692.164
Center Frequency (MHz):	13000		13000	
Free Space Loss (dB):	135.3		135.3	
Max Fresnel Radius (m):	7.853		7.853	
Max 2nd Fresnel Radius (m):	11.106		11.106	
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):	14.439		14.439	
Minimum Clearance Point (m):		46.75		46.75
Terrain Reflection Dispersion (°):		0.5		
Reflection Area 1 (m):	264.916		264.916	
Reflection Area 2 (m):	327.249		327.249	
Reflection Area 3 (m):	1573.913		1573.913	
Reflection Area 4 (m):	2820.576		2820.576	
Reflection Area 5 (m):	2914 - 2945.2			2914 - 2945.2
Reflection Area 6 (m):	3038.743		3038.743	
Reflection Area 7 (m):	3132.2 - 3225.7			3132.2 - 3225.7
Reflection Area 8 (m):	3381.6 - 3412.7			3381.6 - 3412.7
Reflection Area 9 (m):	5251.6 - 5313.9			5251.6 - 5313.9
Reflection Area 10 (m):	5719.07		5719.07	
Reflection Area 11 (m):	6030.735		6030.735	
Reflection Area 12 (m):	6155.4 - 6217.7			6155.4 - 6217.7
Reflection Area 13 (m):	6529.4 - 6622.9			6529.4 - 6622.9
Reflection Area 14 (m):	7152.733		7152.733	
Reflection Area 15 (m):	7215.066		7215.066	
Reflection Area 16 (m):	8960.4 - 9022.7			8960.4 - 9022.7
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):		0.234		0.234
Total Path Loss (dB):	135.534		135.534	
Reception Signal Level (dBm):		-35.734		-35.734

	BER 10-3	BER 10-6	BER 10-3	BER 10-6
Service Threshold (dBm):	-91	-90	-91	-90
Link Gross Margin (dB):	55.266	54.266	55.266	54.266

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	

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 (%):	7.85E-03		7.85E-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):	0.949122		0.949122		
Rainfall Attenuation (dB):	7.499		7.499		

	BER 10-3	BER 10-6	BER 10-3	BER 10-6	
Fading Outage (%):	1.94E-09	2.44E-09	1.94E-09	2.44E-09	
Selective Fading Outage (%):	1.77E-10	1.77E-10	1.77E-10	1.77E-10	
Composite Fading Outage (%):		2.11E-09	2.62E-09	2.11E-09	2.62E-09

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 (%):		2.11E-09	2.62E-09	2.11E-09	2.62E-09
Unavailability due to Rain (%):	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Total Unavailability (%):	2.11E-09	2.62E-09	2.11E-09	2.62E-09	
Unavailability Objective (%):	2.00E-02	2.00E-02	2.00E-02	2.00E-02	

Unavailability due to Fading (s/Year):		0.001	0.001	0.001	0.001
Unavailability due to Rain (s/Year):		0	0	0	0
Total Unavailability (s/Year):	0.001	0.001	0.001	0.001	
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

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B.2 Radio Link Budget Report (Oldglass – Ballyoscail)

Link Budget Report

Site Name:	Oldglass_VF		AB_L1B_VF (Ballyoscail)				
Type:	Cell	Cell					
Latitude:	52°51'19.5"N		52°50'01.9"N				
Longitude:	7°29'23.2"W		7°17'45.4"W				
Altitude (m):	100.0		299.0				
UserData1:	User Data						
Datum:	World Geodetic System 1984 (WGS 84)						
	Forward Link		Reverse Link				
Transmission Site:	Oldglass_VF		AB_L1B_VF				
Reception Site:	AB_L1B_VF		Oldglass_VF				
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):	13000		13000				
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:	HP2-13-NSMA		HP2-13-NSMA				
Transmission Antenna Size (m):		0.6		0.6			
Transmission Antenna Height (m):		15		15			
Transmission Antenna Gain (dBd):		33.76		33.76			
Transmission Antenna Gain (dBi):		35.9		35.9			
Transmission Power EIRP (dBm):		64.9		64.9			
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:	HP2-13-NSMA		HP2-13-NSMA				
Reception Antenna Size (m):	0.6		0.6				
Reception Antenna Height (m):		15		15			

Reception Antenna Gain (dBd):		33.76		33.76
Reception Antenna Gain (dBi):		35.9		35.9
Link Polarization:	Vertical	Vertical		
Cross Polarization Factor (dB):		30		30
Link Distance (m):	13262.649		13262.649	
Azimuth - True (°):	100.357	280.512		
Azimuth - Magnetic (°):	102.302		282.377	
Transmission Inclination (°):	-0.86		0.86	
Reception Inclination (°):	-0.86		0.86	
ITU Recommendation:	ITU-R P.525-2			
Free Space Distance (m):	13264.143		13264.143	
Center Frequency (MHz):	13000		13000	
Free Space Loss (dB):	137.172		137.172	
Max Fresnel Radius (m):	8.747		8.747	
Max 2nd Fresnel Radius (m):	12.371		12.371	
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):	14.569		14.569	
Minimum Clearance Point (m):		13253.149		13253.149
Terrain Reflection Dispersion (°):		0.5		
Reflection Area 1 (m):	104.5 - 123.5		104.5 - 123.5	
Reflection Area 2 (m):	351.5 - 408.5		351.5 - 408.5	
Reflection Area 3 (m):	1358.6 - 1396.6		1358.6 - 1396.6	
Reflection Area 4 (m):	1453.6 - 1491.6		1453.6 - 1491.6	
Reflection Area 5 (m):	1624.6 - 1662.6		1624.6 - 1662.6	
Reflection Area 6 (m):	1795.6 - 1833.6		1795.6 - 1833.6	
Reflection Area 7 (m):	1909.6 - 1947.6		1909.6 - 1947.6	
Reflection Area 8 (m):	2004.6 - 2023.6		2004.6 - 2023.6	
Reflection Area 9 (m):	2080.6 - 2099.6		2080.6 - 2099.6	
Reflection Area 10 (m):	2156.6 - 2213.6		2156.6 - 2213.6	
Reflection Area 11 (m):	2270.611		2270.611	
Reflection Area 12 (m):	2365.6 - 2802.6		2365.6 - 2802.6	
Reflection Area 13 (m):	8616.9 - 8654.9		8616.9 - 8654.9	
Reflection Area 14 (m):	8692.926		8692.926	
Reflection Area 15 (m):	8730.928		8730.928	
Reflection Area 16 (m):	8825.9 - 8844.9		8825.9 - 8844.9	
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):		0.29		0.29
Total Path Loss (dB):	137.462		137.462	
Reception Signal Level (dBm):		-37.662		-37.662

	BER 10-3	BER 10-6	BER 10-3	BER 10-6
Service Threshold (dBm):	-91	-90	-91	-90
Link Gross Margin (dB):	53.338	52.338	53.338	52.338

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

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 (%):	2.10E-02		2.10E-02	

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):	0.949113	0.949113		
Rainfall Attenuation (dB):	8.921	8.921		

	BER 10-3	BER 10-6	BER 10-3	BER 10-6
Fading Outage (%):	8.92E-09	1.12E-08	8.92E-09	1.12E-08
Selective Fading Outage (%):	6.49E-10	6.49E-10	6.49E-10	6.49E-10
Composite Fading Outage (%):		9.57E-09	1.19E-08	9.57E-09	1.19E-08

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 (%):		9.57E-09	1.19E-08	9.57E-09	1.19E-08
Unavailability due to Rain (%):	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Unavailability (%):	9.57E-09	1.19E-08	9.57E-09	1.19E-08
Unavailability Objective (%):	2.00E-02	2.00E-02	2.00E-02	2.00E-02

Unavailability due to Fading (s/Year):	0.003	0.004	0.003	0.004
Unavailability due to Rain (s/Year):	0	0	0	0
Total Unavailability (s/Year):	0.003	0.004	0.003	0.004
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

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