

DOCUMENT COVER SHEET



# TELECOMMUNICATIONS SERVICES GROUP

DOCUMENT TITLE

## Flinders Island Wind Farm Interference Study

DOCUMENT I.D. NUMBER

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## 1. INTRODUCTION

### 1.1. BACKGROUND

As part of Hydro Tasmania's proposed Flinders Island Wind Farm approximately 3km south-east of Whitemark, an environmental impact assessment has been conducted. The objective of the study is to identify and evaluate the potential impact the proposed wind turbines may have on local communications such as radio and television and recommend any actions that need to be taken. This will minimise the effects on the islands existing communications service. The proposed turbine locations are shown in Appendix A. A previous study was completed in 2002; this report updates the previous study.

### 1.2. SCOPE

The electromagnetic interferences study encompasses:

- a) A general review of the potential electromagnetic interference mechanisms.
- b) An analysis of the potential impact wind turbines may have on the island's communications services.
- c) A summary of recommendations and options that will ensure the proposed installation will have a minimal impact on existing communication systems.

### 1.3. FLINDERS ISLAND PROPOSAL

Hydro Tasmania is currently investigating the development of a new wind farm consisting of four towers on Hayes Hill, east of Whitemark. As part of this proposal, the impact of the turbines on existing communication systems requires analysis. Four different turbine designs are currently under consideration. The Vestas V52, Windflow 500, Vergnet 275 and Enercon E33. Each design has a slightly different form of lightning protection. All consist of either an aluminium or copper strip down the length of each blade with sections exposed for lightning strike entry. The Enercon E33 and Vestas V52 have three blades while the Vergnet 275 and Windflow 500 have two. These blades are constructed from fibreglass/epoxy or plastic, both being non conductive. Thus the only components capable of generating interference are the tubular towers and the metal lightning conducting strips in each blade.

The Vestas V52 being one of the larger turbines will be considered in the study as the 'worst case' scenario. Being a three bladed machine, its impact is expected to be greater than the smaller two bladed generators. The Vestas V52 is situated on a 49 metre tubular steel tower with a 52 metre diameter rotor blade giving a total height of around 75 metres. It is expected to have a maximum rotational speed of 26 rpm.

The proposed wind farm is roughly centred at 589,800 mE and 5,556,500 mN (AGD66). This is approximately 2km south of Hayes Hill pinnacle and 3km from the west coast of Flinders Island.

As the Vestas V52 wind turbine, and other manufacturers equivalent, complies with relevant Australian, FCC (U.S.) and/or European electromagnetic compatibility standards the chance of radiated power escaping from the generating unit itself is small.

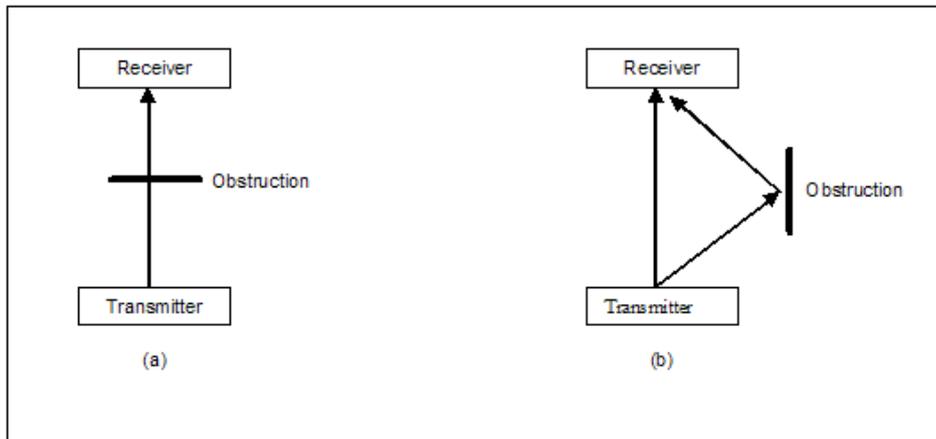
## 2. INTERFERENCE CHARACTERISTICS

The effect a wind farm will have electromagnetically depends on the type and frequency of service and the location of the wind farm with respect to the service. There are three main classes of effect, *obstructive*, *reflective* and *scattering* interference.

*Obstructive Interference* occurs when the wind farm breaks the path of a radio transmission between transmitter and receiver and reduces the received power (Fig. 1a).

*Reflective Interference* (Multi-Path Loss) occurs when the wind farm causes a reflection of the transmitted signal, which is out-of-phase to the main beam (Fig. 1b). The interaction of the two beams, main and reflected, reduces the received power and introduces a lag into the signal.

*Scattering Interference* (Multi-Path Loss) closely related to reflective interference occurs when the wind farm is located in the incident field and interference from the moving blades causes fluctuating “ghost images”.



**Figure 1: Types of Interference a) Obstructive and b) Reflective**

## 2.1. OBSTRUCTIVE INTERFERENCE

As discussed above, radio links generally require a clear line of sight path to sustain adequate link performance characteristics. The clearance criterion is based on a conservative distance from the second Fresnel radius of the main path. (Figure 2). Generally, obstructions within one Fresnel Zone of the main link may have an adverse effect on performance. Consequently, a minimum of the second Fresnel Zone clearance should be maintained.

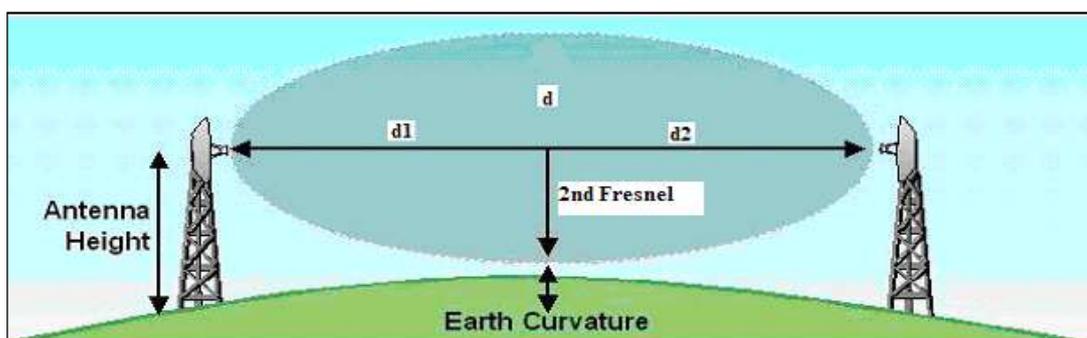
However, if an obstacle is located within the first Fresnel Zone and its width, perpendicular to the radio path is less than 0.3 Fresnel Zone then obstruction interference may be considered insignificant.

$$2ndFresnel = \sqrt{\frac{\lambda * d}{2}} \text{ (m)}$$

Where:

**d**: total hop length (m)

**λ**: wavelength (m)



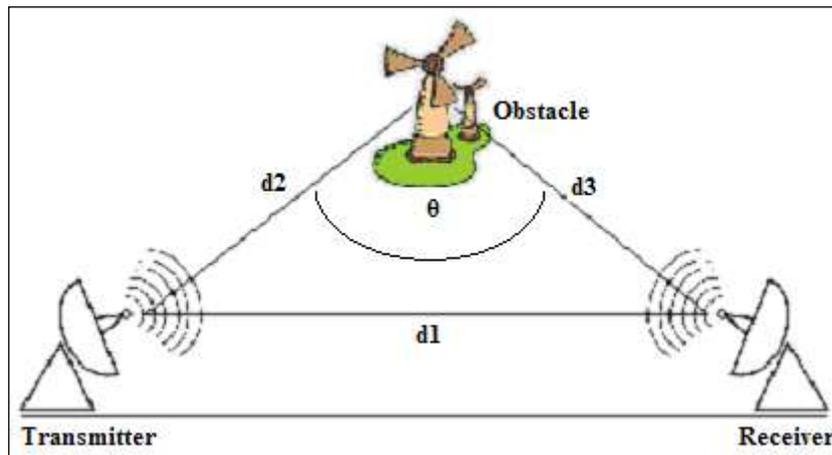
**Figure 2: Fresnel Zone**

## 2.2. REFLECTIVE INTERFERENCE

Multi-path fading is a form of interference caused by reflection and to a lesser extent diffractive interference. Reflections can come from many sources, such as buildings, hills, trees and even wind farms. This type of interference (multi-path) can be particularly severe if the main and reflected signals are equal in magnitude and  $180^\circ$  out of phase. In this preliminary analysis, direct and reflected signals are considered and any other subsequent scattering effect is assumed negligible.

A radio link's performance is determined by establishing the percentage of time the received signal falls below an acceptable threshold. It is for this reason that we need to take into consideration several radio propagation phenomena:

- Free space loss
- Obstruction Loss
- Fading due to Multipath (Atmospheric, Reflections or otherwise)



**Figure 3: Main and Reflective Beam**

In the case of wind turbines, or any potentially reflective surface, the electromagnetic interference on radio communications will be governed by the following major factors:

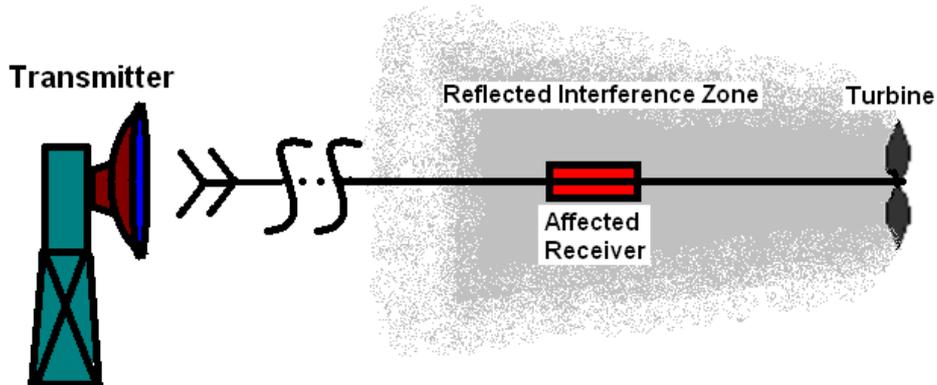
- *Area of reflective surface*
- *Shape and orientation of the obstacle*
- *Material used in the construction of the obstacle*
- *Distance of the incident and reflected signal*
- *Type of communication service*
- *Frequency of the communication surface*
- *Movement of the obstacle*

Past studies have showed that potential obstacle interference can be minimised by adopting the following criteria:

- *Maintain a large reflected hop angle ( $\theta > 120^\circ$ )*
- *Maintain a large distance between obstacle reflector i.e.  $d2$  &  $d3 \gg d1$*
- *Construction of obstacle reflector should be of non-metallic surfaces.*

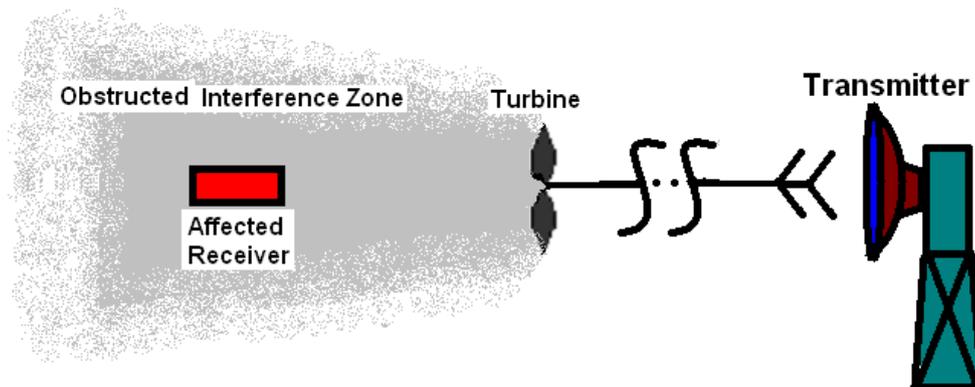
### 2.3. SCATTERING INTERFERENCE

Wind Turbines located in the incident radio field can have an effect on reception, especially those with metal rotors found on some wind turbines. Reflected signals from the rotating blades can vary the reflected signal and cause addition and/or subtraction of the direct signal.



**Figure 4: Backward Scatter Interference**

Figures 4 and 5 show the two regions where interference from moving obstructions may be considered as having a dominant effect on the quality of reception. In the backward scatter region the transmitter signal is reflected off the wind turbine blades and arrives at the receiver with different phases and amplitude to the main signal.



**Figure 5: Forward Scatter Interference**

In the forward scatter region the reception may affect receivers located along a narrow path directly behind the wind turbine and away from the transmitter. This type of interference may cause fluctuation in signal intensity.

### 3. WIND TURBINE ELECTROMAGNETIC INTERFERENCE ON TRANSMISSIONS

#### 3.1. SPECTRUM DEFINITIONS

The radio frequency spectrum includes frequencies between 3Hz and 300GHz where class sections of interest are considered as VHF, UHF and microwave. The characteristics of electromagnetic propagation have a gradual transition between each class of spectrum, specifically properties and interference. Impacts related to interference types are discussed below.

Classes are labelled as in figure 6.

CLASS	FREQUENCY	WAVELENGTH
UHF	3 GHz	1 dm
VHF	300 MHz	1 m
HF	30 MHz	1 dam
	3 MHz	1 hm

**Microwave** – 1GHz to 300GHz

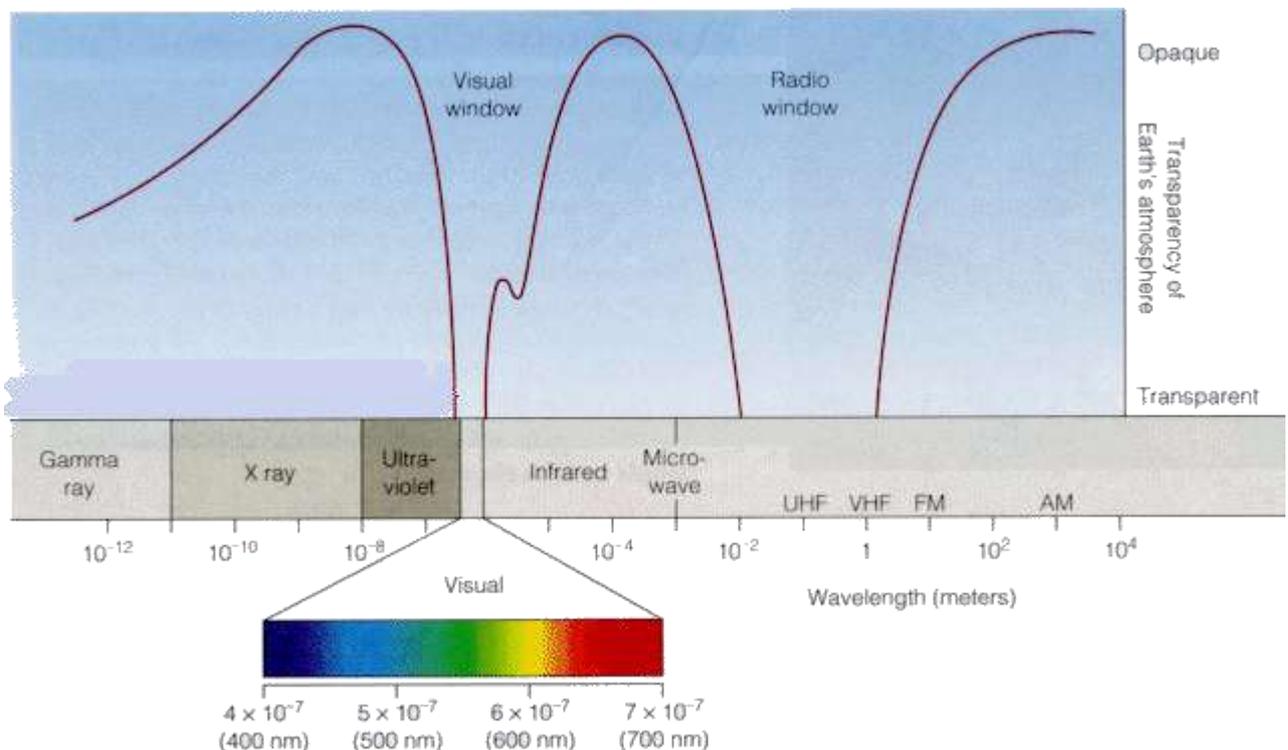


Figure 6: Electromagnetic Spectrum<sup>10</sup>

#### 3.1.1. VERY HIGH FREQUENCY (VHF):

VHF frequencies are used for communications that require greater range than line of sight links. Common uses of VHF are radio broadcasts, two way radio, television channels, aircraft communication and marine radio. FM radio is located in the VHF band. Acceptable reception from FM radio is usually obtainable among city buildings even where line of sight does not exist. This illustrates the relatively flexible nature of VHF. Large objects such as hills or objects high in electrically conductive material will block VHF transmissions. The ionosphere does not usually reflect VHF frequencies keeping VHF signals within the local area. Lower frequencies than VHF such as High Frequency (HF) are reflected by the ionosphere making HF transmissions available thousands

of kilometres away, unlike upper VHF frequencies. Considering the arbitrary boundaries between frequency classes, lower VHF is less vulnerable to obstructive interference than upper VHF.

VHF is susceptible to:

- Reflective interference
- Scattering interference
- Minimal obstructive interference only within close range to large electrically conductive objects or hills.

### 3.1.2. ULTRA HIGH FREQUENCY (UHF):

UHF frequencies are susceptible to atmospheric moisture attenuating signal strength. Line of sight is usually necessary for lower UHF and necessary for upper UHF. Common uses for UHF are cordless telephones, television, mobile phone networks, UHF CB radio, digital television and Global Positioning Systems.

UHF is susceptible to:

- Reflective interference
- Scattering interference
- Obstructive interference in the upper UHF region. Lower UHF behaves much like upper VHF.

### 3.1.3. MICROWAVE:

Microwave frequencies in this document include 1 GHz to 300 GHz overlapping with UHF between 1GHz and 3GHz. Microwave is more sensitive to atmospheric moisture than UHF causing free space loss or signal attenuation over distance. Microwave is strictly dependant on line of sight conditions and is less likely to experience external interference as a result. Common uses include radar cameras, wireless LAN networks such as Bluetooth, Metropolitan Area Networks (MAN) such as WiMAX, wireless broadband and GSM mobile phones.

Microwave is susceptible to:

- Reflective interference
- Obstructive interference
- Scattering interference. This is generally not relevant for microwave, as objects are kept clear from line of sight.

## 3.2. TELEVISION (WITHIN VHF AND UHF CLASSES)

Wind turbines have the potential for causing interference to television reception, primarily where a viewer is in the "shadow" of the wind turbines. Such interference impacts include loss of picture detail or loss of colour. Viewers situated to the side of a turbines blades may also experience periodic ghosting on the picture synchronised with the turning of the blades.

For analogue television, time lags of the order of microseconds give rise to visible ghosts and, in extreme cases, may lead to loss of synchronisation. When blades rotate, the situation worsens because the amplitude of the reflected ray is modulated by the movement causing increasing image scintillation. A ghost image appears which 'jitters' horizontally as each turbine blade interferes with the reception path. In more severe cases, the whole picture may pulsate in brightness, or worse, break up altogether. Turbine blades are the main culprit behind interference with the steel towers being less of a threat. The rotating action of the blades presents a large conductive area. Use of fibreglass/epoxy or plastic blades (i.e. those with limited metallic content) reduces the likelihood of interference caused by the blades.

Digital television is expected to be less vulnerable to wind farm interference. "In the same way that analogue channels can have different coverage depending on factors such as interference and signal strength, so the coverage for digital signals can also vary. There is however a significant difference between analogue and digital signals in terms of reception. Whereas in the analogue world a picture can still be received via a weak signal or one subject to interference (the picture may of course be of low quality), in the digital world the picture is either there or it is not."<sup>6</sup> If digital reception is available, it is generally more tolerant of interference. "Digital reception potentially has high immunity to echoes. While never affecting the quality of the picture, echoes, in particular complex echoes, decrease the quality margin and threaten the reliability of the reception. If the echo or echoes are delayed long enough and are also of sufficient level, the quality margin may be degraded enough to prevent reception."<sup>9</sup>

Although wind turbines have the potential for causing interference to television reception, these are seldom realised and even when they do occur there is a straight forward remedy. This may include more directional antennas, digital television, satellite services and mast head amplifiers.

### **3.3. FIXED RADIO (WITHIN VHF, UHF CLASSES)**

Point-to-point links are generally composed of two directional antennas at each end of the communication path. Directionality permits efficient use of radio frequency spectrum and allows individual links to be considered for interference based on clearances. Conservatively clearance requirements are considered for VHF and UHF classes although impacts may vary across the classes.

### **3.4. MICROWAVE LINKS (WITHIN 1GHZ TO 300GHZ)**

Microwave links can be affected by reflection, blocking and radio frequency interference. In general the directional nature of microwave links means problems are unlikely to arise. If a clearance of 40-200m is set between the link and the wind farm site depending on Fresnel Zone size, interference is unlikely.

### **3.5. BROADCAST RADIO (WITHIN VHF AND UHF CLASSES)**

Point-to-multipoint radio links are constructed in a star configuration, with a central base station (master) transceiver site communicating to multiple remote sites. Mobile phone (GSM and CDMA) services fall into this category. These types of systems are only licensed at the master site and can have any number of remote nodes not listed in the licence. Depending on the location and configuration of the remote node it would be possible for a link to be affected by obstructive or multipathing interference from the wind farm.

Signal delay problems are generally television specific because, in practice, the likely delays caused by diffraction and reflection are too short to be perceived in analogue sound broadcasts or for that matter in low speed digital signals (GSM cellular radio).

## **4. SERVICES POTENTIALLY AFFECTED BY FLINDERS ISLAND WIND FARM**

### **4.1. TELEVISION**

The residences located in the vicinity of the wind farm are likely to receive their signals from transmission sites at Mt Barrow and Mt Horror on the Tasmanian mainland. There are transmission sites in Victoria that could possibly be servicing northern parts of Flinders Island. If Flinders Island residences are tuned to these transmitters, the proposed wind farm poses little threat to their quality of reception. Those tuned to the Tasmanian mainland and within approximately two kilometres of the proposed turbines could be subject to reflective interference. Obstructive interference is unlikely to occur as there are few residences in the 'shadow' of the proposed wind farm. The 1:25000 map indicates few residences in this area. (See Appendix D). The television reception of the main population centre, Whitemark, will not experience obstructive interference as there is 3km clearance.

Due to the weak signal level received from the Tasmanian mainland, mast-head amplifiers may currently be used by residence to increase signal strength. This amplification degrades the signal to noise ratio making Flinders Island residence more susceptible to TV interference.

Residences in Thule Road and Lady Barron Road that are within an approximate two kilometre radius of the wind turbines are under more risk of back-scatter or reflective television interference. According to a recent study, "In the case where the terrain is fairly flat and reception locations are not screened from the wanted transmitter, it is unlikely that a wind turbine installation will cause significant impairment to receptions at distances of more than about 0.5km from the wind turbine site."<sup>7</sup> Considering four turbines are proposed and weak reception currently exists, interference is possible but unlikely for approximately five houses in the Thule Road and Lady Barron Road area within two kilometres of the wind farm.

Since the completion of the previous Flinders Island study completed in 2002, digital television has become partially available (See Appendix C). "Digital television services in Northeast Tasmania are transmitted in a different band (Band V) to analogue television (Bands III & IV)."<sup>8</sup> If nearby residences do require switching to digital television to avoid increased interference, they may need to upgrade their antenna for Band V. For digital reception to be affected by signal delays, the length of delay would be equivalent to echoes stretching the width of the screen on an analogue television and highly unlikely to result from the proposed wind farm for houses within two kilometres. Existing antennas can be re-pointed, repositioned or replaced with more directional designs to improve reception. Satellite television is also an option if necessary.

A baseline survey of television signal strengths and reception quality in the area is an option. This would ensure any perceived impact of the new turbines can be assessed. The quality of digital reception could be included in the survey. This would reduce the likelihood of complaints and ensure an acceptable alternative to reception issues is available.

## 4.2. RADIO LINKS

All radio services licensed with the Australian Communications and Media Authority (ACMA) in a radius of approximately 50 kilometres from the Flinders Island Wind farm site were examined as of 27th January 2007. Those transmitters located close to, or links running past the site with the potential for interference problems are detailed below. Maps of the existing communications infrastructure are in Appendix B.

### 4.2.1.1. FIXED POINT TO POINT RADIO LINKS

Hayes Hill peak, approximately 2km north of the proposed site, is one of the main radio transmitter sites on the island. Being a relatively close site of fixed point to point and point to multi-point links, it is of significant interest in regard to interference. The proximity of these links to the wind farm is analysed below.

#### **VHF (150MHz Links – line of sight not required):**

<b>Telstra</b>	<b>Chappell Island &lt;-&gt; Hays Hill</b>	<b>License 63871</b>
20.46 km, Fixed, Point-to-Point, 154.675 MHz and 149.745 MHz, 16kHz BW, Analogue Modulation , YU8(V) Antenna		
This link runs at a distance of about 2km from the wind farm and hence poses low risk for interference.		

State Fire Commission	Walkers Lookout <-> Mt Arthur	License 516147
151.48 km, Fixed, Point-to-Point, 150.1 MHz and 155.3 MHz, 16kHz BW, Analogue Modulation , 518(H) Antenna		
This link runs at a distance of about 2km from the wind farm and hence poses a low risk for interference. Being a long distance link, the 2 <sup>nd</sup> Fresnel zone radius was considered and found to be around 390m at its widest. This and its low frequency make it highly unlikely to undergo interference.		

**UHF (400MHz Links – line of sight usually necessary):**

Telstra	Big Green Island <-> Hays Hill	License 62951
8.73 km, Fixed, Point-to-Point, 413.825 MHz and 404.375 MHz, 16kHz BW, Analogue Modulation , 150M(H) Antenna		
This link runs at a distance of about 2km from the wind farm and hence poses low risk for interference issues.		

State Fire Commission	Mt Horror <-> Hays Hill	License 1705086
108.92 km, Fixed, Point-to-Point, 410.55 MHz, 16kHz BW, Digital Modulation , ACA-400M Antenna		
This link runs at a distance of about 1.3 km from the wind farm and hence poses a low risk for interference. Being a long distance link, the 2 <sup>nd</sup> Fresnel zone radius was considered and found to be around 200m at its widest. Thus interference is unlikely.		

State Fire Commission	Vinegar Hill <-> Hays Hill	License 1705085
20.8 km, Fixed, Point-to-Point, 412.4375 MHz, 101kHz BW, Digital Modulation , ACA-400M Antenna		
This link runs at a distance of about 1.2 km from the wind farm and hence poses a low risk for interference. The 2 <sup>nd</sup> Fresnel zone radius is around 90m at its widest.		

Telstra	Long Island <-> Hays Hill	License 1700189
26.86 km, Fixed, Point-to-Point, 413.925 MHz and 404.475 MHz, 15kHz BW, Analogue Modulation , Y415(H) Antenna		
This link runs at a distance of about 0.9 km from the wind farm and hence poses a low risk for interference. The 2 <sup>nd</sup> Fresnel zone is around 100m at its widest.		

**UHF (800MHz Links – line of sight necessary):**

Ericsson Australia	Walkers Lookout <-> Mt Barrow	License 1703724
157.34 km, Fixed, Point-to-Point, 854.5 MHz and 930.5 MHz, 200kHz BW, Digital Modulation , GK18-08 Antenna		
This link runs at a distance of about 0.8 km from the wind farm. The 2 <sup>nd</sup> Fresnel zone has a radius of approximately 170m at its widest point. <b>Being a higher frequency, this link is at higher risk of interference than the others.</b>		

**Microwave (GHz Links – line of sight required):**

Telstra	Vinegar <-> Hays Hill	License 1702450
20.1 km, Fixed, Point-to-Point, 1439.5 MHz and 1500.0 MHz, 1200 kHz BW, Digital Modulation , GKA18-1318 Antenna		
This link runs at a distance of about 1.2 km from the wind farm and hence poses a low risk for interference.		

Telstra	Lady Barron <-> Hays Hill	License 84895
20.4 km, Fixed, Point-to-Point, 1439.5 MHz and 1500.0 MHz, 1400 kHz BW, Digital Modulation , 124520 Antenna		
This link runs at a distance of about 1.1 km from the wind farm and hence poses a low risk for interference.		

Telstra	Ranga <-> Hays Hill	License 84894
6.37 km, Fixed, Point-to-Point link, 1439.5 MHz and 1500.0 MHz with 1400 kHz BW and 124520 Antenna, 18.305 GHz and 19.315 GHz with 25.6 MHz BW and VHP2-180A antenna, all being Digital Modulation		
This link runs at a distance of about 0.4 km from the wind farm. Being a relatively short distance link, the 2 <sup>nd</sup> Fresnel zone was considered and found to be around 30m at its widest. <b>Thus this is the closest link to the wind farm and reflection interference is a possibility.</b>		

**4.2.1.2. POINT TO MULTIPOINT MOBILE RADIO LINKS**

The following links are the only point-to-multipoint links that have their base stations located closer than five kilometres to the wind farm and have frequency above 160 MHz. All frequencies below 160 MHz are considered unlikely to have any significant interference due to the wind farm.

Telstra	Hays Hill	License 1136524
2 km, Spectrum, Point to Multi-point link, 839.8 MHz, CNA010H-00 Antenna 28 metres tall, 9.2 MHz BW, Digital Modulation		
The area of coverage partially obstructed by the proposed wind farm is sparsely populated. The low metal content of the turbine blades and cylindrical shape of the turbine tower makes any loss of reception insignificant.		

Telstra	Hays Hill	License 1136525
2 km, Spectrum, Point to Multi-point link, 884.8 MHz and 884.67 MHz, CNA010H-00 Antenna 28 metres tall, 9.2 MHz BW, Digital Modulation		
The area of coverage partially obstructed by the proposed wind farm is sparsely populated. The low metal content of the turbine blades and cylindrical shape of the turbine tower makes any loss of reception insignificant.		

## CONCLUSION AND RECOMMENDATIONS

This study has identified one point to point link that could possibly be affected by the proposed Flinders Island wind farm and several that are unlikely to be affected. None of the links are expected to experience obstructive interference while reflective and scattering interference are possibilities. The low metallic content of the turbine blades and the narrow, cylindrical tower construction make the risk of these adverse interference effects minimal.

Two point to multipoint links within 5 kilometres of the proposed site were identified. These services could possibly experience obstructive interference within close proximity to the wind farm. This is unlikely to cause significant loss of coverage as the obstructed area is small. No documented cases have been found of significant interference to mobile radio and cellular services. It is recommended that all operators that are likely to be affected be contacted as part of the development process.

Television services are more susceptible to wind farm interference than most communication systems. The Thule Rd and Lady Barron Rd area between Whitemark and the proposed site are possibly at risk. (See Appendix D). The newly available digital television broadcasts are far less sensitive to signal reflections and scattering. Thus it provides a good alternative technology for adversely affected residence if not already in use.

General recommendations:

- All generators must be in compliance with the relevant electromagnetic interference standards to ensure the towers do not produce electromagnetic interference.
- Letters should be sent to the licensee of each possibly affected radio service, advising of the intention to install the turbines, requesting any concerns regarding the wind farm be raised. (Refer to Appendix E for a draft letter).
- All links identified as being vulnerable to interference should have their link quality and signal strength measured if this information is not already available.
- It may be prudent to commission a signal strength survey. This could cover the residences within two kilometres of the proposed site and a few samples from Whitemark. The availability of digital television in the area could be tested to ensure the presence of the alternative. (See Appendix C).
- Flinders Island Airport should be notified of the development to enable any concerns to be raised.
- According to the 2002 study, measurement of amateur radio frequency signal strength at Mr Peter Blundstone's residence in Lady Barron Road could be conducted to satisfy his concerns of interference. The possibility of interference is considered extremely low.

# REFERENCES

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- 2) CNCC-TR-C0021, *Electromagnetic interference evaluation report for the proposed Hydro Electric Commission wind farm on King Island*, J. Mann, Hydro Tasmania, August 1994.
- 3) TSG-071-TR-000, *Cowalla Peak Wind Farm EMI Study*, Robert Clark, Hydro Tasmania, July 2003.
- 4) ACMA Database mapping, supplied by Spectrum Engineering Australia, 27/01/07.
- 5) Proposed Turbine Locations, provided by Hydro Tasmania, Business Development, 18/01/07.
- 6) *A Guide to Digital Television and Digital Switchover*, Digital Television DTI, [www.digitaltelevision.gov.uk/pdf\\_documents/publications/guide\\_to\\_digital\\_tv\\_2004.pdf](http://www.digitaltelevision.gov.uk/pdf_documents/publications/guide_to_digital_tv_2004.pdf)  
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- 7) Rohan Fernandez, *Guidelines for Minimising the Impact of Wind Farms in the SAGRN*, TR049- SA, Telstra, October 2003.
- 8) ABC Reception Advice Website, <http://www2b.abc.net.au/reception/frequencyfinder/asp/largemap.asp?transmissionid=5451> – Viewed 31/01/07
- 9) *Installing Digital Terrestrial Television*, Digital Broadcasting Australia, January 2001.
- 10) B Castro, [http://www.twcac.org/Tutorials/tutorials\\_index.htm](http://www.twcac.org/Tutorials/tutorials_index.htm) – Viewed 20/02/07

# APPENDIX A

# APPENDIX A

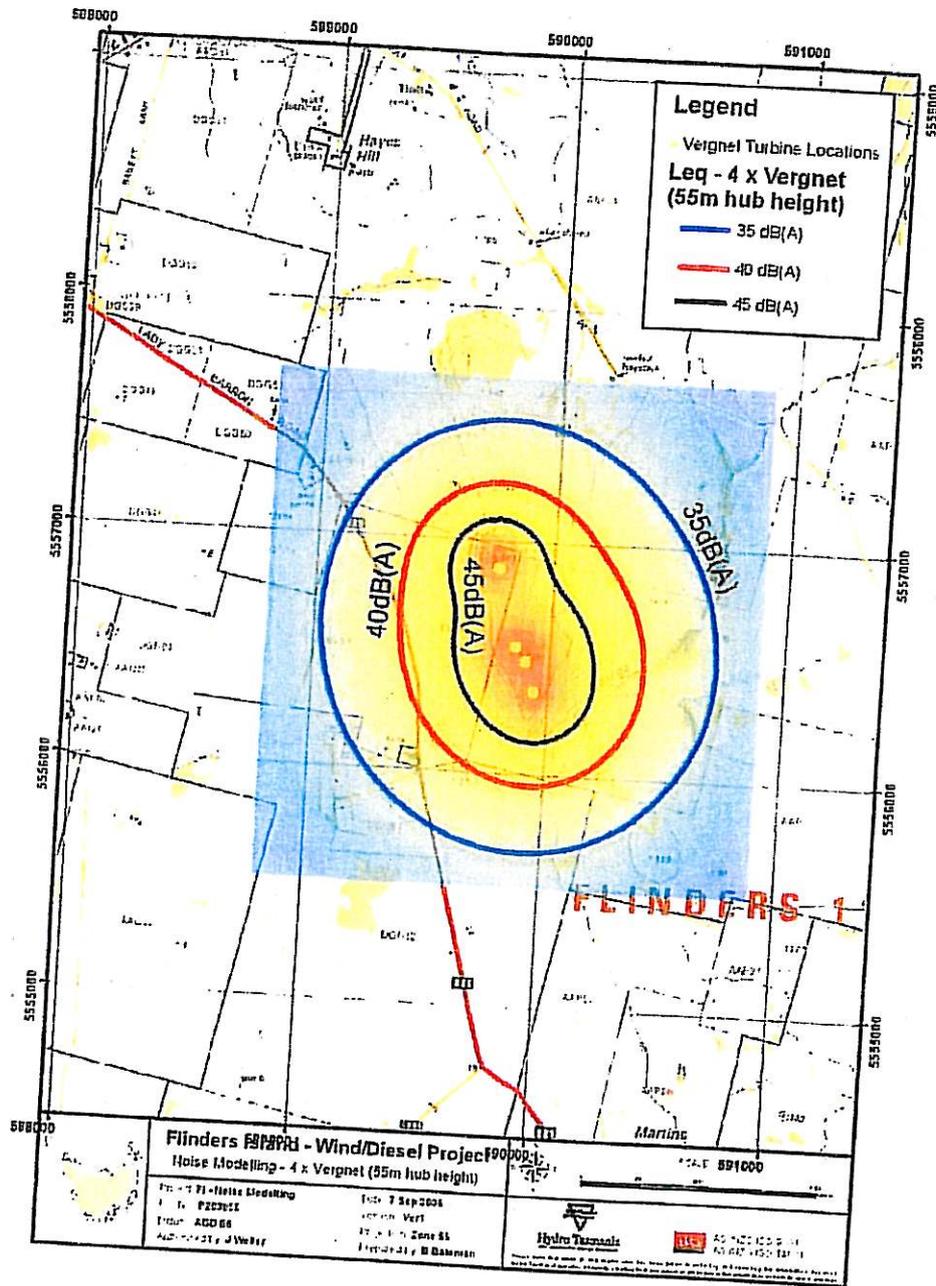
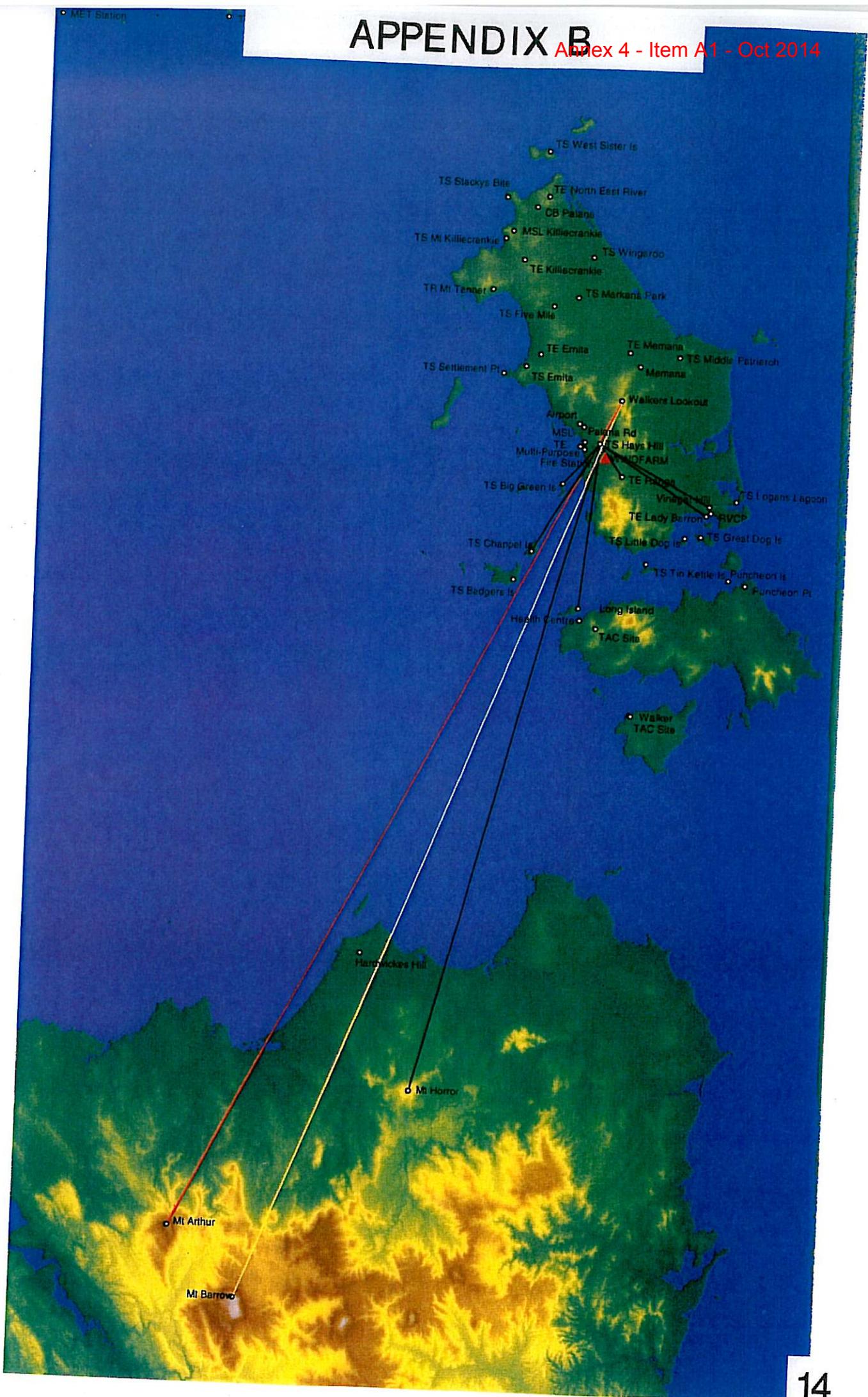


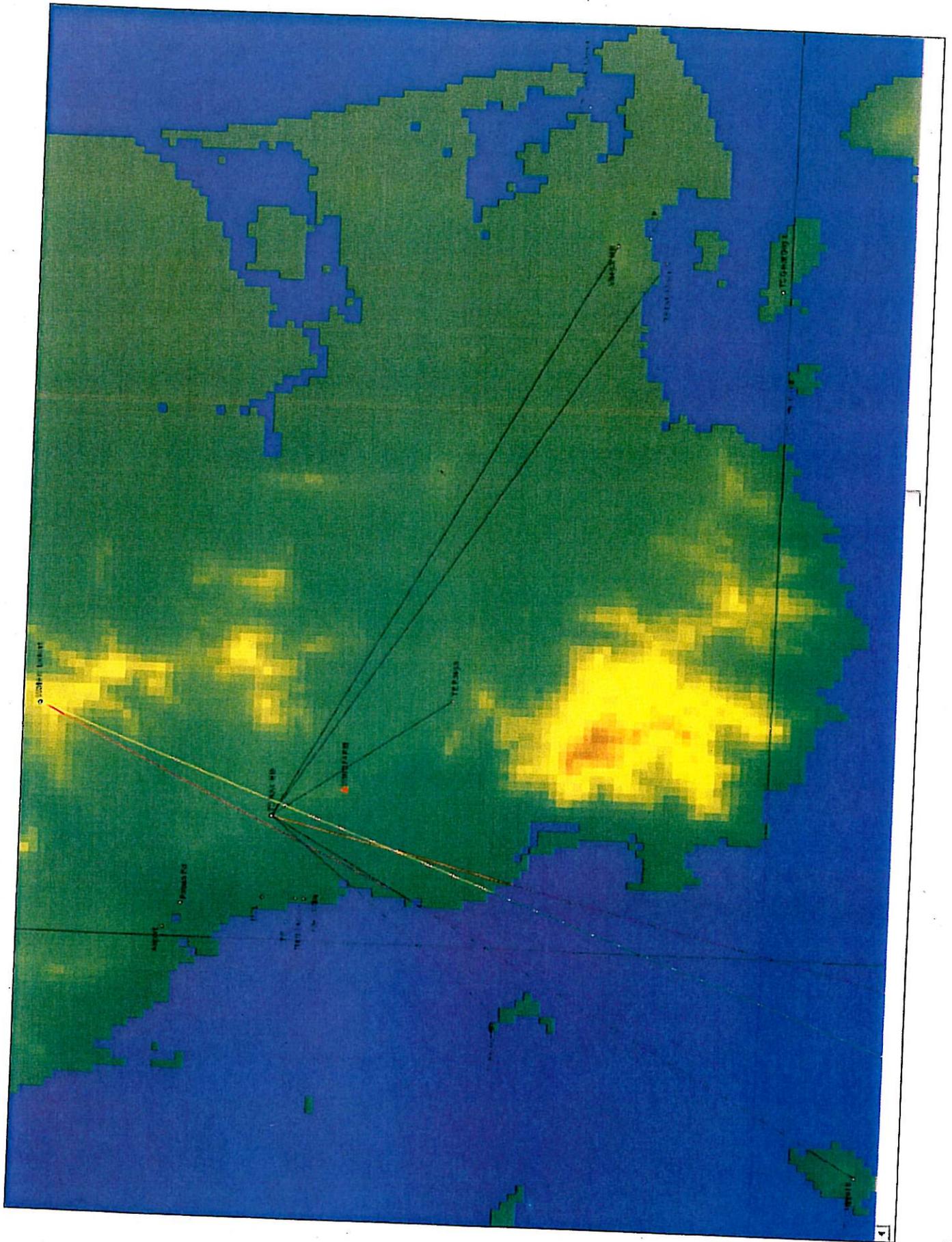
Figure 4-1 Output from Noise Model for 4 x Vergnet Wind Farm at 8 m/s at 10m A.G.L

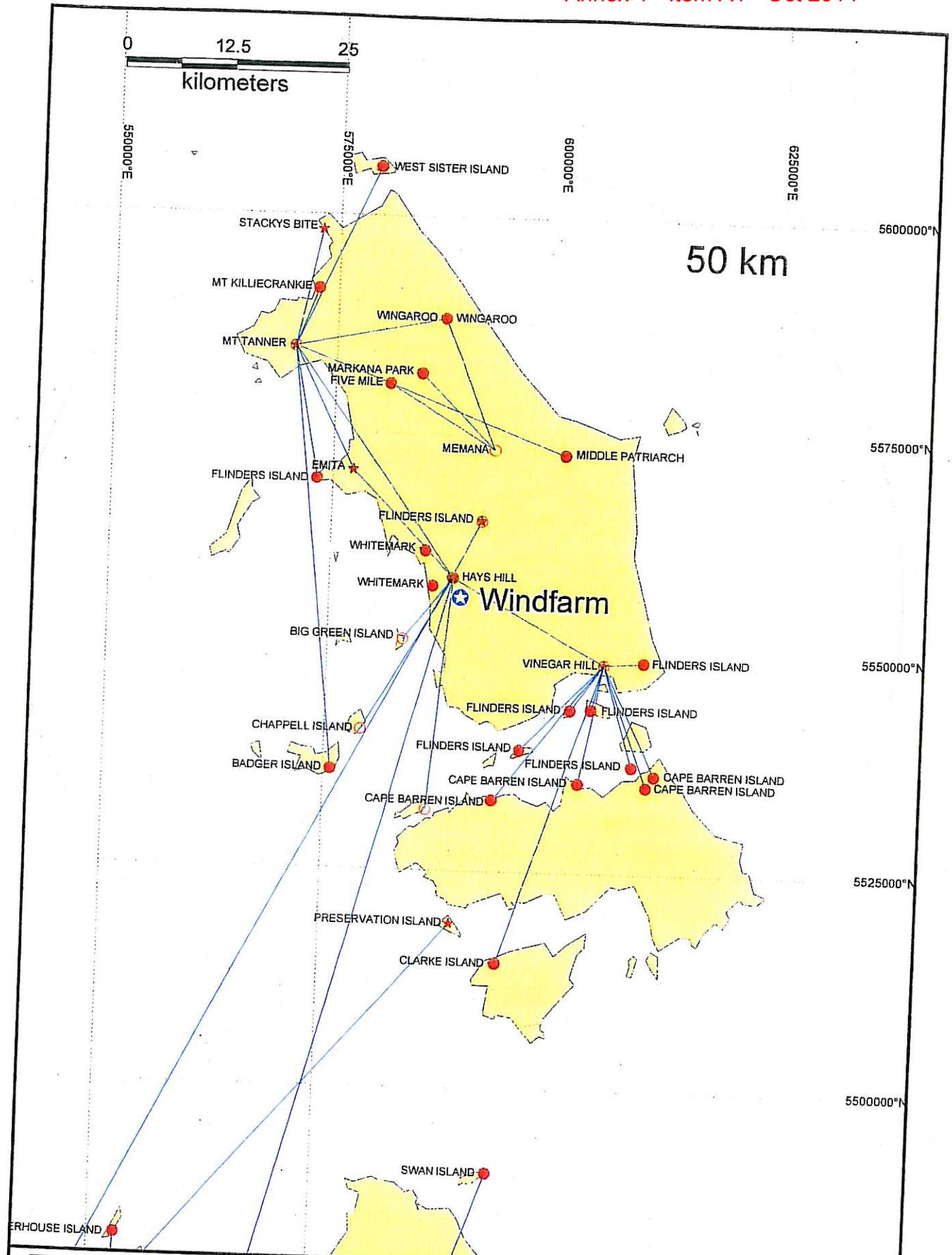
# APPENDIX B

# APPENDIX B

Annex 4 - Item A1 - Oct 2014

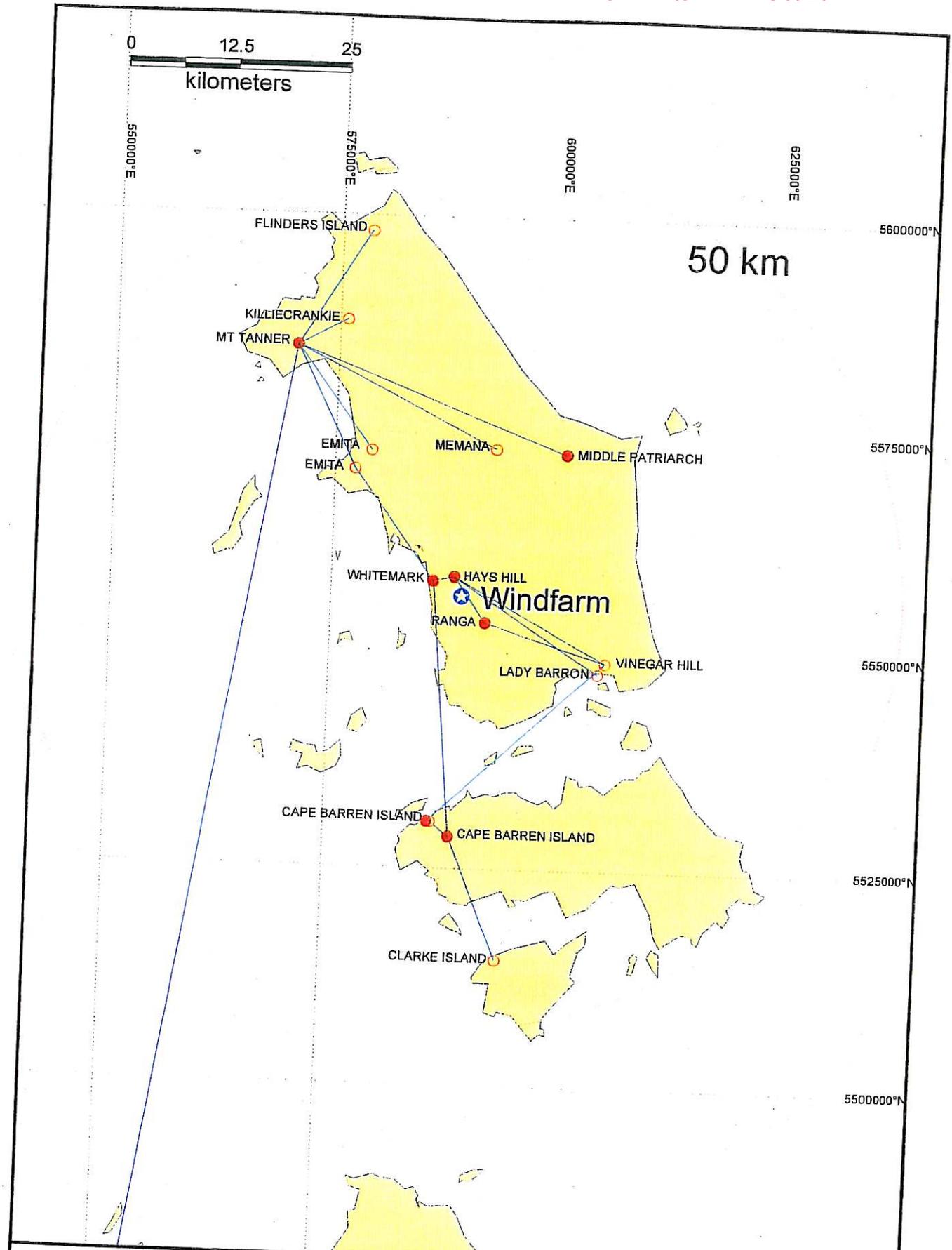






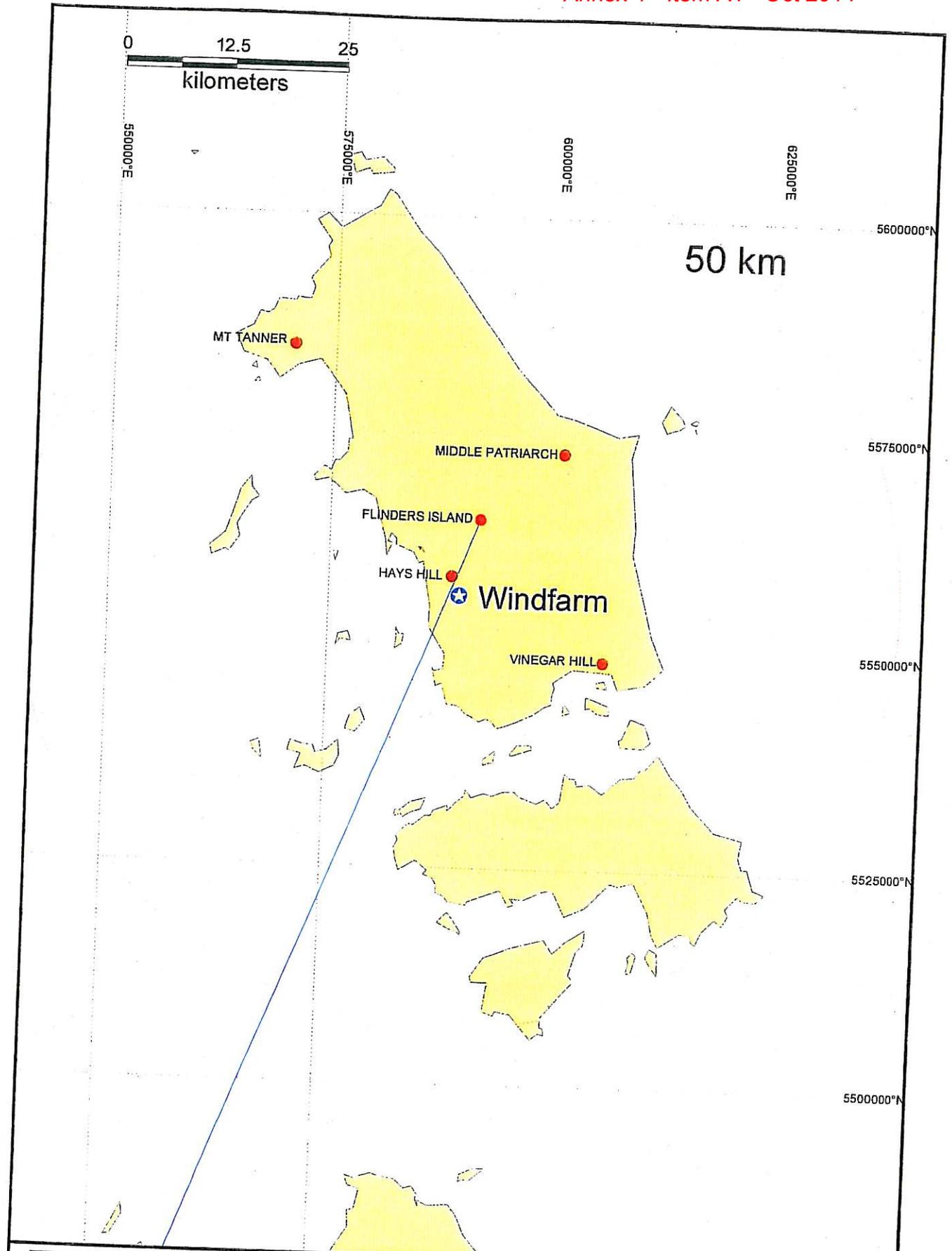
**SPECTRUM ENGINEERING AUSTRALIA** Pty Limited A.C.N. 008 642 028  
**Radiocommunications Planning and Design**  
 Postal: P.O. Box 3213, BELCONNEN ACT 2617  
 Telephone: 02 6253 2555  
 Facsimile: 02 6253 2800

TITLE: <b>Assignments 40-499 MHz</b> Source of data ACMA RRL database	
FILENAME: No Filename	DATE: 30/1/2007
PROJECT: No Project	SCALE: N/A
DRWG NO: No Drawing No	BY: AJM



**SPECTRUM ENGINEERING AUSTRALIA** Pty Limited A.C.N. 008 642 028  
**Radiocommunications Planning and Design**  
 Postal: P.O. Box 3213, BELCONNEN ACT 2617  
 Telephone: 02 6253 2555  
 Facsimile: 02 6253 2800

TITLE: Assignments 1000 MHz and above Source of data ACMA RRL database	
FILENAME: No Filename	DATE: 30/1/2007
PROJECT: No Project	SCALE: N/A
DRWG NO: No Drawing No	BY: AJM



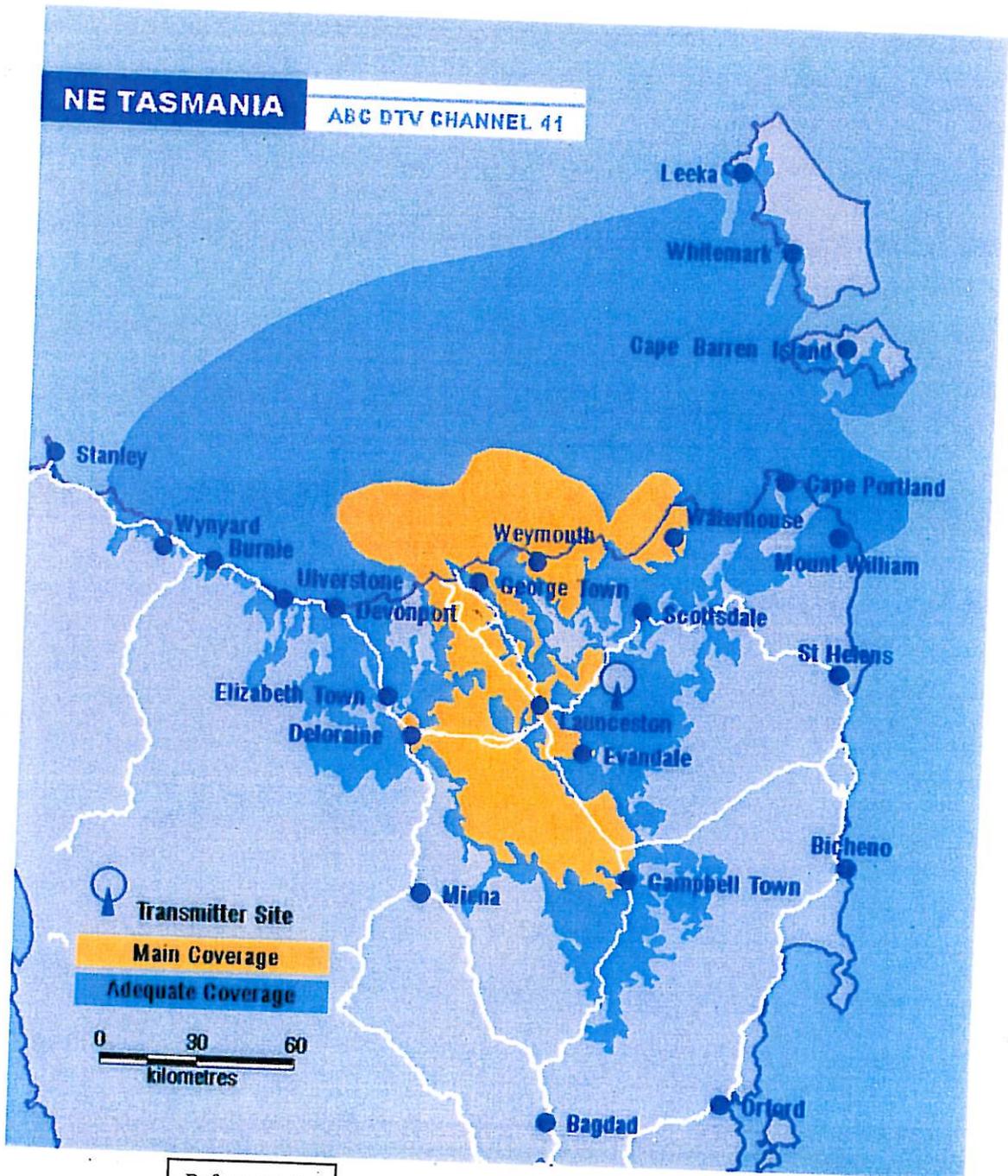
**SPECTRUM ENGINEERING AUSTRALIA** Pty Limited A.C.N. 008 642 028  
**Radiocommunications Planning and Design**  
 Postal: P.O. Box 3213, BELCONNEN ACT 2617  
 Telephone: 02 6253 2555  
 Facsimile: 02 6253 2800

TITLE: Assignments 500-999 MHz Source of data ACMA RRL database	
FILENAME: No Filename	DATE: 30/1/2007
PROJECT: No Project	SCALE: N/A
DRWG NO: No Drawing No	BY: AJM

# APPENDIX C

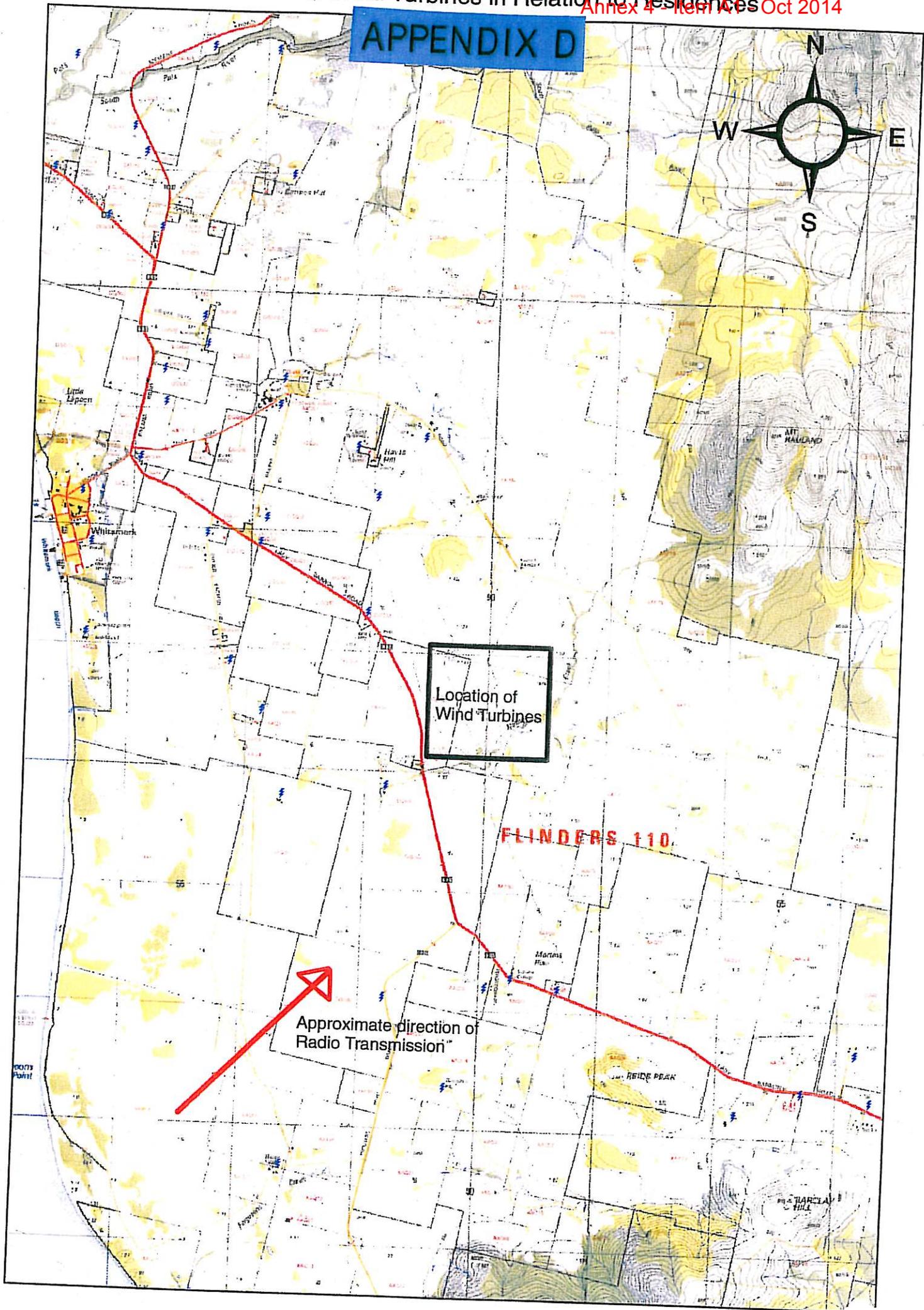
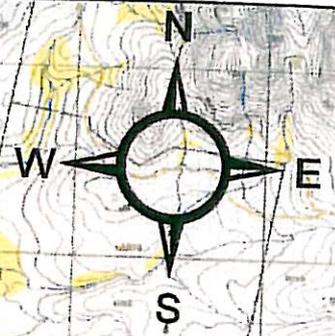
# APPENDIX C

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# APPENDIX D

# APPENDIX D



Location of Wind Turbines

Approximate direction of Radio Transmission

# APPENDIX E

# APPENDIX E

**Note: Attach a map of the site.**

Dear Sir/Madam,

## RE: FLINDERS ISLAND WINDFARM

Hydro Tasmania is currently conducting a communications impact assessment for a proposed Flinders Island wind farm located approximately 3km south east of Flinders Island, Tasmania. The extension will consist of 4 wind turbines with blades 52 metres in diameter, constructed primarily of fibreglass and epoxy resin. The turbines will be erected on tubular steel towers, 50 meters high. For the location of the proposed site please refer to the map attached.

The services that may be potentially affected include:  
(Add links.)

These services have the potential to be affected in the following manner.

A wind farm can have differing effects on radio services, depending on the type and frequency of service and the location of the wind farm with respect to the service. There are two main classes of effect, being *obstruction* and *reflection*. Both of these act to degrade the signal at the receiver and decrease the performance and reliability of the service. With obstruction interference the wind farm breaks the path of a radio transmission between transmitter and receiver, causing the power received from the transmitter to be reduced below what would normally be received (Fig. 1a). Reflection interference can occur when the wind farm is not directly in the path of the radio service, but causes a reflection of the transmitted signal, which is out-of-phase to the main beam (Fig. 1b). When combined at the receiver the main and reflected beams subtract so that the received power is reduced below that which would normally be received (reflection interference is also known as multi-path loss).

Most interference problems associated with wind farms emanate from turbine blades constructed of mostly metal or carbon fibre. Interference is caused by the rotating action of the blades presenting a large conductive area, which causes the obstruction or reflection. The use of fibreglass/epoxy or plastic blades (i.e. those with limited metallic content) reduces the likelihood of interference caused by the blades, however the risk is not completely eliminated. To some extent the steel towers also potentially obstruct and/or reflect radio transmissions.

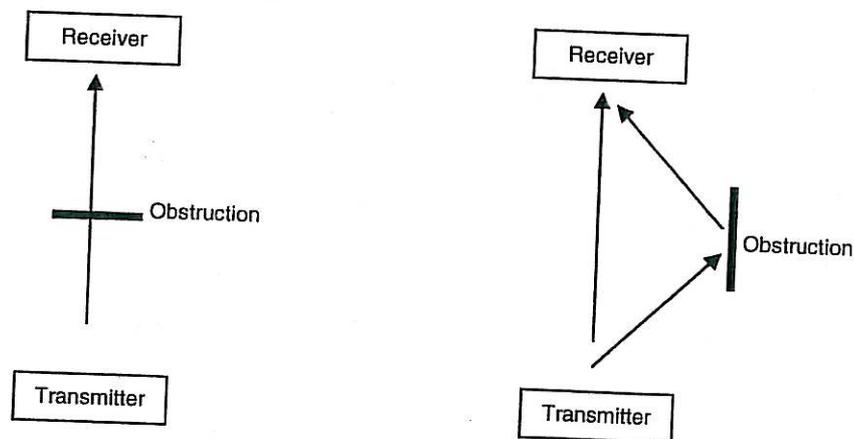


Figure 1. (a) Obstruction, and (b) Reflection Interference.

Fixed point-to-multipoint radio links are constructed in a star configuration, with a central (master) transceiver site communicating to multiple remote sites. These types of systems are only licensed at the master site and can have any number of remote nodes not listed in the licence. Depending on the proximity to the wind farm and configuration of the remote node, it would be possible for a link to be affected by the wind farm.

The same obstruction and reflection factors also have the potential to affect mobile (two-way) radio services. These services usually operate as a transceiver located on a central high point communicating to remote mobile units in vehicles, and hand-helds. Any interference to these services would be likely to be confined to an area close to the wind farm (less than 1 km).

In an attempt to address any future problems that may arise, we request that you send us a written response highlighting any issues that you have, detailing the following:

- Any concerns regarding the effects of the proposed Wind Farm development on your communications system.
- The configuration of any above communications systems.

We would appreciate your early response to this enquiry. Please address your response to

...

Yours faithfully,

...