DNV·GL

BIALA WIND FARM

EMI and EMF Assessment

Environmental Resources Management Australia Pty Ltd

Report No.: 170223-AUME-R-03, Rev. C
Date: 10 July 2015
Status: Final

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Project name:	Biala Wind Farm	DNV GL Energy
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Project No.:	170223	Tel: +61-3-9600-1993
Report No.:	170223-AUME-R-03, Rev.C	

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Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2015-02-24	First issue – DRAFT	H Hurree	T Gilbert	M Bechly
B	2015-07-02	Updated report with feedback responses and reference to SEARs - DRAFT	H Hurree	T Gilbert	
C	2015-07-10	Updated report with feedback responses	H Hurree	T Gilbert	G Slack

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1 EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd, now trading as DNV GL, has been commissioned by Environmental Resources Management Australia Pty Ltd ("ERM" or the "Client") to independently assess electromagnetic interference (EMI) and electromagnetic field (EMF) related impacts associated with the operation of the proposed Biala Wind Farm (the "Project") which is being developed by Newtricity (the "Project Developer"). This report summarises the results of an EMI and EMF assessment conducted at the site.

In accordance with the planning guidelines relevant to the proposed Biala Wind Farm, this document assesses potential risks regarding interference with radiocommunication services operating in the vicinity of the Project. Consideration is also given to potential EMF related impacts.

"Radiocommunications" is used as a broad term in this report to encompass all services that rely on electromagnetic or radio waves to transfer information. There are many methods of transmitting information via radiocommunication. Radiocommunication services operating in the vicinity of the proposed wind farm, and their susceptibility to interference with the wind farm, are discussed in this document. Up to date information relating to nearby telecommunication licences has been obtained from the Australian Communications and Media Authority (ACMA) [1].

Wind turbines may cause interference to television broadcast signals. Historically, analogue television signals have been more likely to suffer from interference. However, digital television services have recently replaced analogue broadcasts and are generally more robust to interference from wind farms. Large scale interference to television signals can generally be avoided by placing the wind turbines distant from the broadcast tower. No television broadcast tower has been identified in close proximity to the Biala Wind Farm site boundary, with the nearest broadcast tower at least 14 km north of the site, at Wades Hill, servicing the town of Crookwell. This tower is likely to be only servicing houses in its immediate area. Digital television signals from the Black Mountain transmitter near Canberra, currently service the area around the Biala Wind Farm. The Digital TV Switchover Australia website indicates that digital television signal has "good coverage" across most of the site, with some regions having variable coverage. This report highlights the areas around the proposed wind farm where interference to terrestrial television broadcasts is most likely to occur. A total of six (6) houses were identified in the potential interference zone for the Black Mountain broadcast tower. Out of the six (6) affected dwellings, two (2) are stakeholder dwellings. It is also possible that some residents currently experience poor or marginal reception of the digital signals and therefore, they may also be susceptible to interference from the wind farm. For such cases, there is a range of mitigation options available to rectify difficulties encountered with television reception, and dwellings in the area may be eligible for the government funded satellite television service.

The Upper Lachlan Shire Council has also indicated that they are in the process of constructing a new broadcast tower in Crookwell. Information regarding the future broadcast tower has not yet been provided, and DNV GL has been unable to assess the likely impact of the Project on transmissions from the tower.

Wind turbines can potentially cause interference to fixed point-to-point links through diffraction, scattering or near-field effects. However, it is possible to design around this issue, as the path and interference zone of point-to-point signals is generally well known. It has been found that three (3) fixed point-to-point links cross the proposed Project site. Calculation of a required exclusion zone has been undertaken for each point-to-point link based on a standard industry methodology. Four (4) of the turbines proposed for the Project site are located within the exclusion zone of one (1) point-to-point link. The operators ofthe three (3) links, New South Wales Rural Fire Service (RFS) and the Upper Lachlan

Shire Council, have been contacted to assess the likely impact of the proposed wind farm development and operation on their services. The RFS has proposed a more conservative definition for the exclusion zone and sixteen (16) turbines are located within the revised exclusion zone. In order to mitigate these potential impacts, the RFS and Upper Lachlan Shire Council have indicated that they are prepared to consider re-routing the fixed links under specified conditions.

Wind turbines can also cause interference with fixed point-to-multipoint links; however it is not possible to identify the locations of paths for point-to-multipoint links as only the base-station is licensed and contained in the ACMA Radiocommunications Database [1]. There are two (2) point-to-multipoint base stations listed in the ACMA database within 20 km of the proposed Biala Wind Farm site boundary, both owned by the Upper Lachlan Shire Council. DNV GL has contacted the Upper Lachlan Shire Council to assess the likely impact of the proposed wind farm on their services. There are also a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, DNV GL has contacted the operators of these stations to seek feedback on any potential impact that the wind farm could have on their services. APPENDIX C details the responses received.

In general, Very High Frequency (VHF) and Ultra High Frequency (UHF) frequency band radio signals, and digital voice based technologies such as mobile phones (often called Global System for Mobile Communications, or GSM phones), and third generation phones (often called 3G or NextG mobiles) are unaffected by wind farm development. Some interference is theoretically possible in areas where coverage is marginal and a wind turbine intercepts the signal. However, the signals are generally robust, and should interference from any source occur, the user can typically move to an area of better reception. DNV GL has contacted mobile phone network operators as part of an extensive consultation process, to seek feedback on any potential impact that the wind farm could have on their services and to date no concerns have been raised.

Emergency services operating radiocommunication assets in the vicinity of the proposed Biala Wind Farm have also been identified. The majority of the licences identified can be broadly described as base to mobile station style communications. As per the above paragraph, these services are typically unaffected by wind farm development. Regardless, the operators of these stations have been contacted as part of a consultation process and their feedback sought on any potential impact that the wind farm could have on their services, and to date no objections have been raised.

It is possible that wind turbines could cause interference to satellite television and internet services if a wind turbine intercepts the signal between a satellite and ground based receiver. It is expected that interference to satellite television or internet services resulting from the development and operation of the proposed Biala wind farm is unlikely.

Broadcast radio signals do not generally suffer from interference from wind turbines. AM radio signals are very unlikely to be affected by wind farms. FM radio signals may experience interference in the form of low level hiss or distortion, but generally only in close proximity to the wind turbines. Any reception difficulties are likely to be easily rectified through the installation of a high quality antenna.

Wind turbines have the potential to interfere with meteorological and aviation radars. Reflection of radar signals by wind turbine blades may give false readings or create a radar "shadow" behind the turbines. Due to the distance from meteorological radar assets, and the high probability that the turbines will lie below the radar line-of-sight, it is unlikely that the proposed Biala Wind Farm will cause any significant interference to meteorological radar. Feedback has been received from the Bureau of Meteorology indicating that it is unlikely that the wind farm will adversely impact their services. It is understood that

a detailed aviation impact study will be undertaken to asses any likely impact on aviation radars due to the wind farm development and operation.

There is a possibility that wind farms can interfere with trigonometrical stations (or trig points) used for surveying purposes. A review of trigonometrical stations in proximity to the wind farm has been conducted and it is unlikely that these stations will be subject to electromagnetic interference from the Project. However, it is possible that there may be other stations in the area that have not been identified or that the sight lines to some nearby stations may be blocked by turbines. To assess these potential impacts DNV GL has consulted with Geoscience Australia and the New South Wales Government Land and Property Information (LPI), who have indicated that no impacts to their assets are expected from the Biala Wind Farm.

Possible cumulative EMI impacts from the proposed Biala Wind Farm and nearby wind farms have also been considered and are presented in section 5.16 of this report.

Electromagnetic waves are continually present in the environment, and are caused by both natural and artificial sources. Low frequency electromagnetic waves (less than approximately 3 kHz) are often labelled electromagnetic fields (EMF), while higher frequency electromagnetic waves are often labelled electromagnetic radiation (EMR). All electrical devices emit electromagnetic waves. Section 5.16 discusses the electromagnetic emissions from wind turbines, including both EMF and EMR. Emissions from other components that may be present in a wind farm have not been assessed, unless specifically stated.

Conclusions and recommendations from this analysis have been made in Section 7 of this report.

2 INTRODUCTION

Environmental Resources Management Australia Pty Ltd ("ERM" or the "Client") has requested that Garrad Hassan Pacific Pty Ltd, now trading as DNV GL ("DNV GL"), carry out an independent assessment of electromagnetic interference (EMI) and electromagnetic field (EMF) related impacts associated with the proposed Biala Wind Farm (the "Project"). The results of the work are reported here. This document has been prepared pursuant to DNV GL proposal 170223/PP/01 Issue A, dated 22 August 2013, and is subject to the terms and conditions contained therein.

In accordance with relevant planning guidelines, this assessment investigates the potential impact of the proposed Project on:

- Fixed point-to-point links,
- Fixed point-to-multipoint links,
- Radiocommunication assets belonging to emergency services,
- Aviation and meteorological radars,
- Trigonometrical stations,
- Citizens Band (CB) radio and mobile phones,
- Wireless internet,
- Broadcast radio,
- Satellite television and internet, and
- Broadcast television.

The assessment also considers potential impacts due to electromagnetic emissions (including electromagnetic fields and electromagnetic radiation) from the proposed wind farm.

In order to conduct the current assessment, up to date information regarding radiocommunication licences in the vicinity of the Project has been obtained from the Australian Communication and Media Authority (ACMA) Radiocommunications (RADCOM) database [1].

Information regarding theprospective turbine model and layout considered in this analysis is detailed in APPENDIX A of this document.

3 DESCRIPTION OF THE SITE AND PROJECT

3.1 General site description

The Project is located approximately 80 km north-northeast of Canberra and 8.5 km northeast of the town of Biala and lies at elevations ranging between 750 m and 930 m. The site and surrounds can generally be described as open farmland interspersed with areas of denser vegetation and tall trees, particularly in the northeast section of the site.

The proposed wind farm is located in a region of high wind farm activity, with the existing Gullen Range and Gunning wind farms located approximately 5.5 km east and 7.2 km south-southeast of the Project respectively. The existing Crookwell Stage 1 wind farm, the approved Stage 2 and proposed Stage 3 wind farms are located at approximately 15 km east-northeast of the Project with the existing Gullen Range Wind Farm located between the Project and the 3 Crookwell wind farms. An assessment of the potential cumulative EMI impacts of the Biala Wind Farm and the neighbouring wind farms has been undertaken and is described in section 5.16.

3.2 The Project

3.2.1 Proposed wind farm layout

The project comprises a number of elements, including 31 individual wind turbines standing up to 185 m to the top of the blade tip with a rotor diameter of up to 150 m and a proposed hub height of 110 m.

A turbine layout comprising 31 turbines has been considered for the current study. Figure 3-1 below shows a map of the site, with the proposed turbine layout and the turbine coordinates listed in APPENDIX A.

3.2.2 House locations

The list of houses neighbouring the wind farm was supplied to DNV GL by Newtricity [2]. Two houses, which were identified by DNV GL during a site visit on 6 April 2014, are also included in the list of houses assessed in this report.

The supplied list of houses also includes unbuilt house locations for which development approval has been granted. An unbuilt house location with development approval lying within the wind farm boundary (designated 'DA16') has been included in the assessment. A second stakeholder location with development approval (designated 'DA17', and located within the site boundary at 715281m E 6170122m N, WGS84 Zone 55) has been identified but has not been included in the assessment at the request of Newtricity. DNV GL has been informed that the involved landholder has an agreement with Newtricity confirming that they will not act on the DA if the Project is granted approval [3].

The coordinates of those dwellings within 2 km of the wind farm are presented in Table B- 3. DNV GL has assumed that all listed houses are potential inhabited residential locations. It should be noted that DNV GL has not carried out a detailed and comprehensive survey of house locations in the area and is relying on information provided by the Client.

Figure 3-1 also shows the Project site boundaries as well as the location of dwellings considered in the assessment.

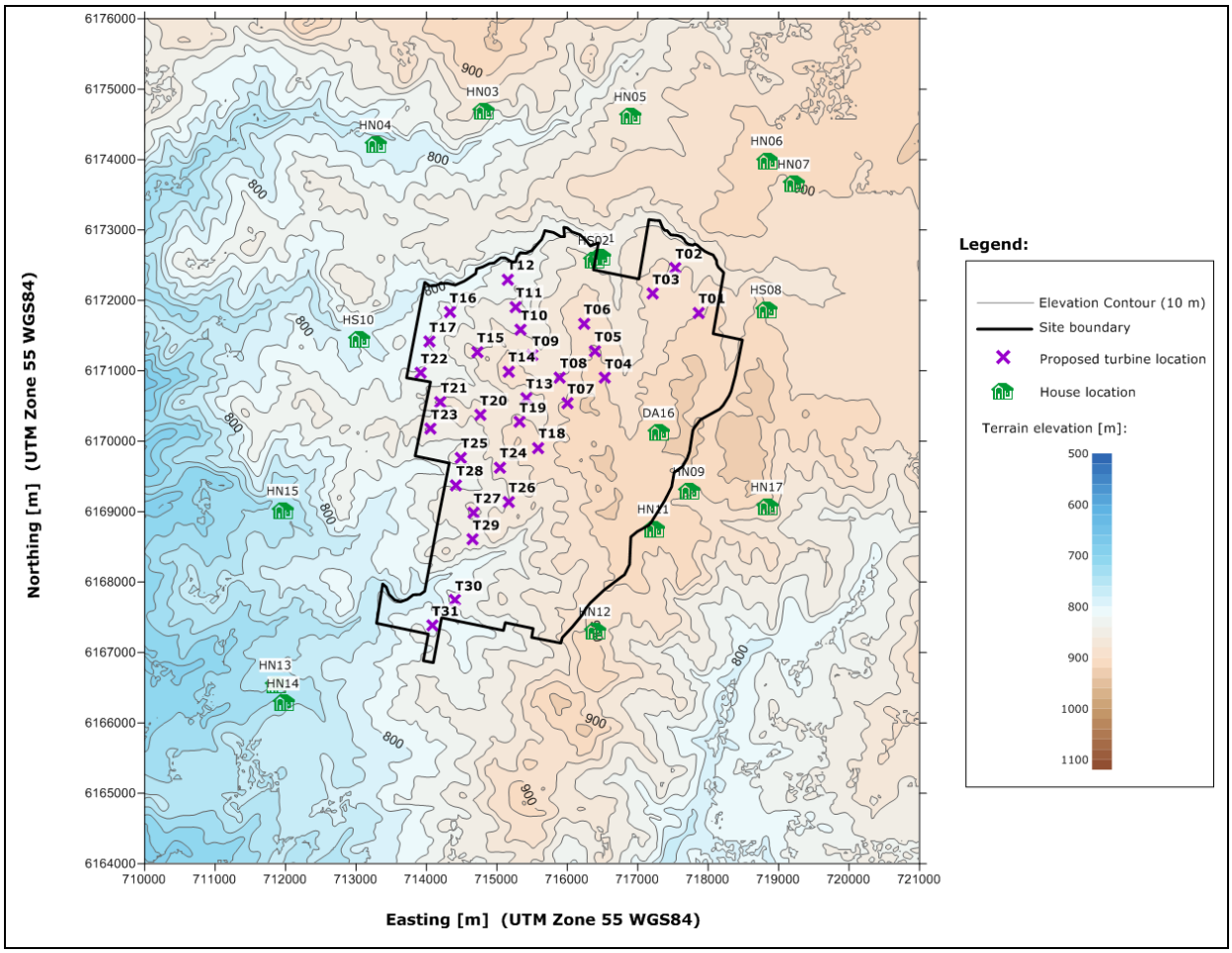


Figure 3-1 Layout of the Biala Wind Farm

4 PLANNING GUIDELINES

Regarding interference to telecommunications services, the Secretary's Environmental Assessment Requirements for the Biala Wind Farm (SEARs) [4] outline the following requirements for the Project:

> *"Telecommunications: identify possible effects on telecommunications systems, assess impacts and mitigation measures including undertaking a full engineering assessment to examine the potential impacts as well as analysis and agreement on the implementation of suitable options to avoid potential disruptions to radio communication services which may include the installation and maintenance of alternative sites"*

In addition, the Draft NSW Planning Guidelines for Wind Farms (Draft NSW Guidelines) [5] currently state:

> *"The potential for a proposed wind farm to cause electromagnetic interference (EMI) with communication signals and services, such as microwave, television, radar and radio transmission signals, should be assessed. Where communication facilities are located in the vicinity of the wind farm, the applicant should:*
>
> - *identify any signals and services which may be affected*
> - *assess the potential for the proposed wind farm to impact on the signals and services*
> - *consult with the relevant parties*
> - *outline proposed measures to avoid or mitigate against electromagnetic interference impacts.*
>
> *Potential electromagnetic interference effects can be calculated from information from affected telecommunications transmitting or receiving stations, local conditions, turbine design and location. The potential for electromagnetic interference from a proposed wind farm should be minimised, if not eliminated, through appropriate turbine design, siting and mitigation. A design measure to reduce EMI is to minimising the use of turbines with metal blades or those with metallic cores. A siting measure is to avoid siting turbines in the 'line of sight' between transmitters and receivers.*
>
> *If a Development Application is approved, detailed conditions of consent will be specified that aim to protect landowners in the area against electromagnetic interference and ensure that any impacts are rectified at the proponent's cost."*

It is also noted that the SEARs state that:

> *"During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, services provides, community groups and affected landowners. In particular you must consult with:*
>
> - *NSW Government Telco Authority and other registered communications licensees (including emergency services)*

A consultation process has been carried out as part of the current assessment, and feedback provided is summarised throughout the report and in APPENDIX C.

Regarding electromagnetic fields, the SEARs provide the following requirements for the project:

> *"Health: … Identify potential hazards and risks associated with electric and magnetic fields and demonstrate the application of the principles of Prudence Avoidance".*

In addition, the Draft NSW Guidelines currently state:

"The assessment should consider the potential for the proposed wind farm and associated transmission line network to generate electro magnetic fields (EMFs).

Wherever electrical equipment operates, electric and magnetic fields (EMFs) are created in the surrounding environment. The main sources of EMFs typically associated with a proposed wind farm is the electrical equipment within the turbine structures, the substation and the interconnecting underground and overhead wiring. The fields associated with these are typically localised.

Despite extensive research and numerous public inquiries, adverse health effects have not been established, but the possibility has not been ruled out. A prudent approach should be applied in designing and siting wind farm facilities. All equipment should be constructed according to industry accepted practices. Provided this occurs, the EMFs associated with the proposed wind farm will typically be well within the relevant health standards (including ARPANSA standards) and, in many cases, will be localised to areas not often frequented by people."

Although the SEARs and Draft NSW Guidelines describe the requirements for these assessments, they do not provide detailed methodologies for assessing EMI and EMF related impacts.

However, the Environmental Protection and Heritage Council (EPHC), in conjunction with the Local Government and Planning Ministers' Council released a draft version of the National guidelines for wind farm development in July 2010 (Draft National Guidelines) [6]. The draft guidelines cover a range of issues spanning over the different stages of wind farm development.

The Draft National Guidelines provide detailed methodologies to guide the assessment of issues related to wind farms, including community consultations, shadow flicker, noise monitoring, electromagnetic interference, impacts on landscapes, and flora and fauna. Other issues that are covered to a lesser extent in the draft guidelines include aircraft safety, blade glint, risk of fire and indigenous heritage.

The Draft National Guidelines provide advice and methodologies to identify likely affected parties, assess the EMI impacts, consult with affected parties and develop mitigation steps to address any likely EMI impacts.

With regard to EMI, DNV GL considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the SEARs and Draft NSW Guidelines, and therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

5 ELECTROMAGNETIC INTERFERENCE (EMI)

If not properly designed, wind farms have the potential to interfere with radiocommunication services. Two services that are most likely to be affected include television broadcast signals and fixed point-to-point microwave signals. Terrestrial broadcast signals are commonly used to transmit domestic television, while microwave links are used for line-of-sight connections for data, voice and video. The interference mechanisms are different for each of these, and hence, there are different ways to avoid interference.

The Draft National Guidelines recommend that a radial distance of 50 to 60 km from the centre of the wind farm would normally capture all of the potentially affected services in the area. However, the methodology used in this assessment to assess the potential for interference to radiocommunications involves locating all of the telecommunication towers within approximately 75 km of the Project site boundaries, and then assessing the telecommunication licences attached to these towers. This is to reduce the likelihood that telecommunication links crossing the site are inadvertently excluded from the assessment.

Other services with the potential to experience interference from the Project have also been identified, and the potential for interference to those services discussed.

5.1 Telecommunication Towers

An image of the ACMA database dated January 2015 was used for this assessment [1]. From the database, there are 4321 telecommunication towers within a nominal 75 km of the wind farm. The locations of these telecommunication towers relative to the Project area are shown in APPENDIX B.

5.2 Fixed licences of point-to-point type

5.2.1 Diffraction

Wind turbines can potentially cause interference, or diffraction, of point-to-point microwave signals and in some cases, point-to-point UHF signals. It is possible to design the wind farm to avoid this issue as the path and interference zone of these signals are well known. The frequency of common microwave signals varies from approximately 1 GHz to 30 GHz. For this analysis DNV GL has used a wider and more conservative frequency range of 0 to 50 GHz. Point-to-point links are often used for line-of-sight connections for data, voice and video. Such links often exist on mobile phone and television broadcast towers.

The criteria used for avoiding diffraction effects of point-to-point signals are normally based on an exclusion zone of circular cross-section around the direct path from the transmitter to the receiver (often called boresight) ([6], [7], [8]). This exclusion zone is defined in terms of Fresnel zones. The n^{th} Fresnel zone is comprised of all points for which, if the radio signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n-\lambda}{2}$ where λ = wavelength.

To avoid interference to point-to-point signals, wind turbines, including the blades, should be kept outside the second Fresnel zone. The radius of the 2^{nd} Fresnel zone varies along the length of the transmission path, and is given by

$$R_{F2} = \sqrt{\frac{2\lambda d_1 d_2}{D}}$$

Where d_1 is the distance from the transmitter

d_2 is the distance from the receiver

D is the distance from the transmitter to receiver, i.e. $d_1 + d_2 = D$

The registered communications licences for each tower in the vicinity of the site were analysed to determine the transmission paths of licence links that may experience interference from wind turbines. Each individual link is given an "Assignment ID" by the ACMA so it can be readily identified. The paths resulting from the towers analysed are shown in APPENDIX B. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some NSW Rural Fire Service towers.

A review of the ACMA database shows that there are three (3) links passing over the Project site boundaries. The links are shown in greater detail in Figure B-3 of APPENDIX B.

Several references ([9] [5] [8]) state that turbines should be located outside either the first or second Fresnel zone in order to avoid interference to that link. For the identified links crossing the site, an exclusion zone has been established based on their operating frequencies, the 2nd Fresnel zone plus the blade length for turbines with a maximum rotor diameter of150 m. The potential exclusion zones are also shown in Figure B-3.

It is common practice to have multiple assignment IDs for the same physical link to cover practicalities such as licensing for sending and/or receiving signals. Accordingly, the Fresnel zone setback has been calculated on the Assignment ID with the lowest frequency for each link crossing the site. Details of the links are provided in Table 5-1 below.

Assignment ID	Licence Number	Frequency (Hz)	Postal address
Point-to-point link crossing the western side of the Project			
8304923-8338762	1938274	404350000	NSW Rural Fire Service Locked mail bag 17 Granville NSW 2142
8304924-8338765	1938274	413800000	
Point-to-point link crossing the centre of the Project			
1211967-1208638	1208631	413800000	NSW Rural Fire Service Locked mail bag 17 Granville NSW 2142
1211968-1208638	1208631	404350000	
8158040-8150171	1431609	413975000	
8158041-8150172	1431609	404525000	
8331160-8371449	1947391	7620500000	
8331165-8371460	1947391	7459500000	
Point-to-point link crossing the eastern side of the Project			
8166892-8161944	1146289	450800000	Upper Lachlan Shire Council PO Box 42 Gunning NSW 2581
8166897-8161952	1146289	460300000	
1211926-1208617	1208630	413800000	NSW Rural Fire Service Locked mail bag 17 Granville NSW 2142
1211927-1208617	1208630	404350000	

Table 5-1 Details of point-to-point links crossing the Project site.

As shown in Figure B-3, there are four (4) turbines that lie within the 2nd Fresnel zone of one link and no turbines lie within the 2nd Fresnel zone of the other two links. DNV GL has contacted the operators of the links, NSW Rural Fire Service (RFS) and Upper Lachlan Shire Council, to seek feedback regarding the potential impact of the Project on their services and operations. RFS has indicated that a revised exclusion zone of 1 km is recommended along the link path line, extending up to 15 km from the radio tower [10]. DNV GL has considered the recommended exclusion zone plus one (1) blade length of 75 m and sixteen (16) turbines lie within the exclusion zone specified by RFS.

Given that a significant number of turbines lie within the exclusion zone specified by the RFS, both link operators have been consulted to determine whether they would be willing to consider re-routing of their links should the wind farm be constructed, with costs to be covered by the Project. NSW RFS have indicated that they would be willing to re-route the links provided that the Project bears all capital and operational expenditure costs associated with the re-routing [11].

Further correspondence with the NSW RFS has indicated that they do not expect the westernmost link to be significantly impacted by the wind farm. However, the central link crossing the middle of the site is expected to suffer from interference due to the large number of turbines that lie within the second Fresnel zone of the link. As mentioned above, NSW RFS is willing to consider the re-routing of this link and has estimated the approximate cost associated with the reconfiguration to be in the order of $125,000.

Furthermore, it has not been possible for NSW RFS to accurately assess the likely level of interference associated the easternmost link as this link is considered to be on an obstructed or diffracted path. While it is considered unlikely that the link will be impacted by the wind farm, NSW RFS has indicated

that should the link be impacted after the turbines have been erected, consideration will be granted to re-route the link. The overall capital cost associated with the re-routing of the two links is expected to be in the order of $150,000 [12].

The Upper Lachlan Council has indicated that they would be willing to re-route their link provided that detailed information regarding the re-routing of the link is provided by the Project, and a bond is lodged with the Council to ensure that the link is re-routed prior to construction of the Project [13].

The council has also indicated via additional correspondence that they would require advice from a third party, with the costs of the services to be covered by the Project Developer [14].

It is noted that the easternmost link path crossing the site supports links operated by both the Upper Lachlan Shire Council and the RFS. It is also noted that there is only a single turbine (T01) within the exclusion zone proposed by the RFS for that link, and that the turbine is violating the exclusion by less than 50 m. Therefore, it is possible that concerns regarding interference to this link could be alleviated by micro-siting of turbine T01.

Similarly, the exclusion zone specified by RFS for the westernmost link path crossing the site is violated by only a single turbine (T31) by less than 100 m, and it may be possible to alleviate concerns regarding interference to this link by micro-siting of turbine T31.

DNV GL recommends that prior to construction of the Project, the Project Developer should engage with the NSW RFS to make arrangements for re-routing of the central link crossing the middle of the site. DNV GL also recommends that prior to construction of the Project, the Project Developer should engage with both NSW RFS and Upper Lachlan Shire Council, to establish suitable arrangements for monitoring potential interference to the westernmost and easternmost links during and after construction of the Project, and carrying out amelioration actions (such as re-routing the link) if interference to the link is encountered.

An assessment was carried out to determine if the links pass over the proposed wind farm at a height that was well above the highest point of the turbines (Hub height + blade length = 185 m). This was achieved by examining the elevation and tower heights at each end of each link, as well as the approximate elevation of the areas within the wind farm boundaries over which the links cross. It was determined that the links do cross the site at a height which has the potential to intersect with turbine blades.

5.2.2 Near-field effects and scattering

The Draft National Guidelines [6] discuss the potential for interference to point-to-point microwave links from two additional mechanisms, near field effects and scattering.

According to the Draft National Guidelines, near field effects are usually limited to approximately 720 m from a communication tower and it is recommended that consultation is required if a turbine is within 1 km of a telecommunication site. The Draft National Guidelines also state that scattering is best avoided by placing wind turbines more than 2 km from a communication tower.

All communication towers are greater than 2 km from the proposed turbine locations, with the closest telecommunication tower located approximately 2.9 km southeast of the nearest turbine (Mt Mary, Site ID 34919). However, the operators of point-to-point links attached to this tower (NSW RFS and Upper Lachlan Shire Council) have been consulted regarding the potential for interference to their services, and their responses are discussed in section 5.2.1 and APPENDIX C of this document. As noted in section 5.2.1 it is possible that re-routing of the links or other mitigation measures may be necessary.

5.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of the point-to-point type. The difference between them is administrative. A point-to-point licence permits communication between two static sites, where the locations of the sites are detailed in the licence register. A point-to-multipoint licence allows communication between a registered static site and multiple unregistered points, or between the static sites. The point-to-multipoint type is usually licensed for a defined operational area.

Administratively, the ACMA database details the location of the static station for a fixed licence of the point-to-multipoint type. Hence, the location of the transmission vectors is not readily identifiable. A review of fixed licences of point-to-multipoint types was undertaken and 44 Assignment ID's were identified within approximately 75 km of the Project. These licences are shown in Figure B-4. The details of the licence holders as per the ACMA database are provided in Table B-1.

There are two point-to-multipoint base stations listed in the ACMA database within 20 km of the Project. The stations are operated by the Upper Lachlan Shire Council. DNV GL has consulted with the Upper Lachlan Shire Council to identify any potential interference issues that may arise from the development and operation of the proposed Project, however the Council have indicated that they are unable to confirm whether the services are likely to be affected. It is DNV GL's opinion that given the locations of these stations, they are unlikely to be affected by the presence of the wind farm.

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, DNV GL has sought feedback from the operators of the majority of stations within 40 km from the centre of the Project to assess any potential impact that the wind farm could have on their services, and to date no concerns have been raised. A summary of the responses sought and received can be found in APPENDIX C of this document.

5.4 Other licence types

A review of the ACMA database for other licences was conducted. These licences are shown in the table below and Figure B-5.

Many of the licences identified can be broadly described as supporting base to mobile station style communications, including radio broadcasting, commercial and private mobile telephony. These licence types are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation and other forms of signal obstruction. Should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services, and are broadly covered in Sections 5.14 and 5.15.

A number of aeronautical licences, and radiodetermination licences which may be used for aircraft navigation, have been identified. It is assumed that potential impacts to these services will be considered as part of an aviation impact study.

Licence Type	Licence Category	Number of Instances
1800 MHz Band	Spectrum	396
2 GHz Band	Spectrum	1399
2.3 GHz Band	Spectrum	114
2.5 GHz Band	Spectrum	92
2.5 GHz Mid Band	Spectrum	32
700 MHz Band	Spectrum	176
800 MHz Band	Spectrum	604
ACA Assigned	ACA	60
Aeronautical Assigned System	Aeronautical	15
Amateur Beacon	Amateur	5
Amateur Repeater	Amateur	22
Ambulatory System	Land Mobile	19
Broadcast Service	Broadcasting	70
CBRS Repeater	Land Mobile	18
Earth Receive	Earth Receive	1
Fixed Earth	Earth	2
Land Mobile System - > 30MHz	Land Mobile	600
Narrowband Area Service station(s)	Broadcasting	6
Narrowcasting Service station(s)	Broadcasting	36
Narrowcasting Service stations (HPON)	Broadcasting	5
PABX Cordless Telephone Service	Land Mobile	1
Paging System - Exterior	Land Mobile	28
Paging System - Interior	Land Mobile	11
PMTS Class B (2110-2170 MHz)	PTS	56
PMTS Class B (935-960 MHz)	PTS	488
Radiodetermination	Radiodetermination	17
Scientific Assigned	Scientific	4

Table 5-2 Details of other licences identified within 75 km of the Project

It is noted that the number of other licenses identified is significant. However, this is primarily because the search area used to identify licenses in the ACMA RADCOM database extends 75 km from the site, and has therefore captured a significant number of licenses that are registered in the area around Canberra. The number of licenses in close proximity to the site is small, with only 62 licenses identified within 20 km of the site boundary.

5.5 Emergency services

A review of the ACMA database was conducted to identify emergency services with licences for radiocommunications assets operating in the vicinity of the Project. The groups identified are listed in the following table along with their contact details. While no direct interference to services is expected, DNV GL has sought feedback from the operators of services within 40km of the centre of the Project. APPENDIX C lists all responses received, and to date no objections have been raised.

Emergency Service	Contact Details	Distance of closest Site from centre of wind farm [km]
Ambulance Service of NSW	Locked bag 105 Rozelle NSW 2039	25
Australian Federal Police	Attn Radio and Electronic support PO Box 401 Canberra ACT 2601	39
Fire and Rescue NSW	Attn AMO Comms Level 8 227 Elizabeth St Sydney NSW 2000	18
Laggan and District Bushfire Brigade	PO Box 105 Crookwell NSW 2583	27
Mulwaree Goulburn Emergency Repeater Group	65 Coromandel St Goulburn NSW 2580	37
NSW Police Force	Engineering Services Level 4 151-241 Goulburn St Sydney Police centre Surry Hills NSW 2010	25
NSW Rural Fire Service	Locked mail bag 17 Granville NSW 2142	5
St John Ambulance Australia (NSW)	9 Deanne Street Burwood NSW 2134	39
ST JOHN AMBULANCE AUSTRALIA INCORPORATED	Attn Mr P LeCornu CEO PO Box 3895 Manuka ACT 2603	39
State Emergency Service (NSW)	PO Box 6126 Wollongong NSW 2500	23

Table 5-3 Emergency services with radiocommunication assets in the vicinity of the Project.

5.6 Aircraft navigation systems

DNV GL understands that an aviation impact study will be undertaken to assess the impact of the Project on nearby aviation systems.

5.7 Aviation radar

Primary surveillance radar (PSR) is used for air traffic control and requires line-of-sight to the target object for successful detection. PSR transmits a pulse of energy that is reflected back to the radar receiver by the target object. Some combinations of turbine orientation and blade angle can cause significant Doppler returns to the illuminating radar, thereby creating false targets on the radar screen. The sporadic nature of these false positives makes them difficult to filter with current radar software. Further, turbines may create a radar obstruction or "shadow" where aircraft are not detected. In

Australia, PSR installations are located at major airports and typically have a range of approximately 50 nautical miles (93 km).

Secondary surveillance radar (SSR) is less vulnerable to interference from wind turbines as SSR does not rely on reflections from objects for detection. Aircraft are required to carry a transponder, which replies to radar interrogations. However, SSR may still be affected by a wind farm as an aircraft transponder may respond to a reflected signal and give a false position reading, or SSR may be obstructed by a wind farm in a similar manner to PSR. SSR installations are also typically located at major airports, and have a range of approximately 250 nautical miles (463 km) when detecting aircraft at high altitude. However, at or near ground level, the range of SSR is expected to be less due to terrain obstructions and curvature of the earth.

The Draft National Guidelines recommend that radar operators be notified of the development of wind farms within 250 nautical miles (463 km) of aviation radar operators [6]. Radar installations are typically located at major airports. As shown in Figure B-6, the Project is located approximately 78 km from Canberra airport and 180 km from the Sydney international airport. DNV GL understands that there is no radar installation at Goulburn airport, which is located approximately 40 km southeast of the site.

It is assumed that a detailed aviation impact study will be undertaken to asses any likely impact on aviation radars due to the wind farm development and operation.

Airport	Location (WGS84)	Approximate distance from the Project [km]
Canberra	S35.30° E149.19°	78
Sydney	S33.94° E151.18°	179
Bankstown	S33.92° E150.99°	165
Camden	S34.04° E150.69°	134

Table 5-4 Airports in the vicinity of the Project site

5.8 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather stations across Australia and uses radar instruments for measuring wind speeds in the upper atmosphere (known as wind finding radar), and determining rain and storm activity (known as weather watch radar).

The "wind finding" radar uses radar echoes from a target to determine the wind speeds and direction. The radar target is attached to a balloon and tracked by the ground radar. The "weather watch" radar, or "weather surveillance" radar, consists of a rotating antenna located on a building, and kept free from any physical obstruction. The antenna is used to direct a thin beam of radio energy upward into the atmosphere which is then reflected back by a cloud mass. The location of the cloud is then determined by the direction and travel time of the reflected beam.

Wind profile measurements are used to ensure the safe and economical operation of aircraft and provide an important source of data for the Bureau's general weather forecasting system. "Weather watch" radars monitor weather situations and are able to indicate the possibility of severe storms out to a distance of 250 km or more. Hence, whilst the uninhibited operation of meteorological radars may not be as critical as aviation radar, there are implications for public safety if severe weather is not predicted or if its approach is masked due to EMI.

Wind farms located at distances greater than 5 km from a BoM field station are unlikely to affect wind finding operations [6]. Generally, the optimal coverage area for "weather watch" radar extends approximately 200 km from the radar installation at a height of approximately 3000 m ([15], [16]) and approximately 100 km at a height of 1000 m [16]. Theoretically, wind farms can impact upon weather watch radar when located within several hundred kilometres of a radar station, however, due to the curvature of the earth, and intervening terrain, the range at or near ground level is generally less.

According to the Draft National Guidelines, consultations with operators of weather stations within 250 nautical miles of the proposed wind farm should be undertaken [6]. It has been identified that the BoM operates eight weather stations within that range with the closest station (Canberra) located approximately 117 km south-southeast of the Project site. The locations of these stations are shown in Figure B-6 and the details of each station can be found below.

BoM Radar site	Location (WGS84)	Approximate Distance from the Project [km]
Yarrawonga	S36.03° E146.03°	338
Wollongong	S34.264° E150.874°	141
Sydney	S33.701° E151.21°	194
Namoi	S31.024° E150.191°	401
Newcastle	S32.73° E152.027°	319
Canberra	S35.66° E149.51°	117
Bairnsdale	S37.89° E147.56°	397
Wagga Wagga	S35.17° E147.47°	180

Table 5-5 BoM radar sites in the vicinity of the Project

It is not expected that the wind farm will cause interference with BoM radar installations, as given the distance between the site and radar installations, and the nature of the intervening terrain, it is likely that radar signals will be intercepted before they are able to be influenced by the Project.

However, in accordance with the recommendations of the Draft National Guidelines, DNV GL has contacted the Bureau of Meteorology to advise them of the Project, and seek feedback on the potential for interference from the proposed development. The BoM has indicated that they do not envisage any significant interference to their radar performance, resulting from the Project development and operation [17].

5.9 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes. Some trig points may host surveying equipment such as GPS antennas and Electronic Distance Measuring (EDM) devices. EDM devices measure the distance from the trig point to the target object by means of a beam of known velocity which is reflected back to the unit from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed. The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 to 5 km while microwave systems can measure distances up to 150 km. However, such systems are not limited by the line of sight or affected by visibility [18].

The Global Navigation Satellite Systems (GNSS) Network is comprised of permanent stations which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. The GNSS network also provides information to the International GNSS Service. Eight stations from the GNSS database in Australia form The Australian Fiducial Network (AFN) ([19], [20]). The AFN stations are equipped with EDM devices and GPS receivers and transmit data to GeoScience Australia via phone lines, internet and/or satellite [19].

The closest GNSS station is located at approximately 85 km southwest of the Project, at Mt Stromlo near Canberra. Due to the significant distance between the Project and the GNSS stations, it is deemed unlikely that the Project will cause interference to the GNSS network.

DNV GL has also undertaken a review of the Primary Geodetic Network of Australia [21] and it has been observed that the Project is located on the edge of first-order and second-order triangulation regions. First-order triangulation depends on trigonometrical stations of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation will then be used for second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

According to the National Geospatial Reference system database from Geoscience Australia [22], there are 50 trig points within 20 km of the Project site boundaries. The details of all 50 trig points are provided in APPENDIX B and illustrated in Figure B-7.

Although it is unlikely that the trig points in close proximity to the wind farm host EDM devices or other equipment that is likely to be subject to electromagnetic interference, DNV GL has consulted with Geoscience Australia and the New South Wales Land and Property Information (LPI) regarding the potential for interference from the development and operation of the Project. Both parties have indicated that they do not expect any interference on their assets resulting from the wind farm development and operation [23], [24].

5.10 Citizens Band radio

Citizen's Band Radio, also known as CB radio, is a class-licensed two-way, short distance, communication service that can be used by any person in Australia, for private or work purposes. The class licence implies that all users of the CB radio operate within the same frequency range on a shared basis and no individual licence is required.

The CB radio service can be used for voice communications activities, telemetry and telecommand applications. The radio operates on 2 frequency bands, namely the high frequency (HF) band at between 26.965 MHz and 27.405 MHz, and the Ultra High frequency (UHF) band at between 476.425 MHz and 477.400 MHz.

The 27 MHz CB radio service was legalised in Australia in the 1970s as a temporary move to switch to the UHF CB over the following years. 27 MHz CB transmit signals in either AM or SSB (Single Side Band) transmission mode. The actual range over which the signal is transmitted depends on the antenna used, the terrain and the interference levels. Over the last decade, the use of 27 MHz CB radio service has declined and has been replaced by UHF CB radio service.

The UHF CB radio service is unique in Australia and uses the FM transmission mode. It provides clear communication over 5-20 km and is less susceptible to power line noise. However, the UHF CB radio service requires "line-of-sight" and is easily hindered by hilly terrain and forested areas. If located on a

hilltop, CB radio signals can be transmitted over at least 50 km. Repeater stations are set up on hilltops by community groups and commercial organisations to transmit signals from one channel to another.

No individual or organisation owns or has the right to use a channel exclusively. However, out of the 40 channels available, some of them will be allocated to emergency, telemetry or repeater inputs.

Since users of CB radio service do not require a licence, there is no record of users of the service and their locations and the channels are shared among the users and the repeater stations without a right of protection from interference. The impact of the Project on CB radio service is expected to be minimal. In the event of interference from the wind turbines, simple steps such as moving a short distance until the signal strength improves would help to mitigate the impact.

5.11 Mobile phones

Mobile phone networks typically operate at frequencies of either between 800 and 900 MHz, or between 1800 and 2100 MHz. At such frequencies, signals are likely to be affected by physical obstructions such as buildings and wind turbines. However, mobile phone networks are designed to operate in such conditions and in most cases, there is sufficient mobile network coverage and signal strength, the presence of wind turbines is unlikely to cause interference.

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is theoretically possible that wind turbines could cause some interference to the signal, although there is little evidence of this in the literature.

A review of mobile phone towers in the vicinity of the Project has been carried out. The nearest mobile phone tower is located more than 13 km from the Project area, meaning that large scale interference to mobile phone signals due to the Biala Wind Farm is unlikely.

Mobile phone network coverage maps have been obtained for Optus [25] and Telstra [26]. Figure B-8 shows the Optus network coverage for the Project area. The map shows good coverage in most locations in the vicinity of the Project, although some areas with coverage require an external antenna to receive 3G coverage. Figure B-9 shows the Telstra 2G network coverage while Figure B-10 shows the 3G (or NextG) coverage. There is coverage for both technologies in the vicinity of the Project; with variable coverage in the northern and eastern section of the site while the southern section of the site has marginal coverage. For the Vodafone network, the nearest tower is approximately 26 km south-southwest of the Project site, near the town of Gunning. Figure B-11 shows the network coverage for the Vodafone network in the vicinity of the Project.

In general, for areas with good coverage, interference to mobile phone signals is unlikely. However, for areas where the reception is likely to be marginal, such as those where an external antenna is required, the possibility for interference exists if a wind turbine intercepts the signal between a mobile phone and the tower.

In case of marginal network coverage, simple procedures are available to mitigate interference, such as moving a short distance to a new or higher location until the signal improves, or using an external antenna to improve the signal.

DNV GL has contacted Telstra, Optus and Vodafone to seek feedback on any potential impact that the Project development and operation could have on their operations and services, and to date no concerns have been raised. A summary of the responses received can be found in APPENDIX C of this document.

5.12 Wireless internet

Yless4U Pty Ltd (Yless4U) hold point-to-multipoint licences in the vicinity of the Project with one base station located near the town of Goulburn, at approximately 33 km from the Project site. As the locations of Yless4U customers are not known, it is not possible to determine whether there is the potential for interference to Yless4U's service. Consequently DNV GL has provided Yless4U with information regarding the Project, and sought feedback regarding the potential for interference. YLess4U have responded indicating that they do have any concerns regarding the Project.

Additionally, a review of the Australian ISP directory has been undertaken and there are four internet providers which operate in the area surrounding the wind farm and Yless4U is not included in the list of internet providers. According to the directory [27], NBNSP, Internode, AusBBS and iPrimus offer internet services based on the National Broadband Network (NBN) of Australia. However, according to the NBN Co Ltd website, the network is not available yet for the Biala area and is not expected for the next 6 months [28].

Consequently, residents in the vicinity of the wind farm may utilise Telstra mobile wireless broadband services. The mobile wireless broadband service utilises the same network as the mobile phone service and therefore, the comments made in Section 5.11 are applicable here. Specifically, the presence of wind turbines is unlikely to cause any interference. However, should interference occur, the simple mitigation options given in Section 5.11 may be applicable.

5.13 Satellite television and internet

In some rural or remote areas, television and internet access can be provided through satellite only. Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. The satellite transmits television signals to the user's antenna at two frequency bands; the C band at between 4 GHz and 8 GHz, and the Ku band at between 12 GHz and 18 GHz. Signals in the C band are susceptible to interference due to radio relay links, radar systems and other devices operating at a similar frequency while signals in the Ku band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. DNV GL understands that there are currently 21 satellites that provide television signals to the east coast of Australia [29].

In the case of satellite internet, the user's computer is connected to a satellite modem which is in turn linked to a satellite dish/antenna mounted on the building roof. When the user accesses the internet, a request is sent to the operation centre of the satellite internet provider via the satellite antenna. Data is then sent back to the user's computer via the same path as shown in the figure below.

Figure 5-1 2 way connection to the Internet via Satellite [30]

Due to marginal coverage of some communication services, a number of residents in the vicinity of the Project may utilise satellite television and internet.

According to the Australian ISP directory [27], there are no satellite ISPs providing satellite internet in the vicinity of the Project.

The main satellite for pay TV and free-to-air TV in Australia is the Optus C1 satellite. From the Project site, the Optus-C1 satellite has an elevation of approximately 49.2° [31]. As above, it is unlikely that the proposed Project will impact upon the line-of-sight from this satellite to any house.

A review of the line-of-sight between all usable TV and internet satellites and houses considered in the analysis in the region of the Project has been undertaken. It has been found that no turbines intercept the line–of-sight of the internet satellite or TV satellites commonly used in Australia.

5.14 Radio broadcasting

DNV GL has assumed that broadcast radio includes both Amplitude Modulation (AM) and Frequency Modulation (FM) radio used to broadcast audio signals. In Australia, AM radio operates in the Medium Wave (MW) band at frequencies of between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency band (VHF) between 87.5 MHz and 108 MHz. The locations of the AM and FM broadcast transmitters in the vicinity of the Project are shown in Figure B-12.

5.14.1 AM Radio

Amplitude Modulation, or AM, radio signals are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also reflected or refracted by the ionosphere at night. This means that AM radio waves are able to travel significant distances under the right conditions. Due to their long wavelength, they can readily propagate around relatively small physical obstructions on the surface of the earth (such as wind turbine), however they do not propagate easily through some dense building materials such as brick, concrete and aluminium.

The distance over which AM radio signals can travel means that the signal may be weak and susceptible to interference by the time it reaches a receiver. Some of the possible sources of interference to AM radio waves include changes in atmospheric conditions, signals from distant AM broadcasters operating on a similar frequency, electrical power lines and electrical equipment including electric motors.

As AM radio signals are able to propagate around obstructions such as turbines, it is expected that a wind farm would not cause significant interference for a receiver. Additionally, due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [32]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna and/or amplifier.

5.14.2 FM Radio

Frequency Modulation, or FM, radio signals are suited to short range broadcasting. Unlike lower frequency signals (such as AM signals), they are not reflected or refracted off the ionosphere. The waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon, however they may be blocked by significant terrain features. FM radio stations therefore tend to have only local coverage and this means that signals are less susceptible to interference from distant FM broadcasters. FM signals are also less susceptible to interference from changes in atmospheric conditions and electrical equipment than AM signals.

FM radio signals are susceptible to interference from buildings and other structures, although they are less vulnerable than higher frequency signals. Reflection or scattering of radio waves by physical structures can reduce signal strength at a receiver, or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can cause hissing or distortion to be heard by a listener. However, generally any interference will only be likely in the immediate vicinity of the wind turbine [32], and should be easily rectified through the installation of a high quality antenna and/or amplifier.

5.14.3 Digital radio

Digital radio services have been introduced in metropolitan licence areas from July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne and Sydney [33]. According to the digital radio coverage map available on the ABC website [34], digital radio is not yet available in the Biala region.

5.15 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in New South Wales are now digital broadcasts [35].

The Broadcast Transmitter Database [35] was examined to identify broadcasters nearby to the proposed Project area, with those found shown in Figure B-12. The nearest broadcast tower is at least 14 km north of the site at Wades Hill. However, this broadcast tower services the town of Crookwell, and is unlikely to be servicing residents in the vicinity of the project. The main television transmitter used by residents in the vicinity of the Project is the Black Mountain transmitter near Canberra [36].

The Upper Lachlan Shire Council has also indicated that they are in the process of constructing a new free-to-air television repeater in the town of Crookwell [13]. Due to the lack of information regarding this new repeater, DNV GL has been unable to assess the likely impact of the Project on the broadcasting services from the repeater. DNV GL has undertaken further consultation with the Upper Lachlan Shire Council to clarify the purpose and coverage area of the repeater, however no further information regarding the new repeater has been received to date.

5.15.1 Interference to television signals

For television broadcast signals, which are omni-directional or point-to-area signals, interference from wind turbines is dependent on many factors including:

- proximity of wind turbines to television broadcast tower;
- proximity of wind turbines to receivers (houses);
- location of wind turbines in relation to houses and television broadcast towers;
- the rotor blade material, rotor speed and rotor blade direction (always into the wind);
- type of receiving antenna (e.g. directional and height);
- location of the television receiver in relation to terrain and other obstacles; and
- frequency and power of the television broadcast signal.

For broadcast signals large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay

TV transmitters are more commonly found in rural areas. Primary TV transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay TV transmitters, while a clearance of at least 6 km is recommended for primary TV transmitters [7].

Wind turbines cause interference to television signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter. This causes multipath errors, which can have different impacts for analogue and digital television signals. A wind turbine has the potential to scatter electromagnetic waves carrying television signals both forward and back.

Forward scatter will only occur if a wind turbine is located approximately between the house and the broadcast site.

The forward scatter region is as shown in the following figure, and according to Ofcom [37], does not typically extend further than 5 km for the worst combination of factors ([7] [38] [39]). Interference may extend beyond 5 km if the houses are screened from the broadcast tower, but do have line-of-sight to the wind turbines [39]. The shape of this region assumes a relatively high gain, directional antenna that has a beam width (or directional range) of approximately ±15° to ±20°. If a lower gain or omni-directional antenna is being used, this region is likely to be larger.

Back scattered signals arrive at the house delayed relative to the source signal from the broadcast tower. The back scatter region is as shown in the figure below, and generally does not extend further than approximately 500 m ([7], [36]), assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio or an omni-directional antenna is used, this region is likely to be larger.

The combination of the forward and back scatter regions, as shown in the following figure, resembles a keyhole.

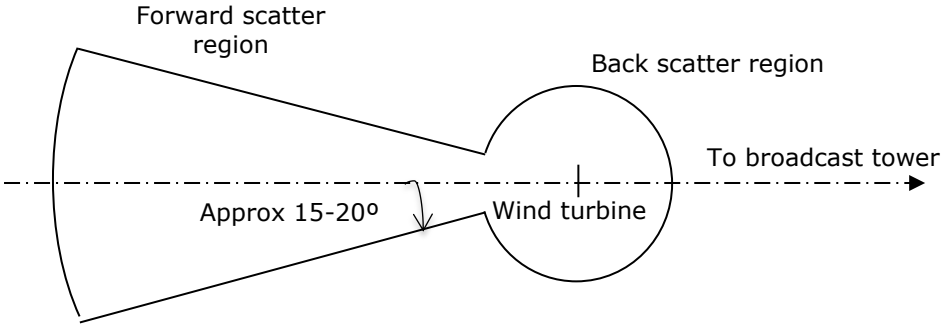


Figure 5-2 Potential television interference zones around a wind turbine

Television interference mechanisms rely on many factors (as previously mentioned) and are complex to calculate. Previous experience has shown that even after great effort has been put into performing such calculations, they tend to have limited accuracy, and would require field validation after the wind farm is operational.

Historically, for analogue television broadcasts, dwellings located within the forward scatter region of a television interference zone might experience a variation in the brightness of the television picture due to the rotation of each blade of the turbine. Dwellings located within the backscatter region of the

interference zone whose antenna is not sufficiently directional to discriminate between the original and delayed signal, might experience a pulsating ghost or secondary signal on the television screen. However, a switchover from analogue to digital terrestrial television for all of Australia occurred prior to the end of 2013 [39]. According to the ACMA [35], there are now no analogue television transmissions in the vicinity of the Project.

5.15.2 Digital television

Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV GL has experience in situations where houses were able to receive adequate digital television reception in an area of adequate signal strength where the digital television signal is passing through a wind farm.

However, the UK telecommunications regulator Ofcom [37], states the following with regard to interference to digital television reception.

> *"Digital television signals are much better at coping with signal reflections, and digital television pictures do not suffer from ghosting. However a digital receiver that has to deal with reflections needs a somewhat higher signal level than one that has to deal with the direct path only. This can mean that viewers in areas where digital signals are fairly weak can experience interruptions to their reception should new reflections appear… reflections may still affect digital television reception in some areas, although the extent of the problem should be far less than for analogue television".*

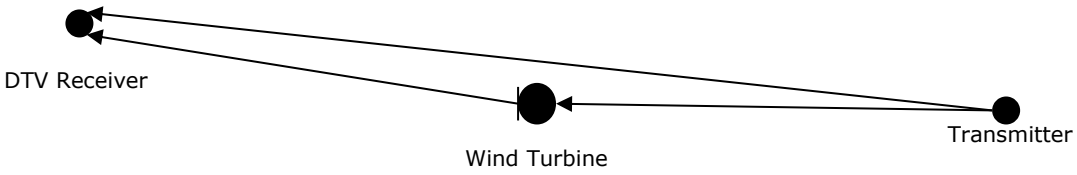
DNV GL has drawn two conclusions from this report:

- Firstly that digital television is very robust and does not suffer from ghosting. In most cases digital television should not be susceptible to interference from wind farm developments.
- Secondly, that areas of weak digital television signal can experience interruptions to their reception should new reflections appear, such as those from nearby wind turbines.

Interference of DTV signals from wind turbine developments can potentially occur in both the forward and backward scatter region. The effect of a wind turbine on a DTV signal can be different depending on the scattering region where the receiver is located [40].

5.15.2.1 Forward scattering region

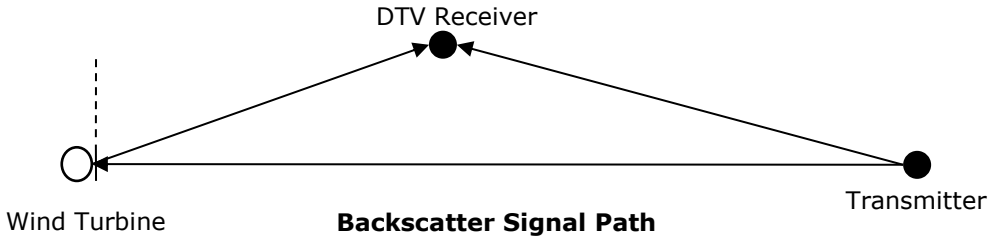
Forward scatter can occur when the transmitter, one or more wind turbines, and receiver are almost aligned as shown below. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [40]. Both of these effects can potentially degrade the DTV signal quality.



Forward Scatter Signal Path

5.15.2.2 Back scattering region

Backscatter from wind turbines occurs when DTV signals are reflected from turbine towers and turbine blades onto a DTV receiver as shown below. The reflected signals are attenuated, time-delayed and phase-shifted (due to a longer path from transmitter to receiver) compared to the original signal. The reflected signals are also time-varying due to the rotation of the blades and vary with wind direction. The resultant signal at the receiver includes the original signal (transmitter to receiver) and a series of time-varying multipath signals (transmitter-turbine-receiver).



5.15.2.3 Impairment caused to DVB-T (Digital Video Broadcasting–Terrestrial) systems

In Australia, digital television signals are transmitted using the DVB-T (Digital Video Broadcasting–Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [38] states the following in regards to the forward scatter region for DVB-T signals:

> *"In most of the situations where the impact of a wind farm to DVB-T reception quality was analysed, the threshold carrier-to-noise (C/N) ratios obtained were similar to those expected in environments with the absence of wind farms. More precisely, the DVB-T reception quality does not seem to be affected in the forward scattering region of the wind turbines."*

In other words, wind turbines do not usually affect DVB-T DTV signals in the forward scatter region. However, ITU [41] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more wind turbines, interference to the reception of the DTV signal is possible.

With regards to back scattering, ITU states:

> *"In the case of the backscattering region, in those situations where the scattered signals from wind turbines are significant in amplitude and variability, the threshold C/N ratio necessary for quasi error free (QEF) condition is higher."*

In other words the C/N ratio needs to be higher in the presence of significant backscatter to achieve the same QEF condition as is the case without the presence of wind turbines.

5.15.2.4 Theoretical models for wind turbine scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [42]. This comparison with empirical data found:

> *"…none of the analyzed methods seems to be accurate enough to provide realistic estimations of the signal scattered by the wind turbines. In conclusion, a more complete scattering model is needed in order to provide more practical estimations of the scattered signals and evaluate their potential impact on the broadcasting services."*

Notably, the scattering model proposed by the ITU to specifically address DTV signals [38], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally DNV GL notes that it only applies to a single wind turbine rather that a wind farm as a whole.

Due to the lack of an accurate scattering model, DNV GL has not performed detailed scatter calculations to predict DTV interference.

As an alternative, it is common practice to identify those dwellings or areas that are most likely to experience potential television interference based on likely forward and back scatter regions. This is often referred to as the 'keyhole' approach, and is an established technique for predicting regions where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [37]. The union of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

To assist in identifying those houses that may have increased likelihood of experiencing television interference due to the proposed Project, both back and forward scatter regions have been determined using the 'keyhole' approach, based on the proposed wind farm layout.

5.15.3 Potentially affected dwellings

Dwellings that have the potential to receive back-scattered or forward-scattered signals from a turbine, (assuming an antenna with a sufficiently narrow beam width and sufficiently high front-to-back ratio is being used), have been highlighted using the 'keyhole' approach described in Section 5.15.1.

The results of the above analysis can be seen in Figure B-13 and Figure B-14. The dwellings that are most likely to be susceptible to interference include those within the possible interference zone. A total of six (6) houses were identified in the potential interference zone for the Black Mountain broadcast tower near Canberra. These are listed in Table B- 3. Out of these affected dwellings, two (2) are stakeholders. However, if the signal received at a dwelling from the transmitter is sufficiently weak, or an antenna with insufficient directional discrimination is installed (i.e., a low gain or omni-directional antenna), interference may still occur outside of the identified interference zones.

According to the Australian Government MySwitch website [36], the area around the Project site is able to receive a digital television signal from the Black Mountain broadcast tower located near Canberra. The coverage maps (reproduced in Figure B-14) suggest that the majority of the area surrounding the Project should receive good coverage with small areas of 'variable' coverage.

Thus, although digital television signals are generally unlikely to be susceptible to interference from wind turbines in areas of adequate signal strength, interference could be encountered in areas where reception is marginal and antennas at dwellings may receive a reflected signal from a turbine that is of sufficient power to interfere with the signal received directly from the transmitter. If reception difficulties are encountered, there are a number of mitigations options available, and these are discussed in further detail in Section 5.15.4.

The method used here to assess the potential interference to television signals from the Project represents a simplified approach which is expected to capture locations where interference is most likely to occur. This simplified analysis is deemed appropriate as the implications of potential television interference are minimal given the good coverage in the vicinity of the wind farm and the large range of mitigation options available.

5.15.4 Mitigation options

As television interference from wind turbines is readily identifiable, appropriate mitigation measures can be readily taken if required.

In the event that TV interference is an issue during wind farm construction or after wind farm commissioning, there are several amelioration options available, in approximate order of increasing cost:

1. Realigning the householder's TV antenna more directly towards their existing transmitter;
2. Tuning the householder's antenna into alternative sources of the same or suitable TV signal;
3. The installation of more directional and/or higher gain antenna at the affected house;
4. Relocating the antenna to a less affected position;
5. The installation of cable/satellite TV at the affected house; and
6. Installation of a TV relay station.

In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue, however, as noted in [40] DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [41] also identified that the receiver height can also affect interference. In areas that are relatively flat and free of vegetation, reflections can enhance or decrease the received signal strength relative to the free path signal strength. ITU found that the received signal strength may not increase monotonically with receiver height. In other words, lowering the receiver height can improve reception in some cases.

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television is comprised of both free to air and subscription based broadcasts. As discussed in section 5.15.3, the majority of areas around the wind farm that are expected to have good coverage (as shown in Figure B-14), however areas which receive 'variable' coverage may be able to access the Viewer Access Satellite Television (VAST) service [43].

It is also noted that the Project Developer have indicated [44] that they are prepared to undertake pre- and post-construction television reception surveys for representative dwellings within 5 km of the wind farm, and also to implement reasonable and feasibile mitigation measures to rectify interference to television signals that are reasonably attributable to the Project.

5.16 Cumulative Impact

As mentioned in Section 3.1, the Project is located in an area of high wind farm development activity with the existing Gunning Wind Farm and the Gullen Range Wind Farm, located at approximately 7.2 km south-southeast and 5.5 km east of the Project respectively. The three (3) Crookwell wind farms are located at approximately 15 km east-northeast of the Project, with the Gullen Range Wind Farm located between the Project and the Crookwell wind farms.

Based on publicly available information, it is understood that the Gullen Range Wind Farm consists of 56 turbines, the Gunning Wind Farm comprises of 31 turbines and Crookwell Stage 1 Wind Farm consists of 8 turbines. The locations of the turbines at the neighbouring wind farms have been obtained from satellite and aerial imagery and are shown in Figure B-15.

5.16.1 Fixed point to point microwave links

Sensible design of a wind farm will avoid the path of point-to-point links which are generally well known. As discussed in section 5.2, three (3) point-to-point links pass through the proposed site boundaries and four turbines proposed for the Project fall within the 2nd Fresnel Zone of the links. The easternmost link also passes near the Gullen Range Wind Farm, with the nearest turbine located at approximately 700 m east of the 2nd Fresnel zone of the link. None of the links cross the Gunning or Crookwell wind farms.

Following consultation with NSW RFS, one of the operators of the links, a new exclusion zone of 1 km width plus 1 blade length, extending for 15km from the tower has been established and up to 16 turbines proposed for the Biala Wind Farm are now located within the new exclusion zone. No turbines from the Gullen Range Wind Farm fall within this new exclusion zone. It is therefore deemed unlikely that cumulative impacts to the links will occur as the link exclusion zones do not intersect turbines from the neighbouring wind farms.

5.16.2 Point-to-multipoint microwave links

As noted earlier, there are two point-to-multipoint stations located within 20 km of the Project site boundary with the closest station located at approximately 16 km northeast of the site, at Hay Street Reservoir, Crookwell.

It is common practice for a point-to-multipoint link to have several unregistered end points and therefore, it is not possible at this stage to determine whether the links are passing through the neighbouring wind farms as well. However, given that the nearest point-to-multipoint station is located approximately 16 km from the wind farm, and interference from the Project is considered unlikely, the potential for cumulative impacts is also considered unlikely.

5.16.3 Other licence types

These licence types are not generally affected by the presence of wind turbines, and therefore there are not expected to be any cumulative impacts from the Project.

5.16.4 Emergency services

As discussed in section 5.5, DNV GL does not expect any direct interference to emergency services from the Project and hence, there are not expected to be any cumulative impacts from the wind farm. Nevertheless, the consultation process described in section 5.5 should capture any adverse impacts not identified.

5.16.5 Aviation radar

It is assumed that an aviation impact study is being undertaken to assess any potential cumulative impacts to aviation radar from the proposed development.

5.16.6 Meteorological radar

It is not expected that the Project will result in any adverse impact on BoM radar installations and therefore, it is not expected that there will be cumulative impacts to BoM radars.

5.16.7 Trigonometrical stations

It is not expected that there will be any electromagnetic interference to trigonometrical stations in the vicinity of the Project. Therefore, it is expected that there will be no cumulative impacts to trigonometrical stations from the proposed Project.

5.16.8 Citizens band radio

It is possible that the potential for interference to CB radio systems could be increased due to cumulative impacts from multiple wind farms. The greater the number of turbines between 2 CB transceivers, the greater the potential for interference. However, as discussed previously, there is no right of protection for CB radio, and it should be possible to rectify interference problems to these services by moving to a location where signal strength and quality are improved, or through the use of an external antenna.

5.16.9 Mobile phones

Although mobile phone signals are generally not susceptible to interference from wind turbines, it is possible that the potential for interference to mobile phone services could be increased due to cumulative impacts from multiple wind farms. The greater the number of turbines between a mobile phone user and mobile phone tower, the greater the potential for interference. However, it should be possible to rectify mobile phone interference issues by moving to a location where signal strength and quality are improved, or through the use of an external antenna.

5.16.10 Wireless internet

As noted in Section 5.12, it is most likely that residents utilise the Telstra NextG wireless broadband services. Consequently, the comments made in Section 5.16.9 above are also applicable here.

5.16.11 Satellite television and internet

As discussed previously, it is unlikely that satellite television signals will experience interference from the Biala Wind Farm and therefore it is unlikely to be any cumulative impacts from the Project.

According to the Australian ISP directory [27], there are currently no satellite ISPs providing internet in the vicinity of the Biala Wind Farm. Therefore, it is unlikely to be any cumulative impacts from the Project.

5.16.12 Radio broadcasting

The impact of the Project on radio broadcasting services is expected to be minimal, and any interference encountered is likely to be easily rectified through the installation of a high quality antenna. As such, cumulative impacts from the wind farm are not expected to be significant.

5.16.13 Terrestrial television broadcasting

The areas that are most likely to experience interference to terrestrial television reception are presented in Section 5.15 for the Project in isolation. A similar analysis, repeated to include the neighbouring wind farms, adds to these potential interference zones and is shown in Figure B-15.

The Crookwell wind farms are located at least 15 km from the Project site, with the Gullen Range Wind Farm between the two sites. Due to the significant distance between the Project and the Crookwell sites, and the relative position of Gullen Range Wind Farm, DNV GL has deemed that residences located around the Crookwell sites are mostly likely to suffer from cumulative terrestrial television interference resulting from the Gullen Range and Crookwell wind farms rather than from the Biala Wind Farm.

Consequently, the assessment of cumulative impacts on terrestrial television signals conducted here considers solely the Gunning, Gullen Range and Biala Wind Farms. DNV GL have not been provided with information regarding potential residences located in the area between the wind farms and there may be cumulative impacts on terrestrial television signals for those residences, particularly for dwellings which have a non-directional or low-gain antenna, and therefore may receive a reflected signal from the surrounding turbines.

Therefore it is expected that those dwellings located between the wind farms, where the signal passes through or is scattered by the turbines at Gunning and/or Biala, are most likely to be susceptible to cumulative impact from the three wind farms. However, it is expected that any interference to terrestrial television can be mitigated by improving the equipment at a house location or other options as listed in section 5.15.4.

6 ELECTROMAGNETIC EMISSIONS FROM WIND TURBINES

Electromagnetic waves are continually present in our environment, and are caused by both natural sources (e.g. the sun, thunderstorms) and artificial sources. Low frequency electromagnetic waves (less than approximately 3 kHz) are often termed electromagnetic fields (EMF), while higher frequency electromagnetic waves are often termed electromagnetic radiation (EMR).

All electrical devices emit electromagnetic waves. This section discusses the electromagnetic emissions from wind turbines, and covers both EMF and EMR. It does not cover emissions from other components that may be present in a wind farm, unless specifically stated.

6.1 Electromagnetic fields (EMF)

Electric and magnetic fields are produced by both natural and artificial sources. However, artificial sources are the dominant sources of EMF and are usually associated with the generation, distribution and use of electricity at the frequency of 50 Hz. The electric field is proportional to the voltage. The magnetic field is proportional to the current.

Electric fields can be shielded by earthed conductive materials and the earth itself but the shielding of magnetic fields is often not practicable.

There are currently no Australian Standards regulating exposure to these fields. The National Health and Medical Research Council (NHMRC) have issued Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields [45]. These guidelines are aimed at preventing immediate health effects resulting from exposure to these fields. The recommended magnetic field exposure limit for members of the public (24 hour exposure) is 100 microtesla (1,000 mG - milligauss), while the recommended electric field exposure limit is 5000 V/m.

In Australia, The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), is the Federal Government agency charged with responsibility for protecting the health and safety of people, and the environment, from the harmful effects of ionising and non-ionising radiation. ARPANSA published a draft standard for Exposure Limits for Electric and Magnetic Fields in 2006. According to the ARPANSA website, the Radiation Health Committee (RHC) decided in 2011 to redraft the proposed standard as guidelines, and the draft is currently in preparation [46].

The exposure limits in the draft standard include significant safety factors and margins. The relevant limits relevant for general exposure to 50 Hz in the draft standard [47] are:

- 100 microtesla magnetic field (1000 mG)
- 5000 V/m electric field

It is noted that the exposure limits in the ARPANSA draft standard are the same as those recommended by the NHMRC.

In a wind turbine, the electrical fields will be shielded by the wind turbine tower which is earthed, but the nacelle may not be completely shielded. However voltages in the nacelle are most often low, and even when high voltage is used, the high voltage cables for the different phases will be in close proximity and balanced and so will act to cancel each other out. Thus the electric fields from a wind turbine will be well below that of a typical power line operating at the same voltage.

Magnetic fields decrease with distance and this happens more quickly when the individual wires are close together and the currents flow in opposite direction causing the fields to cancel each other out. This is the case for wind turbines and thus magnetic fields can be expected to be low.

This expectation has been verified by measurements conducted in the vicinity of a wind turbine in Canada [48]. This measured a maximum of 0.4 milligauss (at the tower door) in the vicinity of the wind turbine, which is less that 1/1000th of the recommended limit (which already includes safety margins).

It can be concluded that EMF from wind turbines are well within the applicable guidelines and no adverse health effects can be expected.

As per the Secretary's Environmental Assessment Requirements (SEARs) and the NSW Guidelines, demonstration of the application of the principles of Prudent Avoidance is required. Prudent Avoidance, as described by the Energy Networks Association (ENA) [49], involves reducing magnetic field exposure where this is practicable and can be done at a modest cost. The proposed electrical collector group for Biala Wind Farm is likely to be comprised of predominantly underground cabling with the potential for a small section of overhead transmission line. The underground cabling network is likely to be comprised of three-core cables, where the conductors of the cables are laid close together in a trefoil phase arrangement. This arrangement of cables can help to reduce EMF levels [50]. In relation to the section of overhead transmission line, DNV GL notes that the route is selected in a remote area infrequently inhabited by people, thereby minimising the risk of EMF exposure. The EMF from the collector group network (cables and transmission line) therefore does not pose a particular risk and could be said to demonstrate the principles of Prudent Avoidance.

The EMFs from other components (transformers, underground cables, substation and transmission lines) in a wind farm are expected to be typical of similar installations that are used elsewhere, and therefore do not pose a particular risk.

6.2 Electromagnetic radiation (EMR)

All electrically-powered equipment produces electromagnetic radiation (radio waves). For most equipment this effect is unwanted (unintended radiation) and is limited by design to comply with mandatory standards. For other equipment (transmitters) the radiation is intentional and necessary (for example in telecommunications systems).

Some common sources of unwanted electromagnetic radiation which may be found in wind turbines include switch mode power supplies, microprocessors and variable speed drives. These types of devices are commonly found in homes, offices and factories. Switch mode power supplies are used in computers, phone chargers, TVs, energy saving lights. Microprocessors are almost ubiquitous. Variable speed drives are used for lifts, water pumping, industrial equipment, and in "inverter" air conditioning units.

Wind turbines are constructed to stringent standards to ensure electrical compatibility. Under the IEC standard for wind turbines IEC 61400-1, there are a number of other standards referenced. Among these are standards related to electromagnetic compatibility (EMC) [51]. These include standards both with respect to immunity and emission of electromagnetic waves. The standard which to which emissions must be limited is IEC 61000-6-4 "Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 4: Emission standard for industrial environments".

Electrical equipment sold in Australia and New Zealand must meet certain requirements with respect to EMC. IEC 61400-6-4 is one of the recognised standards under the regulations to demonstrate compliance with the regulations [52]. In addition wind turbines are internationally traded, and so will be designed to meet the EMC standards in areas which they are sold, such as European Directives on EMC, which are required for installation in Europe and to display the EC mark.

DNV GL has performed measurements of electromagnetic emissions from wind turbines in Denmark and the UK [53]. The measurements were performed due to a proposed wind farm in the vicinity of a British Telecom satellite receiving station, where there was some concern that the installation could be affected even though the wind turbines complied with proven EMC emissions standards.

The measurements were conducted on pitch controlled, fixed speed turbines of the type proposed for the wind farm next to the satellite station, which were manufactured by Vestas. The only emissions that were able to be detected were detected when the measurement equipment was located inside the wind turbine tower. The emissions that were detected were thought to emanate from switch mode power supplies. No emissions were able to be detected from outside the wind turbine. Prior to the study being performed it was thought that the tower may act as an antenna, however the study demonstrated that the tower in fact acts as a shield. It should also be noted that the study was conducted some time ago, and since that time, wind turbines have evolved to include other technologies, such as variable speed drives, which have the potential to cause emissions, however EMC standards have also evolved during that time, meaning that any emissions from these technological developments are likely to be controlled.

From a practical perspective, the following is noted:

- Devices which are likely to cause electromagnetic emissions (microprocessors, switched mode power supplies, variable speed drives) are located within metallic panels, which will act as shields. The outputs from variable speed drives are also filtered.
- Many such components are located within the wind turbine tower or metallic components such as the hub, which will provide a further degree of shielding.
- There is a strong incentive on wind turbine manufacturers to control electromagnetic emissions at source, as wind turbines themselves containing sensitive electronic components which may themselves be affected by electromagnetic emissions.
- Despite large numbers of wind turbines being installed, DNV GL is not aware of any issues in the public domain, where problems have been caused by electromagnetic emissions from wind turbines.

Given that wind turbines are constructed to standards that are recognised EMC regulations in Australia, New Zealand, and many other markets, and the nature of the design of wind turbines means that the components likely to cause emissions are effectively shielded, it is considered unlikely that electromagnetic emissions from wind turbines will have an adverse effect.

7 CONCLUSIONS

Potential electromagnetic interference (EMI) and electromagnetic field (EMF) impacts in the vicinity of the proposed Project have been investigated. The proposed wind farm would involve the installation of 31 wind turbine generators. DNV GL has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 150 m or less, and an upper tip height of 185 m or less.

7.1 Fixed point-to-point links

Several point-to-point microwave links were identified with a path crossing, or near to, the proposed Project site boundaries. Of these links, three (3) links were identified passing within the Project area. Further analysis showed that the link passing in the centre of site is close enough to the ground over the proposed wind farm site such that turbines could potentially interfere with the signal. Four turbines were found to fall within the 2nd Fresnel zone of one link. Following consultation with one of the operators of the links, NSW Rural Fire Service, a new exclusion zone of 1 km wide plus 1 blade length was established around each link and sixteen turbines were found to lie within the larger exclusion zones. The link operators have indicated that they are willing to re-route the links, provided that specified conditions are met by the Project.

DNV GL recommends that prior to construction of the Project, the Project Developer should engage with the NSW RFS to make arrangements for re-routing of the central link crossing the middle of the site. DNV GL also recommends that prior to construction of the Project, the Project Developer should engage with both NSW RFS and Upper Lachlan Shire Council, to establish suitable arrangements for monitoring potential interference to the westernmost and easternmost links during and after construction of the Project, and carrying out amelioration actions (such as re-routing the link) if interference to the link is encountered.

7.2 Fixed point-to-multipoint licences

It is common practice for point-to-multipoint stations to have several unregistered end points and thus, without knowledge about all station locations within the multipoint network, it is not possible to determine if there are any potential EMI impacts. There are two (2) point-to-multipoint base stations listed in the ACMA database within 20km of the proposed Project area, operated by the Upper Lachlan Shire Council. DNV GL has consulted with the Upper Lachlan Shire Council to identify any potential interference issues that may arise from the development and operation of the proposed Project, however the Council have indicated that they are unable to confirm whether the services are likely to be affected. It is DNV GL's opinion that given the locations of these stations, they are unlikely to be affected by the presence of the wind farm. There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. DNV GL has sought feedback from the operators of the majority of stations within 40 km from the centre of the Project to assess any potential impact that the wind farm could have on their services, and to date no concerns have been raised.

7.3 Other licence types

A review of other licences within 75 km of the proposed Project site was conducted. Many of the licences identified can broadly be described as base to mobile station style communication, and include radio broadcasting, commercial and private mobile telephony. These licence types are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation and other

forms of signal obstruction. For most services, should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

7.4 Emergency services

Emergency services with radiocommunications assets in the vicinity of the site have been identified and have been consulted to seek feedback on the potential for adverse impacts to their services.

The closest radiocommunication asset belongs to the NSW Rural Fire Service, located at approximately 5 km from the centre of the Project site. Aside from the issues discussed in section 5.2.1, no additional objections have been raised by the RFS.

The other radiocommunication assets belonging to the emergency services are located at a distance greater than 18 km from the site. Due to the significant distance between the radiocommunication sites and the Project, it is considered unlikely that the Project will cause interference to emergency services' assets. However, DNV GL has sought feedback from the operators of services within 40km of the centre of the Project, and to date no objections have been raised.

7.5 Aircraft navigation systems

It is assumed that an aviation impact study will be carried out to assess any adverse impacts of the Project on aviation navigation systems.

7.6 Aviation radar

The proposed Project is located approximately 78 km from the nearest major airport (Canberra). Due to the significant distance of the major airports from the wind farm and the high probability that the turbines will lie below the aviation radar line-of-sight, it is unlikely that the proposed Project will have an impact on aviation radar.

It is assumed that an aviation impact study will be undertaken to assess the impacts of the Project development on aviation radars.

7.7 Meteorological radar

DNV GL has also undertaken an assessment of the Bureau of Meteorology (BoM) radar stations operating in the vicinity of the proposed Project and the closest station is located at approximately 117 km south-southeast of the site, at Canberra. Due to the distance between the station and the site, and the intervening terrain, it is unlikely that the wind farm would have an impact on meteorological radar operations, however in accordance with the Draft National Wind Farm Development Guidelines, DNV GL has contacted the Bureau of Meteorology to advise them of the Project, and seek feedback on the potential for interference from the proposed development. The BoM has indicated that they do not envisage any significant interference to their radar performance, resulting from the Project development and operation.

7.8 Trigonometrical stations

A total of 50 trigonometrical stations have been identified within 20 km of the proposed Project. Although they are unlikely to host equipment that is susceptible to electromagnetic interference, DNV GL

has consulted with Geoscience Australia and New South Wales Land and Property Information (LPI) to notify them of the proposed Project and seek feedback on the potential for interference from the wind farm. Both parties have indicated that they do not expect any interference on their assets resulting from the wind farm development and operation.

7.9 Citizens Band radio

Users of Citizen Band radio do not require a licence and DNV GL is not able to identify the users of the service and their locations. The channels are shared equally among the different users without the right of protection from interference. If interference is experienced it should be possible to improve signal quality by moving a short distance. It is therefore considered that the impact of the Project on the CB radio service shall be minimal.

7.10 Mobile phones

In general, mobile phone signals are not susceptible to interference from wind turbines. The nearest mobile phone base station is at least 13 km from the Project site, and so large scale interference from the Biala wind farm is unlikely. Published mobile GSM and 3G network coverage has been reviewed for the area around the proposed Project. It has been found that there is good coverage in some areas around the proposed wind farm, and mobile signals are unlikely to be affected in these areas. However there are some areas where coverage may be marginal and therefore mobile signals may be susceptible to interference from the wind farm. DNV GL has contacted Optus, Telstra and Vodafone to seek feedback on any potential impact that the Project could have on their services and to date no concerns have been raised. DNV GL also notes that if interference is encountered, mitigation options are available, such as installation of an external antenna or moving a short distance until the signal improves.

7.11 Wireless internet

The wireless internet provider Yless4U operates a point-to-multipoint station approximately 33 km from the site. It is not possible to identify customers who are using the Yless4U Broadband service, And consequently DNV GL has provided Yless4U with information regarding the Project, and sought feedback regarding the potential for interference. YLess4U have responded indicating that they do have any concerns regarding the Project.

According to the ISP directory [27], four (4) other internet providers operate in the vicinity of the Project, providing wireless internet based on the National Broadband Network of Australia. However, according to the NBN website, the network is not yet available for the Project area, with no roll-out expected for the next 6 months. It is most likely that residences around the Project utilise Telstra NextG wireless broadband services instead.

7.12 Satellite television and internet

Residents in the vicinity of the wind farm may also have access to satellite television. DNV GL has reviewed the line-of-sight of the commonly used TV satellite and it has been found that no turbine intercepts the line-of-sight between houses considered in this analysis and these satellites. According to the ISP directory [27], no satellite internet services are available in the vicinity of the Project.

7.13 Radio broadcasting

An examination of the likely impact of the wind farm on radio broadcasting has also been carried out. It is unlikely that the proposed Project will have an impact on AM radio as the signals are able to propagate around obstructions and buildings. FM signals however may be susceptible to interference from objects such as wind turbines, resulting in hissing and distortion of the signal. This can be mitigated by the installation of a high quality antenna. At present, digital radio is not available in the Project area.

7.14 Terrestrial television broadcasting

Broadcast towers around the proposed Project were investigated to see if television interference would be an issue for the proposed Project. Television interference mechanisms are complex to calculate and can have limited predictive accuracy. Television interference is generally limited to less than 5 km from wind turbines and is a function of the visibility of the wind turbines and the transmitter from the receptor. Digital terrestrial broadcasts have recently replaced analogue broadcasts in New South Wales and are generally much less susceptible to interference from wind farms. However, interference is possible, particularly in areas of low signal strength.

Work presented here highlights the areas around the proposed Project site where interference to terrestrial television broadcasts is more likely to occur. A total of six (6) houses were identified in the potential interference zone for the Black Mountain broadcast tower near Canberra. Two (2) of these dwellings are stakeholders.

The Project site is in a location for which there is good predicted digital terrestrial television coverage across most of the site according to the Australian Government Digital Ready MySwitch website. However, in the areas where digital reception is marginal, residents in the vicinity of the Project may be eligible to receive access to the Government-funded satellite television service to view free-to-air television.

Should interference be encountered that is attributable to the wind farm, the amelioration options below should be followed in order to rectify the problem:

1. Realigning the householders TV antenna more directly towards their existing transmitter;
2. Adjusting the height of the TV antenna;
3. Tuning the householder's antenna into alternative sources of the same or suitable TV signal;
4. The installation of a more directional and/or higher gain antenna at the affected building;
5. Relocating the antenna to a less affected position;
6. The installation of a cable or satellite TV receiver at the affected house;
7. Installation of a TV relay station.

7.15 Cumulative Impacts

Possible cumulative EMI impacts from the Project and nearby wind farms have been considered in section 5.16. Cumulative impacts are not expected to occur for most services considered, however the possibility exists for cumulative impacts to point-to-multipoint stations, mobile phones, wireless internet, CB radio and television services. Options exist to mitigate most interference issues should they occur.

7.16 Electromagnetic emissions from wind turbines

Consideration has been given to potential electromagnetic fields (EMF) and electromagnetic radiation (EMR) in the vicinity of wind turbines. DNV GL has deemed that EMF strengths and EMR levels are likely to be within limits imposed by applicable guidelines and no adverse impacts are expected.

8 REFERENCES

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APPENDIX A SITE INFORMATION

No of turbines	31
Hub Height Option [m]	110
Rotor blade length [m]	75
Rotor diameter [m]	150
Total height to tip [m]	185

Table A-1 Turbine option under consideration at the Project site

Turbine ID	Easting[1] [m]	Northing[1] [m]
T01	717864	6171824
T02	717535	6172459
T03	717211	6172095
T04	716535	6170896
T05	716389	6171280
T06	716235	6171670
T07	716003	6170542
T08	715899	6170905
T09	715503	6171219
T10	715337	6171583
T11	715269	6171908
T12	715149	6172300
T13	715415	6170615
T14	715165	6170992
T15	714719	6171266
T16	714332	6171832
T17	714042	6171415
T18	715593	6169908
T19	715322	6170274
T20	714763	6170375
T21	714201	6170556
T22	713921	6170969
T23	714064	6170175
T24	715042	6169630
T25	714491	6169769
T26	715169	6169139
T27	714673	6168987
T28	714425	6169376
T29	714657	6168605
T30	714409	6167741
T31	714079	6167384

Note 1. Coordinate system used is Zone 55, WGS84 datum

Table A-2 Proposed turbine layout for the Project site

APPENDIX B EMI ASSESSMENT RESULTS

Assignment ID	Site ID	Licence No.	Location (AGD66)	Distance to Project (km)	Licence Owner
1109605-1109197	9580	1108758	690683m E 6094201m N Z55	75.7	ACTEW Distribution Ltd and Jemena Networks (ACT) Pty Ltd Attn Radio workshop GPO Box 366 Canberra ACT 2601
1109607-1109198	9580	1108759	690683m E 6094201m N Z 55	75.7	
1234253-1227467	9580	1230472	690683m E 6094201m N Z55	75.7	
1234252-1227467	9580	1230472	690683m E 6094201m N Z55	75.7	
1109606-1109197	9580	1108758	690683m E 6094201m N Z55	75.7	
1109603-1109196	9580	1108757	690683m E 6094201m N Z55	75.7	
1100979-6564	9580	1101113	690683m E 6094201m N Z55	75.7	
1100978-6564	9580	1101113	690683m E 6094201m N Z55	75.7	
1104889-1104601	9580	1106423	690683m E 6094201m N Z55	75.7	
1104783-1104601	9580	1106423	690683m E 6094201m N Z55	75.7	
1109604-1109196	9580	1108757	690683m E 6094201m N Z55	75.7	
1109608-1109198	9580	1108759	690683m E 6094201m N Z55	75.7	
1110689-1110247	9580	1109738	690683m E 6094201m N Z55	75.7	
1110690-1110248	9580	1109739	690683m E 6094201m N Z55	75.7	
1110691-1110249	9580	1109740	690683m E 6094201m N Z55	75.7	
8176720-8176199	9580	1185877	690683m E 6094201m N Z55	75.7	Aerial Capital Enterprises Pty Ltd PO Box 1233 Fyshwick ACT 2609
8176732-8176213	9580	1185877	690683m E 6094201m N Z55	75.7	
1806918-2224070	102185	1149059	691720m E 6093820m N Z55	76.5	Australian National Botanic gardens PO Box 1777 Canberra ACT 2601
1217654-1213351	202399	1234158	703000m E 6149000m N Z55	21.1	Australian Rail Track Corporation PO Box 10343 Gouger St Adelaide SA 5000
1217653-1213351	202399	1234158	703000m E 6149000m N Z55	21.1	
143180-21478	9666	451054	691100m E 6097100m N Z55	73.3	Australian Sports Commission PO Box 176 Belconnen ACT 2616
8276008-8303572	9012278	1928304	683605m E 6100487m N Z55	73.0	Belconnen Magpies Sport Club Ltd PO Box 144 Kippax ACT 2615
8276009-8303573	9012278	1928304	683605m E 6100487m N Z55	73.0	
4107-25138	34853	10582	655950m E 6186950m N Z55	60.5	Boorowa Council PO Box 96 Boorowa NSW 2586
1235564-1228610	9480	1231599	224000m E 6170700m N Z56	55.8	Bureau of Meteorology Comms Section GPO Box 1289 Melbourne VIC 3001
1235565-1228611	205697	1231600	762941m E 6172939m N Z55	44.0	
1235572-1228618	205701	1231607	752927m E 6150092m N Z55	39.4	
1235592-1228638	205714	1231627	763482m E 6245455m N Z55	86.5	
1235591-1228637	205716	1231626	243747m E 6144260m N Z56	78.3	
1101766-1101964	10522	1956681	679500m E 6245300m N Z55	81.8	Cowra Shire Council Private bag 342 Cowra NSW 2794
1101765-1101964	10522	1956681	679500m E 6245300m N Z55	81.8	
1101762-1101962	100700	1956682	643450m E 6232750m N Z55	93.6	
1101763-1101962	100700	1956682	643450m E 6232750m N Z55	93.6	

Table B-1 Details of point-to-multipoint licences within 75 km of the Project

Assignment ID	Site ID	Licence No.	Location (AGD66)	Distance to Project (km)	Licence Owner
158122-11772	9605	493181	697100m E 6097000m N Z55	71.9	Department of Defence Director, Spectrum Office CP1-4-019 Campbell Park Attn David Murray Canberra ACT 2600
8175591-8174651	9002254	1184813	238331m E 6162368m N Z56	69.8	Endeavour Energy PO Box 6366 (J Chadd L02299) Blacktown DC NSW 2148
8175597-8174659	9002254	1184813	238331m E 6162368m N Z56	69.8	
1424260-1419213	404074	1429638	749890m E 6148994m N Z55	38.1	Essential Energy PO Box 718 Queanbeyan NSW 2620
1424261-1419213	404074	1429638	749890m E 6148994m N Z55	38.1	
1423201-1418359	404074	1427988	749890m E 6148994m N Z55	38.1	
1423200-1418359	404074	1427988	749890m E 6148994m N Z55	38.1	
7938-27329	35237	26488	745950m E 6152490m N Z55	32.0	Goulburn City Council Locked Bag 22 Goulburn DC NSW 2580
314882-27329	35237	26488	745950m E 6152490m N Z55	32.0	
1102937-1102855	100872	1105029	774650m E 6155890m N Z55	57.4	Goulburn Mulwaree Council Locked bag 22 Goulburn NSW 2580
1102936-1102855	100872	1105029	774650m E 6155890m N Z55	57.4	
1104782-1104500	9590	1214312	693834m E 6093346m N Z55	75.8	Itron Australasia Pty Ltd Actaris Pty Ltd 8 Rosberg Road Windfield SA 5013
1105023-1104710	101195	1106560	721540m E 6095920m N Z55	70.7	Palerang Council PO Box 348 Bungendore NSW 2621
1105024-1104710	101195	1106560	721540m E 6095920m N Z55	70.7	
1236085-1229009	205768	1232279	723039m E 6094480m N Z55	72.0	
1236086-1229009	205768	1232279	723039m E 6094480m N Z55	72.0	
1224835-1218777	9534	1220708	706209m E 6217575m N Z55	46.2	State Water Corporation NSW Private bag 2 (C-/ A Burrell) Wodonga VIC 3691
1224834-1218777	9534	1220708	706209m E 6217575m N Z55	46.2	
1224836-1218778	10522	1220709	679500m E 6245300m N Z55	81.8	
1224837-1218778	10522	1220709	679500m E 6245300m N Z55	81.8	
1101551-1101828	100672	1103856	644407m E 6125448m N Z55	80.4	
1101552-1101828	100672	1103856	644407m E 6125448m N Z55	80.4	
1224830-1218775	100685	1220705	712513m E 6236155m N Z55	63.9	
1224831-1218775	100685	1220705	712513m E 6236155m N Z55	63.9	
8168911-8164853	205716	1148261	243747m E 6144260m N Z56	78.3	Sydney Catchment Authority PO Box 323 Penrith NSW 2751
1203529-1202161	9377	1202981	230746m E 6199614m N Z56	70.2	Telstra Corporation Ltd Attn Tom Fairbrother (Radio Engineering) Locked bag 810 Adelaide SA 5000
1203252-1202161	9377	1202981	230746m E 6199614m N Z56	70.2	
1207879-1205301	10409	1204710	230350m E 6213820m N Z56	76.8	
1206014-1205301	10409	1204710	230350m E 6213820m N Z56	76.8	
1203485-1202133	200514	1202984	239110m E 6196722m N Z56	76.5	
1203254-1202133	200514	1202984	239110m E 6196722m N Z56	76.5	
1203520-1202154	200515	1202983	774300m E 6201900m N Z55	63.1	
1203253-1202154	200515	1202983	774300m E 6201900m N Z55	63.1	

Table B-1 Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence No.	Location (AGD66)	Distance to Project (km)	Licence Owner
8416804-8480910	9022060	1981362	694200m E 6096907m N Z55	72.5	Territory & Municipal Services Directorate Roads ACT PO Box 777 Fyshwick ACT 2609
358979-27327	41454	178455	728075m E 6184610m N Z55	16.1	Upper Lachlan Council PO Box 42 Gunning NSW 2581
81689-27327	41454	178455	728075m E 6184610m N Z55	16.1	
1828256-2243775	139601	1932398	761111m E 6190131m N Z55	46.8	
1828255-2243775	139601	1932398	761111m E 6190131m N Z55	46.8	
8391723-8445826	9019481	1968122	707586m E 6149840m N Z55	18.0	
8391722-8445825	9019481	1968122	707586m E 6149840m N Z55	18.0	
8391720-8445823	9019482	1968121	758542m E 6190088m N Z55	44.3	
8391721-8445824	9019482	1968121	758542m E 6190088m N Z55	44.3	
1231202-1224733	9529	1227638	680050m E 6141725m N Z55	42.4	Yass Valley Council PO Box 6 Yass NSW 2582
1231198-1224733	9529	1227638	680050m E 6141725m N Z55	42.4	
8408295-8469229	9484	1977109	745960m E 6150500m N Z55	33.0	YLess4U Pty Ltd 62 Newington Road Bywong NSW 2621

Table B-1 Details of point-to-multipoint licences within 75 km of the Project (concluded)

Trig Point	Easting[1] [m]	Northing[1] [m]	Trig Point	Easting[1] [m]	Northing[1][m]
Bald Peak	713943.9	6161258.1	Medway	711189.3	6171042.7
Brian	717048.6	6162574.6	Midgee	704572.8	6167396.0
Butts	723748.1	6172527.7	Midgee	704572.9	6167395.8
Crookwell	719902.4	6178672.1	Mountain Ash	720337.4	6160807.1
Crookwell	719902.7	6178671.9	Mountain Ash	720337.6	6160807.0
Cullarin	717515.6	6160857.7	Oaks	714537.3	6161671.4
Cullarin	717516.1	6160858.7	Pejar	725682.9	6173338.4
Cullarin	717515.6	6160859.0	Pejar	725683.1	6173338.3
Cullarin	717515.7	6160857.5	Pomeroy	723952.0	6168514.4
Cullarin	717516.3	6160858.5	Pomeroy	723952.2	6168514.2
Dalton	708009.4	6160967.9	Rockfield	725512.7	6165434.1
Dalton	708010.2	6160967.4	Rockfield	725512.9	6165434.0
Fitton	721608.2	6169179.5	Romner	713003.8	6180112.3
Fitton	721608.3	6169179.3	Romner	713004.0	6180112.2
Gunning	710912.6	6157637.0	Sugarloaf	722278.3	6164039.3
Gurrundah	719351.2	6163589.2	Sugarloaf	722278.5	6164039.1
Highest Point	720779.1	6173972.1	Trinity	724175.5	6176982.9
Highest Point	720779.3	6173971.5	Trinity	724265.2	6176948.8
Kialla	725820.1	6169834.6	Wattman	719547.9	6177046.9
Kialla	725820.3	6169834.5	Wattman	719622.5	6177030.8
Kildare	704340.6	6165740.2	Wattman	719548.2	6177046.8
Kildare	704341.9	6165739.6	Wheeo	712257.9	6179546.6
Mary	715494.6	6165821.3	Wheeo	712258.0	6179545.1
Mary	715494.8	6165821.2	Winduella	712051.1	6174583.4
Medway	711189.2	6171042.8	Winduella	712051.9	6174582.3

Note 1. Coordinate system used is Zone 55, AGD66 datum

Table B- 2 Details of trigonometrical stations within 20 km of the Project

House ID	Easting[1] [m]	Northing[1] [m]	Status	Within TV EMI zone from Canberra Tower
HS01	716458	6172607	Stakeholder	✓
HS02	716378	6172571	Stakeholder	✓
HN03	714805	6174684		✓
HN04	713279	6174207		
HN05	716899	6174610		✓
HN06	718838	6173981		✓
HN07	719217	6173652		✓
HS08	718825	6171869	Stakeholder	
HN09	717729	6169285		
HS10	713039	6171444	Stakeholder	
HN11	717228	6168754		
HN12	716395	6167298		
HN13	711857	6166539		
HN14	711969	6166279		
HN15	711963	6169014		
DA16	717303	6170119	Development Approval	
HN17	718838	6169071		

Note 1. Coordinate system used is Zone 55, WGS84 datum

Table B- 3 List of houses with the potential to experience EMI to digital television from the Black Mountain broadcast tower near Canberra

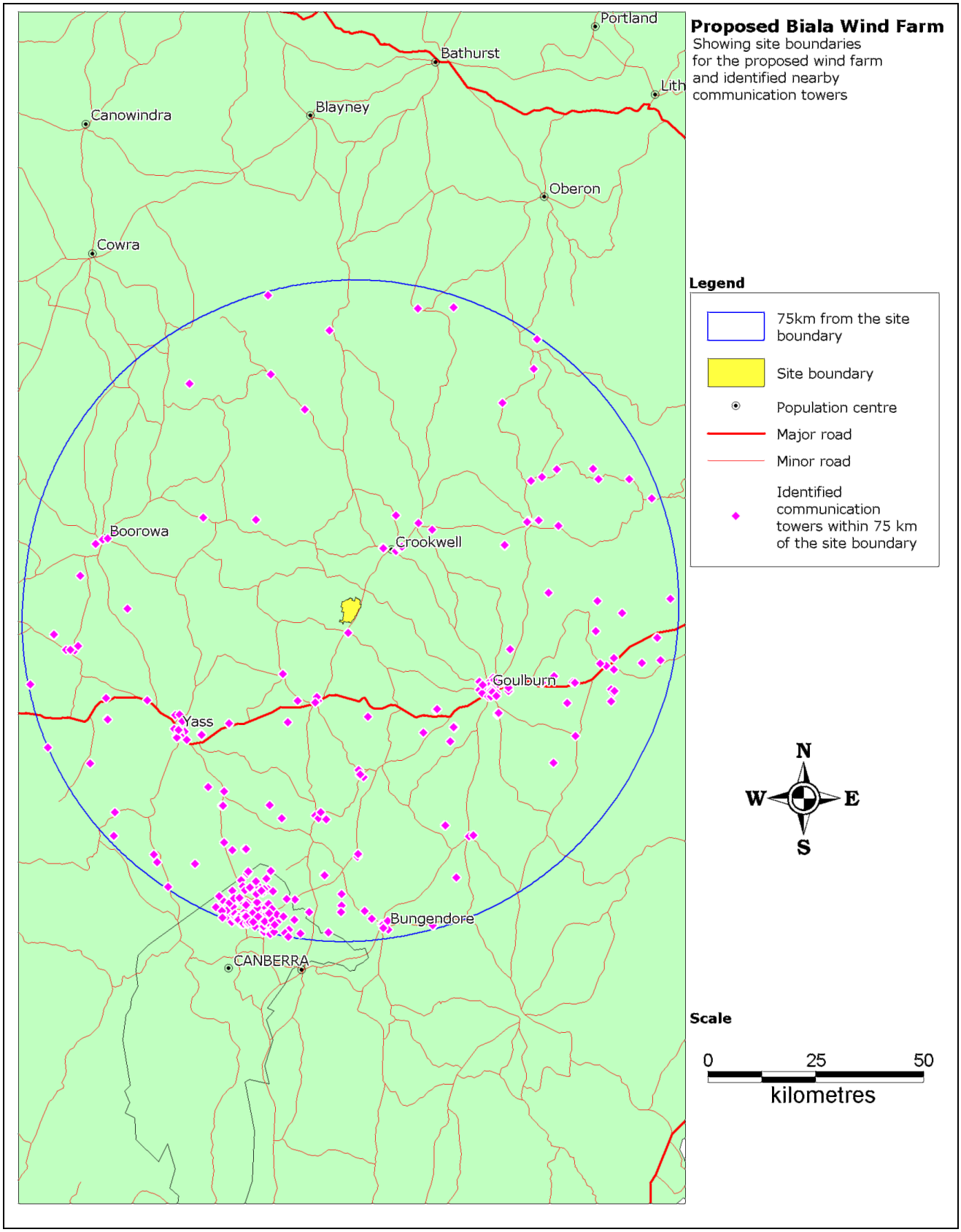

Figure B-1 Location of the Biala Wind Farm and identified proximate radiocommunication sites

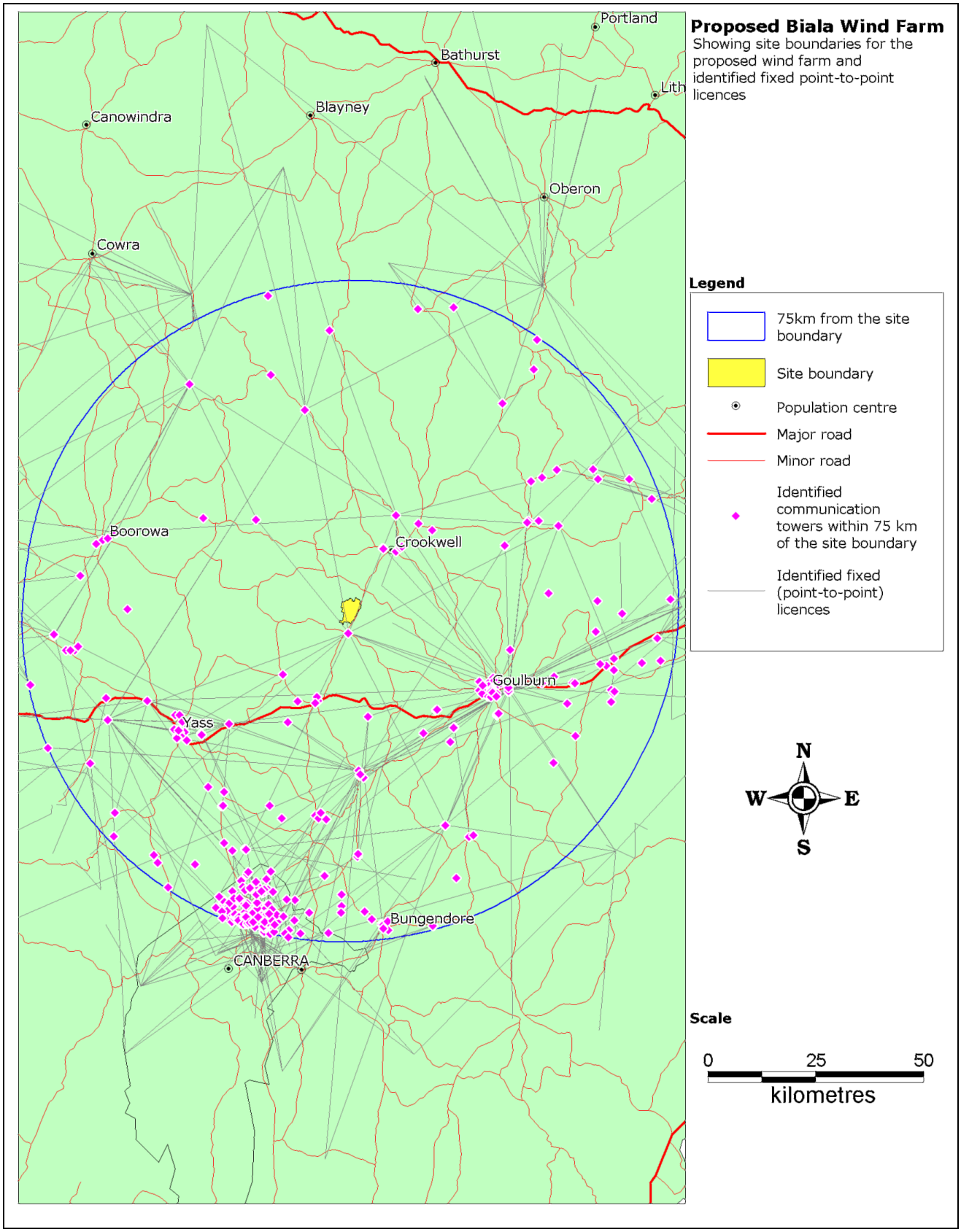

Figure B-2 Identified transmission vectors for fixed licences of point-to-point type proximate to Biala Wind Farm

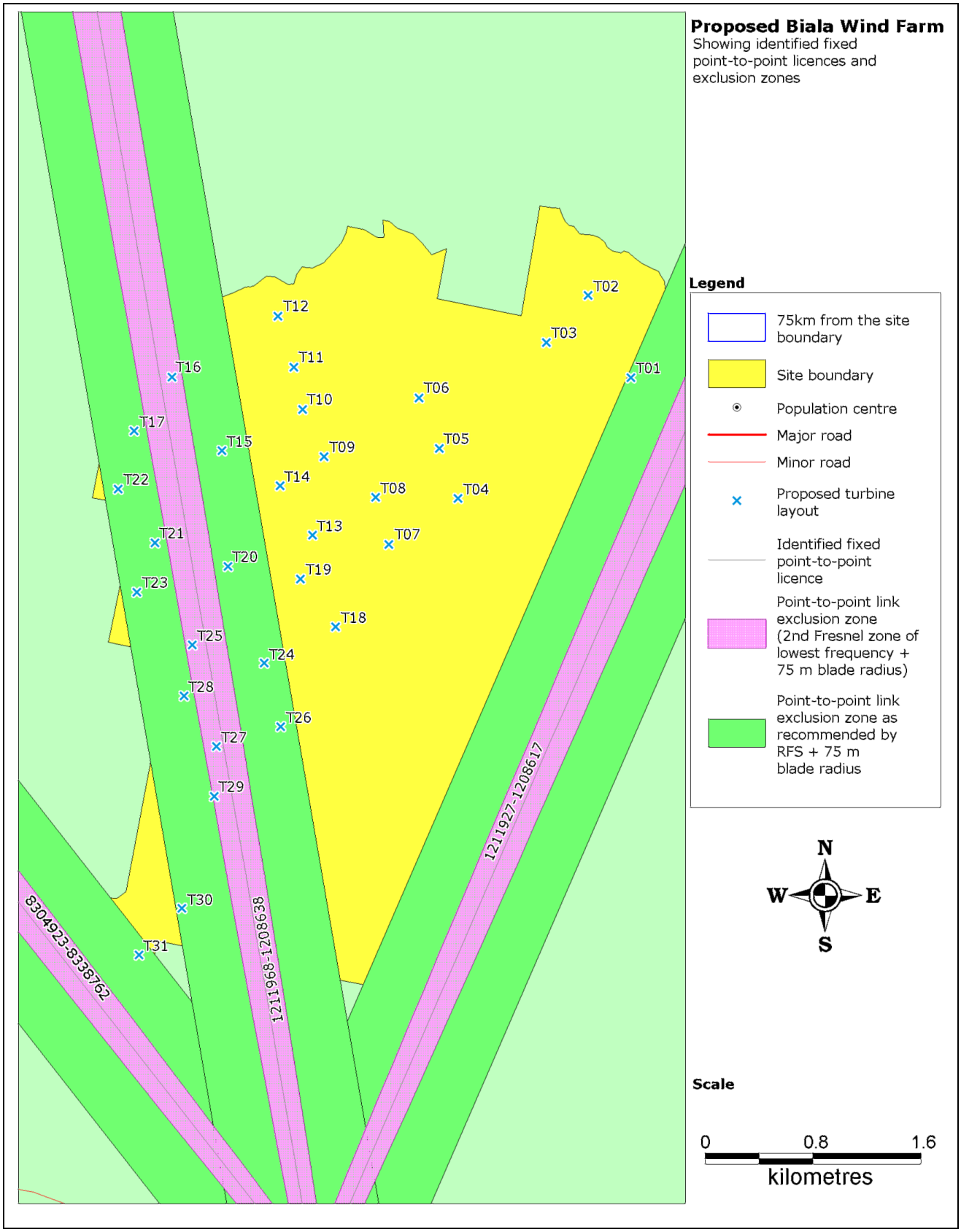

Figure B-3 Identified point-to-point telecommunication link vectors and exclusion zones for the proposed Biala Wind Farm

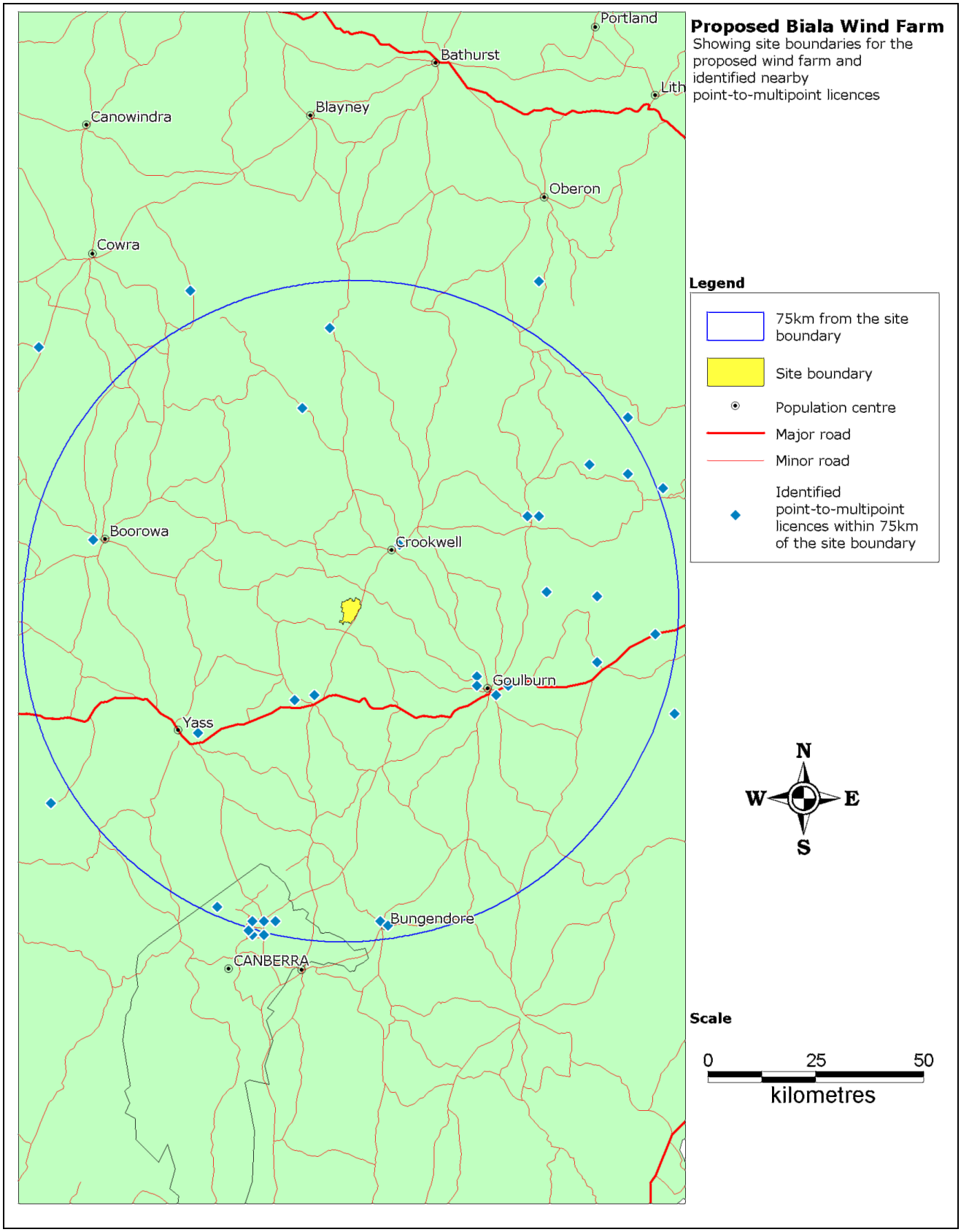

Figure B-4 Location of point-to-multipoint licences within 75 km of the Biala Wind Farm

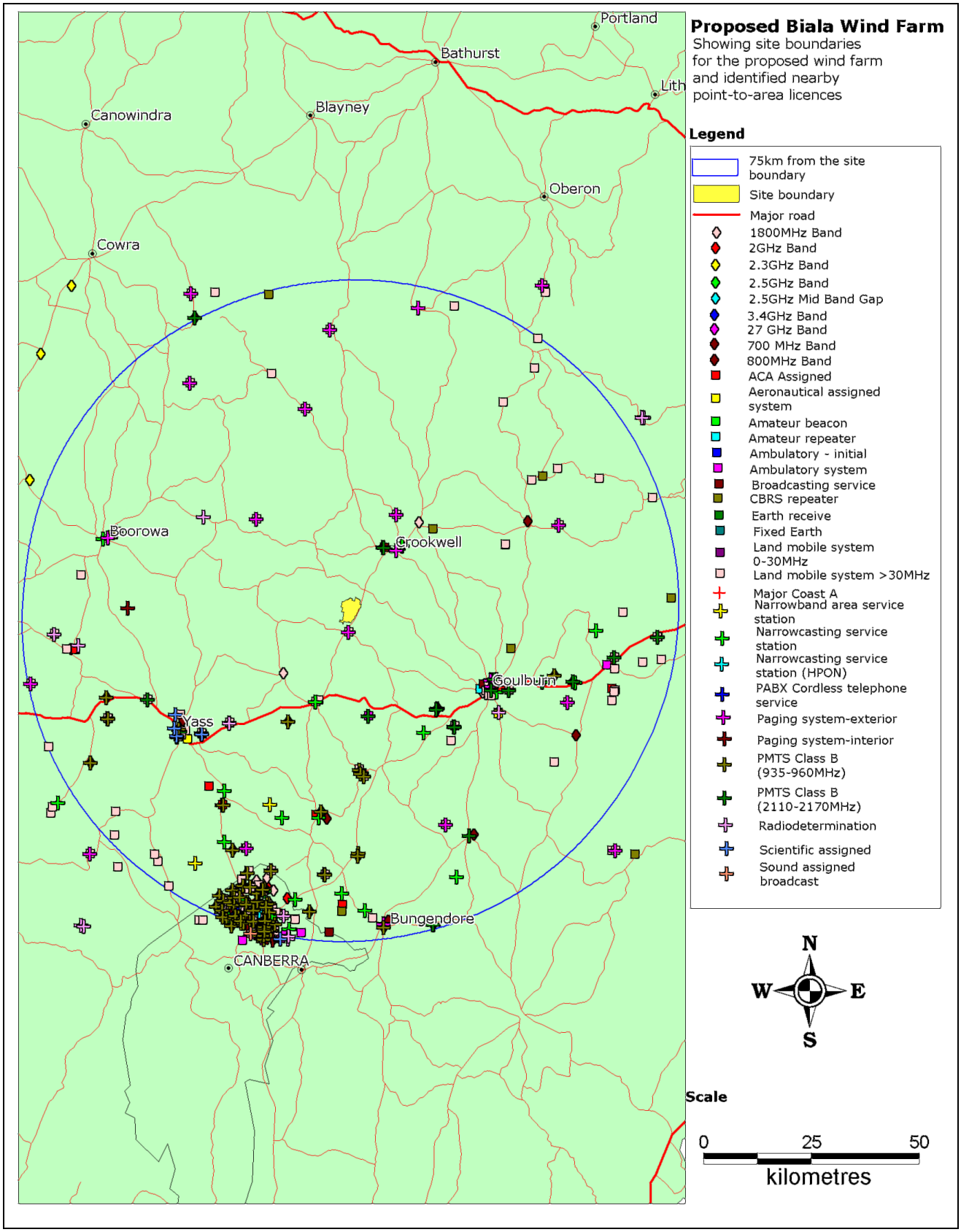

Figure B-5 Location of general point to area licences within 75 km of the Biala Wind Farm

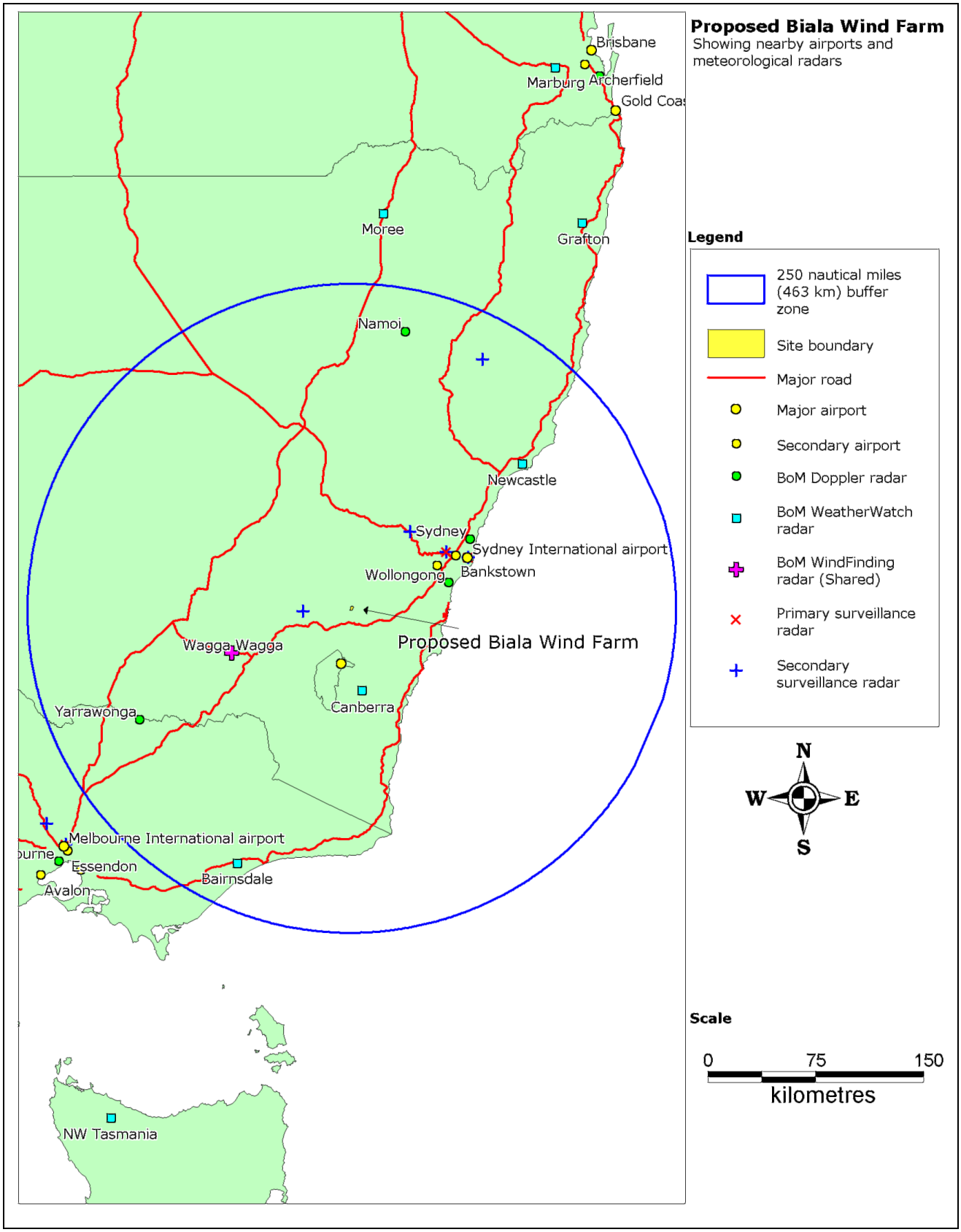

Figure B-6 Location of major airports and Bureau of Meteorology weather watch radar sites within 250 nautical miles of the Project

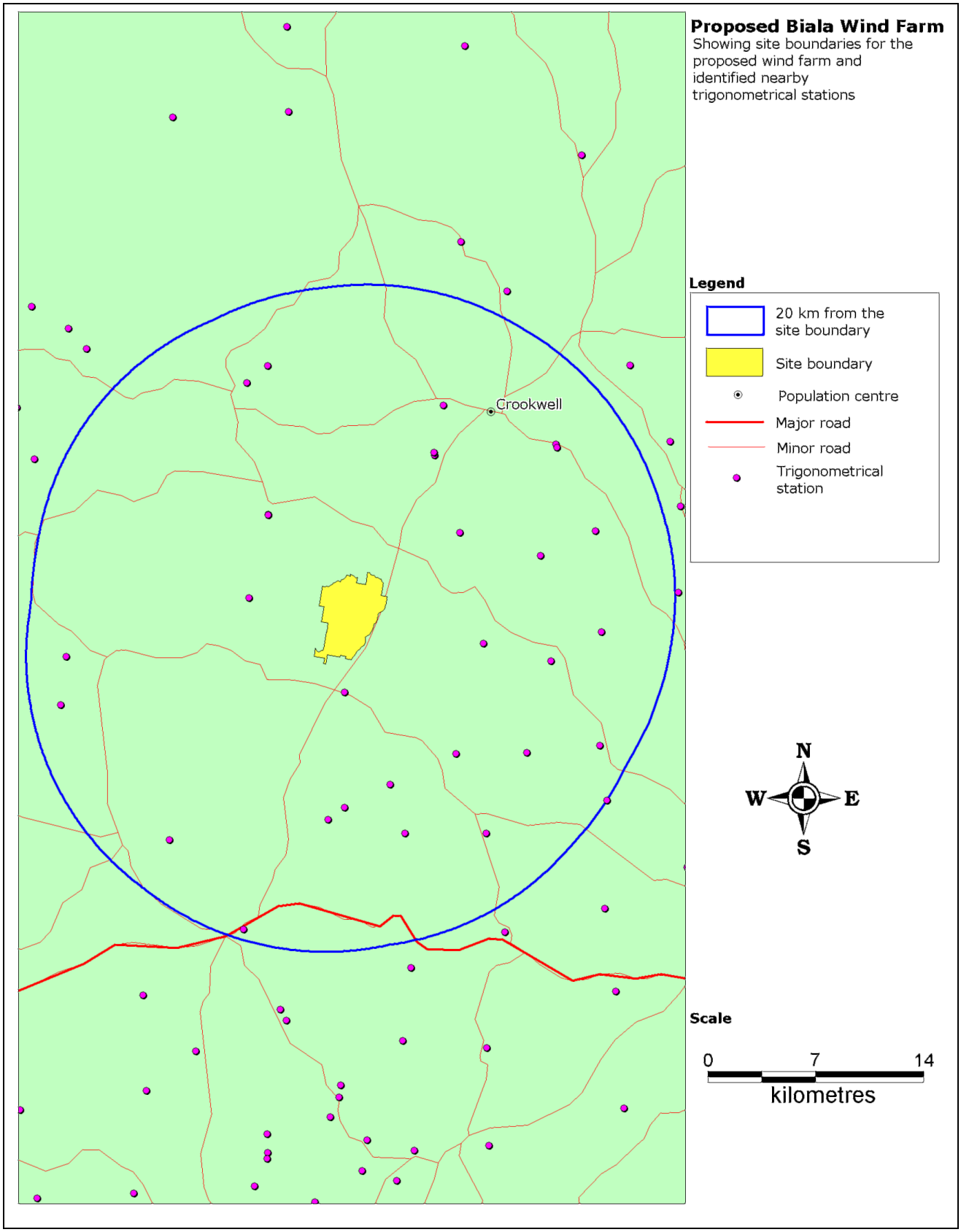

Figure B-7 Location of trigonometrical stations within 20 km of the Project site

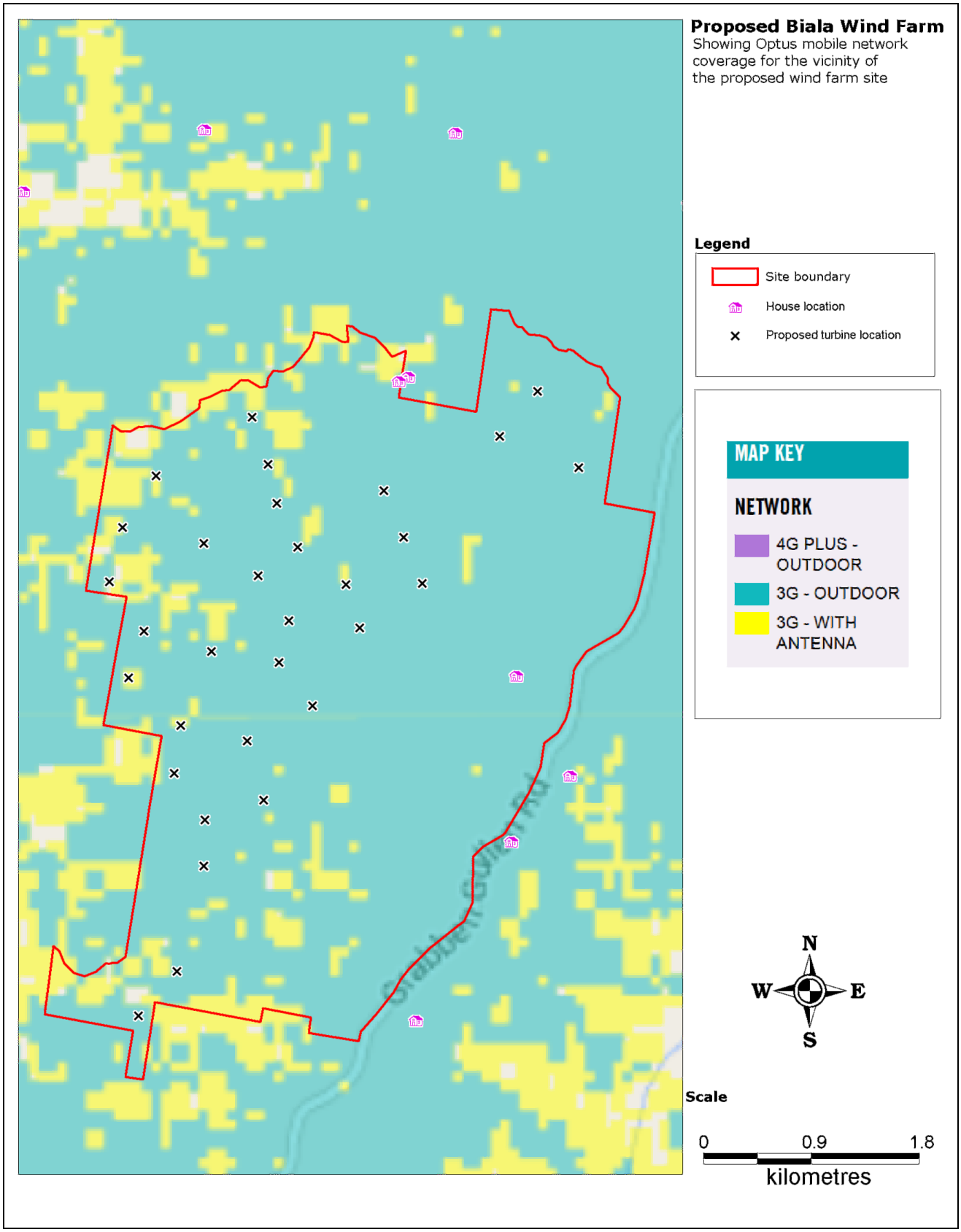

Figure B-8 Optus mobile network coverage in the vicinity of the Project

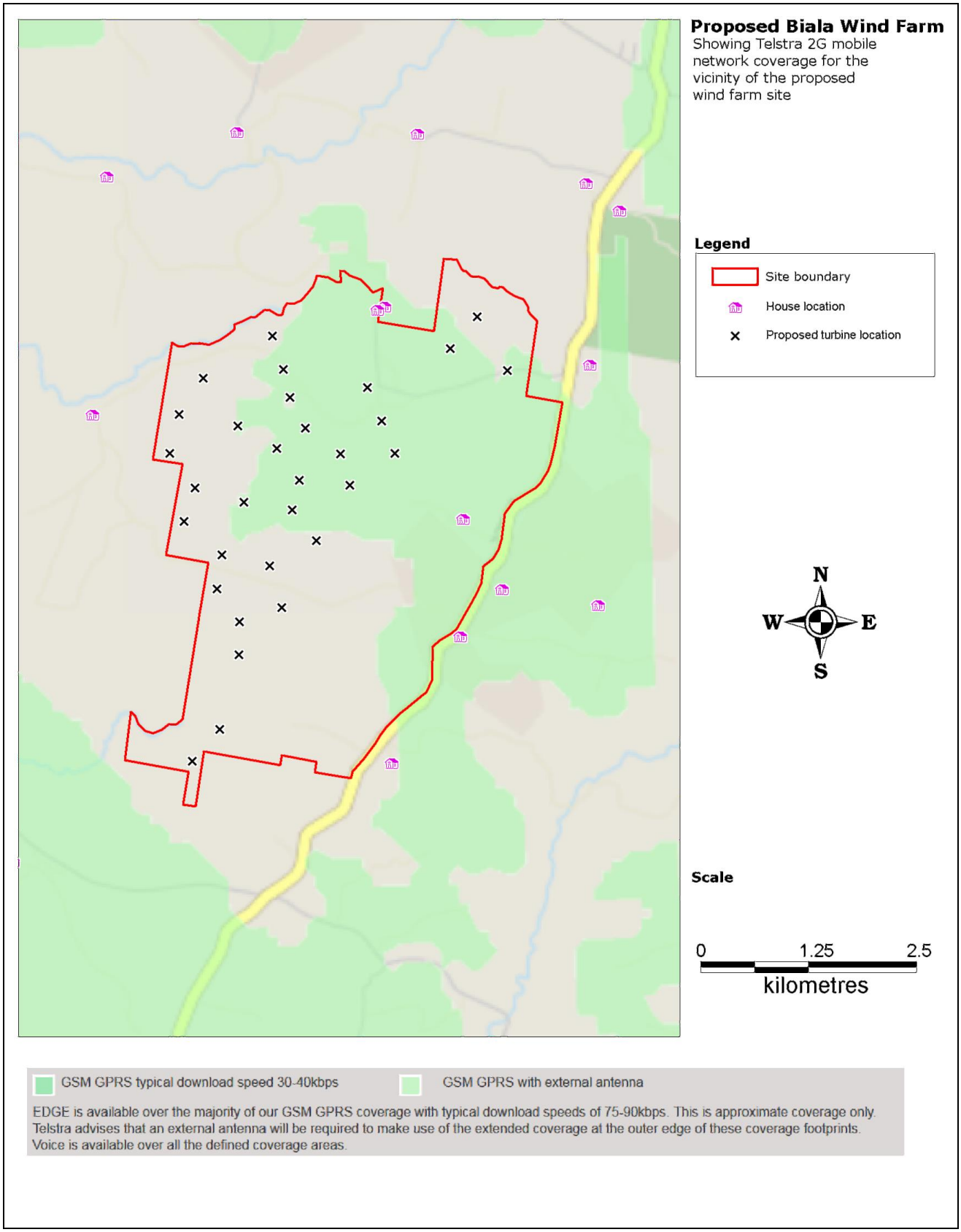

Figure B-9 Telstra 2G mobile network coverage in the vicinity of the Project

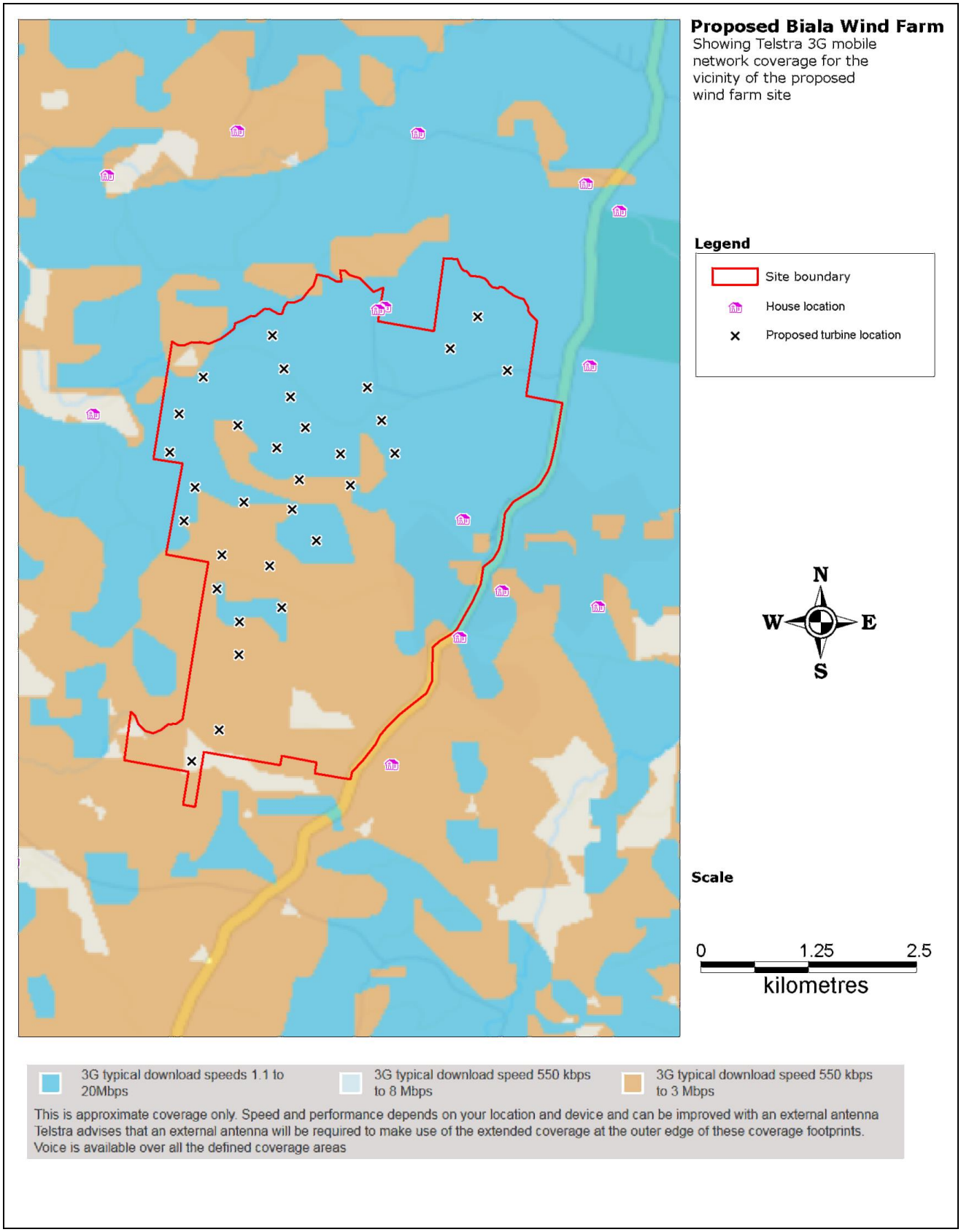

Figure B-10 Telstra 3G (NextG) mobile network coverage in the vicinity of the Project

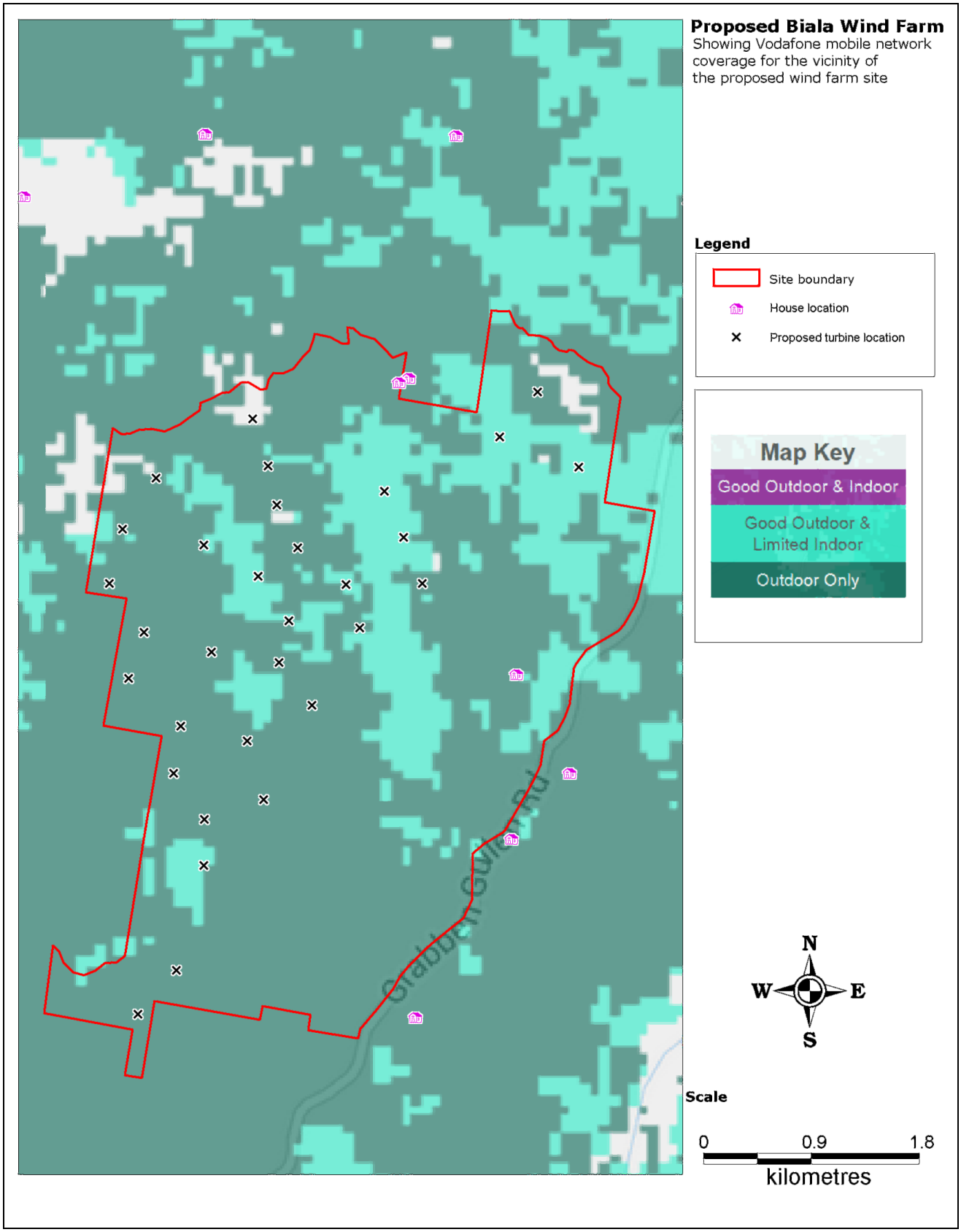

Figure B-11 Vodafone mobile network coverage in the vicinity of the Project

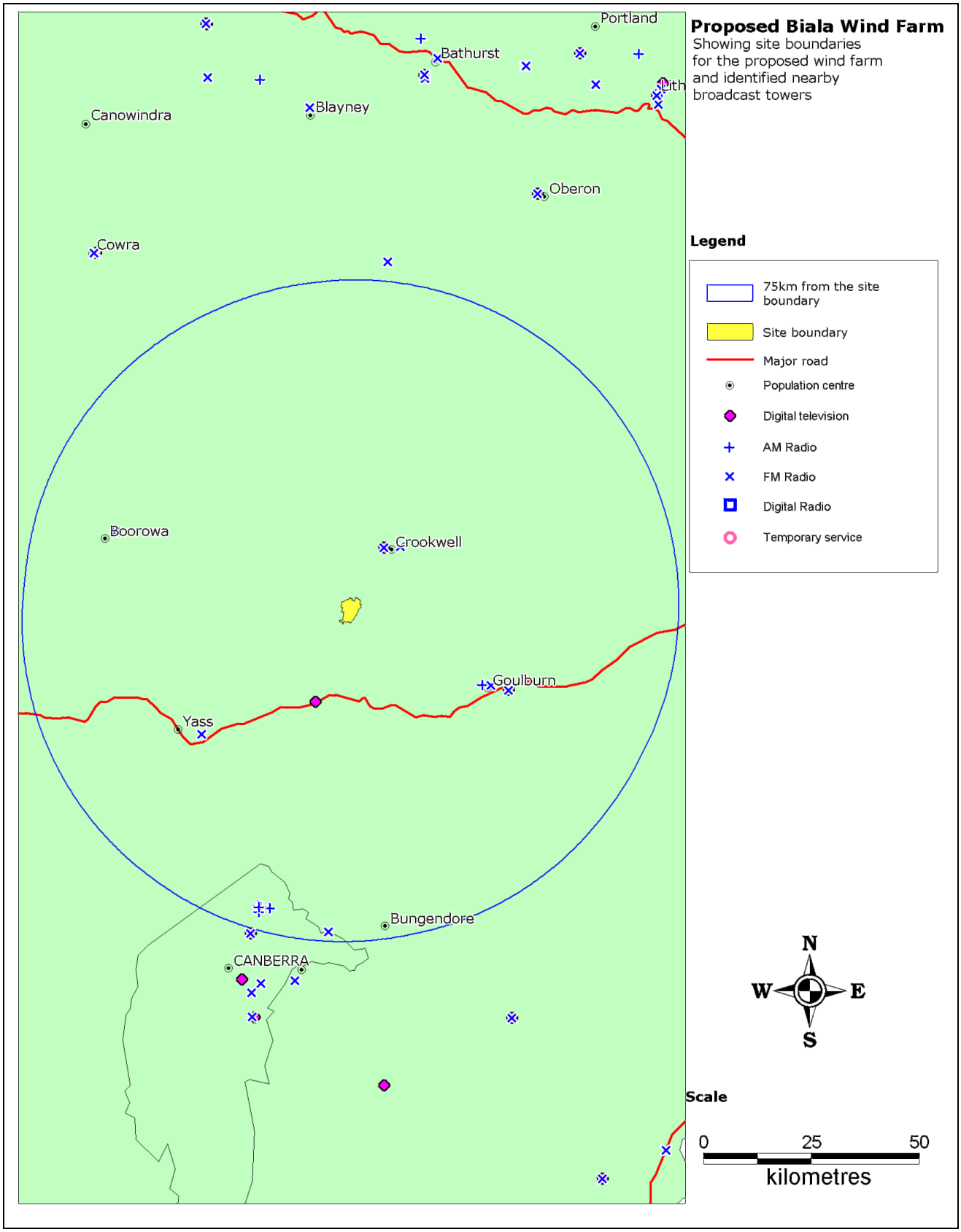

Figure B-12 Location of broadcast transmitters in the vicinity of the Project

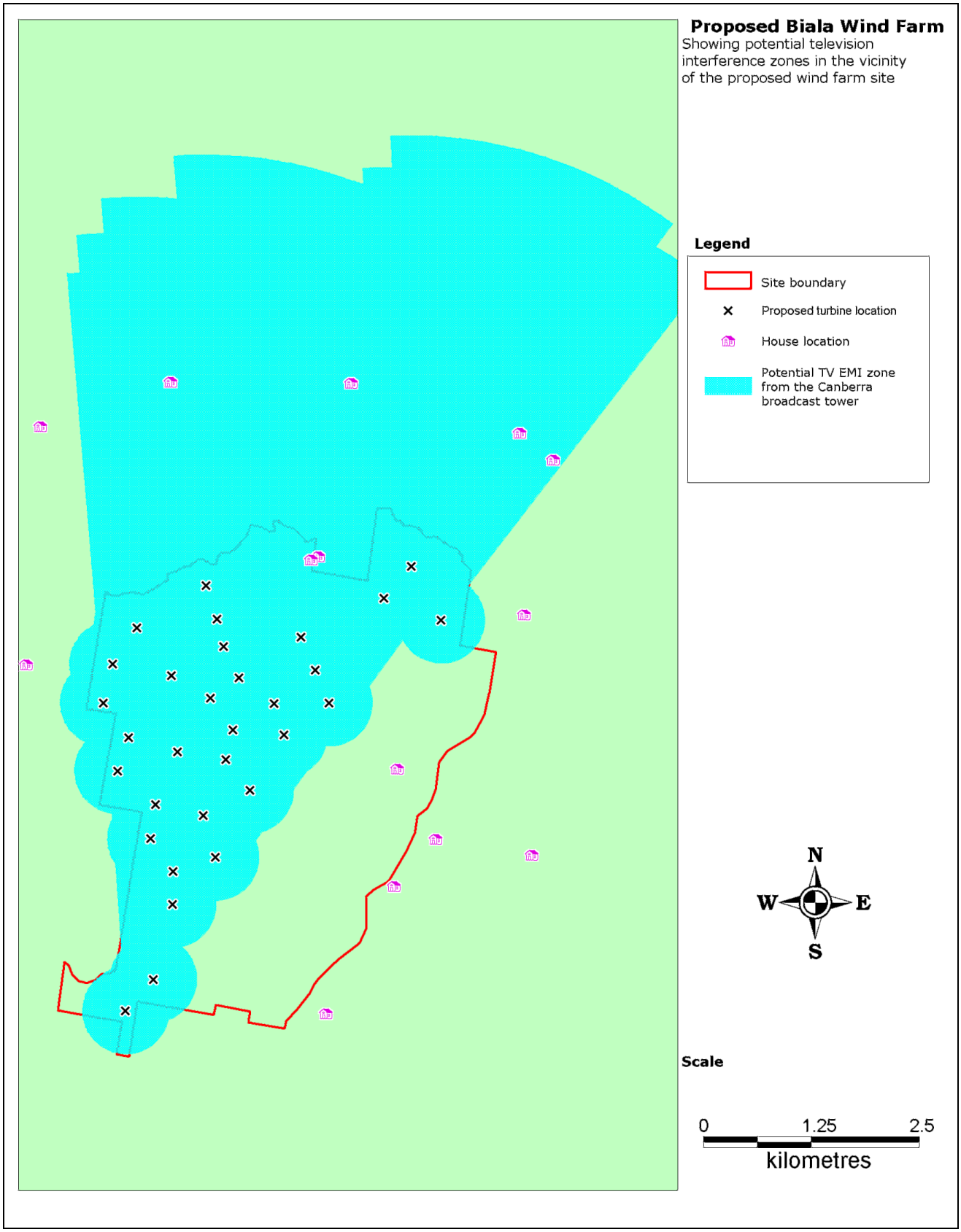

Figure B-13 Potential TV EMI zones from the Canberra broadcast tower

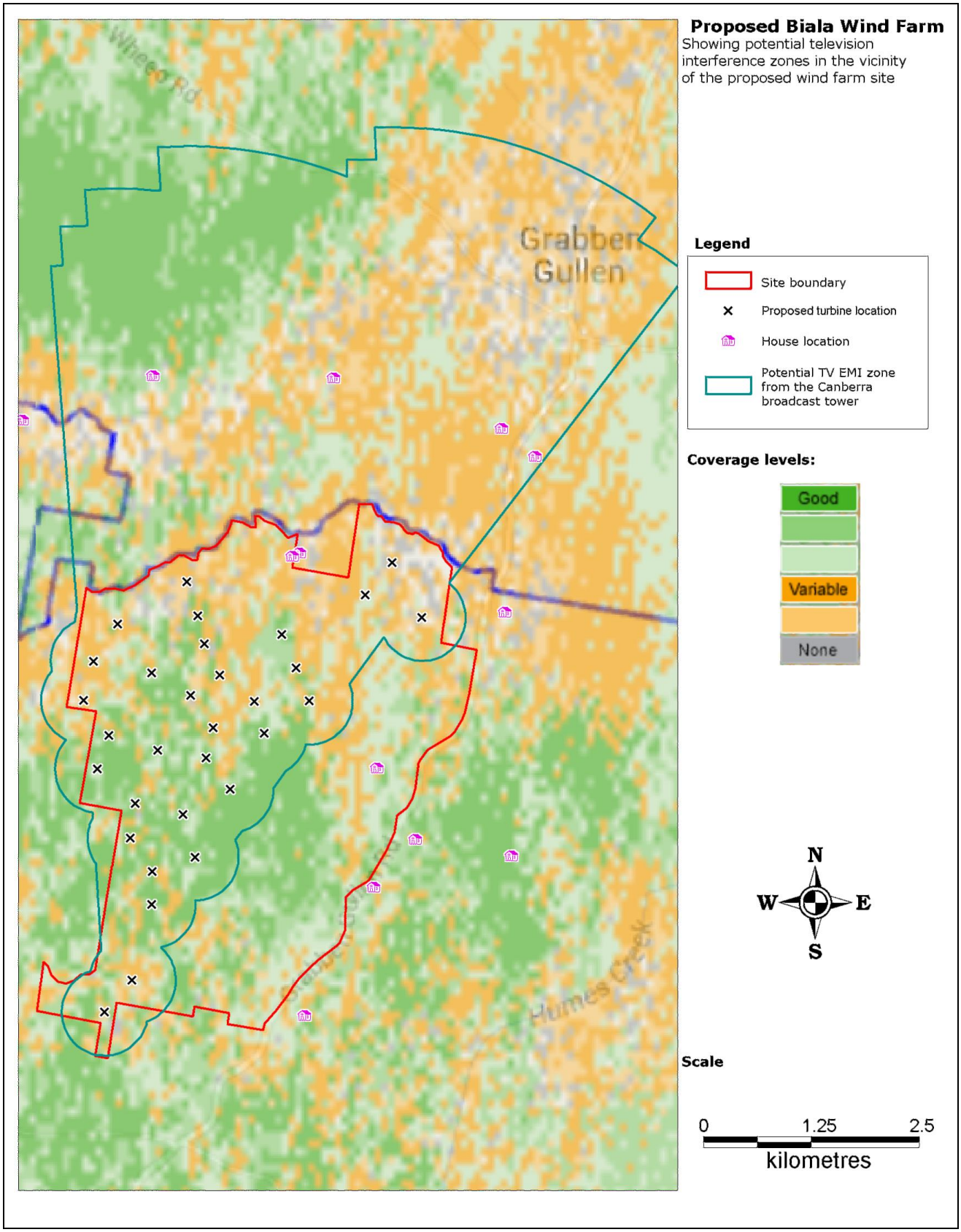

Figure B-14 Potential TV EMI zones and coverage levels from the Canberra broadcast tower

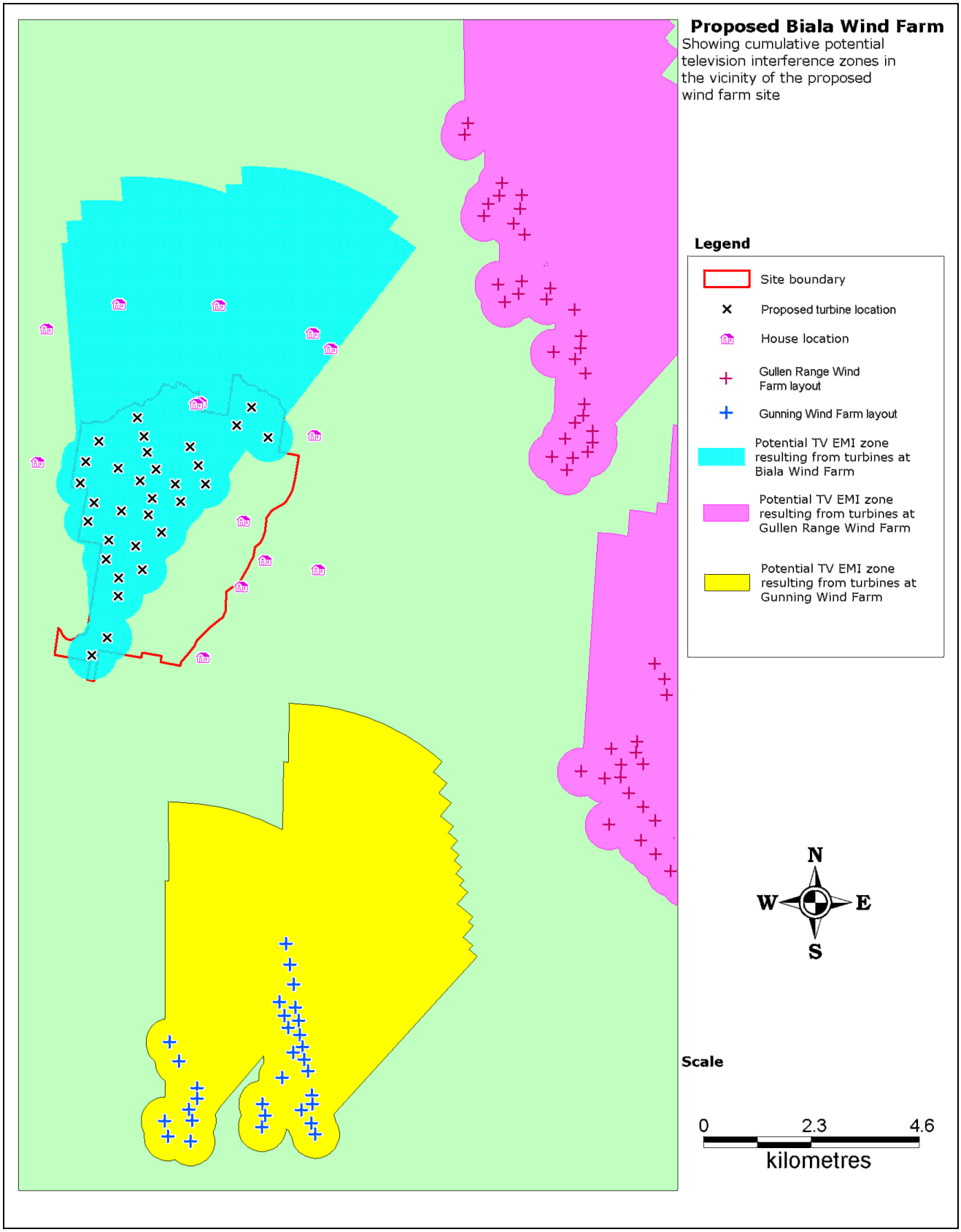

Figure B-15 Potential TV EMI zones from the Canberra broadcast tower, resulting from the Biala, Gunning and Gullen Range wind farms.

APPENDIX C CONSULTATION PROCESS

Below is a summary of the responses received to-date following the consultation process undertaken by DNV GL.

	Licence type	Closest distance to site [km]	Operator	DNV GL Reference	Response received
1	Fixed point-to-multipoint, meteorological radars	39.4	Bureau of Meteorology	170223-AUME-L-01	Response received on 10-04-2015: No significant interference is expected with the radar performance. Response received on 06-05-2015: The chance of interference to the radio network by the wind farm is minimal.
2	Fixed Point-to-point, paging system, land mobile system	2.9	NSW Rural Fire Service	170223-AUME-L-02	Letter received on 24-04-2015: Detailed calculations on each of the three links were undertaken. Turbine T31 is unlikely to cause serious interference to the paging link on this path The link # 1947391 crossing the middle of the site is likely to be impacted by interference from turbines. Mitigating options are either to relocate the turbines or re-route the link. The costs associated with the re-routing is expected to be in the order of $125,000 It has not been possible to assess the likely level of interference caused by turbine T01 on the last link. Calculations indicate that there is little likelihood of interference; however, should the performance of the link be found unacceptable after T01 is erected, arrangements can be made to re-route the link. The costs associated with re-routing the 2 links are expected to be approximately $150,000
3	Fixed point-to-point, point-to-multipoint	2.9	Upper Lachlan Council	170223-AUME-L-03	Response received on 16-01-2015: The council will require detailed descriptions of what work is involved in the re-routing (to enable a third party assessment of the proposal). Council will also be seeking that a bond will be lodged with Council to ensure that the work is carried out before work commences on construction of the wind farm. Response received on 30-04-2015: Council's position is that it requires the Project Developer to pay for it to receive advice from a third party provider.
4	Point-to-multipoint	21.1	Australian Rail Track Corporation	170223-AUME-L-04	Letter received on 07-05-2015: ARTC has reviewed your proposal for the proposed Biala Wind Farm and the potential for interference with electromagnetic signals and it

	Licence type	Closest distance to site [km]	Operator	DNV GL Reference	Response received
					does not pose any problems to ARTC signals. .
5	Point-to-multipoint	38.1	Essential Energy	170223-AUME-L-05	Response received on 08-04-2015: There is no objection to the proposal and it is highly unlikely that the proposed wind farm will cause interference to Essential Energy's radio network.
6	Point-to-multipoint	32	Goulburn city council	170223-AUME-L-06	Response received on 07-03-2015: We do not see any issues with the development.
7	Point-to-multipoint	33	YLess4U Pty Ltd	170223-AUME-L-07	*No response received to date*
8	Land mobile system	25	Ambulance service of NSW	170223-AUME-L-08	Response received on 09-07-2015: With respect to the detailed correspondence on the proposed Biala Wind Farm … from a NSW Ambulance perspective can see no immediate or future impact on our operations.
9	Land mobile system	39	Australian Federal Police	170223-AUME-L-09	*No response received to date*
10	Land mobile system, paging system	18	Fire and Rescue NSW	170223-AUME-L-10	Response received on 06-05-2015: The information provided indicates the proposed Biala Wind Farm will have no adverse effects on the telecommunication services in use by FRNSW in the area.
11	CBRS repeater	27	Laggan and district Bushfire Brigade	170223-AUME-L-11	*No response received to date*
12	CBRS repeater	37	Mulwaree Goulburn Emergency Repeater Group	170223-AUME-L-12	*No response received to date*
13	Land mobile system	25	NSW Police Force	170223-AUME-L-13	Response received on 07-05-2015: The degradation to radio coverage cannot be assessed in the absence of data. Assessment of this nature is complex and requires a longer time. Therefore, we have no strong evidence to object for the Proposed installations
14	Ambulatory system, Land mobile system	39	St John Ambulance	170223-AUME-L-14	Response received on 11-05-2015: There will be no impact by this Project on St John radio licences/installed equipment.
15	Aeronautical assigned, land mobile system	23	State Emergency Service (NSW)	170223-AUME-L-15	*No response received to date*

	Licence type	Closest distance to site [km]	Operator	DNV GL Reference	Response received
16	Trigonometrical stations	2.3	Geoscience Australia	170223-AUME-L-16	Letter received on 24-03-2015: Geoscience Australia does not foresee any impact to our trigonometrical stations, Global Navigational Satellite System stations, equipment, facilities or services associated with the proposed Biala Wind Farm
17	Trigonometrical stations	2.3	Land Property Information	170223-AUME-L-17	Response received on 04-05-2015: No potential impacts are expected on LPI geodetic assets
18	Mobile phone network	-	Telstra Operations	170223-AUME-L-18	Response received on 25-05-2015: [N]earest mobile facility is 13kms away and there are no planned sites to be located any closer … would not anticipate any negative impacts on our facilities. Response received on 01-06-2015: Based on the provided information relating to the proposed wind farm … results of rayline analysis investigation reveals that there is no potential for undue interference from the proposed wind farm on or around the Telstra communication tower.
19	Mobile phone network	-	Optus mobile network	170223-AUME-L-19	Response received on 24-03-2015: Optus has no concerns from a mobile network perspective.
20	Mobile phone network	-	Vodafone Australia Pty Ltd	170223-AUME-L-20	*No response received to date*
21	-	-	NSW Government Telco Authority	-	Response received on 30-06-2015: The Telco Authority have reviewed the Biala Wind Farm Proposal and its possible effects on radio communications in the area. The Telco Authority has no objection to the proposal and it is highly unlikely that the proposed wind farm will cause interference to the Telco Authority' radio network.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.