G.8 ELECTROMAGNETIC INTERFERENCE

DNV·GL

RYE PARK WIND FARM

EMI Assessment

Rye Park Renewable Energy Pty Ltd

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EXECUTIVE SUMMARY

DNV GL has been commissioned by Rye Park Renewable Energy Pty Ltd ("Tilt Renewables" or "the Proponent") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Rye Park Wind Farm ("the Project") in southeastern New South Wales. The results of the EMI assessment are described in this document and summarised in the table on the following pages.

Background and methodology

Development consent for the Project was issued by the NSW Planning Assessment Commission on 22 May 2017 [1] ("the Development Consent"). An EMI assessment to support the development application was prepared by Epuron in 2016 [2] ("the previous EMI assessment").

DNV GL understands that the Proponent is now seeking a modification to the Development Consent, which will include changes to the turbine layout and tip height ("Mod-1"). This document is intended to support that modification and presents the anticipated differences in potential EMI impacts arising from the proposed changes in turbine configuration.

DNV GL has assessed the potential EMI impacts for the Project in accordance with the Director-General's Requirements for the Rye Park Wind Farm [3], NSW Wind Energy Guideline [4], and Draft National Wind Farm Development Guidelines [5]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

Three turbine configurations have been considered:

- **Configuration 1** represents the 109-turbine layout and dimensions presented in the previous EMI assessment for the Project [2].
- **Configuration 2** represents the 92-turbine layout subsequently approved during the Planning Assessment Commission process.
- **Configuration 3** represents the 80-turbine layout and increased turbine dimensions in the proposed modification to the Development Consent for the Project.

A total of 243 dwellings have been identified within 5 km of the potential turbine locations, 26 of which are associated dwellings.

Outcomes of the assessment

Compared to Configurations 1 and 2, the changes proposed for Configuration 3 are not expected to result in any increased impact to nearby radiocommunication towers, point-to-point links, emergency services communications, meteorological radar, trigonometrical stations, citizen's band radio communications, or satellite television and internet signals.

The larger turbine dimensions proposed for the modification to the Development Consent may increase the potential for interference with point-to-area style communications such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting. However, DNV GL notes that the removal of turbines in Configuration 3 compared to Configurations 1 and 2 has reduced the number of dwellings in the potential interference zones for the three television broadcasting towers servicing the area. If interference to mobile phone, radio, or television signals is experienced as a result of the Project, a range of options are available to rectify difficulties.

While the Project may also cause interference to point-to-multipoint links in the vicinity of the Project, further information from the operators of those services is required to determine the likely impacts. DNV GL has commenced consultation with the operators of all potentially-affected point-to-multipoint licences in the vicinity of the Project to establish the link paths and hence determine the likely impacts. Based on the responses received to date, there are no point-to-multipoint links crossing the Project boundary.

DNV GL also recommends consulting with all other organisations operating services that may be affected by the Project, to seek feedback regarding any potential for EMI-related impact and identify mitigation measures if required. It is understood that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

DNV GL notes that the Project is located in an area of high wind farm development activity, with multiple approved and operating wind farms in the vicinity of the site. The larger turbine dimensions proposed for Configuration 3 may increase the potential for cumulative impacts on mobile phone, radio, and television signals, although the proposed removal of turbines may reduce the risk of these signals being impacted by multiple wind turbines compared to Configurations 1 and 2.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings for Configuration 3	Anticipated change in impact	
		Relative to Configuration 1	Relative to Configuration 2
Radiocommunication towers	No towers within 2 km of proposed turbine locations	No change expected	No change expected
Fixed point-to-point links	Two links crossing Project boundary, operated by: NSW Rural Fire Service (RFS) Office of Environment and Heritage Diffraction effects: no turbines in exclusion zones Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	No change expected	No change expected
Fixed point-to-multipoint links	Two base stations within 20 km of Project boundary, operated by: Hilltops Council Yass Valley Council Potential for interference if links cross the Project site in proximity to turbines	Unable to determine impacts without knowing the link paths DNV GL has commenced consultation with the operators to establish link paths and potential for impact Based on responses received to date, there are no links crossing the Project site	Unable to determine impacts without knowing the link paths DNV GL has commenced consultation with the operators to establish link paths and potential for impact Based on responses received to date, there are no links crossing the Project site
Emergency services	Point-to-point links: one NSW RFS link crossing boundary (see above) Mobile telephony systems: unlikely to be affected	No change expected	No change expected
Meteorological radar	Unlikely to be affected	No change expected	No change expected
Trigonometrical stations	Unlikely to be affected	No change expected	No change expected
Citizen's band radio	Unlikely to be affected	No change expected	No change expected
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
Wireless internet	Available services: mobile phone networks, NBN NBN currently available as a fixed wireless and satellite service	Larger turbine dimensions may increase potential for interference with services provided by mobile phone networks	Larger turbine dimensions may increase potential for interference with services provided by mobile phone networks

Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings for Configuration 3	Anticipated change in impact	
		Relative to Configuration 1	Relative to Configuration 2
Satellite television and internet	Services intended for Australia: unlikely to be affected Other services: signals from four satellites intercepted at 13 dwellings Services are not intended for Australia and so dwellings are not expected to be receiving signals from these satellites	Number of potentially-affected dwellings reduced by 3	Number of potentially-affected dwellings increased by 1
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference in close proximity to turbines Digital radio signals: not available in vicinity of Project	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
Television broadcasting	May experience interference in areas with poor or marginal reception	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
	Canberra tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the south 29 dwellings in potential interference zone	Number of dwellings in potential interference zone reduced by 10	Number of dwellings in potential interference zone reduced by 3
	Central Tablelands tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the north 40 dwellings in potential interference zone Most potentially-affected dwellings are outside the apparent coverage areas and may not be receiving signals from this tower	Number of dwellings in potential interference zone reduced by 12	Number of dwellings in potential interference zone reduced by 1
	SW Slopes / E Riverina tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the north 36 dwellings in potential interference zone Most potentially-affected dwellings are outside the apparent coverage areas and may not be receiving signals from this tower	Number of dwellings in potential interference zone reduced by 21	No change in number of dwellings in potential interference zone

1 INTRODUCTION

Rye Park Renewable Energy Pty Ltd ("Rye Park Renewable Energy" or "the Proponent") has commissioned DNV GL to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Rye Park Wind Farm ("the Project") in southeastern New South Wales. The results of this work are reported here. This document has been prepared in accordance with DNV GL proposal L2C-178647-AUME-P-01 Issue C, dated 27 February 2019, and is subject to the terms and conditions in that agreement.

Development consent for the Project was issued by the NSW Planning Assessment Commission on behalf of the Minister for Planning on 22 May 2017 [1] ("the Development Consent"). An EMI assessment to support the submission of the development application was prepared by another consultant in 2016 [2] ("the previous EMI assessment").

DNV GL understands that the Proponent is now seeking a modification to the Development Consent, which will include changes to the turbine layout and tip height ("Mod-1"). This assessment has been prepared to support the proposed modification of the Development Consent. This document presents the anticipated differences in potential EMI impacts arising from the proposed changes in turbine configuration compared to the turbine layout and dimensions presented in the previous EMI assessment for the Project and those subsequently approved during the Planning Assessment Commission process.

In accordance with the Director-General's Requirements for the Rye Park Wind Farm [3], the NSW Wind Energy Guideline for State significant wind energy development (NSW Wind Energy Guideline) prepared by the NSW Department of Planning and Infrastructure in December 2016 [4], and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [5], this assessment investigates the potential EMI impact of the Project on:

- fixed point-to-point links
- fixed point-to-multipoint links
- radiocommunication assets belonging to emergency services
- meteorological radars
- trigonometrical stations
- Citizen's band (CB) radio and mobile phones
- wireless internet
- satellite television and internet
- broadcast radio and television.

"Radiocommunications" is used as a broad term in this report to encompass all services that rely on microwave or radio frequency electromagnetic waves to transfer information, including those listed above.

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The proposed Project site is located in the Hilltops, Yass Valley, and Upper Lachlan Local Government Areas (LGAs) in New South Wales, approximately 4 km west of the township of Rye Park and 250 km southwest of Sydney.

2.2 The project

2.2.1 Proposed wind farm layout

The wind farm layout for the proposed modification to the Development Consent for the Project consists of 80 turbines with a maximum tip height of 200 m. An indicative rotor diameter of 170 m has been considered in this assessment.

For the purpose of this assessment, the Proponent has asked DNV GL to consider three configurations, as summarised in Table 1 [6, 7, 8, 9, 10].

- **Configuration 1** represents the 109-turbine layout presented in the previous EMI assessment for the Project that supported the original development application.
- **Configuration 2** represents the 92-turbine layout subsequently approved during the Planning Assessment Commission process. DNV GL understands that the 17 turbine locations removed between Configuration 1 and Configuration 2 were omitted from the layout to reduce visual impacts.
- **Configuration 3** represents the 80-turbine layout and increased turbine dimensions proposed in this modification.

Table 1 Turbine configurations for the proposed Project considered in this assessment [6, 7, 8, 9, 10]

Configuration	Number of turbines	Indicative rotor diameter [m]	Maximum upper tip height [m]
Configuration 1	109	130	157
Configuration 2	92	130	157
Configuration 3	80	170	200

A map of the site comparing the layouts for the three configurations is shown in Figure 1, and the coordinates of the turbine locations are presented in Table 8, Table 9, and Table 10.

2.2.2 Dwelling locations

There are 243 dwellings within 5 km of potential turbine locations at the Project, 35 of which have been identified as associated dwellings [11]. The coordinates of these dwellings are presented in Table 11, and the dwellings and site boundaries considered in this assessment are also shown in Figure 1.

DNV GL has not carried out a detailed and comprehensive survey of building locations in the area and is relying on information provided by the Proponent. For the purposes of this assessment, DNV GL has assumed that all listed dwellings are inhabited.

3 REGULATORY REQUIREMENTS

The Director-General's Requirements for the Rye Park Wind Farm [3] outline the following requirement for the assessment of interference to telecommunication services:

> *"Possible effects on telecommunication systems must be identified."*

In addition, the NSW Wind Energy Guideline [4] currently states:

> *"…the consent authority will give consideration to the risk of electromagnetic interference with telecommunication services in the area, and the adequacy of the measures proposed to ensure the level of service is maintained."*

Although both the Director-General's Requirements and the NSW Wind Energy Guideline describe the requirements for assessing EMI related impacts, they do not provide detailed methodologies for these assessments.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [5]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development.

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

DNV GL considers that the recommendations of the Draft National Guidelines meet, if not exceed, the Director-General's Requirements and the NSW Wind Energy Guideline, and therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

4 METHODOLOGY AND RESULTS

If not properly designed, wind farms have the potential to interfere with radiocommunication services. Two services that are most likely to be affected are television broadcast signals and fixed point-to-point signals. Terrestrial broadcast signals are commonly used to transmit domestic television, while point-to-point 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 Proponent has asked DNV GL to complete this assessment based on three configurations for the Project, as outlined in Table 1 and described in Section 2.2.1.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 130 m and a tip height of 157 m has been considered for Configurations 1 and 2, and a hypothetical turbine with a rotor diameter of 170 m and a tip height of 200 m has been considered for Configuration 3. These dimensions represent the maximum tip height and rotor diameter for each configuration. The results generated based on these turbine configurations will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying the following criteria:

- a rotor diameter of 130 m or less for Configurations 1 and 2, and 170 m or less for Configuration 3
- an upper tip height of 157 m or less for Configurations 1 and 2, and 200 m or less for Configuration 3.

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

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from an image of the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 7 January 2020 [12].

Other services with the potential to experience interference from the Project have also been identified. These services include meteorological radars, trigonometrical stations, CB radio and mobile phones, wireless internet, broadcast radio, satellite television and internet, and broadcast television. The potential for interference to those services has been assessed.

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a radiocommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV GL recommends consulting with organisations operating services that may be impacted by the development and operation of the Project, to disseminate basic information on the Project, request responses from the organisations regarding whether they foresee any potential EMI-related impacts on their operations and services, and identify potential

mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

4.1 Radiocommunication towers

From the ACMA RRL database, there are 1097 radiocommunication towers within a nominal 75 km of the Project site boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 2.

Wind turbines located close to radiocommunication sites have the potential to cause interference through near-field effects or reflection or scattering of the signals. According to the Draft National Guidelines [5], the near-field zone for a transmission tower can vary from several metres to approximately 720 m depending on the service type. The Draft National Guidelines recommend that any radiocommunication site within 1 km of a proposed turbine location be considered as a having the potential to be impacted by near-field effects. The potential for a turbine to cause reflection or scattering of signals also depends on a number of factors, including the service type, the required signal-to-noise ratio for the service, and the distances between the user, transmission tower, and turbine. Since there is no single criterion for potential impact on radiocommunication services due to near-field effects and reflection or scattering, the Draft National Guidelines recommend consulting with the service operator if any turbine is to be located within 2 km of a radiocommunication site.

There are no radiocommunication towers located within 2 km of the proposed turbine locations for any of the three turbine configurations. The nearest radiocommunication tower is site ID 10008199, located approximately 4 km from the nearest proposed turbine location. DNV GL notes that a mobile phone licence is operated by Telstra at this site. The relative potential impacts on mobile phone networks due to changes in turbine layout and dimensions proposed for Configuration 3 compared to Configurations 1 and 2 are discussed in Section 4.10.

4.2 Fixed licences of point-to-point type

Wind turbines can potentially cause interference to point-to-point microwave links and, in some cases, point-to-point ultra high frequency (UHF) links through three mechanisms: diffraction of the signal, reflection or scattering of the signal, and near-field effects. It is generally possible to design around these issues as the link paths and potential interference zones for these signals can be determined.

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 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 GHz to 50 GHz.

The registered radiocommunication licences for each tower according to the ACMA RRL database were analysed to determine the transmission paths of licenced links that may experience interference from wind turbines.

Each individual link was given a unique identifier or "Assignment ID" so that it could be readily distinguished. This Assignment ID was taken as either the Device Registration ID (for spectrum

licences associated with the use of certain frequency band within a particular geographic area) or the EFL ID (for apparatus licences associated with the use of a particular device).

The links paths associated with the analysed towers are shown in Figure 3. 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 emergency services towers.

There are two point-to-point links recorded in the ACMA RRL database that pass over the proposed Project site (operated by the NSW Rural Fire Service (RFS) and Office of Environment and Heritage). The details of the links are provided in Table 12, and the link paths are shown in greater detail in Figure 4.

4.2.1 Interference caused by diffraction

The potential for interference to a fixed point-to-point link through diffraction or obstruction of the signal can usually be avoided by keeping clear of an exclusion zone of circular cross-section around the link path from the transmitter to the receiver [5] [13] [14], typically defined in terms of the Fresnel zones for the link. The *n*th Fresnel zone is comprised of all points for which, if the 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.

The radius of the *n*th Fresnel zone varies along the length of the signal, and is given by:

$$R_{Fn} = \sqrt{\frac{n\lambda d_1 d_2}{D}}$$

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, such that $d_1+d_2 = D$

To avoid interference to point-to-point links caused by signal diffraction, wind turbines, including the blades, should be kept outside of an exclusion zone based on either the second Fresnel zone as recommended in [5] and [13], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [15] (although DNV GL understands that this zone is under review by the authors of that document). For each of the identified links crossing the proposed Project site, DNV GL has established a diffraction exclusion zone based on the second Fresnel zone for that link.

It is common practice to have multiple Assignment IDs for the same physical link to cover practicalities such as licensing for sending or receiving signals. Accordingly, the second Fresnel zone for each link has been calculated based on the Assignment ID with the lowest frequency. Each exclusion zone also includes the rotor radius for turbines with a 130 m rotor diameter for Configurations 1 and 2, and a 170 m rotor diameter for Configuration 3, and an additional buffer of 25 m on either side to account for potential inaccuracies in the tower locations given in the ACMA RRL database. The potential diffraction exclusion zones are shown in Figure 4 for all three turbine configurations.

The turbines located within the diffraction exclusion zone for each point-to-point link crossing the proposed Project site are summarised in Table 2. There are no turbines located within the exclusion zones for any of the point-to-point links passing over the proposed Project site for any of the three turbine configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to point-to-point links through diffraction effects.

An assessment was also carried out to determine if the links pass over the Project at a height that is well above the highest point of the turbines (maximum tip height of 157 m for Configurations 1 and 2, and 200 m for Configuration 3). This was achieved by examining the elevation and tower heights at each end of the link, as well as the approximate elevation of the areas within the Project boundaries over which the link crosses. It was determined that the links do cross the site at a height which has the potential to intersect with turbine blades for all three configurations. However, as no turbines are located within the exclusion zones for the links, no impacts are expected.

4.2.2 Interference caused by reflection or scattering

Interference due to reflection or scattering of a fixed point-to-point link can occur when the signal produced by the transmitting antenna is reflected, scattered, or re-radiated by an intervening object into the corresponding receiver antenna. If the reflected or scattered signal is sufficiently strong that the ratio of the direct signal to the indirect signal is lower than the required carrier-to-interference (C/I) ratio, or protection ratio, for the link, the link performance can be degraded. The extent to which an object such as a wind turbine will reflect or scatter electromagnetic waves is characterised by its radar cross section (RCS) [13].

Reference [13] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a wind turbine at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and wind turbine, and comparing this to the required C/I ratio, a potential interference zone can be defined.

DNV GL has assessed that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid reflection or scattering effects and so it is not expected that the Project will cause interference to the point-to-point links through reflection or scattering effects for any of the three configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to point-to-point links through reflection or scattering effects.

4.2.3 Interference caused by near-field effects

The potential for interference to fixed point-to-point links caused by near-field effects can generally be avoided by keeping clear of the near-field zone for the transmitting or receiving antenna. Within the near-field zone, local inductive and capacitive effects are significant and it is difficult to predict the potential impacts of other objects on the transmitted or received signal. Although the near-field distance typically varies with direction relative to the link path, for most practical purposes the near-field zone can be approximated as a sphere centred on the transmitting or receiving antenna.

Reference [13] presents an equation for estimating the radius of the near-field zone for a point-to-point link from the properties of the transmitting or receiving antenna.

DNV GL has assessed that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid near-field effects and so it is not expected that the Project will cause interference to the point-to-point links through near-field effects for any of the three configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to point-to-point links through near field effects.

4.2.4 Summary of point-to-point interference effects

Table 2 summarises the turbines located within the calculated diffraction, reflection/scattering, and near-field interference zones for each of the point-to-point links crossing the Project site. There are no turbines located within the potential interference zones for any of the point-to-point links passing over proposed Project site for any of the three turbine configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to point-to-point links.

Table 2 Details of turbines located within the interference zones established by DNV GL for point-to-point links crossing the proposed Project site

Link no.	Operator	Turbines within potential interference zone for Configurations 1, 2, and 3		
		Diffraction	Reflection/scattering	Near-field
1	NSW Rural Fire Service (RFS)	None	Not assessed[1]	Not assessed[1]
2	Office of Environment and Heritage	None	Not assessed[1]	Not assessed[1]

1. Transmission towers are located more than 5 km from the proposed turbine locations. Interference caused by reflection or scattering of signals or near-field effects is not expected for this link.

4.2.5 Stakeholder consultation

DNV GL recommends consulting with the operators of the point-to-point links crossing the proposed Project site, to determine the likelihood that the Project will cause interference to their operations and services through diffraction, reflection or scattering, or near-field effects. The consultation would also identify potential mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

Previous advice received from the NSW RFS recommended a 1 km wide clearance zone extending 15 km along the link path for their point-to-point links in the 400 MHZ frequency band, and a 300 m wide clearance zone for the remainder of the link path [16]. The NSW RSF point-to-point link crossing the Project site has signal frequencies of 404.35 MHz and 413.8 MHz, and so DNV GL expects that the advice received previously will also be relevant for this link.

The clearance zones previously requested by the NSW RFS are shown in Figure 5 for the NSW RFS point-to-point link crossing the Project site. Each clearance zone also includes the rotor radius for turbines with a 130 m rotor diameter for Configurations 1 and 2, and a 170 m rotor diameter for Configuration 3, and an additional buffer of 25 m on either side to account for potential

inaccuracies in the tower locations given in the ACMA RRL database. There are no turbines located within the clearance zones requested by the NSW RFS for any of the three turbine configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to the NSW RFS point-to-point link crossing the Project site.

4.3 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 one or more static sites and multiple points or between the points. The point-to-multipoint type is usually licensed for a defined operational area.

Administratively, the ACMA RRL database details the location of the static station for a fixed licence of the point-to-multipoint type. Hence, the paths of the transmission vectors are not readily identifiable. A review of fixed point-to-multipoint licences was undertaken and 146 Assignment IDs were identified within approximately 75 km of the proposed site. These licences are shown in Figure 6. The details of the licence holders as per the ACMA database are provided in Table 13.

There are two point-to-multipoint base stations listed in the ACMA RRL database within 20 km of the Project boundary. These stations are operated by Hilltops Council (Site ID 34853) and Yass Valley Council (Site ID 9529). There are also several point-to-multipoint base stations located more than 20 km from the site.

Each of the three turbine configurations considered in this assessment have the potential to cause interference to fixed point-to-multipoint links if those links cross the Project site in close proximity to turbines. Because the link paths cannot be identified from publicly-available information, it is not possible to determine whether the changes to the turbine layout and dimensions proposed for Configuration 3 will result in any increased impacts to point-to-multipoint links compared to Configurations 1 and 2 without obtaining further information from the operators of those services.

4.3.1 Stakeholder consultation and responses

Since it is not possible to determine if there are any potential impacts to a point-to-multipoint network without knowing the locations of each station in the network, DNV GL recommends that consultation with these operators is prioritised as the point-to-multipoint links may constrain the turbine placement. Consequently, DNV GL has contacted the operators of all potentially-affected base stations within 60 km of the Project to establish the link paths and determine the likelihood that the proposed Project will cause interference to their services, as well as to identify mitigation measures if required. Responses have been received from several operators, as summarised in Table 21.

ActewAGL Distribution have confirmed that none of their point-to-multipoint links cross the Project site boundary, and that impacts are therefore not expected.

Yass Valley Council have provided DNV GL with the coordinates of each of their facilities, which DNV GL have used to analyse the link paths in the point-to-multipoint network. Based on this analysis, all of the link paths are at least 7 km from the Project site boundary and so impacts are

not expected for these links. To date, DNV GL are awaiting confirmation of these analysis results from Yass Valley Council.

Responses have not yet been received from Hilltops Council, Upper Lachlan Shire Council, or Water NSW.

4.4 Other licence types

Other licences in the ACMA database were reviewed. These licences and associated Assignment IDs are shown in Table 14 and Figure 7.

Many of the licences identified can be broadly described as base to mobile station style communications, including radio broadcasting and 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, mitigation consists of the user simply moving to receive a clearer signal.

Potential impacts to emergency services signals and commercial mobile telephony signals are considered in Sections 4.5 and 4.10 respectively.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services and are considered in Sections 4.13 and 4.14.

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

4.5 Emergency services

A review of the ACMA RRL database was conducted to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 15 along with their contact details. The potential for interference to a point-to-point link operated by the NSW RFS has already been evaluated in Section 4.2, and impacts to this link are not expected for any of the three turbine configurations. Given the distances between the site and other emergency services radiocommunication assets, it is considered unlikely that the Project will interfere with the signals associated with these assets for any of the three turbine configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to emergency services communications.

DNV GL recommends contacting the operators of all stations within approximately 60 km of the Project, to seek feedback regarding any potential impact that the Project could have on their operations and services and identify potential mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

4.6 Aircraft navigation systems and radar

DNV GL understands that a separate aviation impact study has been undertaken to assess the impact of the Project on nearby aviation navigation systems and radar.

4.7 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 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 BoM'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.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high risk of interference to the radar signal and subsequent loss of weather data [17]. For wind farms located within 20 km of a radar, the WMO recommends consultation and analysis be undertaken to assess the likelihood of turbines interfering with the radar signals or Doppler velocity measurements. Similarly, the Network of European Meteorological Services (EUMETNET) recommends that, to avoid potential for interference, wind turbines should not be located within 5-10 km of a meteorological radar, depending on the antenna frequency band, and that an impact study should be undertaken for wind turbines located within 20-30 km of a radar site [18].

Wind farms located at distances greater than 5 km from a BoM weather station are unlikely to affect wind finding operations [5]. Generally, the optimal coverage area for "weather watch" radar extends approximately 200 km from the radar installation at a height of approximately 3000 m [19] [20], and approximately 100 km at a height of 1000 m [20]. 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 (463 km) of the proposed Project should be undertaken [5]. DNV GL has identified that the BoM operates eight weather stations within that range with the closest station, "Canberra", located approximately 108 km southeast of the Project site. The locations of these stations are shown in Figure 8 and the details of each station can be found in Table 16.

It is not expected that the Project will cause interference with BoM radar installations for any of the three configurations, 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 by terrain before they are able to be influenced by the Project. Therefore, compared to Configurations 1 and 2, the changes

to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to meteorological radars.

DNV GL recommends contacting the BoM regarding the Project to seek feedback on whether interference to their operations and services is likely and to identify potential mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

4.8 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 Global Positioning System (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 km to 5 km, and could be intercepted or obstructed by the presence of turbines. However, the risk of impact is considered low as it is likely to be possible to relocate the target to obtain an unobstructed view of the trig point. Microwave systems can measure distances up to 150 km, but such systems are not limited by the line of sight or affected by visibility [21].

Global navigation satellite system (GNSS) technology is also commonly used for surveying and distance measurements, as it enables users to accurately determine their geographic location using positioning and timing information received from satellite signals. Geoscience Australia currently operates several GNSS networks across Australia, including the Australian Regional GNSS Network (ARGN) and the AuScope GNSS network [22]. The ARGN is comprised of 20 permanent GNSS Continuously Operating Reference Stations (CORS) which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Eight stations from the ARGN form the Australian Fiducial Network (AFN) [23], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country. In New South Wales, Land and Property Information (LPI) also operates a state-wide GNSS CORS network, known as CORSnet-NSW, which is used to provide positioning data for mapping, surveying, agriculture, and industry [24] [25]. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, or satellite communications.

The closest ARGN or AuScope GNSS station is located approximately 11 km southwest of the Project, at Yass [26]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network. The closest CORSnet-NSW GNSS station is also located at Yass, approximately 11 km southwest of the Project [27]. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and

dimensions proposed for Configuration 3 are not expected to result in any increased impacts to nearby GNSS stations.

DNV GL has also undertaken a review of the primary geodetic network of Australia [28] and has observed that the Project is located within the first-order triangulation region. 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 are then used for the second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

According to Geoscience Australia [26], there are 56 trig points within 20 km of the Project site boundary. Six trig points are located inside the site boundary, with the nearest trig point located approximately 219 m from the nearest proposed turbine location in the layout for Configuration 3. The details of all 56 trig points are provided in Table 17 and illustrated in Figure 9. Compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to nearby trig stations.

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV GL recommends contacting Geoscience Australia and LPI to inform them of the Project, seek feedback regarding whether interference to their systems is possible, and identify mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

4.9 Citizen's 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. It is commonly used in rural areas for emergency communications, road safety information, communication between recreational travellers, and general conversation. 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 communication activities, telemetry, and telecommand applications. The radio service operates on two frequency bands, namely the high frequency (HF) band between 26.965 MHz and 27.405 MHz and the ultra-high frequency (UHF) band between 476.425 MHz and 477.400 MHz.

The HF CB radio service was legalised in Australia in the 1970s as a temporary move to switch to UHF CB over the following five years, and transmits signals in either AM (amplitude modulation) 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 the HF 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 (frequency modulation) 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 a clear 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 services 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 services is expected to be minimal for all three configurations. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to CB radio services. 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.

4.10 Mobile phones

Mobile phone networks typically operate at frequencies of either between 700 and 900 MHz, or between 1800 MHz and 2600 MHz, however some new services may operate at up to 3500 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, if there is sufficient mobile network coverage and signal strength, the presence of wind turbines is unlikely to cause any 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.

DNV GL has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 10. The nearest mobile phone tower is located approximately 3 km west of the Project boundary (site ID 10008199).

Mobile phone network coverage maps have been obtained for Optus, Telstra, and Vodafone.

Figure 11 shows the Optus network coverage for the Project area [29]. Outdoor 4G Plus coverage is available to the south, southwest, and northwest of the site. Areas across the site and to the west and southeast can receive outdoor 3G coverage, although an external antenna is required in some areas and there is minimal to no coverage to the north, northeast, and east.

Figure 12 shows the Telstra network coverage for the Project area [30]. 4GX coverage is available across most of the site, and in areas to the immediate east, south, and northwest. Coverage is limited to the 3G network in areas to the north and west, with some locations requiring an external antenna, and there is minimal to no coverage to the northeast and further east of the site.

Figure 13 shows the Vodafone network coverage for the Project area [31]. 4G coverage is available in areas to the south, southwest, and southeast of the site, with isolated areas of coverage to the east. Outdoor 3G coverage is available across most of the site area, and to the northwest, but there is minimal to no coverage to the immediate west and to the north and northeast.

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. Additionally, the larger turbine dimensions proposed for Configuration 3 may increase the potential for interference with mobile phone signals compared to Configurations 1 and 2.

DNV GL recommends contacting Optus, Telstra, and Vodafone to inform them of the proposed Project, seek feedback on any potential impact that the Project could have on their services, and identify potential mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

In cases 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.

4.11 Wireless internet

Residents in the vicinity of the Project are likely to use wireless broadband services provided by Optus, Telstra, and Vodafone. These wireless broadband services use the same networks as mobile phone services for those providers, and therefore the comments made in Section 4.10 are applicable here. Specifically, the presence of wind turbines is unlikely to cause any interference in areas with good coverage, although the larger turbine dimensions proposed for Configuration 3 may increase the potential for interference with wireless broadband services compared to Configurations 1 and 2. Should interference occur, the simple mitigation options given in Section 4.10 may be applicable.

The National Broadband Network (NBN) website [32] indicates that the network is currently available as a fixed wireless service in the areas surrounding the Project site. It is therefore likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. The locations of NBN fixed wireless towers within 75 km of the Project site are shown in Figure 10, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 14. Given the relative positions of the NBN towers and coverage areas, it is considered unlikely that the Project will impact users of the NBN fixed wireless service. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to NBN services.

DNV GL recommends contacting NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, allow them to take the presence of the Project into account in their coverage planning maps, and identify potential mitigation measures if required. DNV GL understands that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

DNV GL understands that, if interference to NBN fixed wireless signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available to improve the signal reception. These could include installing a new NBN tower to service the affected dwellings or moving the outdoor antennas at the affected dwellings a short distance away, to a location where

the signal is not impacted by the turbines, and connecting that antenna to the dwelling via a cable (described by NBN Co as a "non-standard install process" [33]). However, these mitigation options have not been confirmed by NBN Co. It may also be possible to avoid impact by micro-siting the turbines in some cases. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

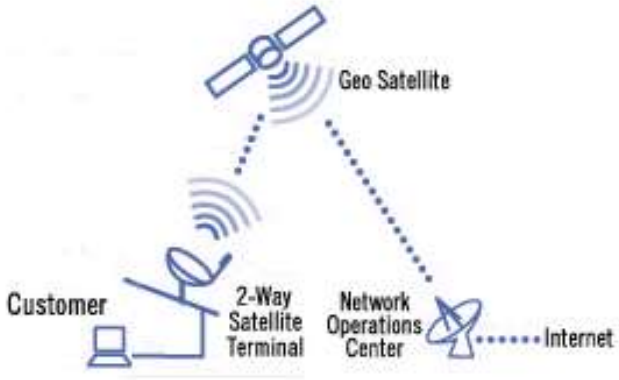
The potential for signals from the NBN SkyMuster I and II satellites to be intercepted by wind turbines at the Project has been considered as part of the analysis described in Section 4.12.

4.12 Satellite television and internet

In some rural or remote areas, television and internet access can only be provided through satellite signals.

Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. Satellite television signals are typically transmitted to the user's antenna in one of two frequency bands: the C-band between 4 GHz and 8 GHz, or the Ku-band 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. 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 20 satellites that can provide television to the east coast of Australia [34]. The main satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [35] [36].

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 or 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. Satellite internet signals are typically transmitted in the Ku-band, as for satellite television, or the Ka-band, with frequencies ranging from 26.5 GHz to 40 GHz. Like signals in the Ku-band, signals in the Ka-band are susceptible to deterioration caused by moisture in the air, but newer satellites contain technologies that help to minimise the loss of signal quality associated with rain and other weather conditions. The main satellites for providing satellite internet in Australia are the IPSTAR (THAICOM-4) and Optus D2 satellites, and the NBN SkyMuster I and II satellites.



Two-way connection to the internet via satellite [37]

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

A number of satellites transmit television and internet signals that can be received in Australia. DNV GL has analysed the line-of-sight to dwellings in the vicinity of the Project for satellites which provide any television or internet services to eastern Australia. Although only a small number of satellites are likely to be providing services intended for Australia, all viewable satellites have been considered.

The results of the analysis are summarised in Table 3 below. The analysis has shown that signals from three satellites may be intercepted by turbines for 16 dwelling locations for Configuration 1 and 12 dwelling locations for Configuration 2, while signals from four satellites may be intercepted by turbines for 13 dwelling locations for Configuration 3. However DNV GL understands that these satellites do not transmit signals designed for Australian audiences [36], and as such it is unlikely that residents in the vicinity of the Project will be receiving signals from these satellites. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to satellite television and internet signals.

Table 3 Number of dwellings for which satellite television and internet signals may be intercepted by turbines at the Project

Satellite	Number of dwellings for which satellite signals may be intercepted by turbines		
	Configuration 1	Configuration 2	Configuration 3
Eutelsat 70B	2 (no associated dwellings)	1 (no associated dwellings)	1 (no associated dwellings)
Intelsat 22	13 (no associated dwellings)	11 (no associated dwellings)	12 (no associated dwellings)
Apstar 7	2 (1 associated dwelling)	1 (no associated dwellings)	1 (no associated dwellings)

Thaicom 5	None	None	1 (1 associated dwelling)
All satellites[1]	16 (1 associated dwelling)	12 (no associated dwellings)	13 (1 associated dwelling)

1. There are several dwellings for which signals from more than one satellite may be intercepted by turbines at the Project. This entry represents the total number of dwellings that may experience interference to television or internet signals from any satellite, and therefore may be less than the sum of the dwellings affected for each individual satellite.

4.13 Radio broadcasting

Radio stations typically broadcast using one of two forms of transmission: either amplitude modulation (AM) or frequency modulation (FM). In Australia, AM radio operates in the medium wave (MW) band at frequencies between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency (VHF) band between 87.5 MHz and 108 MHz. The locations of AM and FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [38], and are shown in Figure 15.

4.13.1 AM radio

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 physical obstructions on the surface of the earth (such as wind turbines), 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 the Project will 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 [39]. However, the larger turbine dimensions proposed for Configuration 3 may increase the potential for interference with AM radio broadcasting through reflection or scattering of the signals compared to Configurations 1 and 2. Any interference problems are likely to be easily resolved through the installation of a high-quality antenna or amplifier.

4.13.2 FM radio

FM radio signals are better 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, which 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. Interference to FM signals can occur by two mechanisms: reflection or scattering of the radio waves, or physical obstruction and attenuation of the broadcast signal.

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the 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 result in hissing, fluttering, or distortion being heard by the listener [40]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [39] [41]. It is unlikely that any permanent FM radio receivers will be located sufficiently close to the Project to be affected, although the larger turbine dimensions proposed for Configuration 3 may increase the potential for interference with FM radio broadcasting through reflection or scattering of the signals compared to Configurations 1 and 2.

Wind turbines located close to an FM transmission tower may also present a physical obstruction to the radio signal. If the line-of-sight between the tower and a radio receiver is blocked by a turbine, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [40]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmission tower [42].

The closest FM broadcast transmission tower is located approximately 8 km from the proposed site boundary or 9 km from the nearest wind turbine (turbine 89). Due to the considerable distance between the transmission tower and the site, it is not expected that the Project will cause interference to the FM radio signals from this tower. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to FM radio broadcasting through signal obstruction.

If interference to FM radio signals is experienced, mitigation options include installing high-quality antennas or amplifiers at affected residences, increasing the broadcast signal strength from the transmission tower, moving the tower to a new location further away from the turbines, or installing a signal repeater on the opposite side of the Project.

4.13.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in 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 [43]. Digital radio broadcasts in Australia operate in the VHF band at frequencies between 174 MHz and 230 MHz, and therefore tend to have only local coverage within the visual horizon. According to the digital radio coverage map available on the ABC website [44], digital radio is not yet available in the Project region. While there are no digital radio broadcasts in the vicinity of the Project, no interference to digital radio signals is possible. Therefore, compared to Configurations 1 and 3, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to digital radio broadcasting.

4.14 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 Australia are now digital broadcasts [38]. 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 dwellings were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

The United Kingdom telecommunications regulator Ofcom [40] states the following with regard to interference to DTV 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 DTV is very robust and does not suffer from ghosting. In most cases DTV signals are not susceptible to interference from wind farm developments.
- Secondly, that areas of weak DTV signal can experience interruptions to their reception should new reflections appear, such as those from nearby wind turbines.

The ACMA Broadcast Transmitter Database [38] was examined to identify broadcasters nearby to the proposed Project, with those found shown in Figure 15. The main television transmitter used by residents in the vicinity of the Project is the Canberra transmitter at Black Mountain. However, it is also possible that residents to the north and northwest of the site receive television signals from the Central Tablelands transmitter, while residents to the west of the site may receive signals from the SW Slopes / E Riverina transmitter.

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

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

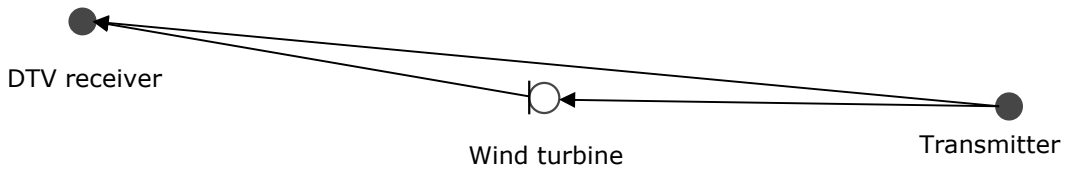
4.14.1 Large scale interference

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 television transmitters are more commonly found in rural areas. Primary television 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 television transmitters, while a clearance of at least 6 km is recommended for primary television transmitters [14]. The closest digital television transmitter to the Project is the Yass relay transmitter, which is approximately 9 km away, and so the Project is not expected to cause large scale interference. Therefore, compared to Configurations 1 and 2, the changes to the turbine layout and dimensions proposed for Configuration 3 are not expected to result in any increased impacts to television broadcasting through large scale interference.

4.14.2 Forward and back scatter

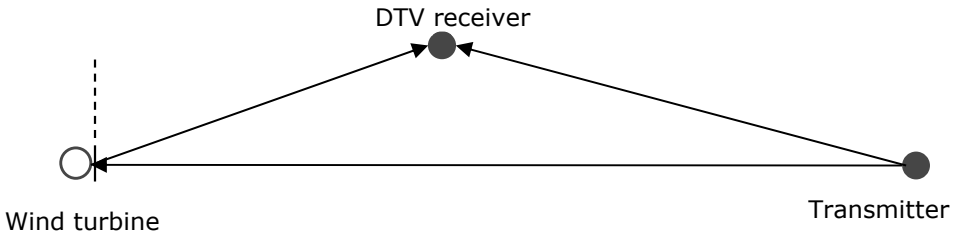
Wind turbines cause interference to television signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A wind turbine has the potential to scatter electromagnetic waves carrying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

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 [45]. Both of these effects can potentially degrade the DTV signal quality.



Forward scatter signal path

Back scatter 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).



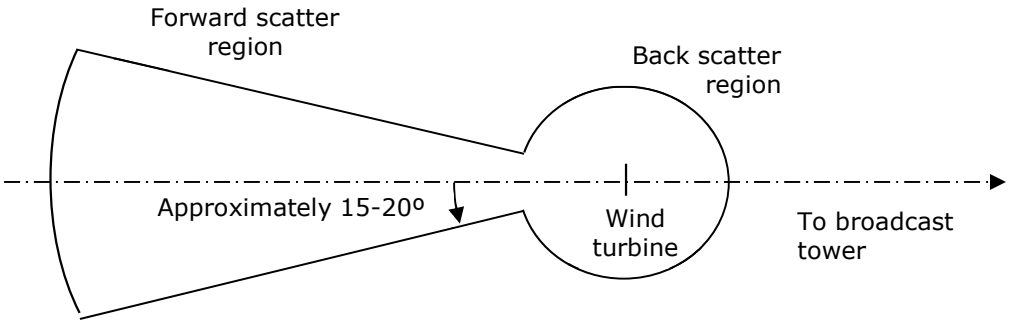
Back scatter signal path

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 [45].

According to Ofcom [40], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [14] [46]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the wind turbines [40]. The shape of this region, assuming a relatively high gain, directional antenna, can be represented by a circular segment with an azimuthal range of approximately ±15° to ±20°, corresponding to the beam width of the antenna. If a lower gain or omni-directional antenna is being used, this region is likely to be larger.

Back scattered signals arrive at the dwelling delayed relative to the source signal from the broadcast tower. The back scatter region generally does not extend further than 500 m [14] [47], 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 be larger.

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



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.

In Australia, digital television signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [48] 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 analyzed, the threshold C/N [carrier-to-noise] ratios obtained were similar to those expected in environments with the absence of wind farms. More precisely, in the forward scattering region of the wind turbines, where the transmit antenna, one or more turbines and the receive antenna are lined-up (±60° behind the wind turbine), the DVB-T reception quality may not be affected though further work of analysis is needed in order to confirm this point, especially in the vicinity of 0°."*

In other words, wind turbines are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [49] 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. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [49].

With regards to back scattering, the 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 back scatter to achieve the same QEF condition as is the case without the presence of wind turbines, which effectively means that interference is more likely to occur as coverage quality decreases. The implications of this conclusion for dwellings in the vicinity of the Project are discussed in Section 4.14.4.

4.14.3 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 [50]. 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 [48], 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 than 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. As introduced above, this is often referred to as the 'keyhole' approach, and is an established technique for predicting 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 [40]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring. The results of using this approach to identify the dwellings that have increased potential to receive scattered signals from a turbine in the Project, and hence have an increased likelihood of experiencing interference to television signals, are described in Section 4.14.4.

4.14.4 Potential impacts for dwellings

According to the Australian Government mySwitch website [47], the area around the Project is able to receive DTV signals from the Canberra, Central Tablelands, and SW Slopes / E Riverina broadcast towers. The coverage maps (reproduced in Figure 16 to Figure 18) suggest that coverage is variable across the site for all three transmitters. Coverage from the Canberra tower is good in some areas to the south and southwest of the site, but is generally poor in the north, northwest, and east. Coverage from the Central Tablelands tower is available in some areas to the north, northwest, and west, while coverage from the SW Slopes / E Riverina tower is only available in isolated areas to the west of the site.

Dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine in the Project (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 above.

The results of the analysis can be seen in Table 18 to Table 20 and Figure 16 to Figure 18. The dwellings that are most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 4 below. Based on the coverage maps in Figure 17 and Figure 18, most of the dwellings within the potential interference zones for the Central Tablelands and SW Slopes / E Riverina towers are outside the apparent coverage areas and therefore may not be receiving signals from these towers. Dwellings within the potential interference zones for the Canberra broadcast tower are in areas of variable coverage for signals from that tower, according to the coverage map in Figure 16, and could experience interference from the Project. Note that 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.

The analysis has shown that, due to the removal of turbines in the proposed turbine layout, the number of dwellings in the potential interference zones for the three television broadcasting towers servicing the area is generally fewer for Configuration 3 than for Configurations 1 and 2. However, as noted above, interference may still occur outside of these zones under some circumstances. Additionally, the larger turbine dimensions proposed for Configuration 3 may increase the potential for interference with television broadcasting through reflection or scattering of the signals.

Table 4 Number of dwellings located within potential interference zones for digital television broadcast towers in the vicinity of the Project site

Digital television broadcast tower	Number of dwellings within potential interference zone		
	Configuration 1	Configuration 2	Configuration 3
Canberra (Black Mountain)	39 (14 associated dwellings)	32 (9 associated dwellings)	29 (9 associated dwellings)
Central Tablelands (Mt Canobolas)	52 (22 associated dwellings)	41 (20 associated dwellings)	40 (19 associated dwellings)
SW Slopes / E Riverina (Mt Ulandra)	57 (8 associated dwellings)	36 (6 associated dwellings)	36 (6 associated dwellings)

Although DTV signals are generally unlikely to be susceptible to interference from wind turbines in areas of adequate coverage, interference could be encountered in areas where coverage 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. Based on the coverage maps for the area around the Project, it is possible that some areas could be deemed to have marginal reception, and interference could be encountered. If reception difficulties are encountered, there are a number of mitigation options available, and these are discussed in further detail in Section 4.14.5.

In order to better understand the DTV signal coverage in the area around the Project, and hence evaluate the potential impacts and mitigation options more thoroughly, DNV GL recommends that the Proponent commissions a pre-construction survey to determine the television signal strength and quality at representative locations within 5 km of the Project site. Additionally, since the coverage maps suggest that most of the dwellings within the potential interference zones for the Central Tablelands and SW Slopes / E Riverina broadcast towers are outside the apparent coverage areas, DNV GL recommends that the Proponent attempt to establish whether residents in the area around the Project are indeed using these towers as a source of television signals, through inspections of antenna orientations, or a written survey of residents.

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 reasonably low given the large range of mitigation options available.

4.14.5 Mitigation options

In the event that television interference is an issue during construction or after commissioning of the Project, there are several amelioration options available:

1. realigning the resident's television antenna more directly towards their existing transmitter
2. tuning the resident's antenna into alternative sources of the same television signal or a substitute signal
3. installing a more directional or higher gain antenna at the affected dwelling

4. relocating the antenna to a less affected position
5. installing cable or satellite television at the affected dwelling
6. installing a television 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 [45] DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [49] 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. The 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 comprises of both free to air and subscription based broadcasts. Residents in areas which are unable to receive DTV through their normal television antenna due to local interference, terrain, or distance from the transmitter in their area may be eligible to access the Australian Government funded Viewer Access Satellite Television (VAST) service [51].

4.15 Cumulative impacts

DNV GL notes that the Project is located in an area of high wind farm development activity, with multiple approved and operating wind farms in the vicinity of the Project site. Consequently, it is possible that some radiocommunication services could experience cumulative impacts from the proposed Project.

The nearest wind farm developments are summarised in Table 5 and shown in Figure 19, based on information obtained from publicly-available sources. Other wind farms in the area include the operating Gunning and Gullen Range Wind Farms, located approximately 30 km and 35 km east of the Project site respectively [52] [53], the approved Coppabella Wind Farm, located approximately 35 km southwest of the Project site [54], and the Collector Wind Farm, which is currently under construction approximately 35 km southeast of the Project site [55].

Table 5 Other wind farm developments located within 10 km of the Project site

Wind farm	Status	Number of turbines	Location	Source
Bango Wind Farm	Approved	46	Approximately 8 km west of the Project	[56] [57] [58]

Table 6 summarises the anticipated EMI-related impact of the Project in isolation for Configuration 3, as discussed in Sections 4.1 to 4.14, and the expected cumulative impact of the Project in conjunction with the nearby Bango Wind Farm. Given the distance of the Gunning, Gullen Range, Coppabella, and Collector Wind Farms from the Project site, it is considered unlikely that these developments will contribute to any cumulative impact from the proposed Project. For services where impact from the Project itself is considered either unlikely or non-existent, it is generally expected that there will be no cumulative impact.

There is some potential for increased interference to mobile phone signals in areas of marginal coverage, or where there may be multiple wind turbines between the user and the mobile phone tower. If interference is experienced, the mitigation options given in Section 4.10 may be applicable. Signal coverage for the Telstra network is generally good across most of the Project site and surrounding area, and so this service is expected to be less susceptible to cumulative impacts than the Optus and Vodafone networks, for which the signal coverage is more limited. Similarly, there is potential for increased interference to radio broadcasting signals in areas where there are multiple turbines between the user and the transmission tower.

There is potential for increased interference to television broadcast signals received from the SW Slopes / E Riverina tower at dwellings located to the east of the site. Dwellings in this area could experience interference caused by both the Project and the Bango Wind Farm, as indicated in Figure 20. There is also some potential for increased interference to signals received from the Canberra and Central Tablelands at dwellings located between the Project and the Bango Wind Farm, and to the northwest and southwest of the Project respectively, as indicated in Figure 21 and Figure 22. However, all of the dwellings that may be susceptible to interference from the Project are located more than 5 km from the Bango Wind Farm turbines. Since the forward scatter region for interference to DTV signals typically does not extend further than 5 km, the risk of cumulative impacts at these dwellings is generally considered to be low. Nevertheless, as noted in Section 4.14.4, interference may be experienced in areas outside the identified interference zones if the coverage is already marginal, either due to the local terrain, limitations of the transmitted signal, or impacts of other wind farms, or if the directional discrimination of the receiving antenna is insufficient. To better understand the DTV signal coverage in the area around the Project, DNV GL recommends that the Proponent commissions a pre-construction survey to determine the television signal strength and quality at representative locations within 5 km of the Project site. If television interference is found to be a problem at these dwellings after commissioning of the Project, the mitigation options given in Section 4.14.5 may be applicable.

Compared to Configurations 1 and 2, the larger turbine dimensions proposed for Configuration 3 may increase the potential for cumulative impacts on point-to-area style services such as mobile phone signals and broadcast radio and television signals. However, the proposed removal of turbines in Configuration 3 may reduce the risk of these signals being impacted by multiple wind turbines compared to Configurations 1 and 2.

As discussed in Section 4.3, it is not possible to determine if there are any potential impacts to a point-to-multipoint network without knowing the locations of each station in the network. Therefore, further information from the service operators is required to assess the potential for cumulative impact to point-to-multipoint links in the vicinity of the Project and to determine whether changes to the turbine layout and dimensions proposed for Configuration 3 will result in any increased potential for impacts to those links compared to Configurations 1 and 2. DNV GL has

commenced consultation with the operators of all potentially-affected point-to-multipoint licences in the vicinity of the Project to establish the link paths and hence determine the likely impacts, as discussed in Section 4.3.1. Based on the responses received to date, there are no point-to-multipoint links crossing the Project boundary.

It is noted that DNV GL has conducted a preliminary assessment of the potential for cumulative impacts from the Project at this stage, and that further investigation may be required to better understand the risks of cumulative impacts. A detailed assessment of the potential for cumulative impacts may be conducted at a later date if deemed necessary.

Table 6 Expected cumulative EMI-related impacts from the Project and neighbouring wind farms

Licence or service type	Anticipated impact from the Project in isolation (Configuration 3)	Anticipated cumulative impact from the Project and the Bango Wind Farm (Configuration 3)	Anticipated change in cumulative impact	
			Relative to Configuration 1	Relative to Configuration 2
Radiocommunication towers	Unlikely to cause interference (see Section 4.1)	None	No change expected	No change expected
Fixed point-to-point links	Unlikely to cause interference (see Section 4.2)	None	No change expected	No change expected
Fixed point-to-multipoint links	Unable to determine impacts without knowing the link paths (see Section 4.3) DNV GL has commenced consultation with the operators to establish link paths and potential for impact Based on the responses received to date, there are no links crossing the Project site	Based on the consultation responses received to date, no cumulative impact expected	Based on the consultation responses received to date, no change expected	Based on the consultation responses received to date, no change expected
Other licence types	Base to mobile station style communications: see "Emergency services", "Mobile phones", "Radio broadcasting", "Television broadcasting" Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment			
Emergency services	Unlikely to cause interference (see Section 4.5)	Unlikely	No change expected	No change expected
Meteorological radar	Unlikely to cause interference (see Section 4.7)	None	No change expected	No change expected
Trigonometrical stations	Unlikely to cause interference (see Section 4.8)	Unlikely	No change expected	No change expected
Citizen's band radio	Unlikely to cause interference (see Section 4.9)	None	No change expected	No change expected
Mobile phones	Potential for interference in areas of marginal coverage (see Section 4.10)	Potential for increased interference where there are multiple turbines between the tower and the user	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact

Table 6 Expected cumulative EMI-related impacts from the Project and neighbouring wind farms (continued)

Licence or service type	Anticipated impact from the Project in isolation (Configuration 3)	Anticipated cumulative impact from the Project and the Bango Wind Farm (Configuration 3)	Anticipated change in cumulative impact	
			Relative to Configuration 1	Relative to Configuration 2
Wireless internet	Potential for interference to services provided by mobile phone networks (see Section 4.11)	Potential for increased interference to services provided by mobile phone networks where there are multiple turbines between the tower and the user	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact
Satellite television and internet	Unlikely to cause interference (see Section 4.12)	None	No change expected	No change expected
Radio broadcasting	Potential for interference in close proximity to turbines (see Section 4.13)	Potential for increased interference where there are multiple turbines between the tower and the user	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact
Television broadcasting	Potential for interference to signals from the Canberra, Central Tablelands, SW Slopes / E Riverina towers (see Section 4.14)	Potential for increased interference to signals from the SW Slopes / E Riverina tower received at dwellings located to the east of the Project site, and to signals from the Canberra and Central Tablelands towers received at dwellings located between the Project and the Bango Wind Farm, although dwellings that are affected by the Project are outside the expected interference zones for the Bango Wind Farm	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact	Fewer turbines may decrease potential for cumulative impact, larger turbine dimensions may increase potential for cumulative impact

5 CONCLUSIONS

Broadcast towers and transmission paths around the Project were investigated to determine if EMI would be experienced as a result of the development and operation of the Project. For the purpose of this assessment, DNV GL has considered three turbine configurations.

- **Configuration 1** represents the 109-turbine layout and dimensions presented in the previous EMI assessment for the Project.
- **Configuration 2** represents the 92-turbine layout subsequently approved during the Planning Assessment Commission process.
- **Configuration 3** represents the 80-turbine layout and increased turbine tip height in the proposed modification to the Development Consent for the Project. The assessment for Configuration 3 has been based on a hypothetical turbine with a rotor diameter of 170 m and an upper tip height of 200 m.

The results of this assessment are summarised in Table 7. Compared to Configurations 1 and 2, the changes proposed for Configuration 3 are not expected to result in any increased impact to nearby radiocommunication towers, point-to-point links, emergency services communications, meteorological radar, trigonometrical stations, citizen's band radio communications, or satellite television and internet signals.

The larger turbine dimensions proposed for the modification to the Development Consent may increase the potential for interference with point-to-area style communications such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting. However, DNV GL notes that the removal of turbines in Configuration 3 compared to Configurations 1 and 2 has reduced the number of dwellings in the potential interference zones for the three television broadcasting towers servicing the area. If interference to mobile phone, radio, or television signals is experienced as a result of the Project, a range of options are available to rectify difficulties.

Since it is not possible to determine the potential EMI impacts on point-to-multipoint links without obtaining further information from the service operators, DNV GL recommends that consultation with these operators is prioritised as the link paths may constrain the turbine placement. Consequently, DNV GL has commenced consultation with those operators to establish the link paths and determine the potential for the Project to cause interference to their services. Based on the responses received to date, there are no point-to-multipoint links crossing the Project boundary.

DNV GL also recommends consulting with all other organisations operating services that may be affected by the Project, to seek feedback regarding any potential for EMI-related impact, and identify mitigation measures if required. It is understood that the Proponent intends to undertake this consultation prior to construction, once a final turbine type is selected and the turbine layout is being finalised.

DNV GL notes that the Project is located in an area of high wind farm development activity, with multiple approved and operating wind farms in the vicinity of the site. The larger turbine dimensions proposed for Configuration 3 may increase the potential for cumulative impacts on mobile phone, radio, and television signals, although the proposed removal of turbines may reduce

the risk of these signals being impacted by multiple wind turbines compared to Configurations 1 and 2.

Table 7 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings for Configuration 3	Anticipated change in impact	
		Relative to Configuration 1	Relative to Configuration 2
Radiocommunication towers	No towers within 2 km of proposed turbine locations Nearest tower: 5 km from turbines	No change expected	No change expected
Fixed point-to-point links	Two links crossing Project boundary, operated by: NSW Rural Fire Service (RFS) Office of Environment and Heritage Diffraction effects: no turbines in exclusion zones Reflection/scattering and near-field effects: turbines are sufficiently far from towers to avoid impacts	No change expected	No change expected
Fixed point-to-multipoint links	146 assignments within 75 km of Project boundary Two base stations within 20 km of Project boundary, operated by: Hilltops Council Yass Valley Council Potential for interference if links cross the Project site in proximity to turbines	Unable to determine impacts without knowing the link paths DNV GL has commenced consultation with the operators to establish link paths and potential for impact. Based on responses received to date, there are no links crossing the Project site	Unable to determine impacts without knowing the link paths DNV GL has commenced consultation with the operators to establish link paths and potential for impact. Based on responses received to date, there are no links crossing the Project site
Other licence types	Base to mobile station style communications: unlikely to be affected (see "Emergency services", "Mobile phones", "Radio broadcasting", "Television broadcasting") Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-	-
Emergency services	Point-to-point links: one NSW RFS link crossing boundary (see "Fixed point-to-point links") Base to mobile station style communications: unlikely to be affected	No change expected	No change expected
Meteorological radar	Nearest station: "Canberra", 108 km from Project Unlikely to be affected	No change expected	No change expected
Trigonometrical stations	56 stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by turbines	No change expected	No change expected
Citizen's band radio	Unlikely to be affected	No change expected	No change expected

Table 7 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings for Configuration 3	Anticipated change in impact	
		Relative to Configuration 1	Relative to Configuration 2
Mobile phones	Variable coverage across site Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
Wireless internet	Likely service providers: mobile phone networks, NBN NBN: available as a fixed wireless and satellite service in areas surrounding the Project	Larger turbine dimensions may increase potential for interference with services provided by mobile phone networks	Larger turbine dimensions may increase potential for interference with services provided by mobile phone networks
Satellite television and internet	Services intended for Australia: unlikely to be affected Other services: signals from four satellites intercepted at 13 dwellings Services are not intended for Australia and so dwellings are not expected to be receiving signals from these satellites	Number of potentially-affected dwellings reduced by 3	Number of potentially-affected dwellings increased by 1
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference (low level hiss or distortion) in close proximity to turbines Digital radio signals: not available in vicinity of Project	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception	Larger turbine dimensions may increase potential for interference	Larger turbine dimensions may increase potential for interference
	Canberra tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the south 29 dwellings (9 associated dwellings) in potential interference zone	Number of dwellings in potential interference zone reduced by 10	Number of dwellings in potential interference zone reduced by 3
	Central Tablelands tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the north 40 dwellings (19 associated dwellings) in potential interference zone Most potentially-affected dwellings are outside the apparent coverage areas and may not be receiving signals from this tower	Number of dwellings in potential interference zone reduced by 12	Number of dwellings in potential interference zone reduced by 1
	SW Slopes / E Riverina tower: 'poor' to 'variable' coverage across Project site, with areas of 'good' coverage in the north 36 dwellings (6 associated dwellings) in potential interference zone Most potentially-affected dwellings are outside the apparent coverage areas and may not be receiving signals from this tower	Number of dwellings in potential interference zone reduced by 21	No change in number of dwellings in potential interference zone

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LIST OF TABLES

Table 8 Proposed turbine layout for Configuration 1 [7]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
1	676629	6186672	723	65	684812	6175374	663
2	676471	6186291	716	66	682384	6175319	709
3	676320	6185897	706	67	680267	6175231	699
4	676320	6185509	684	68	684506	6175044	671
5	677805	6185279	716	69	682302	6174979	719
6	676377	6185158	667	71	682195	6173075	731
7	677490	6184967	727	72	682099	6172655	734
9	677384	6184591	720	73	681120	6172346	711
11	677266	6184203	735	74	681358	6172003	725
12	677322	6183750	727	75	681388	6171634	737
16	677936	6182318	717	76	680446	6171508	715
17	681368	6182678	728	77	681464	6171283	737
18	678502	6182471	705	78	680782	6171250	709
20	681054	6182312	748	79	680673	6170767	703
21	678588	6181965	695	80	682014	6170267	760
22	679549	6181989	693	82	682004	6169806	745
25	679389	6181591	710	83	681810	6169398	737
26	678511	6181575	704	84	681373	6167591	761
28	678484	6181184	734	85	681917	6167300	727
29	678385	6180840	756	86	681730	6166773	749
30	679009	6180754	742	87	681536	6166404	734
31	680367	6180463	761	90	681137	6165157	736
32	678570	6180428	738	93	681045	6164377	739
34	678899	6180032	730	94	680716	6163813	707
35	679581	6180032	742	95	681550	6163639	747
36	680242	6180109	741	96	682288	6163400	738
37	678987	6179642	713	97	682410	6162959	716
38	679645	6179648	745	98	682319	6162534	730
39	680098	6179394	719	99	682358	6162122	720
41	680008	6179119	711	101	682364	6161546	702
42	680994	6179015	702	102	686233	6156685	745
43	679027	6179114	714	103	685997	6156377	747
44	678960	6178706	687	104	686150	6156084	743
45	678438	6178498	669	119	683654	6152722	743
47	678190	6178066	699	120	684987	6152789	747
48	681515	6177825	763	122	683572	6152343	732
49	681955	6177678	725	124	685103	6152217	731
50	681372	6177446	776	125	684396	6152175	742
51	681355	6177078	743	127	684307	6151723	726
52	681625	6176824	724	128	683138	6151393	703
53	681153	6176713	751	129	684402	6151298	727
56	681509	6176441	722	130	683127	6151016	701
58	682400	6176161	724	131	683001	6150684	706
61	680965	6176347	752	133	678003	6181399	703
62	680830	6175999	747	134	677946	6181062	715
63	682309	6175645	713	135	679301	6180383	743
64	683431	6175508	700	136	680809	6181821	739

Table 8 Proposed turbine layout for Configuration 1 [7] (continued)

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
137	680652	6181414	727	145	686104	6154215	720
138	680607	6181022	734	146	684178	6174388	693
139	680934	6177688	773	147	684451	6173978	717
140	680771	6177337	726	148	684474	6173545	713
141	680488	6175710	742	149	683804	6173875	718
142	684592	6152523	736	150	682052	6170803	757
143	681415	6167988	758	151	677325	6185689	696
144	678465	6177749	680				

1. Coordinate system: MGA zone 55, GDA94 datum.

Table 9 Proposed turbine layout for Configuration 2 [8]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
1	676629	6186672	723	69	682302	6174979	719
2	676471	6186291	716	71	682195	6173075	731
3	676320	6185897	706	72	682099	6172655	734
4	676320	6185509	684	73	681120	6172346	711
5	677805	6185279	716	74	681358	6172003	725
6	676377	6185158	667	75	681388	6171634	737
7	677490	6184967	727	76	680446	6171508	715
9	677384	6184591	720	77	681464	6171283	737
11	677266	6184203	735	78	680782	6171250	709
12	677322	6183750	727	79	680673	6170767	703
17	681368	6182678	728	80	682014	6170267	760
18	678502	6182471	705	82	682004	6169806	745
20	681054	6182312	748	83	681810	6169398	737
21	678588	6181965	695	84	681373	6167591	761
22	679549	6181989	693	85	681917	6167300	727
25	679389	6181591	710	86	681730	6166773	749
26	678511	6181575	704	87	681536	6166404	734
28	678484	6181184	734	102	686233	6156685	745
30	679009	6180754	742	103	685997	6156377	747
31	680367	6180463	761	104	686150	6156084	743
32	678570	6180428	738	119	683654	6152722	743
34	678899	6180032	730	120	684987	6152789	747
35	679581	6180032	742	122	683572	6152343	732
36	680242	6180109	741	124	685103	6152217	731
37	678987	6179642	713	125	684396	6152175	742
38	679645	6179648	745	127	684307	6151723	726
39	680098	6179394	719	128	683138	6151393	703
41	680008	6179119	711	129	684402	6151298	727
42	680994	6179015	702	130	683127	6151016	701
43	679027	6179114	714	131	683001	6150684	706
48	681515	6177825	763	135	679301	6180383	743
49	681955	6177678	725	136	680809	6181821	739
50	681372	6177446	776	137	680652	6181414	727
51	681355	6177078	743	138	680607	6181022	734
52	681625	6176824	724	139	680934	6177688	773
53	681153	6176713	751	140	680771	6177337	726
56	681509	6176441	722	141	680488	6175710	742
58	682400	6176161	724	142	684592	6152523	736
61	680965	6176347	752	143	681415	6167988	758
62	680830	6175999	747	145	686104	6154215	720
63	682309	6175645	713	146	684178	6174388	693
64	683431	6175508	700	147	684451	6173978	717
65	684812	6175374	663	148	684474	6173545	713
66	682384	6175319	709	149	683804	6173875	718
67	680267	6175231	699	150	682052	6170803	757
68	684506	6175044	671	151	677325	6185689	696

1. Coordinate system: MGA zone 55, GDA94 datum.

Table 10 Proposed turbine layout for Configuration 3 [9]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
1	676629	6186672	723	69	682302	6174979	719
2	676471	6186291	716	71	682195	6173075	731
3	676320	6185897	706	72	682099	6172655	734
4	676320	6185509	684	73	681120	6172346	711
5	677805	6185279	716	74	681358	6172003	725
7	677490	6184967	727	75	681388	6171634	737
9	677384	6184591	720	76	680446	6171508	715
11	677266	6184203	735	78	680782	6171250	709
12	677322	6183750	727	79	680673	6170767	703
17	681368	6182678	728	80	682014	6170267	760
18	678502	6182471	705	82	682004	6169806	745
20	681054	6182312	748	83	681810	6169398	737
21	678588	6181965	695	84	681373	6167591	761
22	679549	6181989	693	85	681917	6167300	727
25	679389	6181591	710	86	681730	6166773	749
26	678511	6181575	704	87	681536	6166404	734
28	678484	6181184	734	119	683654	6152722	743
30	679009	6180754	742	120	684987	6152789	747
31	680367	6180463	761	122	683572	6152343	732
32	678570	6180428	738	124	685103	6152217	731
34	678899	6180032	730	125	684396	6152175	742
36	680242	6180109	741	127	684307	6151723	726
37	678987	6179642	713	128	683138	6151393	703
39	680098	6179394	719	129	684402	6151298	727
41	680008	6179119	711	130	683127	6151016	701
42	680994	6179015	702	131	683001	6150684	706
43	679027	6179114	714	135	679301	6180383	743
48	681515	6177825	763	136	680809	6181821	739
49	681955	6177678	725	137	680652	6181414	727
50	681372	6177446	776	138	680607	6181022	734
51	681355	6177078	743	139	680934	6177688	773
58	682400	6176161	724	141	680488	6175710	742
61	680965	6176347	752	142	684592	6152523	736
62	680830	6175999	747	143	681415	6167988	758
63	682309	6175645	713	145	686104	6154215	720
64	683431	6175508	700	146	684178	6174388	693
65	684812	6175374	663	147	684451	6173978	717
66	682384	6175319	709	148	684474	6173545	713
67	680267	6175231	699	150	682052	6170803	757
68	684506	6175044	671	151	677325	6185689	696

1. Coordinate system: MGA zone 55, GDA94 datum.

Table 11 Dwellings in the vicinity of the proposed Project [11]

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R001	677418	6187127	Associated	0.9	0.9	0.9
R002	678095	6185733	Associated	0.5	0.5	0.5
R004	680436	6185190	Non-Associated	2.6	2.6	2.6
R006	681484	6184020	Non-Associated	1.4	1.4	1.4
R007	681917	6183967	Non-Associated	1.4	1.4	1.4
R008	682339	6183864	Non-Associated	1.5	1.5	1.5
R009	682517	6183838	Non-Associated	1.6	1.6	1.6
R010	682842	6183767	Non-Associated	1.8	1.8	1.8
R011	679650	6183618	Non-Associated	1.6	1.6	1.6
R014	677807	6183115	Associated	0.8	0.8	0.8
R015	675095	6182805	Associated	2.4	2.4	2.4
R016	677297	6181991	Associated	0.7	1.3	1.3
R017	676127	6181740	Non-Associated	1.9	2.3	2.3
R018	676024	6181739	Non-Associated	2.0	2.4	2.4
R019	676412	6181665	Non-Associated	1.6	2.1	2.1
R020	676130	6181544	Associated	1.9	2.4	2.4
R022	676095	6181037	Non-Associated	1.8	2.4	2.4
R024	683597	6178847	Non-Associated	2.0	2.0	2.0
R025	677075	6178323	Associated	1.1	2.1	2.1
R026	676523	6178178	Non-Associated	1.7	2.7	2.7
R028	684090	6177918	Non-Associated	2.1	2.1	2.1
R029	676434	6177903	Non-Associated	1.8	2.9	2.9
R034	681817	6174338	Associated	0.8	0.8	0.8
R036	679988	6173811	Associated	1.5	1.5	1.5
R038	679623	6173620	Non-Associated	1.7	1.7	1.7
R040	678605	6171136	Associated	1.9	1.9	1.9
R041	681870	6168503	Associated	0.7	0.7	0.7
R042	683370	6168206	Associated	1.7	1.7	1.7
R044	679986	6166322	Associated	1.5	1.5	1.5
R045	682847	6165279	Non-Associated	1.7	1.7	1.7
R046	681835	6164679	Associated	0.8	1.8	1.8
R047	680155	6162689	Non-Associated	1.3	4.0	4.0
R048	679834	6162662	Non-Associated	1.5	4.1	4.1
R049	680667	6162540	Associated	1.3	4.0	4.0
R050	680701	6161784	Non-Associated	1.7	4.7	4.7
R051	680970	6161588	Associated	1.4	4.9	4.9
R052	684135	6161246	Associated	1.8	5.0	5.8
R053	680877	6160875	Non-Associated	1.6	5.6	5.6
R054	683514	6155819	Associated	2.5	2.5	3.0
R056	686567	6153140	Associated	1.2	1.2	1.2
R059	684670	6149654	Associated	1.7	1.7	1.7
R060	684244	6149529	Associated	1.7	1.7	1.7
R061	684489	6149335	Associated	2.0	2.0	2.0

Table 11 Dwellings in the vicinity of the proposed Project [11] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R063	683875	6148991	Non-Associated	1.9	1.9	1.9
R064	*676239*	*6180502*	*Associated*	*1.8*	*2.3*	*2.3*
R065	676668	6179644	Non-Associated	1.9	2.1	2.1
R066	*683628*	*6159544*	*Associated*	*2.4*	*3.9*	*5.9*
R067	683606	6159059	Non-Associated	2.8	3.5	5.5
R068	684235	6160336	Non-Associated	2.2	4.2	6.4
R069	676002	6175948	Non-Associated	3.0	4.3	4.3
R070	675919	6175950	Non-Associated	3.1	4.4	4.4
R071	675814	6175406	Non-Associated	3.5	4.4	4.4
R072	*677635*	*6173854*	*Associated*	*3.0*	*3.0*	*3.0*
R073	*677725*	*6173856*	*Associated*	*2.9*	*2.9*	*2.9*
R074	677256	6172562	Non-Associated	3.4	3.4	3.4
R075	677851	6172291	Non-Associated	2.7	2.7	2.7
R076	676803	6171944	Non-Associated	3.7	3.7	3.7
R077	677654	6169542	Non-Associated	3.3	3.3	3.3
R078	676707	6169056	Non-Associated	4.3	4.3	4.3
R079	676671	6168992	Non-Associated	4.4	4.4	4.4
R080	*679215*	*6168709*	*Associated*	*2.3*	*2.3*	*2.3*
R081	678216	6166375	Non-Associated	3.2	3.3	3.3
R082	677982	6165692	Non-Associated	3.2	3.6	3.6
R083	678818	6162988	Non-Associated	2.1	4.4	4.4
R085	680217	6161078	Non-Associated	2.2	5.5	5.5
R086	680739	6159422	Non-Associated	2.7	6.1	7.0
R087	682469	6156694	Non-Associated	3.5	3.5	4.2
R088	682860	6156066	Non-Associated	3.1	3.1	3.4
R089	681098	6154853	Non-Associated	3.3	3.3	3.3
R090	680583	6151407	Non-Associated	2.5	2.5	2.5
R091	680875	6148463	Non-Associated	3.1	3.1	3.1
R092	681812	6147909	Non-Associated	3.0	3.0	3.0
R093	680723	6147619	Non-Associated	3.8	3.8	3.8
R094	680028	6147815	Non-Associated	4.1	4.1	4.1
R095	680529	6147037	Non-Associated	4.4	4.4	4.4
R096	680529	6146998	Non-Associated	4.4	4.4	4.4
R097	681049	6146176	Non-Associated	4.9	4.9	4.9
R098	684400	6148461	Non-Associated	2.6	2.6	2.6
R099	689280	6153857	Non-Associated	3.2	3.2	3.2
R100	684738	6148432	Non-Associated	2.8	2.8	2.8
R101	688189	6154931	Non-Associated	2.2	2.2	2.2
R102	685395	6158972	Non-Associated	2.4	2.4	4.8
R103	688158	6159213	Non-Associated	3.2	3.2	5.4
R104	688448	6159572	Non-Associated	3.6	3.6	5.9
R105	688749	6159082	Non-Associated	3.5	3.5	5.5
R106	688206	6160370	Non-Associated	4.2	4.2	6.5

Table 11 Dwellings in the vicinity of the proposed Project [11] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R107	686879	6160480	Non-Associated	3.9	3.9	6.3
R108	685842	6160591	Non-Associated	3.6	3.9	6.4
R109	684831	6165424	Non-Associated	3.2	3.4	3.4
R110	684391	6165083	Non-Associated	2.7	3.1	3.1
R111	684234	6167383	Non-Associated	2.3	2.3	2.3
R112	686151	6177467	Non-Associated	2.5	2.5	2.5
R113	*684054*	*6179129*	*Associated*	*2.6*	*2.6*	*2.6*
R114	*683962*	*6183346*	*Associated*	*2.7*	*2.7*	*2.7*
R115	684767	6183708	Non-Associated	3.5	3.5	3.5
R116	681337	6185781	Non-Associated	3.1	3.1	3.1
R117	681030	6186528	Non-Associated	3.5	3.5	3.5
R118	681128	6186796	Non-Associated	3.6	3.6	3.6
R119	679979	6187579	Non-Associated	3.2	3.2	3.2
R120	679167	6188823	Non-Associated	3.3	3.3	3.3
R121	673113	6188366	Non-Associated	3.9	3.9	3.9
R122	671741	6187148	Non-Associated	4.7	4.7	4.7
R124	673168	6185478	Non-Associated	3.1	3.1	3.1
R125	673241	6185272	Non-Associated	3.1	3.1	3.1
R126	673137	6186723	Non-Associated	3.3	3.3	3.3
R127	672865	6184811	Non-Associated	3.5	3.5	3.5
R128	*678848*	*6183498*	*Associated*	*1.1*	*1.1*	*1.1*
R129	687424	6148652	Non-Associated	4.0	4.0	4.0
R130	673183	6185598	Non-Associated	3.1	3.1	3.1
R131	*674633*	*6183862*	*Associated*	*2.2*	*2.2*	*2.4*
R132	*675005*	*6182884*	*Associated*	*2.5*	*2.5*	*2.5*
R133	680562	6147046	Non-Associated	4.4	4.4	4.4
R135	679999	6147821	Non-Associated	4.1	4.1	4.1
R137	686573	6148420	Non-Associated	3.6	3.6	3.6
R138	686660	6148328	Non-Associated	3.7	3.7	3.7
R139	687199	6148339	Non-Associated	4.1	4.1	4.1
R140	687418	6148615	Non-Associated	4.0	4.0	4.0
R141	687456	6149042	Non-Associated	3.8	3.8	3.8
R142	688783	6148859	Non-Associated	5.0	5.0	5.0
R143	688712	6149106	Non-Associated	4.8	4.8	4.8
R144	688869	6149542	Non-Associated	4.6	4.6	4.6
R145	678834	6149712	Non-Associated	4.3	4.3	4.3
R146	688806	6149898	Non-Associated	4.4	4.4	4.4
R147	678909	6150247	Non-Associated	4.1	4.1	4.1
R148	678110	6150900	Non-Associated	4.9	4.9	4.9
R149	678227	6152209	Non-Associated	5.0	5.0	5.0
R151	689009	6153254	Non-Associated	3.1	3.1	3.1
R152	678918	6153120	Non-Associated	4.6	4.6	4.6
R153	689004	6153469	Non-Associated	3.0	3.0	3.0

Table 11 Dwellings in the vicinity of the proposed Project [11] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R154	679214	6154085	Non-Associated	4.6	4.6	4.6
R155	682087	6155970	Non-Associated	3.6	3.6	3.6
R156	682424	6156503	Non-Associated	3.6	3.6	4.0
R157	682567	6157576	Non-Associated	3.6	3.6	4.9
R158	679832	6158239	Non-Associated	4.2	6.4	6.7
R159	680150	6158414	Non-Associated	3.8	6.2	6.7
R160	686516	6163209	Non-Associated	4.1	5.9	5.9
R161	686558	6163349	Non-Associated	4.2	5.9	5.9
R162	686194	6163423	Non-Associated	3.8	5.5	5.5
R163	686122	6163365	Non-Associated	3.7	5.5	5.5
R164	686179	6163303	Non-Associated	3.8	5.6	5.6
R165	686730	6164124	Non-Associated	4.5	5.7	5.7
R166	686578	6164097	Non-Associated	4.3	5.5	5.5
R167	686605	6163812	Non-Associated	4.3	5.7	5.7
R168	686585	6163793	Non-Associated	4.2	5.7	5.7
R169	686768	6164315	Non-Associated	4.6	5.6	5.6
R170	683284	6165017	Non-Associated	1.9	2.2	2.2
R175	689083	6176435	Non-Associated	4.4	4.4	4.4
R177	675210	6178587	Non-Associated	3.0	3.8	3.8
R179	675135	6178717	Non-Associated	3.1	3.8	3.8
R180	675088	6178761	Non-Associated	3.2	3.9	3.9
R181	674875	6178540	Non-Associated	3.3	4.1	4.1
R182	675037	6178486	Non-Associated	3.2	4.0	4.0
R183	674578	6178693	Non-Associated	3.7	4.3	4.3
R184	673469	6178896	Non-Associated	4.8	5.3	5.3
R185	674831	6178963	Non-Associated	3.5	4.0	4.0
R186	675142	6178988	Non-Associated	3.2	3.7	3.7
R187	675113	6178835	Non-Associated	3.2	3.8	3.8
R188	675224	6179170	Non-Associated	3.2	3.6	3.6
R189	674755	6179114	Non-Associated	3.6	4.0	4.0
R190	674929	6179085	Non-Associated	3.4	3.9	3.9
R191	674993	6179119	Non-Associated	3.4	3.8	3.8
R192	*675172*	*6179170*	*Associated*	*3.2*	*3.6*	*3.6*
R193	675059	6178927	Non-Associated	3.2	3.8	3.8
R194	675004	6178932	Non-Associated	3.3	3.9	3.9
R195	674752	6178927	Non-Associated	3.5	4.1	4.1
R196	674852	6178901	Non-Associated	3.4	4.0	4.0
R197	675003	6178871	Non-Associated	3.3	3.9	3.9
R198	675154	6178827	Non-Associated	3.1	3.8	3.8
R199	675207	6178841	Non-Associated	3.1	3.7	3.7
R200	675115	6178809	Non-Associated	3.2	3.8	3.8
R202	684519	6179497	Non-Associated	3.1	3.1	3.1
R203	676049	6179500	Non-Associated	2.5	2.7	2.7

Table 11 Dwellings in the vicinity of the proposed Project [11] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R204	675863	6179390	Non-Associated	2.7	2.9	2.9
R206	685306	6180642	Non-Associated	4.4	4.4	4.4
R207	672288	6187479	Non-Associated	4.3	4.3	4.3
R209	672542	6188800	Non-Associated	4.6	4.6	4.6
R210	672541	6189270	Non-Associated	4.8	4.8	4.8
R211	687811	6148549	Non-Associated	4.4	4.4	4.4
R212	689159	6149506	Non-Associated	4.9	4.9	4.9
R213	679947	6154232	Non-Associated	4.0	4.0	4.0
R214	679299	6153729	Non-Associated	4.5	4.5	4.5
R216	690718	6155201	Non-Associated	4.6	4.6	4.7
R217	679547	6155316	Non-Associated	4.9	4.9	4.9
R218	687614	6160188	Non-Associated	3.8	3.8	6.2
R219	686206	6164280	Non-Associated	4.0	5.1	5.1
R220	686269	6165266	Non-Associated	4.4	4.8	4.8
R223	674862	6178409	Non-Associated	3.3	4.2	4.2
R226	675069	6178599	Non-Associated	3.2	3.9	3.9
R230	675291	6179035	Non-Associated	3.1	3.6	3.6
R232	674827	6178687	Non-Associated	3.4	4.1	4.1
R234	674816	6178852	Non-Associated	3.5	4.1	4.1
R243	681627	6156031	Non-Associated	3.9	3.9	3.9
R244	679843	6157268	Non-Associated	5.0	5.9	5.9
R246	678838	6153796	Non-Associated	4.9	4.9	4.9
R259	679376	6155053	Non-Associated	4.9	4.9	4.9
R262	680441	6154534	Non-Associated	3.7	3.7	3.7
R266	676126	6178067	Non-Associated	2.1	3.1	3.1
R267	675619	6180141	Non-Associated	2.5	3.0	3.0
R268	675798	6179747	Non-Associated	2.5	2.8	2.8
R269	675542	6178459	Non-Associated	2.7	3.5	3.5
R270	675545	6178651	Non-Associated	2.7	3.5	3.5
R271	675812	6176676	Non-Associated	2.8	4.0	4.0
R272	675077	6178674	Non-Associated	3.2	3.9	3.9
R274	675072	6178723	Non-Associated	3.2	3.9	3.9
R276	674959	6179291	Non-Associated	3.4	3.8	3.8
R277	674797	6177072	Non-Associated	3.5	4.7	4.7
R278	674900	6178637	Non-Associated	3.3	4.1	4.1
R279	674830	6177839	Non-Associated	3.4	4.4	4.4
R280	674827	6178559	Non-Associated	3.4	4.2	4.2
R281	674896	6178572	Non-Associated	3.3	4.1	4.1
R282	672813	6183624	Non-Associated	3.9	3.9	4.0
R283	674251	6179077	Non-Associated	4.1	4.5	4.5
R284	674150	6179201	Non-Associated	4.2	4.6	4.6
R286	683162	6184437	Non-Associated	2.5	2.5	2.5
R288	675035	6179594	Non-Associated	3.3	3.6	3.6

Table 11 Dwellings in the vicinity of the proposed Project [11] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]		
				Configuration 1	Configuration 2	Configuration 3
R289	672895	6185072	Non-Associated	3.4	3.4	3.4
R290	685210	6146484	Non-Associated	4.8	4.8	4.8
R291	686571	6146903	Non-Associated	4.9	4.9	4.9
R292	674883	6178516	Non-Associated	3.3	4.1	4.1
R294	681540	6148503	Non-Associated	2.6	2.6	2.6
R295	689276	6153049	Non-Associated	3.4	3.4	3.4
R296	689334	6159068	Non-Associated	3.9	3.9	5.8
R298	677624	6169761	Non-Associated	3.2	3.2	3.2
R303	675012	6174765	Non-Associated	4.6	5.3	5.3
R304	673912	6168651	Non-Associated	7.1	7.1	7.1
R308	685152	6146518	Non-Associated	4.7	4.7	4.7
R309	681194	6187371	Non-Associated	4.0	4.0	4.0
R310	674929	6179121	Non-Associated	3.4	3.9	3.9
R313	690893	6155645	Non-Associated	4.8	4.8	5.0
R314	688121	6159393	Non-Associated	3.3	3.3	5.6
R315	686718	6158805	Non-Associated	2.2	2.2	4.6
R316	686237	6162634	Non-Associated	3.8	6.0	6.0
R317	686240	6165612	Non-Associated	4.5	4.6	4.6
R318	686391	6166303	Non-Associated	4.6	4.6	4.6
R319	686200	6179899	Non-Associated	4.7	4.7	4.7
R323	679280	6152986	Non-Associated	4.2	4.2	4.2
R324	680449	6161468	Non-Associated	1.9	5.1	5.1
R325	675154	6178653	Non-Associated	3.1	3.8	3.8
R326	680497	6158049	Non-Associated	4.0	5.7	6.2
R328	*674877*	*6183534*	*Associated*	*2.2*	*2.2*	*2.4*
R329	673626	6185507	Non-Associated	2.7	2.7	2.7
R330	675185	6183010	Non-Associated	2.3	2.3	2.3

1. Coordinate system: MGA zone 55, GDA94 datum.

Associated dwellings are indicated by *underlined italic text.*

Table 12 Details of point-to-point links crossing the proposed Project site

Link no.	Assignment ID	Licence number	Frequency [MHz]	Licence owner
1	767069, 767070	1208625/1	404.350	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142
	767067, 767068	1208625/1	413.800	
2	893818, 893819	1923870/1	856.550	Office of Environment and Heritage Asset Management Unit Level 3, PO Box 1967 HURSTVILLE BC NSW 1481
	893816, 893817	1923870/1	932.550	

Table 13 Details of point-to-multipoint licences within 75 km of the proposed Project

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
732437	9580	1101113/1	-35.276	149.098	56	ACTEW Distribution Ltd and Jemena Networks (ACT) Pty Ltd ACTEW AGL Distribution Attn Radio Workshop ICT Supplier Management PO Box 366 CANBERRA ACT 2601
732436	9580	1101113/1	-35.276	149.098	56	
735079	9580	1106423/1	-35.276	149.098	56	
735082	9580	1106423/1	-35.276	149.098	56	
736755	9580	1108757/1	-35.276	149.098	56	
736763	9580	1108759/1	-35.276	149.098	56	
736766	9580	1108759/1	-35.276	149.098	56	
736752	9580	1108757/1	-35.276	149.098	56	
736758	9580	1108758/1	-35.276	149.098	56	
736761	9580	1108758/1	-35.276	149.098	56	
778186	9580	1230472/1	-35.276	149.098	56	
778189	9580	1230472/1	-35.276	149.098	56	
872727	134287	1910141/1	-35.337	149.118	63	
872728	134287	1910141/1	-35.337	149.118	63	
872734	134287	1910142/1	-35.337	149.118	63	
872733	134287	1910142/1	-35.337	149.118	63	
778190	134287	1230473/1	-35.337	149.118	63	
778191	134287	1230473/1	-35.337	149.118	63	
883571	138718	1917466/1	-35.355	149.131	65	
883572	138718	1917466/1	-35.355	149.131	65	
738060	9619	1109854/1	-35.378	149.124	67	
738062	9619	1109854/1	-35.378	149.124	67	
738064	9619	1109870/1	-35.378	149.124	67	
738063	9619	1109870/1	-35.378	149.124	67	
736737	9619	1108754/1	-35.378	149.124	67	
736734	9619	1108754/1	-35.378	149.124	67	
734401	9619	1105832/1	-35.378	149.124	67	
736748	9619	1108756/1	-35.378	149.124	67	
736743	9619	1108755/1	-35.378	149.124	67	
734404	9619	1105832/1	-35.378	149.124	67	
736745	9619	1108756/1	-35.378	149.124	67	
736740	9619	1108755/1	-35.378	149.124	67	
740866	11543	1139632/1	-35.386	148.813	69	
736771	11543	1108760/1	-35.386	148.813	69	
736768	11543	1108760/1	-35.386	148.813	69	
740869	11543	1139632/1	-35.386	148.813	69	
726303	9666	451054/1	-35.249	149.102	53	Australian Sports Commission PO Box 176 BELCONNEN ACT 2616
726306	9666	451054/1	-35.249	149.102	53	
1306309	205701	1231607/1	-34.758	149.765	65	Bureau of Meteorology GPO Box 1289 MELBOURNE VIC 3001
1306306	205701	1231607/1	-34.758	149.765	65	
760036	136620	1190158/1	-35.314	149.191	62	Capital Airport Group Pty Ltd Level 4, 21 Terminal Avenue Plaza Offices West CANBERRA AIRPORT ACT 2609
760039	136620	1190158/1	-35.314	149.191	62	

Table 13 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
943089	100700	1956682/1	-34.034	148.555	56	Cowra Shire Council Private Bag 342 COWRA NSW 2794
943090	100700	1956682/1	-34.034	148.555	56	
943079	10522	1956681/1	-33.916	148.943	59	
5304293	10522	10684557/1	-33.916	148.943	59	
5304292	10522	10684557/1	-33.916	148.943	59	
943082	10522	1956681/1	-33.916	148.943	59	
2471857	153172	10210503/1	-33.900	148.857	60	
2471856	153172	10210503/1	-33.900	148.857	60	
943094	100701	1956683/1	-34.103	148.389	61	
943099	100701	1956683/1	-34.103	148.389	61	
2471853	10739	10210502/1	-34.050	148.440	61	
2471852	10739	10210502/1	-34.050	148.440	61	
943071	34531	1956679/1	-33.829	148.698	71	
943068	34531	1956679/1	-33.829	148.698	71	
2471848	34531	10210501/1	-33.829	148.698	71	
2471849	34531	10210501/1	-33.829	148.698	71	
978098	34531	1974299/1	-33.829	148.698	71	
978101	34531	1974299/1	-33.829	148.698	71	
1267414	9605	493181/1	-35.249	149.168	54	Department of Defence Director Defence Spectrum Office D DSO APW-GF-173, Anzac Park West PO Box 7953 CANBERRA BC ACT 2610
1267417	9605	493181/1	-35.249	149.168	54	
1270206	136234	1135737/1	-35.325	149.174	62	
1270203	136234	1135737/1	-35.325	149.174	62	
740321	9570	1138925/1	-35.306	149.117	59	Embassy of the United States of America Moonah Place YARRALUMLA ACT 2600
740324	9570	1138925/1	-35.306	149.117	59	
808694	404074	1427988/1	-34.769	149.732	62	Essential Energy Attn: Ray Northcott PO Box 5730 PORT MACQUARIE BC NSW 2444
808691	404074	1427988/1	-34.769	149.732	62	
737007	198028	1109185/1	-34.813	148.502	45	Goldenfields Water County Council PO Box 220 TEMORA NSW 2666
737004	198028	1109185/1	-34.813	148.502	45	
809518	9551	1428645/1	-34.485	148.318	54	
809521	9551	1428645/1	-34.485	148.318	54	
812594	404919	1431887/1	-34.704	148.187	70	
812591	404919	1431887/1	-34.704	148.187	70	
4643397	9023709	10588354/1	-34.756	149.688	58	Goulburn Mulwaree Council Locked Bag 22 GOULBURN NSW 2580
4643398	9023709	10588354/1	-34.756	149.688	58	
681534	35237	26488/1	-34.738	149.688	58	
681535	35237	26488/1	-34.738	149.688	58	
1940038	34853	10582/2	-34.446	148.699	19	Hilltops Council Locked Bag 5 YOUNG NSW 2594
1940037	34853	10582/2	-34.446	148.699	19	
735363	101225	1106673/1	-34.553	148.368	51	
735360	101225	1106673/1	-34.553	148.368	51	
2130189	100385	1231909/2	-34.373	148.278	58	
2130190	100385	1231909/2	-34.373	148.278	58	

Table 13 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
754442	39001	1183976/1	-35.195	148.375	73	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142
754439	39001	1183976/1	-35.195	148.375	73	
6050502	138861	10780366/1	-35.301	149.075	58	Office of the Official Secretary to the Governor-General Grounds Coordinator Government House Dunrossil Drive YARRALUMLA ACT 2600
6050505	138861	10780366/1	-35.301	149.075	58	
887781	138861	1920468/1	-35.301	149.075	58	
887778	138861	1920468/1	-35.301	149.075	58	
1785973	101195	1106560/2	-35.254	149.436	66	Queanbeyan Palerang Regional Council PO Box 90 QUEANBEYAN NSW 2620
1785974	101195	1106560/2	-35.254	149.436	66	
3756258	10004297	10196677/2	-35.248	149.452	66	
3756257	10004297	10196677/2	-35.248	149.452	66	
3564897	9702	10410970/1	-35.341	149.266	67	
3564898	9702	10410970/1	-35.341	149.266	67	
1785961	205768	1232279/2	-35.266	149.453	68	
1785962	205768	1232279/2	-35.266	149.453	68	
3564909	10009407	10410973/1	-35.372	149.214	68	
3564910	10009407	10410973/1	-35.372	149.214	68	
3564905	10009406	10410972/1	-35.403	149.206	71	
3564906	10009406	10410972/1	-35.403	149.206	71	
3564901	10009405	10410971/1	-35.431	149.221	75	
3564902	10009405	10410971/1	-35.431	149.221	75	
736456	9702	1107238/1	-35.341	149.266	67	
736459	9702	1107238/1	-35.341	149.266	67	
957184	141384	1964316/1	-35.420	149.222	74	
957187	141384	1964316/1	-35.420	149.222	74	
762620	49191	1192693/1	-35.304	149.090	59	Royal Canberra Golf Club West Bourne Woods YARRALUMLA ACT 2600
762623	49191	1192693/1	-35.304	149.090	59	
2436506	9580	10196612/1	-35.276	149.098	56	Telematics Wireless Ltd PO Box 1911 Israel HaZafon 5811801
2436494	9580	10196609/1	-35.276	149.098	56	
2436497	9580	10196609/1	-35.276	149.098	56	
2436501	9580	10196610/1	-35.276	149.098	56	
2436498	9580	10196610/1	-35.276	149.098	56	
2436505	9580	10196611/1	-35.276	149.098	56	
2436509	9580	10196612/1	-35.276	149.098	56	
2436502	9580	10196611/1	-35.276	149.098	56	
992164	9022060	1981362/1	-35.250	149.136	54	Transport Canberra and City Services Directorate Roads ACT PO Box 777 FYSHWICK ACT 2609
992167	9022060	1981362/1	-35.250	149.136	54	
992175	9617	1981363/1	-35.365	149.119	66	
992172	9617	1981363/1	-35.365	149.119	66	
965105	9019481	1968122/1	-34.771	149.270	21	Upper Lachlan Shire Council Upper Lachlan Council PO Box 42 GUNNING NSW 2581
965102	9019481	1968122/1	-34.771	149.270	21	
965101	9019482	1968121/1	-34.397	149.814	73	
965098	9019482	1968121/1	-34.397	149.814	73	

Table 13 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
2825744	9534	10275997/1	-34.161	149.238	41	Water NSW Attn: P Dudley PO Box 398 PARRAMATTA NSW 2124
2825741	9534	10275997/1	-34.161	149.238	41	
2863356	9534	1220708/2	-34.161	149.238	41	
2863355	9534	1220708/2	-34.161	149.238	41	
2807380	100672	1103856/2	-35.002	148.584	45	
2807381	100672	1103856/2	-35.002	148.584	45	
2498966	10004857	10213157/1	-33.981	148.948	51	
2498963	10004857	10213157/1	-33.981	148.948	51	
2825725	10522	10275993/1	-33.916	148.943	59	
2863359	10522	1220709/2	-33.916	148.943	59	
2863360	10522	1220709/2	-33.916	148.943	59	
2825728	10522	10275993/1	-33.916	148.943	59	
2825760	100685	10276001/1	-33.992	149.302	60	
2825757	100685	10276001/1	-33.992	149.302	60	
2863348	100685	1220705/2	-33.992	149.302	60	
2863347	100685	1220705/2	-33.992	149.302	60	
2863384	10739	1220715/2	-34.050	148.440	61	
2863383	10739	1220715/2	-34.050	148.440	61	
776171	9529	1227638/1	-34.849	148.971	8	Yass Valley Council PO Box 6 YASS NSW 2582
776168	9529	1227638/1	-34.849	148.971	8	

Table 14 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	2862
2 GHz Band	Spectrum	4655
2.3 GHz Band	Spectrum	1773
2.5 GHz Band	Spectrum	1016
2.5 GHz Mid Band Gap	Spectrum	60
3.4 GHz Band	Spectrum	680
700 MHz Band	Spectrum	1934
800 MHz Band	Spectrum	1954
Aeronautical Assigned System	Aeronautical	73
Amateur Beacon	Amateur	5
Amateur Repeater	Amateur	70
Ambulatory - Initial	Land Mobile	8
Ambulatory System	Land Mobile	282
Cat 3 DRMT	Broadcasting	1
CBRS Repeater	Land Mobile	22
Commercial Radio	Broadcasting	15
Commercial Television	Broadcasting	12
Community Broadcasting	Broadcasting	12
Earth Receive	Earth Receive	38
Fixed Earth	Earth	43
Fixed Receive	Fixed Receive	16
Foundation Cat 1 DRMT	Broadcasting	1
HF Domestic Service	Broadcasting	1
Land Mobile System - > 30MHz	Land Mobile	1721
Land Mobile System 0-30MHz	Land Mobile	68
Limited Coast Assigned System	Maritime Coast	8
Narrowband Area Service station(s)	Broadcasting	16
Narrowcasting Service (Fixed Tax)	Broadcasting	6
Narrowcasting Service (LPON)	Broadcasting	70
Narrowcasting Service Station(s)	Broadcasting	1
National Broadcasting	Broadcasting	29
PABX Cordless Telephone Service	Land Mobile	2
Paging System - Exterior	Land Mobile	46
Paging System - Interior	Land Mobile	17
PMTS Class B	PTS	372
PMTS Class B (935-960 MHz)	PTS 900 MHz	498
Radiodetermination	Radiodetermination	42
Retransmission	Broadcasting	34
Retransmission (Out of Area)	Broadcasting	3
Scientific Assigned	Scientific	10

Table 15 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
ACT Justice and Community Safety Directorate (Corrective Services)	ACT Justice and Community Safety Directorate Corrective Services Attention Danny Warburton or Dayanand Deshmukh Locked Bag 6000 GREENWAY ACT 2900	67
ACT Emergency Services Agency	ACT Emergency Services Agency GPO Box 158 (ICT Support ACTESA) CANBERRA ACT 2601	41
Ambulance Service of NSW	Ambulance Service of NSW Service Manager Telecommunications Matt Wheat Locked Bag 105 ROZELLE NSW 2039	6
Australian Federal Police	Australian Federal Police Attn T&I Eileen Ferber PO Box 401 CANBERRA ACT 2601	42
Department of Justice Corrective Services NSW	Department of Justice Corrective Services NSW Security & Intelligence LMB 3 Australia Post Business Centre SILVERWATER NSW 1811	63
Laggan and District Bushfire Brigade	Laggan and District Bushfire Brigade PO Box 105 CROOKWELL NSW 2583	51
Mulwaree Goulburn Emergency Repeater Group	Mulwaree Goulburn Emergency Repeater Group 9 William Street GOULBURN NSW 2580	53
NSW Government Telecommunications Authority	NSW Telecommunications Authority Telco Authority (GRN) Locked Bag 2 HAYMARKET NSW 1240	6
NSW Police Force	NSW Police Force Radio Engineering Services Level 4, 151-241 Goulburn St Sydney Police Centre SURRY HILLS NSW 2010	6
NSW Rural Fire Service	NSW Rural Fire Service Locked Mail Bag 17 GRANVILLE NSW 2142	11
NSW Volunteer Rescue Association Inc	NSW Volunteer Rescue Association Inc Secretary PO Box 6151 DURAL DC NSW 2158	30
St John Ambulance Australia (NSW)	St John Ambulance Australia (NSW) Deane Street BURWOOD NSW 2134	42
St John Ambulance Australia Incorporated	St John Ambulance Australia Incorporated Attn: Paul Stein 170 Forster Road MOUNT WAVERLEY VIC 3149	42
State Emergency Service (NSW)	State Emergency Service (NSW) PO Box 6126 WOLLONGONG NSW 2500	20

Table 15 Emergency services with radiocommunication assets in the vicinity of the proposed Project (continued)

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Wamboin Rural Fire Brigade	Wamboin Rural Fire Brigade 112 Bingley Way WAMBOIN NSW 2620	58

Table 16 BoM radar sites in the vicinity of the proposed Project

BoM radar site	Location[1]		Distance to Project [km]
Canberra	S35.66°	E149.51°	108
Wagga Wagga	S35.17°	E147.47°	146
Wollongong	S34.26°	E150.87°	172
Sydney	S33.70°	E151.21°	220
Yarrawonga	S36.03°	E146.03°	303
Newcastle	S32.73°	E152.03°	340
Bairnsdale	S37.89°	E147.56°	369
Namoi	S31.02°	E150.19°	398

1. Coordinate system: Lat/Lon WGS84 datum.

Table 17 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude	Longitude	Distance to Project [km]
ACTNW1	GDA94	S34° 52' 32.48"	E148° 57' 13.19"	11
ACTNW2	GDA94	S34° 53' 8.92"	E148° 57' 36.07"	12
ACTNW3	GDA94	S34° 53' 31.89"	E148° 58' 21.46"	13
ACTNW4	GDA94	S34° 54' 9.80"	E148° 58' 39.12"	14
ACTNW5	GDA94	S34° 54' 37.20"	E148° 58' 48.43"	14
Besnard	AGD66 GDA94	S34° 35' 57.48" S34° 35' 51.87"	E148° 50' 15.63" E148° 50' 19.95"	10
Blakney	AGD66 GDA94	S34° 37' 23.86" S34° 37' 18.25"	E148° 58' 40.53" E148° 58' 44.84"	Within Project boundaries
Bland	AGD66 GDA94	S34° 57' 2.98" S34° 56' 57.38"	E149° 1' 28.68" E149° 1' 33.01"	19
Boambold	AGD66 GDA94	S34° 56' 55.86" S34° 56' 50.26"	E148° 54' 59.26" E148° 55' 3.60"	20
Bobby	AGD66 GDA94	S34° 36' 5.45" S34° 35' 59.84"	E148° 53' 23.75" E148° 53' 28.06"	6
Bolong	AGD66	S34° 20' 43.57"	E148° 55' 46.49"	11
Bowning	AGD66 AGD66 AGD84 GDA94 GDA94	S34° 46' 46.41" S34° 46' 46.32" S34° 46' 46.35" S34° 46' 40.81" S34° 46' 40.72"	E148° 49' 46.30" E148° 49' 46.60" E148° 49' 46.53" E148° 49' 50.63" E148° 49' 50.93"	15
Buffalo	AGD66 AGD66 AGD84 GDA94	S34° 34' 53.56" S34° 34' 53.65" S34° 34' 53.67" S34° 34' 48.04"	E148° 51' 38.26" E148° 51' 38.33" E148° 51' 38.26" E148° 51' 42.64"	8
Carramumbola	AGD66 GDA94	S34° 25' 24.01" S34° 25' 18.40"	E148° 44' 55.41" E148° 44' 59.73"	15
Cockatoo	AGD66 GDA94	S34° 55' 1.16" S34° 54' 55.55"	E149° 0' 9.03" E149° 0' 13.36"	15
Corumgaroo	AGD66 GDA94	S34° 34' 51.56" S34° 34' 45.95"	E148° 57' 27.48" E148° 57' 31.80"	Within Project boundaries
Cramp	AGD66 GDA94	S34° 25' 21.48" S34° 25' 15.87"	E149° 9' 9.95" E149° 9' 14.25"	14
Crosby	AGD66 GDA94	S34° 35' 4.76" S34° 34' 59.15"	E148° 47' 49.14" E148° 47' 53.46"	13
Dalton	AGD66 GDA94	S34° 43' 46.33" S34° 43' 40.71"	E149° 12' 55.76" E149° 13' 0.06"	15
Denbigh	AGD66 GDA94	S34° 29' 28.74" S34° 29' 23.12"	E149° 6' 47.30" E149° 6' 51.60"	9
Douro	AGD66 GDA94	S34° 51' 0.92" S34° 50' 55.32"	E148° 55' 23.15" E148° 55' 27.48"	10
Forest	AGD66 GDA94	S34° 32' 36.70" S34° 32' 31.09"	E148° 51' 28.31" E148° 51' 32.62"	7
Gododo	AGD66 GDA94	S34° 33' 52.40" S34° 33' 46.80"	E148° 47' 41.00" E148° 47' 45.32"	13
Grove	AGD66 GDA94	S34° 29' 17.90" S34° 29' 12.29"	E148° 56' 9.40" E148° 56' 13.71"	Within Project boundaries
Gwynne	AGD66 GDA94	S34° 30' 38.60" S34° 30' 32.99"	E148° 45' 46.41" E148° 45' 50.73"	14
Hawkins	AGD66 GDA94	S34° 44' 42.82" S34° 44' 37.21"	E148° 59' 6.26" E148° 59' 10.58"	1

Table 17 Trigonometrical stations in the vicinity of the proposed Project (continued)

Station name	Datum	Latitude	Longitude	Distance to Project [km]
Hollywood	AGD66	S34° 24' 35.29"	E149° 8' 20.52"	14
	GDA94	S34° 24' 29.67"	E149° 8' 24.82"	
Hume	AGD66	S34° 31' 40.52"	E148° 58' 28.18"	Within Project boundaries
	GDA94	S34° 31' 34.91"	E148° 58' 32.49"	
Jerrawa	AGD66	S34° 46' 22.256"	E149° 5' 3.30"	5
Kildare	AGD66	S34° 38' 42.03"	E149° 7' 59.39"	11
	GDA94	S34° 38' 36.42"	E149° 8' 3.70"	
Laidaw	GDA94	S34° 50' 25.49"	E148° 54' 9.34"	11
	AGD66	S34° 50' 31.07"	E148° 54' 4.74"	
Laidlaw	GDA94	S34° 50' 25.47"	E148° 54' 9.07"	11
Leatherjacket	AGD66	S34° 35' 50.50"	E148° 52' 7.21"	8
	GDA94	S34° 35' 44.89"	E148° 52' 11.53"	
Lestrange	AGD66	S34° 27' 33.71"	E149° 5' 59.49"	9
	GDA94	S34° 27' 28.09"	E149° 6' 3.79"	
Mallyon	AGD66	S34° 38' 40.13"	E148° 52' 10.04"	7
	GDA94	S34° 38' 34.52"	E148° 52' 14.36"	
Maloy	AGD66	S34° 53' 53.45"	E149° 6' 8.08"	16
	GDA94	S34° 53' 47.84"	E149° 6' 12.40"	
Manton	AGD66	S34° 51' 9.69"	E148° 58' 14.19"	8
	GDA94	S34° 51' 4.08"	E148° 58' 18.51"	
Margules	AGD66	S34° 49' 55.29"	E149° 3' 31.35"	7
Merryong	AGD66	S34° 49' 35.28"	E149° 11' 43.80"	16
	GDA94	S34° 49' 29.67"	E149° 11' 48.11"	
Midgee	AGD66	S34° 36' 54.24"	E149° 8' 14.65"	12
	GDA94	S34° 36' 48.62"	E149° 8' 18.95"	
Mundoonen	AGD66	S34° 49' 46.68"	E149° 2' 28.32"	6
	AGD66	S34° 49' 46.43"	E149° 2' 28.46"	
	AGD84	S34° 49' 46.71"	E149° 2' 28.26"	
	GDA94	S34° 49' 41.07"	E149° 2' 32.64"	
Murrumbateman	AGD66	S34° 55' 15.26"	E149° 3' 9.59"	16
	GDA94	S34° 55' 9.65"	E149° 3' 13.92"	
Narrawa	AGD66	S34° 23' 45.53"	E149° 6' 39.05"	13
	AGD66	S34° 23' 45.53"	E149° 6' 39.05"	
	AGD84	S34° 23' 45.56"	E149° 6' 38.98"	
	GDA94	S34° 23' 39.92"	E149° 6' 43.34"	
	GDA94	S34° 23' 39.92"	E149° 6' 43.35"	
Needles	AGD66	S34° 45' 56.59"	E149° 2' 45.47"	2
	GDA94	S34° 45' 50.99"	E149° 2' 49.78"	
Pudman	AGD66	S34° 29' 27.60"	E148° 50' 26.07"	7
	GDA94	S34° 29' 21.99"	E148° 50' 30.38"	
Race Course	AGD66	S34° 51' 26.57"	E148° 54' 36.46"	12
	GDA94	S34° 51' 20.96"	E148° 54' 40.79"	
Range	AGD66	S34° 51' 27.71"	E149° 4' 41.68"	11
	GDA94	S34° 51' 22.10"	E149° 4' 46.00"	
Reddall	AGD66	S34° 49' 8.00"	E148° 55' 44.63"	7
	GDA94	S34° 49' 2.39"	E148° 55' 48.96"	
Rose	AGD66	S34° 53' 12.70"	E149° 1' 29.84"	12
	GDA94	S34° 53' 7.10"	E149° 1' 34.16"	
Snowden	AGD66	S34° 30' 59.37"	E148° 56' 2.47"	Within Project boundaries
	GDA94	S34° 30' 53.76"	E148° 56' 6.79"	

Table 17 Trigonometrical stations in the vicinity of the proposed Project (continued)

Station name	Datum	Latitude	Longitude	Distance to Project [km]
Stumpy	AGD66	S34° 48' 16.63"	E148° 50' 4.62"	15
	GDA94	S34° 48' 11.03"	E148° 50' 8.95"	
Suffolk	AGD66	S34° 20' 18.73"	E148° 48' 43.02"	14
	GDA94	S34° 20' 13.12"	E148° 48' 47.34"	
Terry	AGD66	S34° 53' 50.64"	E148° 56' 35.52"	14
	GDA94	S34° 53' 45.03"	E148° 56' 39.85"	
Vernon	AGD66	S34° 35' 34.05"	E148° 58' 58.73"	Within Project boundaries
	GDA94	S34° 35' 28.43"	E148° 59' 3.04"	
Wallah	AGD66	S34° 23' 56.95"	E149° 2' 11.19"	9
	GDA94	S34° 23' 51.34"	E149° 2' 15.49"	
Yass	AGD66	S34° 52' 21.46"	E148° 52' 1.24"	16
	GDA94	S34° 52' 15.85"	E148° 52' 5.57"	

Table 18 Dwellings with increased potential to experience EMI to DTV from the Canberra television broadcast tower

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Configuration 1	Configuration 2	Configuration 3
R001	*677418*	*6187127*	*X*	*X*	*X*
R002	*678095*	*6185733*	*X*	*X*	*X*
R004	680436	6185190	X	X	X
R006	681484	6184020	X	X	X
R011	679650	6183618	X	X	X
R014	*677807*	*6183115*	*X*	*X*	*X*
R016	*677297*	*6181991*	*X*		
R019	676412	6181665	X		
R024	683597	6178847	X	X	X
R028	684090	6177918	X	X	X
R034	*681817*	*6174338*	*X*	*X*	*X*
R036	*679988*	*6173811*	*X*	*X*	*X*
R038	679623	6173620	X	X	X
R041	*681870*	*6168503*	*X*	*X*	*X*
R042	*683370*	*6168206*	*X*		
R044	*679986*	*6166322*	*X*		
R045	682847	6165279	X		
R046	*681835*	*6164679*	*X*		
R054	*683514*	*6155819*	*X*	*X*	*X*
R068	684235	6160336	X	X	
R080	*679215*	*6168709*	*X*		
R087	682469	6156694	X	X	X
R088	682860	6156066	X	X	X
R089	681098	6154853	X	X	X
R102	685395	6158972	X	X	X
R107	686879	6160480	X	X	
R108	685842	6160591	X	X	
R113	*684054*	*6179129*	*X*	*X*	*X*
R116	681337	6185781	X	X	X
R117	681030	6186528	X	X	X
R118	681128	6186796	X	X	X
R128	*678848*	*6183498*	*X*	*X*	*X*
R155	682087	6155970	X	X	X
R156	682424	6156503	X	X	X
R157	682567	6157576	X	X	X
R202	684519	6179497	X	X	X
R243	681627	6156031	X	X	X
R309	681194	6187371	X	X	X
R315	686718	6158805	X	X	X

1. Coordinate system: MGA zone 55, GDA94 datum.

Associated dwellings are indicated by *underlined italic text.*

Table 19 Dwellings with increased potential to experience EMI to DTV from the Central Tablelands television broadcast tower

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Configuration 1	Configuration 2	Configuration 3
R014	677807	6183115	X	X	X
R015	675095	6182805	X	X	X
R016	677297	6181991	X	X	X
R017	676127	6181740	X	X	X
R018	676024	6181739	X	X	X
R019	676412	6181665	X	X	X
R020	676130	6181544	X	X	X
R022	676095	6181037	X	X	X
R025	677075	6178323	X	X	X
R026	676523	6178178	X		
R029	676434	6177903	X		
R031	679304	6177019	X	X	X
R034	681817	6174338	X	X	X
R036	679988	6173811	X	X	X
R038	679623	6173620	X	X	X
R041	681870	6168503	X	X	X
R042	683370	6168206	X	X	X
R044	679986	6166322	X	X	X
R045	682847	6165279	X	X	X
R046	681835	6164679	X	X	X
R047	680155	6162689	X	X	X
R049	680667	6162540	X	X	X
R050	680701	6161784	X	X	X
R051	680970	6161588	X	X	X
R053	680877	6160875	X		
R056	686567	6153140	X	X	
R059	684670	6149654	X	X	X
R060	684244	6149529	X	X	X
R061	684489	6149335	X	X	X
R063	683875	6148991	X	X	X
R064	676239	6180502	X	X	X
R065	676668	6179644	X	X	X
R067	683606	6159059	X		
R072	677635	6173854	X		
R073	677725	6173856	X		
R085	680217	6161078	X		
R086	680739	6159422	X		
R087	682469	6156694	X		
R098	684400	6148461	X	X	X
R100	684738	6148432	X	X	X
R132	675005	6182884	X	X	X
R137	686573	6148420	X	X	X

Table 19 Dwellings with increased potential to experience EMI to DTV from the Central Tablelands television broadcast tower (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Configuration 1	Configuration 2	Configuration 3
R157	682567	6157576	X		
R170	683284	6165017	X	X	X
R203	676049	6179500	X	X	X
R204	675863	6179390	X	X	X
R267	675619	6180141	X	X	X
R268	675798	6179747	X	X	X
R290	685210	6146484	X	X	X
R308	685152	6146518	X	X	X
R324	680449	6161468	X		
R330	675185	6183010	X	X	X

1. Coordinate system: MGA zone 55, GDA94 datum.

Associated dwellings are indicated by *underlined italic text.*

Table 20 Dwellings with increased potential to experience EMI to DTV from the SW Slopes / E Riverina television broadcast tower

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Configuration 1	Configuration 2	Configuration 3
R001	677418	6187127	X	X	X
R002	678095	6185733	X	X	X
R004	680436	6185190	X	X	X
R006	681484	6184020	X	X	X
R007	681917	6183967	X	X	X
R008	682339	6183864	X	X	X
R009	682517	6183838	X	X	X
R010	682842	6183767	X	X	X
R011	679650	6183618	X		
R024	683597	6178847	X	X	X
R028	684090	6177918	X	X	X
R042	683370	6168206	X	X	X
R045	682847	6165279	X		
R046	681835	6164679	X		
R052	684135	6161246	X		
R056	686567	6153140	X	X	X
R099	689280	6153857	X	X	X
R101	688189	6154931	X	X	X
R109	684831	6165424	X		
R110	684391	6165083	X		
R111	684234	6167383	X	X	X
R112	686151	6177467	X	X	X
R113	684054	6179129	X	X	X
R114	683962	6183346	X	X	X
R115	684767	6183708	X	X	X
R116	681337	6185781	X	X	X
R117	681030	6186528	X	X	X
R118	681128	6186796	X	X	X
R119	679979	6187579	X	X	X
R120	679167	6188823	X	X	X
R151	689009	6153254	X	X	X
R153	689004	6153469	X	X	X
R160	686516	6163209	X		
R161	686558	6163349	X		
R162	686194	6163423	X		
R163	686122	6163365	X		
R164	686179	6163303	X		
R165	686730	6164124	X		
R166	686578	6164097	X		
R167	686605	6163812	X		
R168	686585	6163793	X		
R169	686768	6164315	X		

Table 20 Dwellings with increased potential to experience EMI to DTV from the SW Slopes / E Riverina television broadcast tower (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Configuration 1	Configuration 2	Configuration 3
R170	683284	6165017	X		
R175	689083	6176435	X	X	X
R202	684519	6179497	X	X	X
R206	685306	6180642	X	X	X
R216	690718	6155201	X	X	X
R219	686206	6164280	X		
R220	686269	6165266	X		
R286	683162	6184437	X	X	X
R295	689276	6153049	X	X	X
R309	681194	6187371	X	X	X
R313	690893	6155645	X	X	X
R316	686237	6162634	X		
R317	686240	6165612	X		
R318	686391	6166303	X	X	X
R319	686200	6179899	X	X	X

1. Coordinate system: MGA zone 55, GDA94 datum.

Associated dwellings are indicated by *underlined italic text.*

Table 21 Summary of service operators contacted by DNV GL and responses received to date

	Licence/service type	Distance of closest site	Operator	DNV GL reference	Response received to date
1	Fixed point-to-multipoint	56 km	ActewAGL Distribution	PP229290-AUME-L-01	Response received by email on 10/02/2020: *"No link paths traverse the proposed Rye Park Wind Farm Site. We do not envisage any impact to ActewAGL Distribution Radio Communications systems. However, until the Turbines are in place and operational, we are unable to provide a guarantee that there will be no interference to ActewAGL Radio Communications."*
2	Fixed point-to-multipoint	19 km	Hilltops Council	PP229290-AUME-L-02	No response received to date
3	Fixed point-to-multipoint	22 km	Upper Lachlan Shire Council	PP229290-AUME-L-03	No response received to date
4	Fixed point-to-multipoint	41 km	Water NSW	PP229290-AUME-L-04	No response received to date
5	Fixed point-to-multipoint	8 km	Yass Valley Council	PP229290-AUME-L-05	Response received by email on 5/02/2020: *"The facility at Mount Manton is the Repeater Station which is the 'key infrastructure' that communicates between water and sewer assets located in Yass, Bowning, Binalong and Murrumbateman and controls them. It requires direct line of sight between Mount Manton tower and each of the facilities. You would need to demonstrate the lines of sight are not interfered with and if required relocate/redesign the turbines."* Coordinates of facilities provided by email on 16/02/2020; lines of sight determined by DNV GL and all found to be more than 7 km from the Project boundary; interference not expected (pending confirmation from Yass Valley Council)

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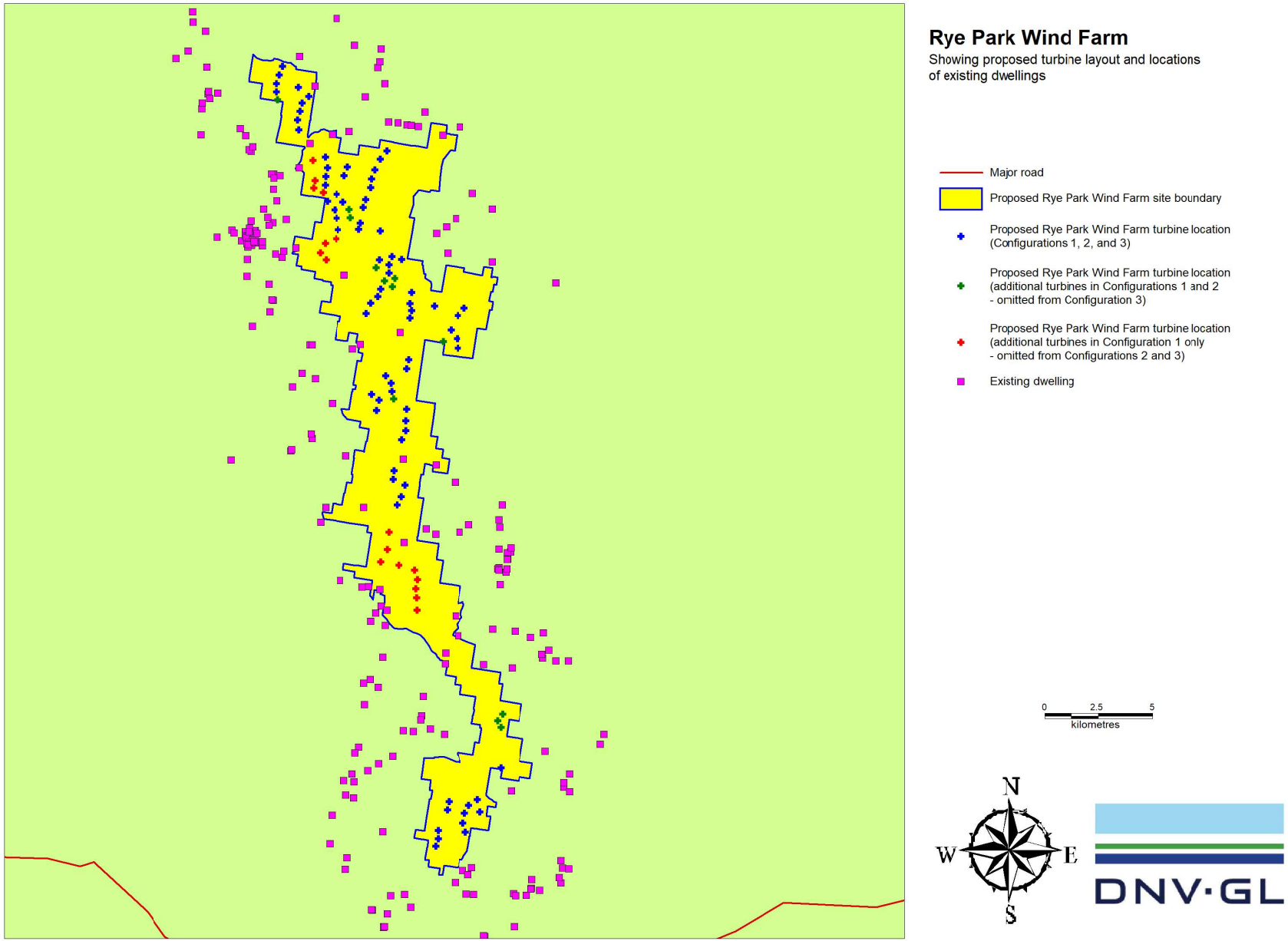

Figure 1 Map of the proposed Project, showing site boundaries, turbine locations, and locations of nearby dwellings

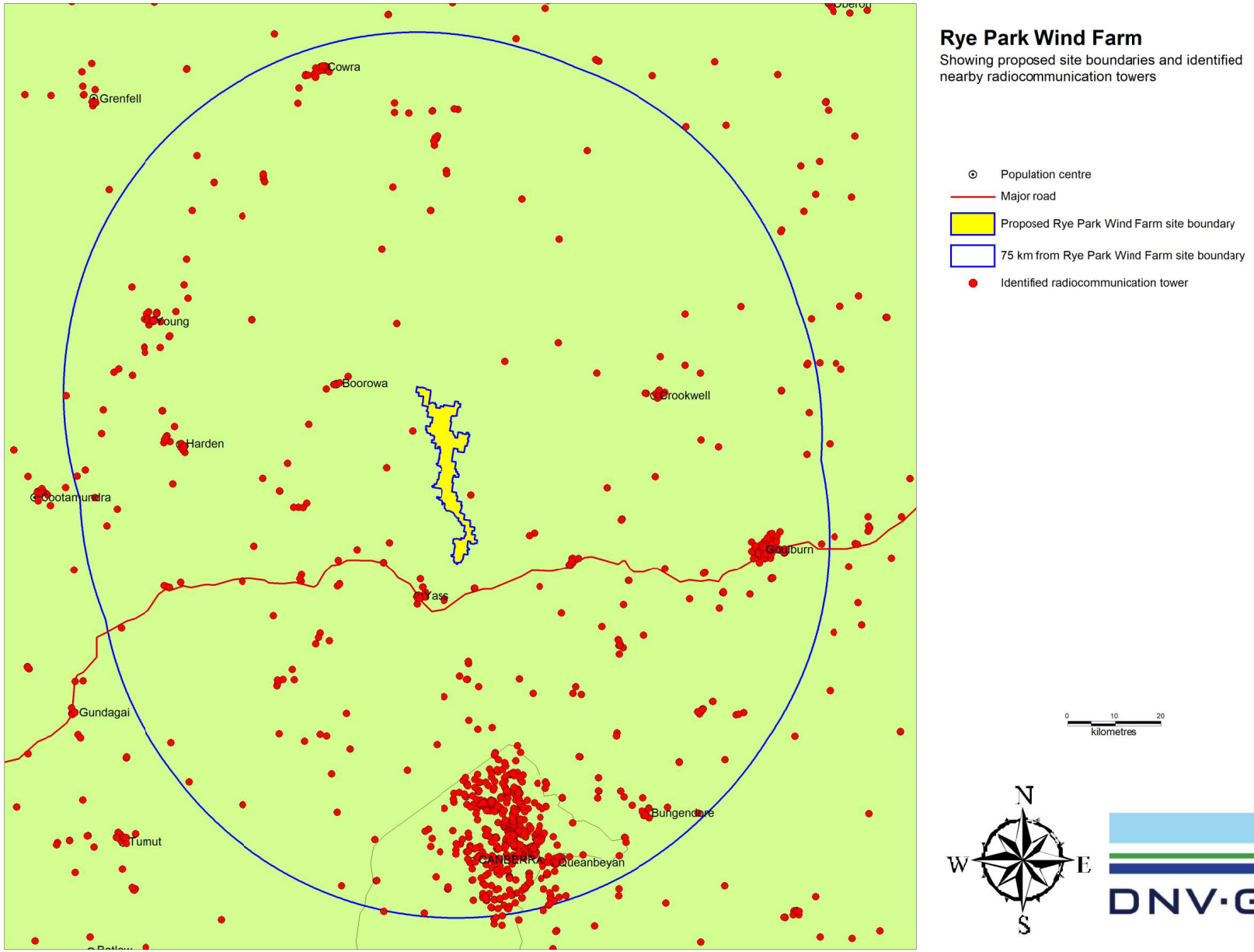

Figure 2 Location of the proposed Project and identified proximate radiocommunication sites

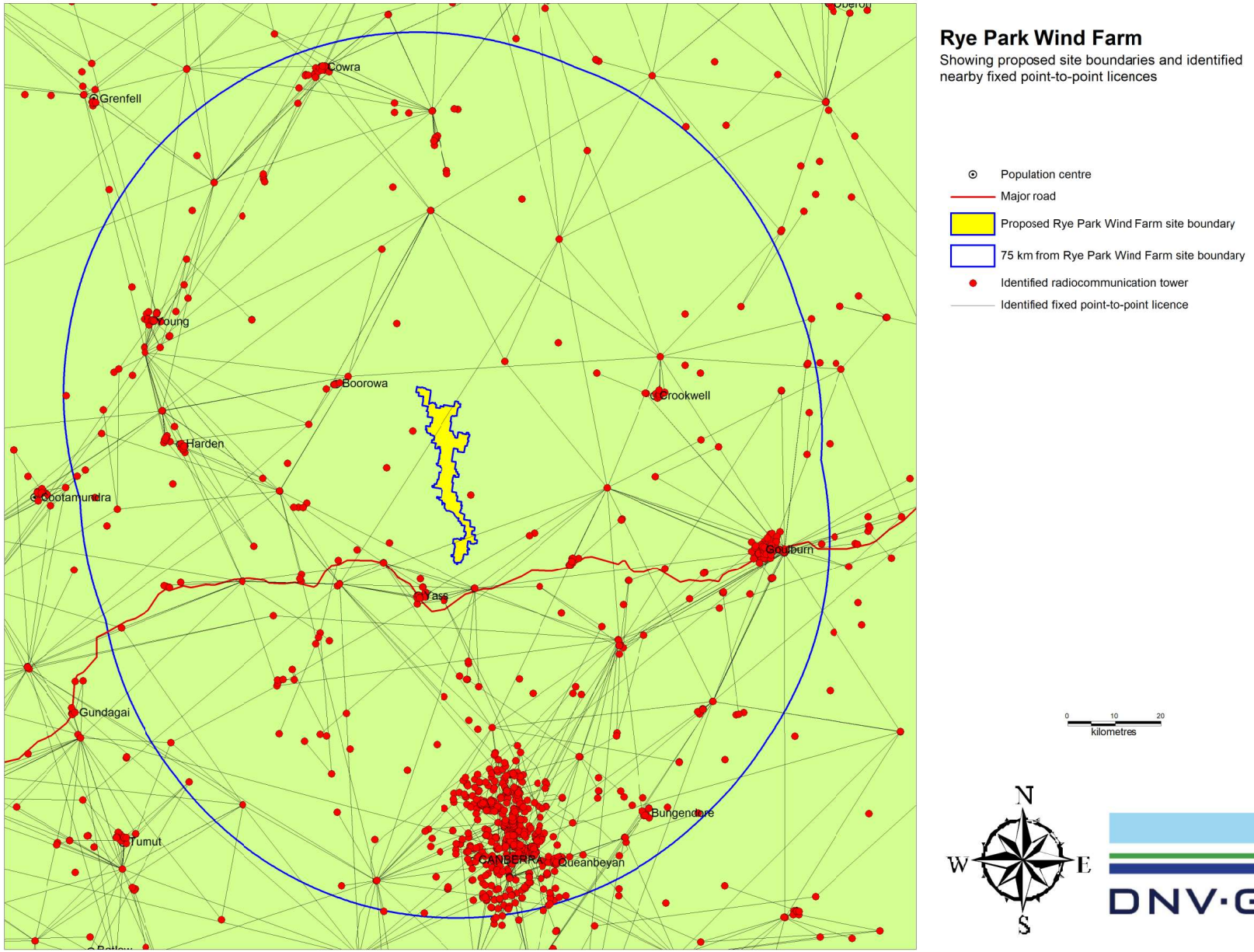

Figure 3 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

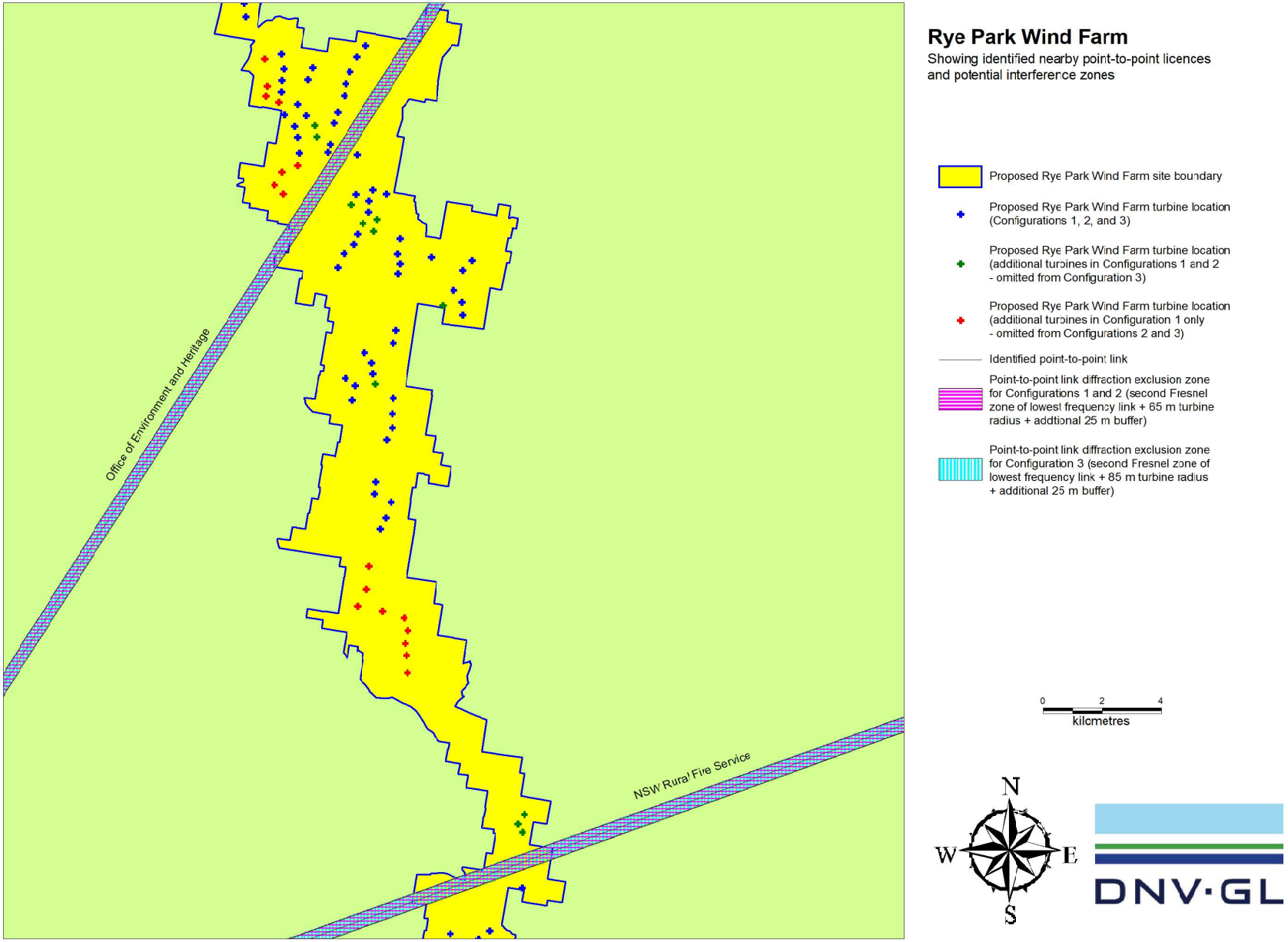

Figure 4 Identified point-to-point radiocommunication vectors and calculated interference zones for Configurations 1, 2, and 3 for the proposed Project

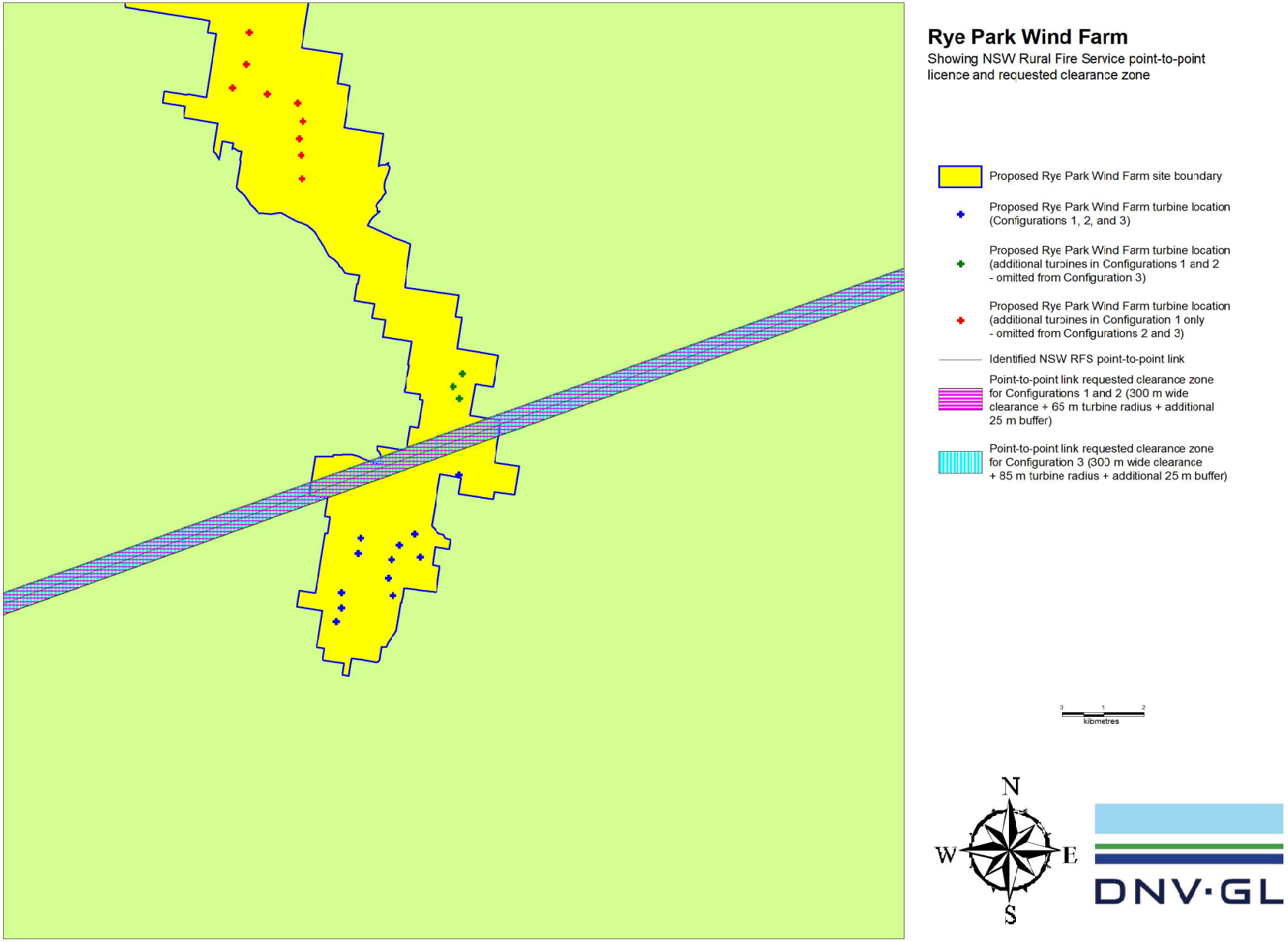

Figure 5 Identified point-to-point radiocommunication vectors operated by the NSW Rural Fire Service and requested clearance zone for Configurations 1, 2, and 3 for the proposed Project

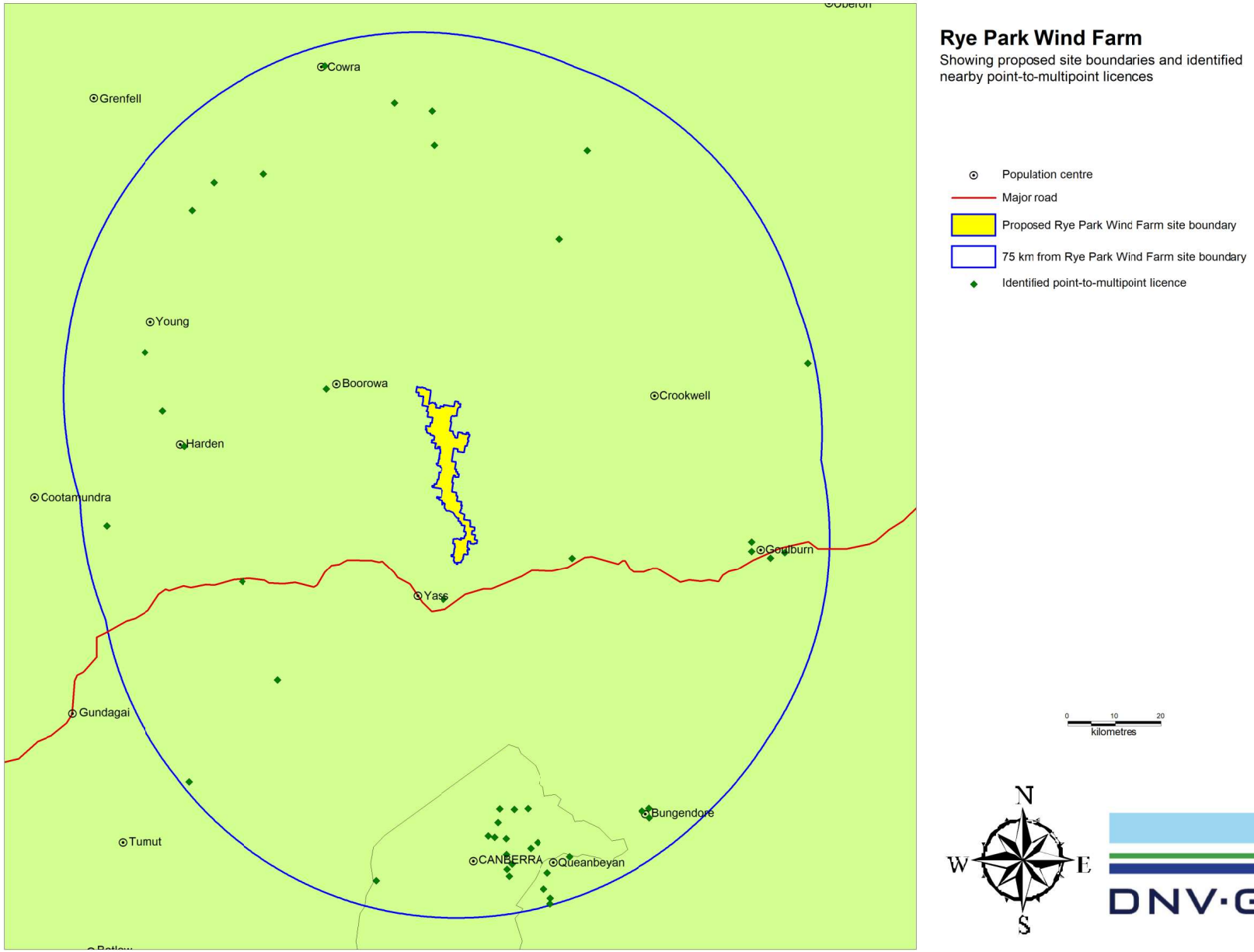

Figure 6 Location of point-to-multipoint licences in the vicinity of the proposed Project

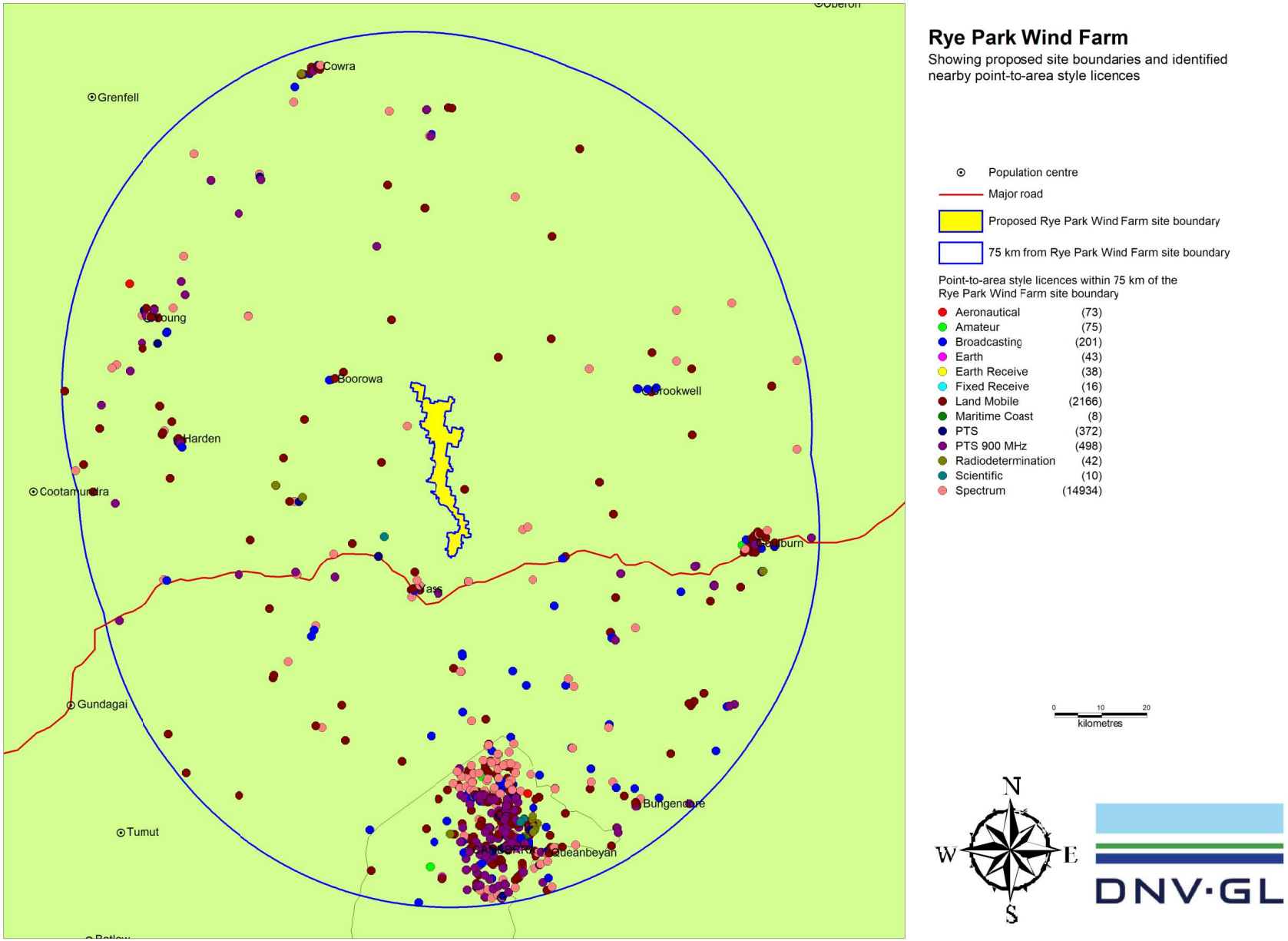

Figure 7 Location of general point-to-area style licences within 75km of the proposed Project

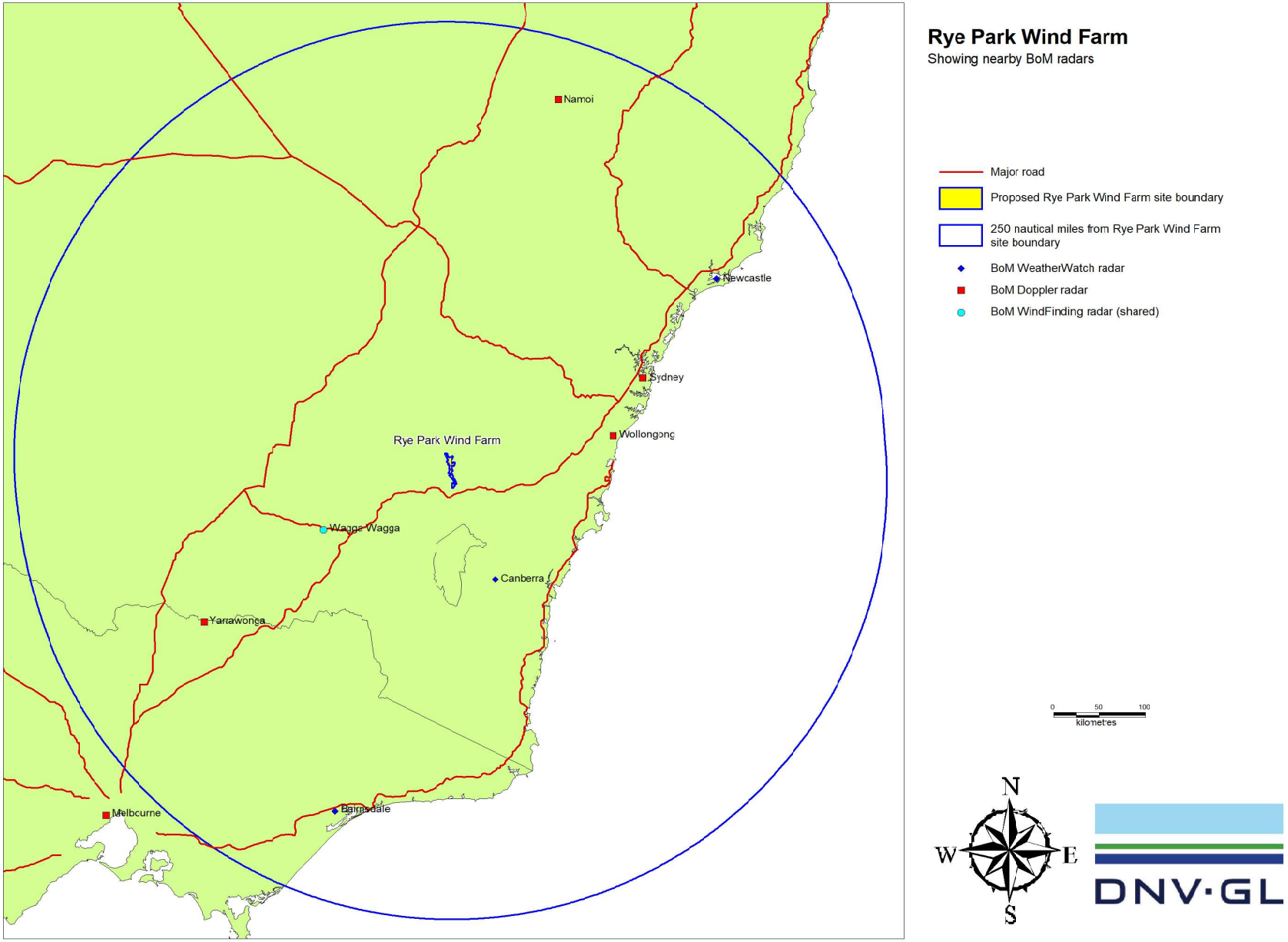

Figure 8 Location of meteorological radar sites within 250 nautical miles of the proposed Project

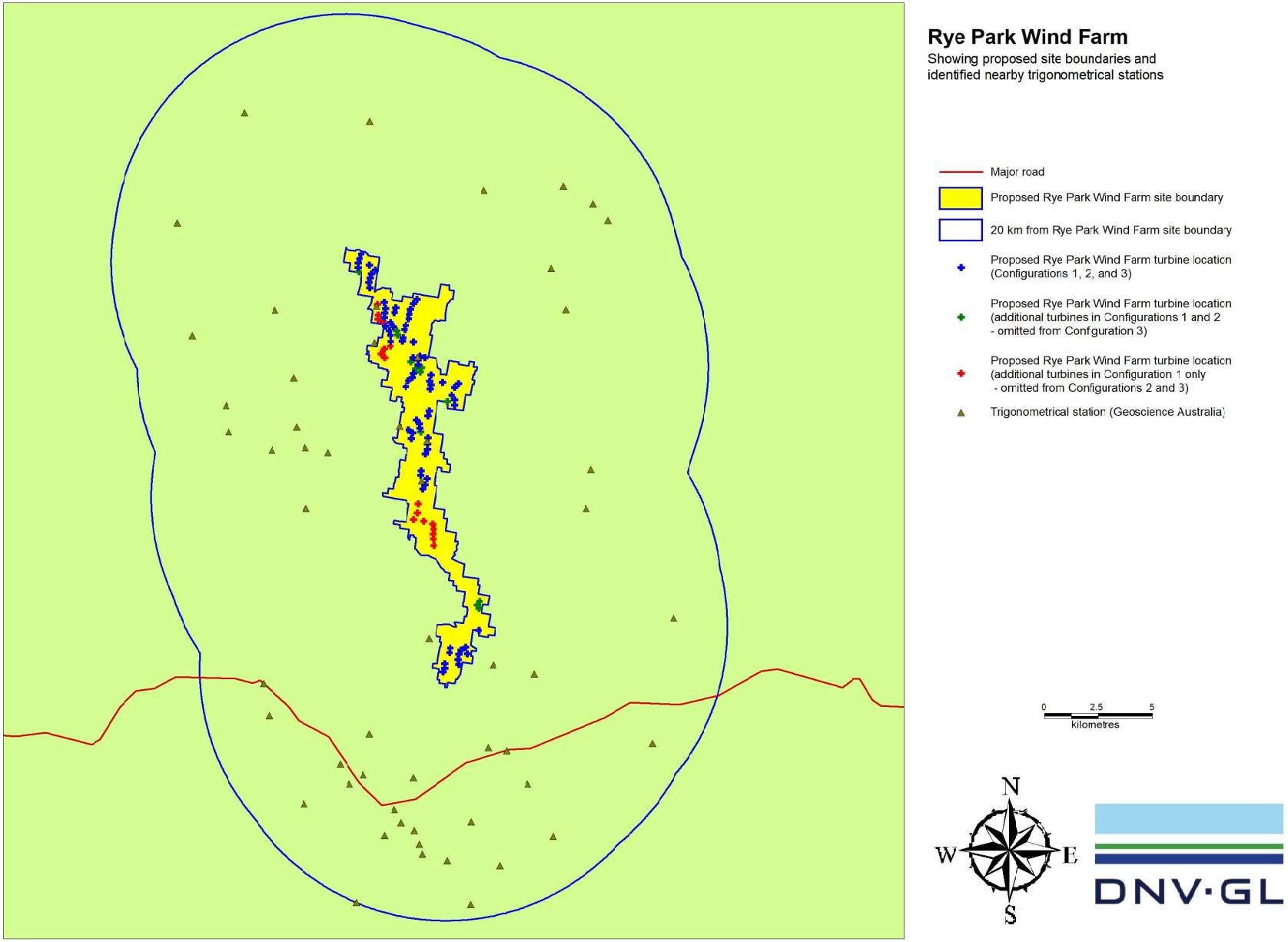

Figure 9 Location of trigonometrical stations within 20 km of the proposed Project

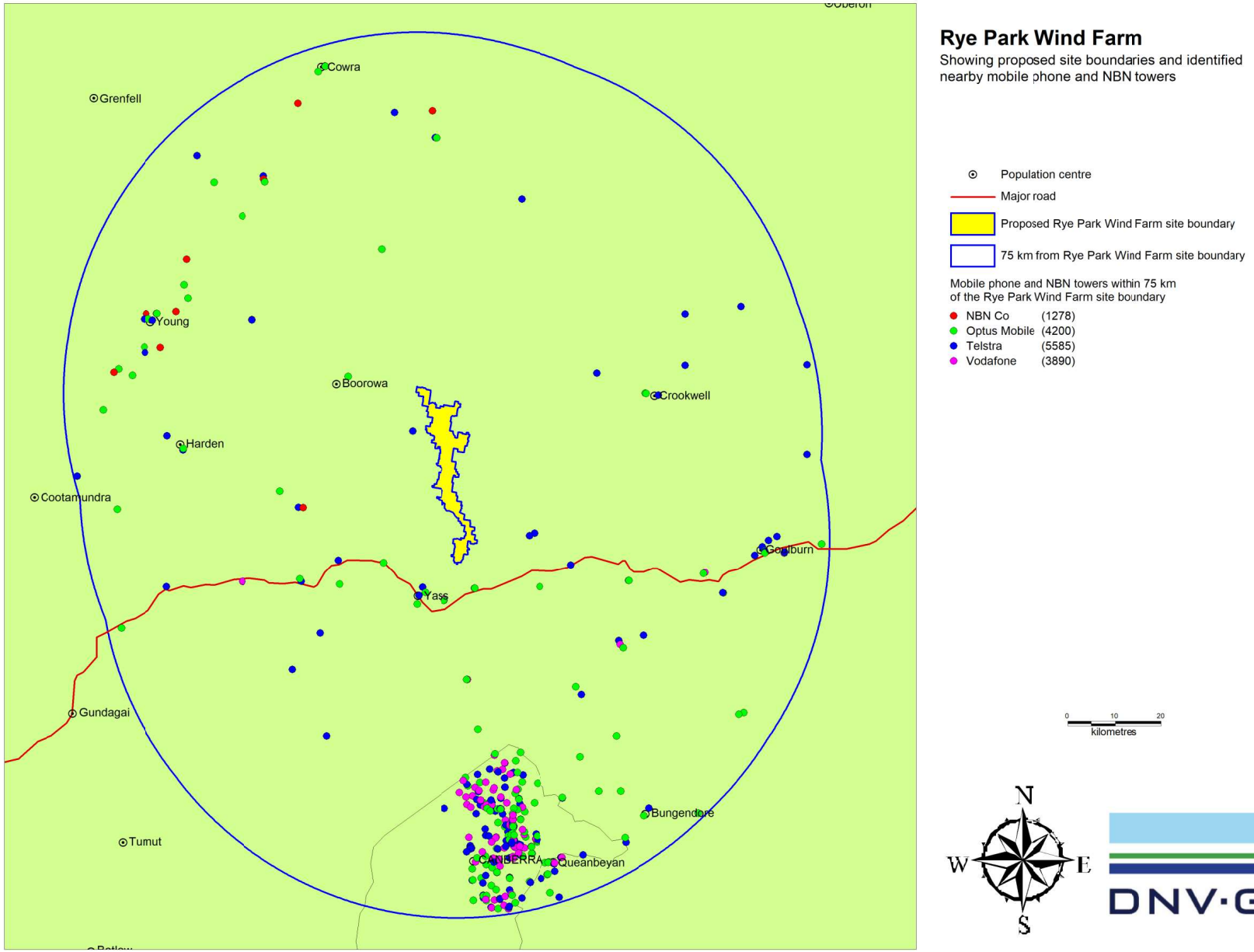

Figure 10 Location of mobile phone and NBN towers within 75 km of the proposed Project

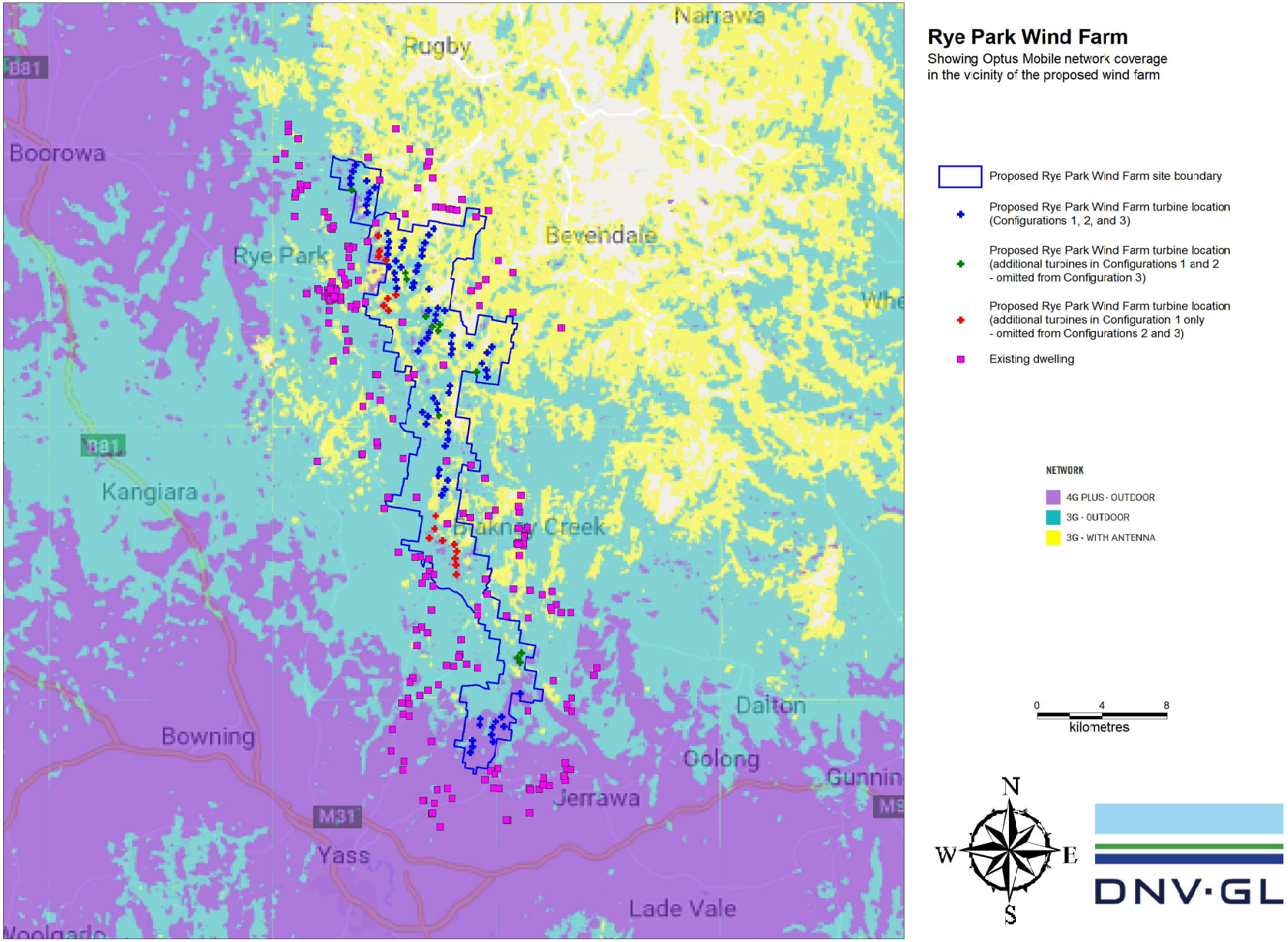

Figure 11 Optus Mobile network coverage (Apple iPhone X handset) for the proposed Project

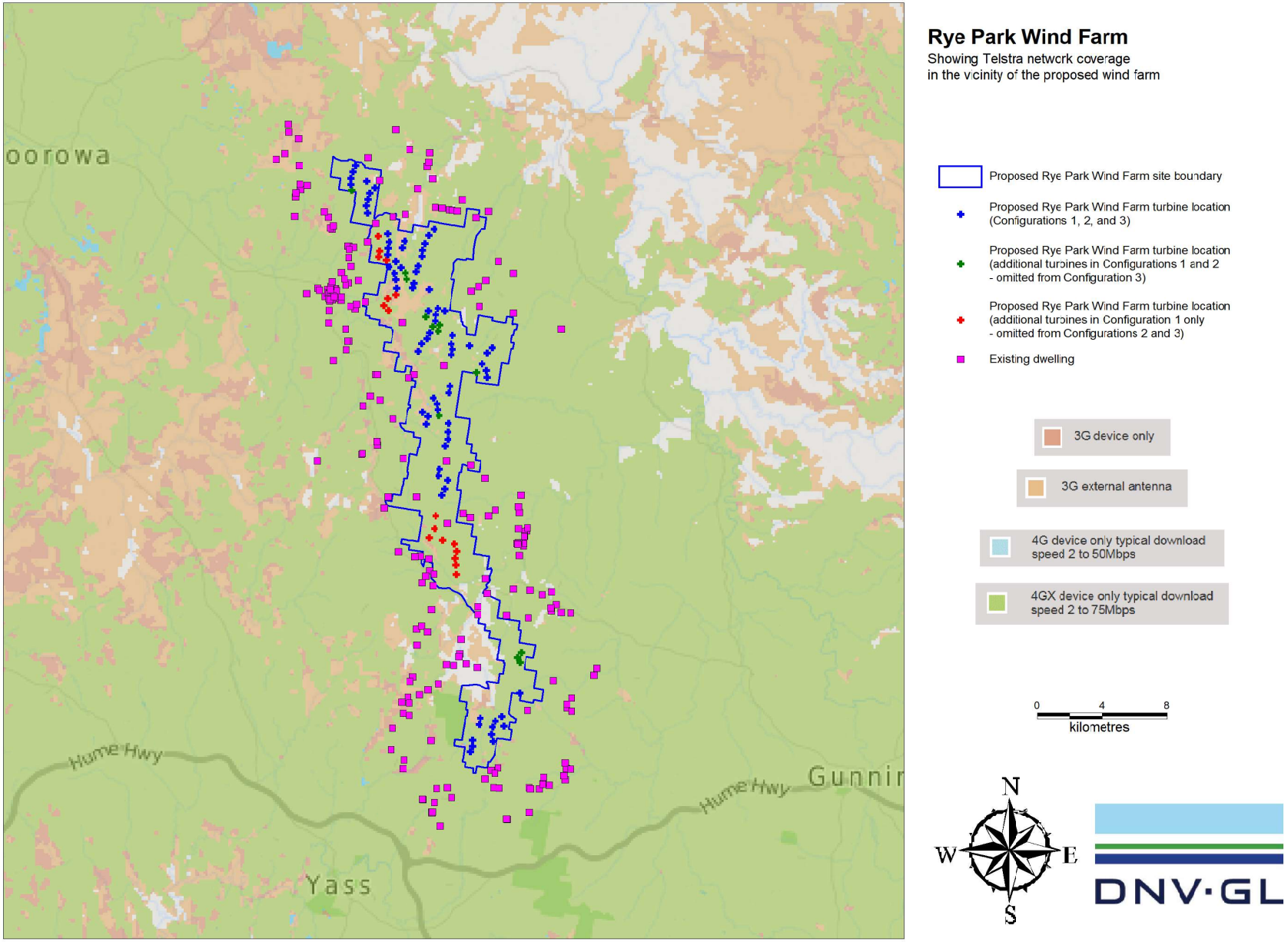

Figure 12 Telstra network coverage for the proposed Project

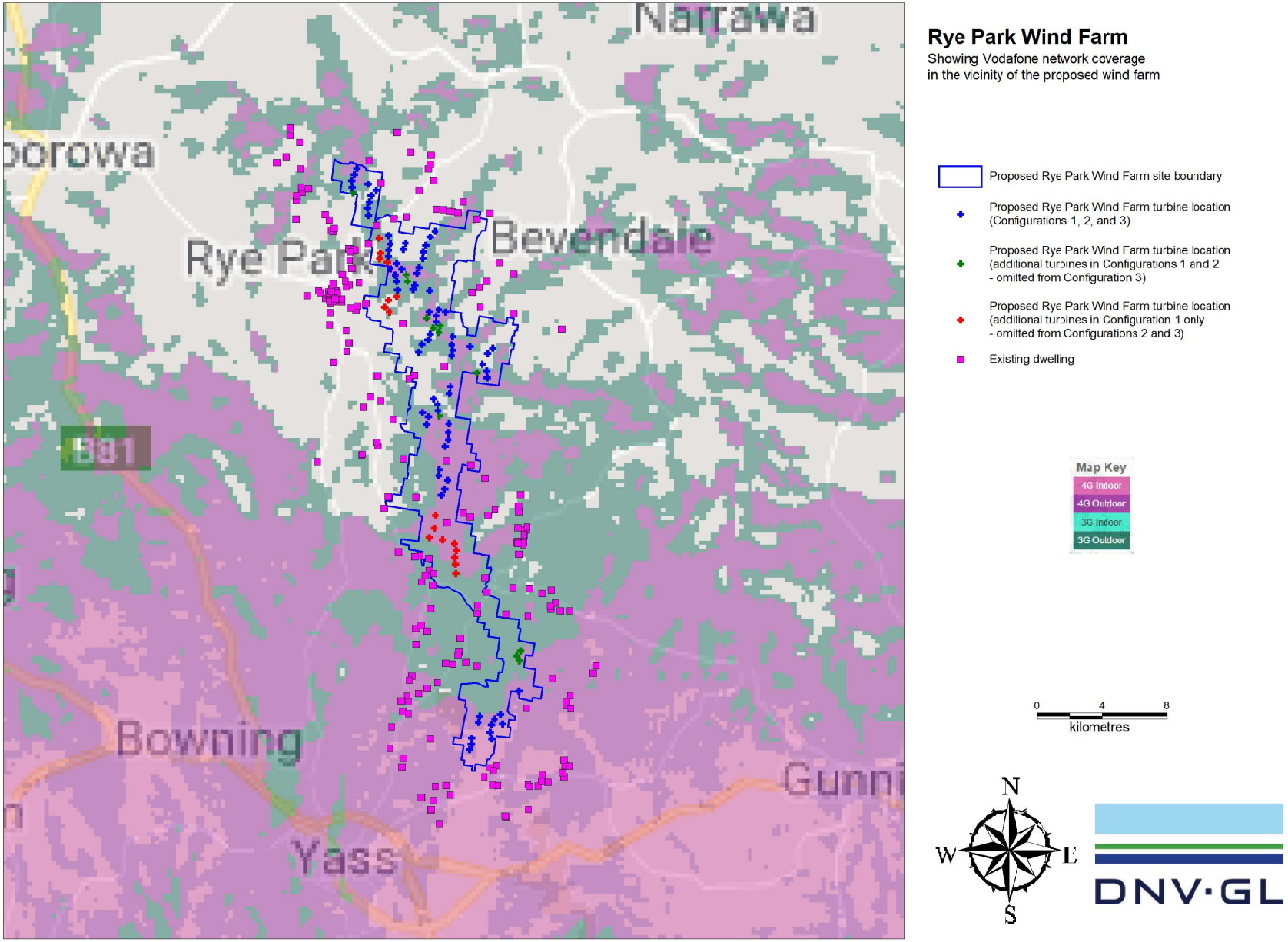

Figure 13 Vodafone network coverage (Apple iPhone X handset) for the proposed Project

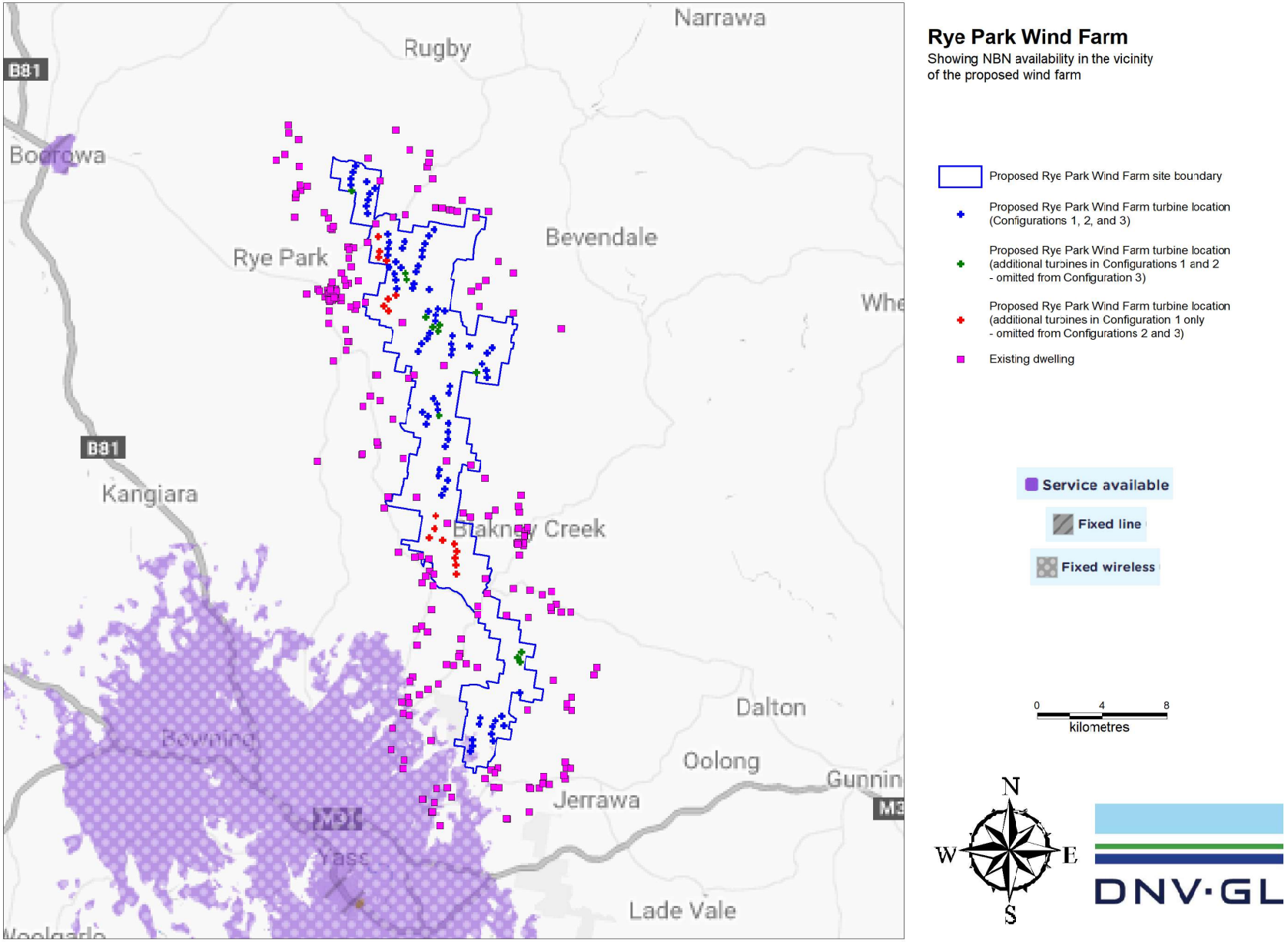

Figure 14 NBN internet coverage in the vicinity of the proposed Project

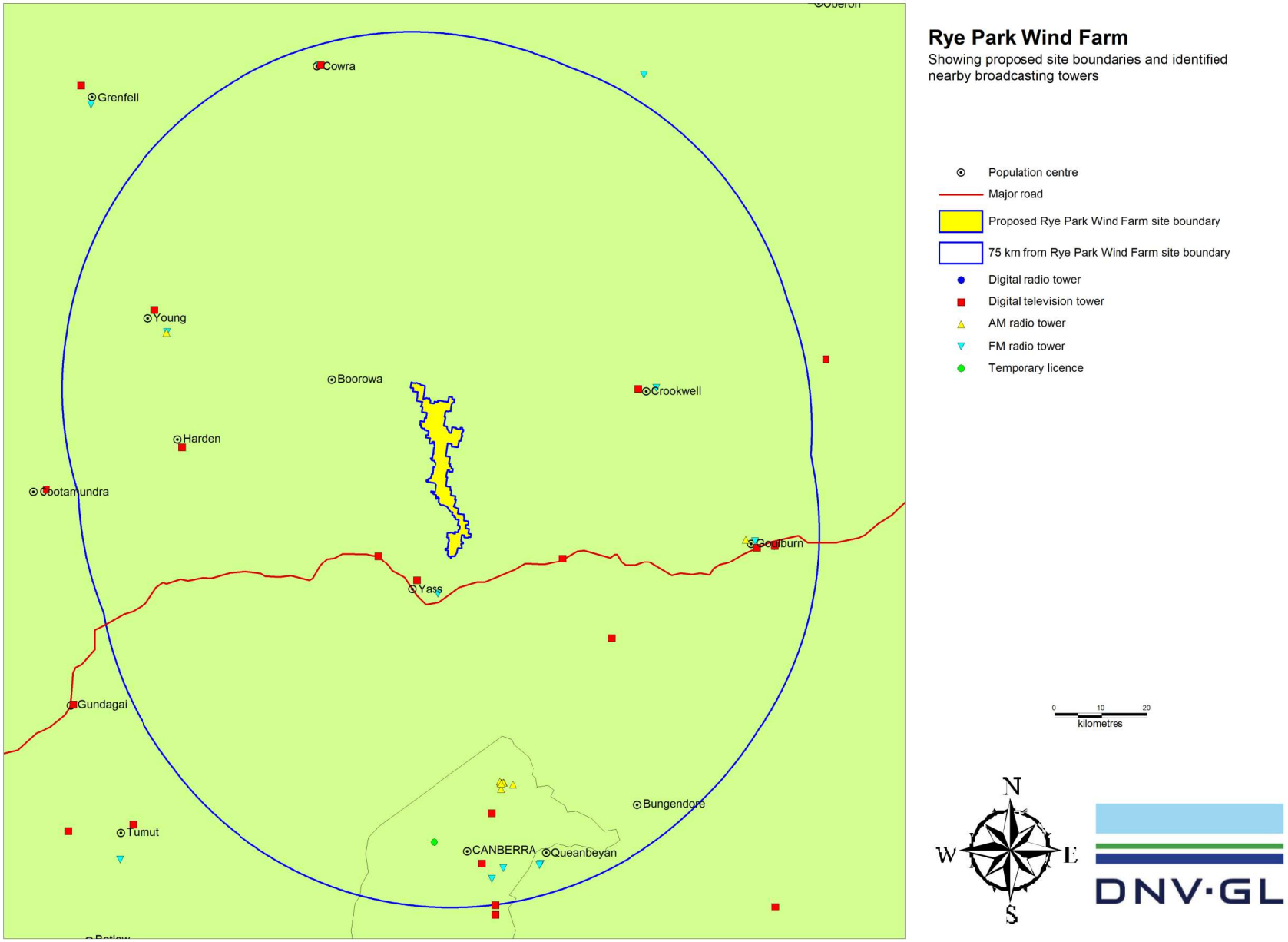

Figure 15 Location of broadcast transmitters in the vicinity of the proposed Project

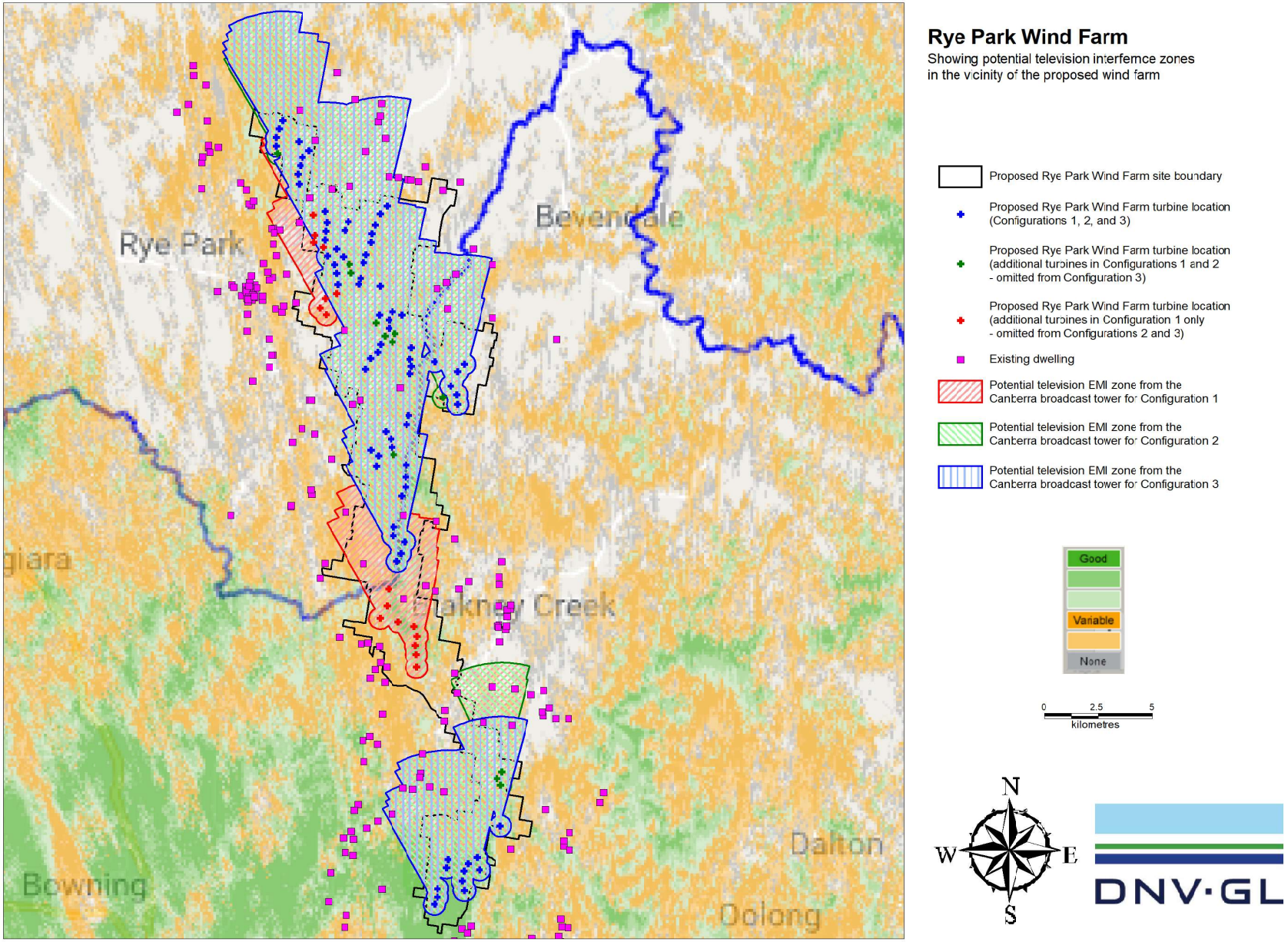

Figure 16 Potential television EMI zones from the Canberra broadcast tower for Configurations 1, 2, and 3 for the proposed Project

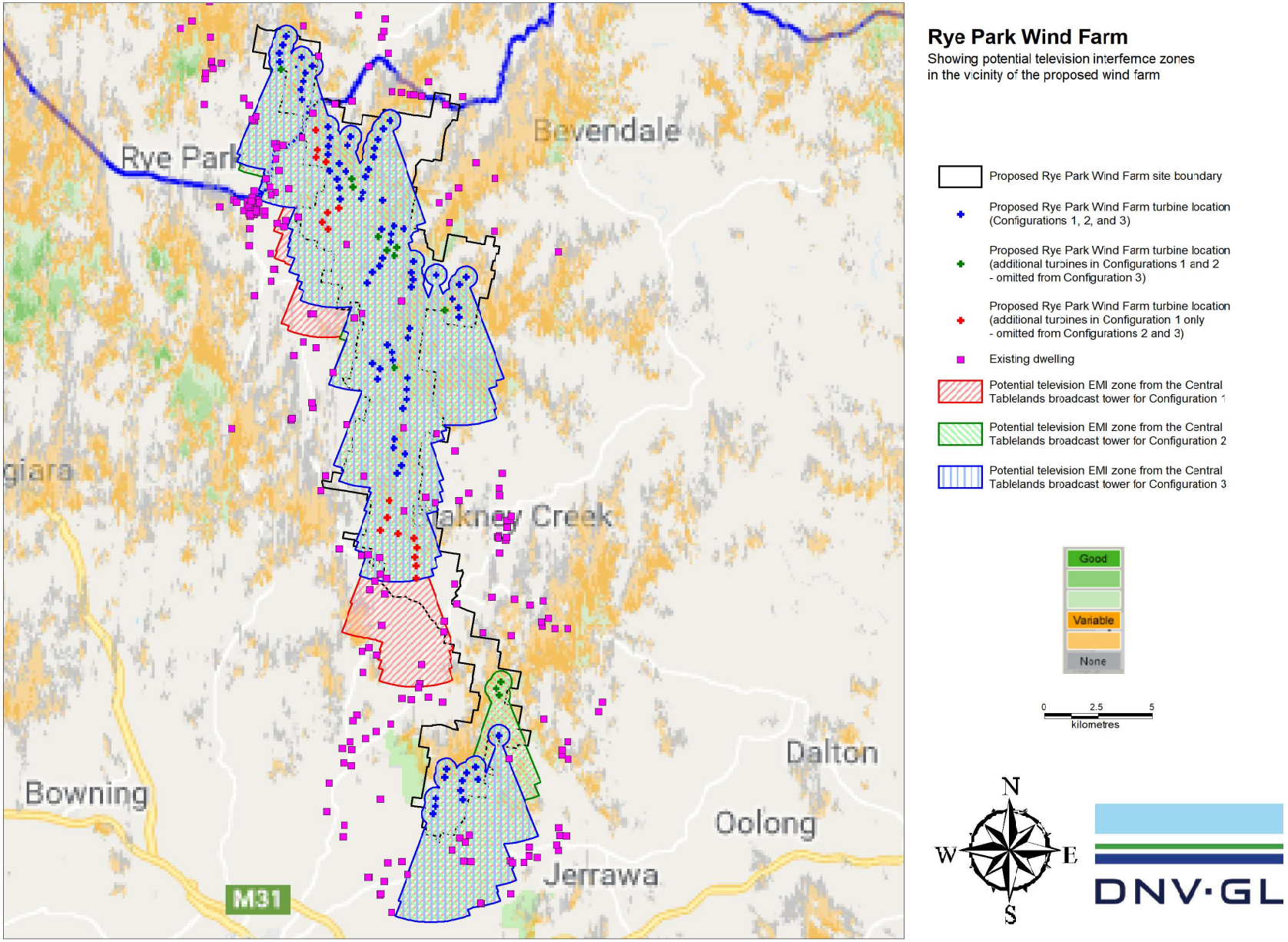

Figure 17 Potential television EMI zones from the Central Tablelands broadcast tower for Configurations 1, 2, and 3 for the proposed Project

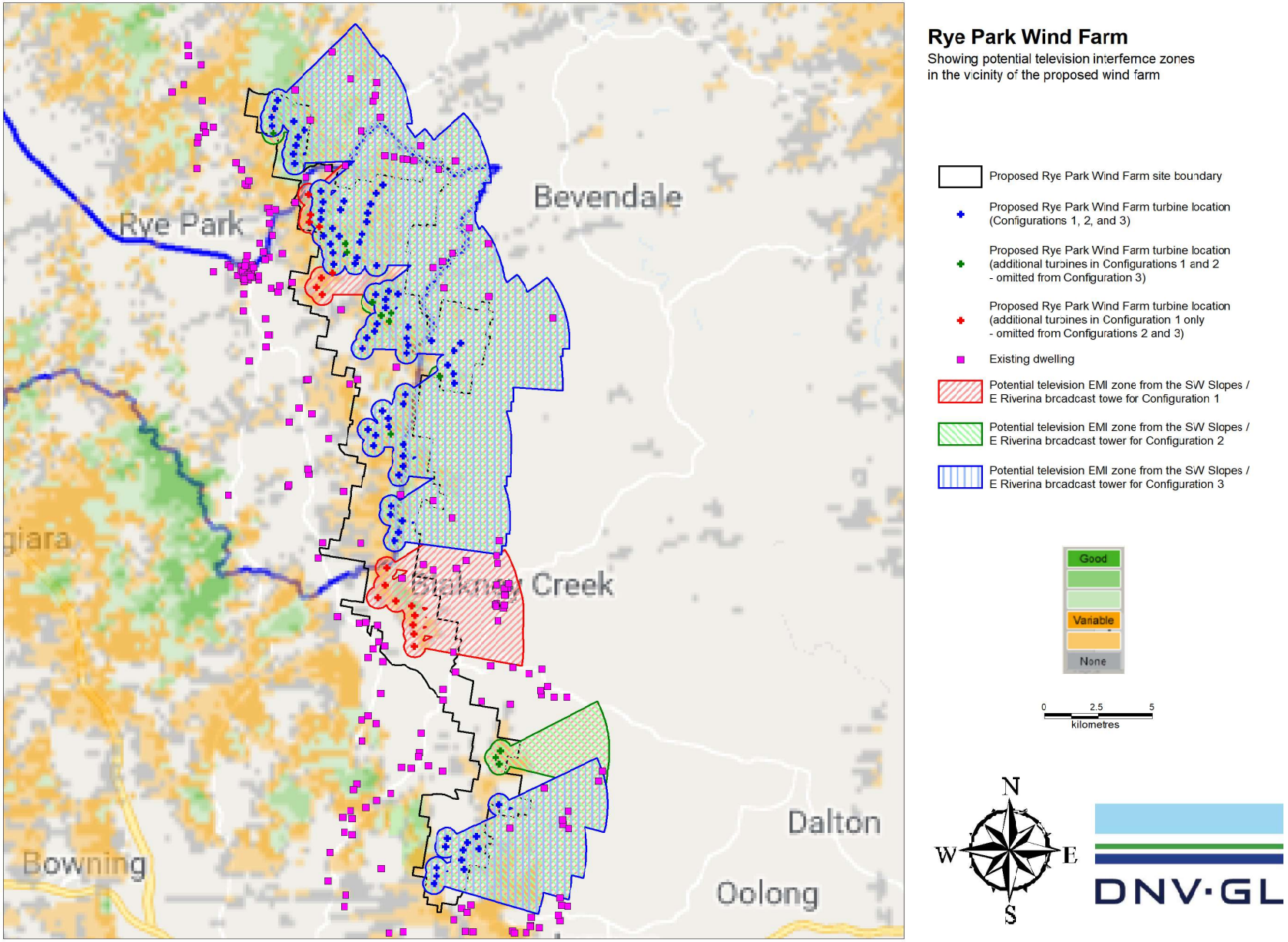

Figure 18 Potential television EMI zones from the SW Slopes / E Riverina broadcast tower for Configurations 1, 2, and 3 for the proposed Project

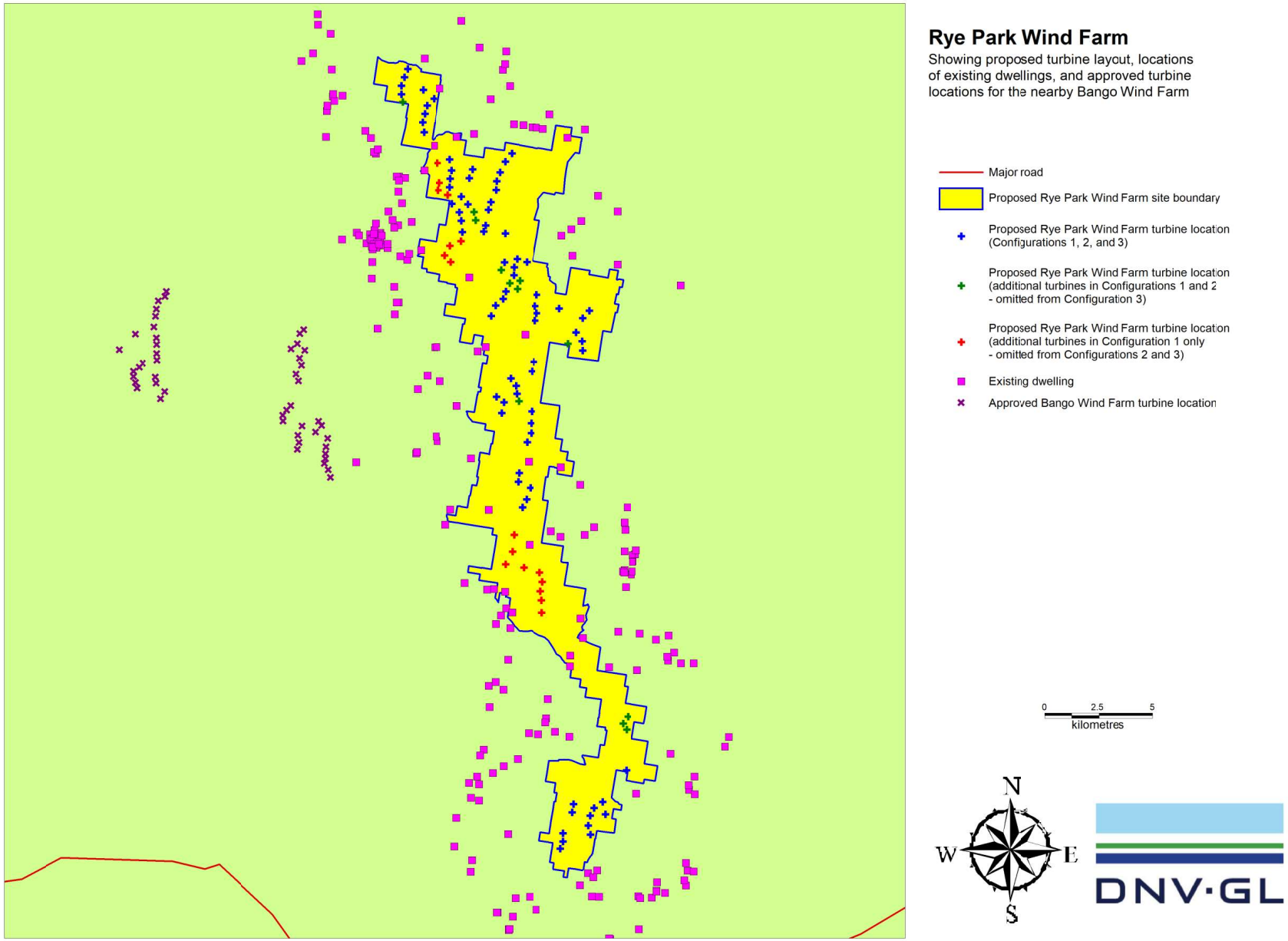

Figure 19 Map of the proposed Project, showing other wind farm developments within 10 km of the Project site

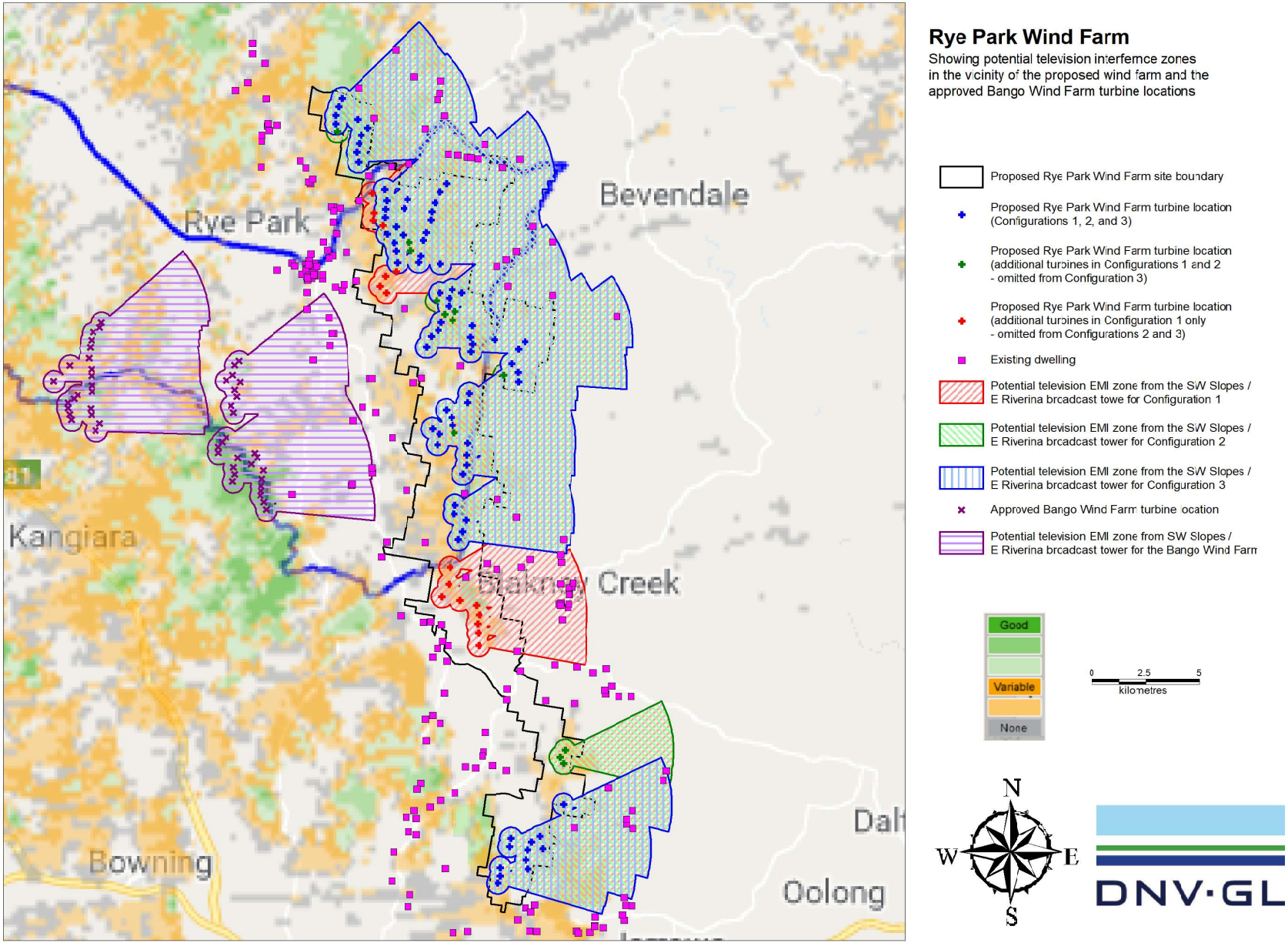

Figure 20 Potential television EMI zones from the SW Slopes / E Riverina broadcast tower for the proposed Project and the approved Bango Wind Farm

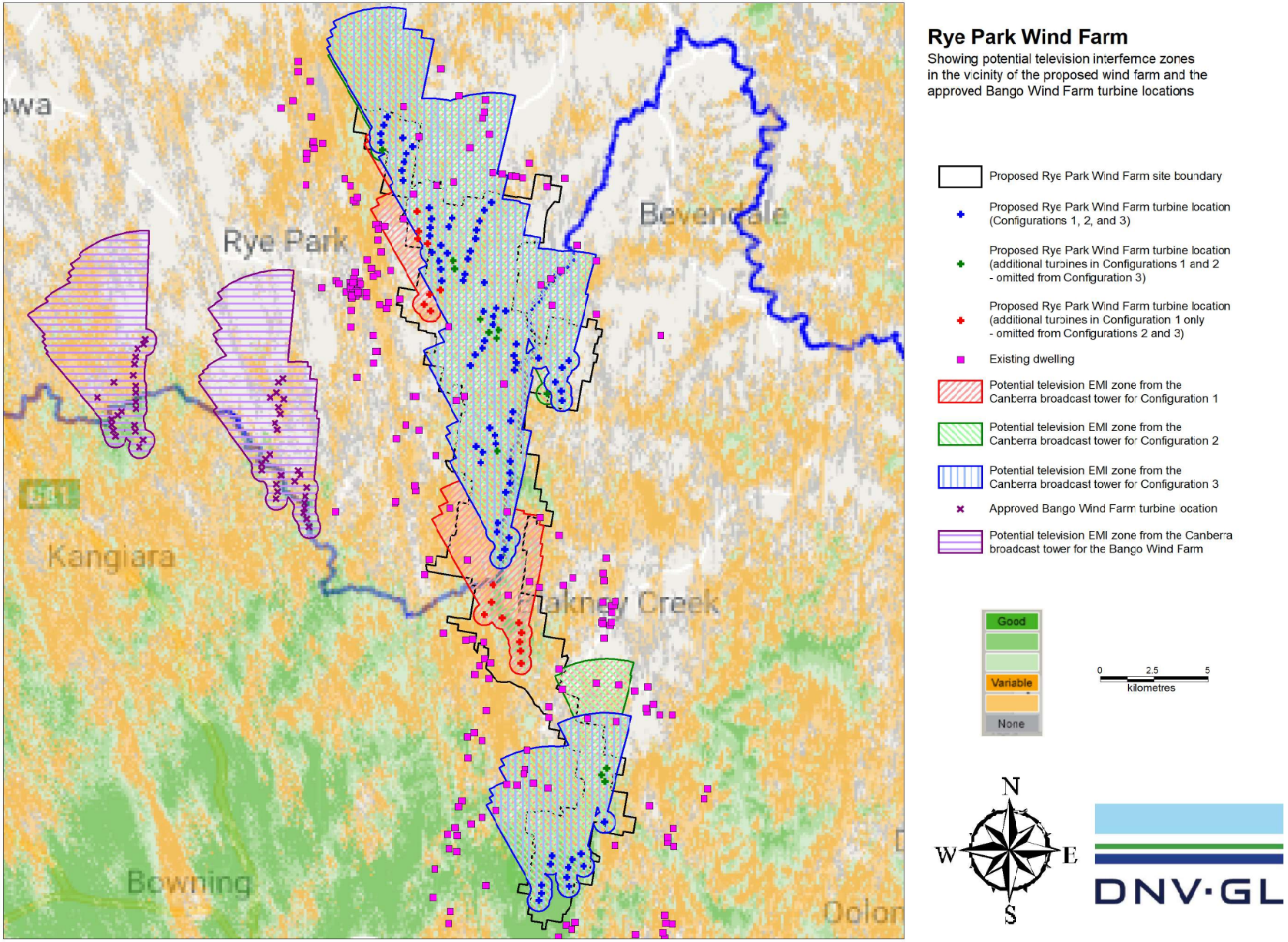

Figure 21 Potential television EMI zones from the Canberra broadcast tower for the proposed Project and the approved Bango Wind Farm

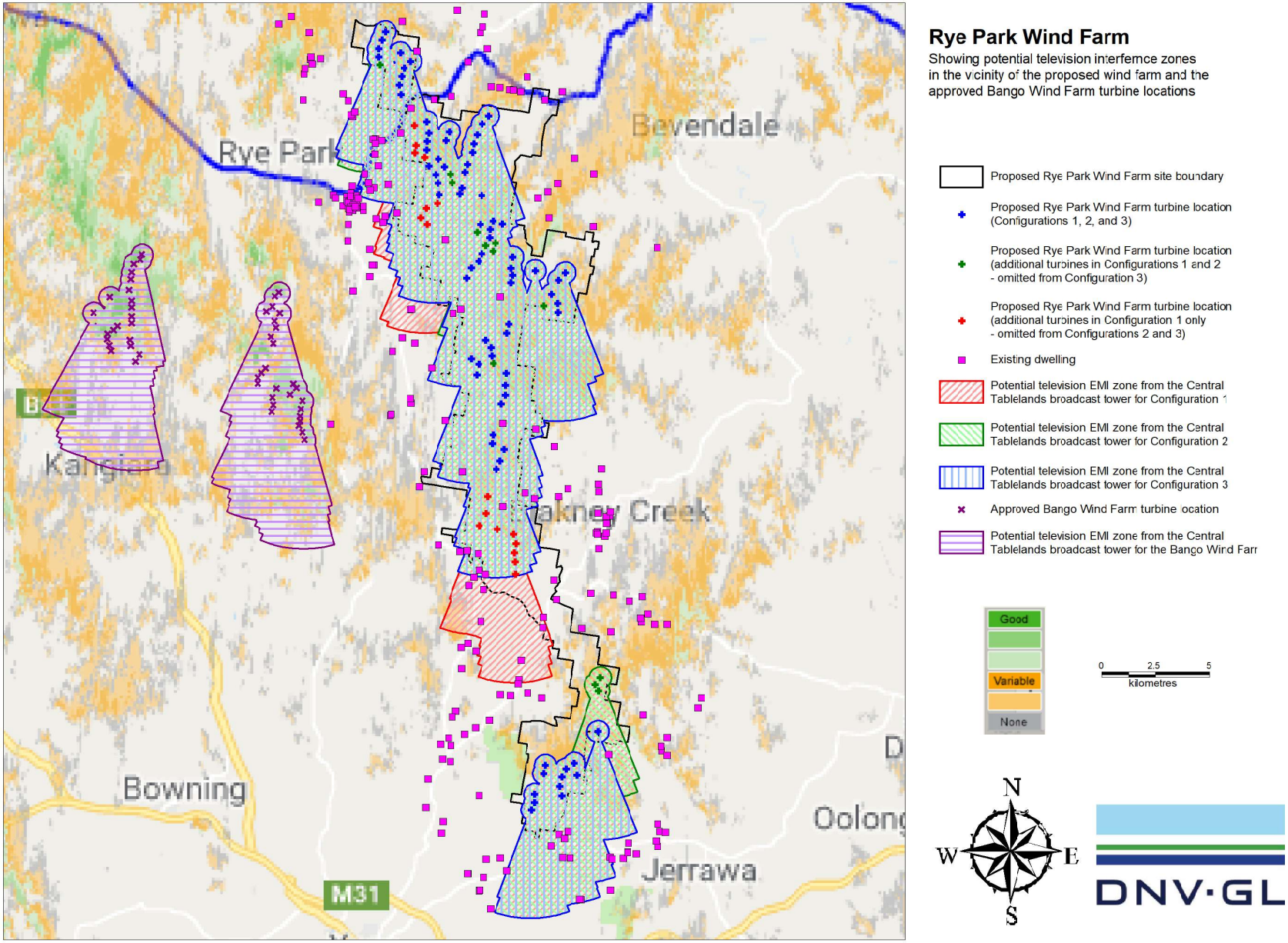

Figure 22 Potential television EMI zones from the Central Tablelands broadcast tower for the proposed Project and the approved Bango Wind Farm

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.