WILLATOOK WIND FARM

Planning Application Report

Appendix M Electromagnetic interference

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WILLATOOK WIND FARM

EMI Assessment

Willatook Wind Farm Pty Ltd

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EXECUTIVE SUMMARY

DNV has been commissioned by Willatook Wind Farm Pty Ltd ("the Proponent") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Willatook Wind Farm ("the Project") in western Victoria. The results of the EMI assessment are described in this document.

Background and methodology

DNV has assessed the potential EMI impacts for the Project in accordance with the Victorian Planning Guidelines [1] and Draft National Wind Farm Development Guidelines [2]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

A Project layout consisting of 59 generic wind turbines with a rotor diameter of 190 m, upper tip height of 250 m, and lower tip height of 40 m has been considered. These dimensions represent the maximum upper tip height and minimum lower tip height within the maximum rotor and tower hub height dimensions. Consultation with operators of nearby radiocommunication services was undertaken based on a previous layout for the Project consisting of 75 turbines, but DNV notes that the potential impacts of the 59-turbine layout considered here are expected to be the same or less than the impacts for the 75-turbine layout.

A total of 136 dwellings have been identified within 5 km of the proposed turbine locations, 23 of which are stakeholder dwellings belonging to wind farm host landowners or landowners who have entered into a formal agreement with the Proponent.

Outcomes of the assessment

The results of the EMI assessment are summarised in the table on the following page.

There is one fixed point-to-point link passing over the Project boundaries. The link operator, AusNet Services, has advised that interference can be avoided by maintaining a clearance of 20 m either side of the link path. There are no turbines located within the clearance zone requested by AusNet Services or the diffraction interference zone established by DNV. While there is potential for turbines to interfere with the link through reflection or scattering of the signals, the feedback received from AusNet Services suggests that interference is unlikely provided that the requested clearance is maintained.

There is potential for interference to NBN wireless internet signals received from the Hawkesdale NBN tower at dwellings in the vicinity of the Project, although NBN Co has advised that the proposed turbine locations are not expected to cause interference to their services. If interference is experienced after construction of the Project, it is likely that problems could be rectified by relocating the antennas at the affected dwellings to achieve a clearer signal or to receive signals from an alternative tower. DNV understands that the Proponent has committed to ongoing consultation with NBN Co, and to implementing mitigation measures, as required, in the event that the Project causes interference to NBN fixed wireless signals.

Signals from satellites that provide television and internet services intended for Australian audiences may be intercepted by turbines at the Project for one stakeholder dwelling, although DNV understands that this dwelling is currently in a 'dilapidated' state. Interference to signals from satellites that transmit programs intended for international audiences is also possible at several nearby dwellings. However, it is considered unlikely that residents will be receiving signals from

these satellites due to their low angles of elevation and the availability of alternative services. If interference is experienced, mitigation options could include realigning or upgrading the user's satellite dish or seeking an alternative source of the same programming or service. DNV recommends that the Proponent engages with the residents or owners of potentially affected dwellings to determine if any are currently receiving these satellite signals, and to establish an understanding of how any impacts may be mitigated.

Interference to digital television (DTV) signals from nearby broadcast towers may be experienced in areas that already have marginal reception. The potential for interference is higher for signals from the Portland and Western Victoria towers, which have poor to marginal coverage across the Project site, than for signals from the Warrnambool tower, which is the primary transmitter for the area and has stronger signal coverage. Feedback received from BAI Communications, who operate these towers, also suggests that residents in the vicinity of the Project may experience interference to DTV signals from the Portland and Western Victoria towers. However, based on coverage maps and modelling conducted by BAI Communications, it is expected that the potentially affected dwellings will be able to receive alternative signals from one of the other towers and the overall impact will be minimal. If interference is experienced, mitigation options may include realigning or upgrading the user's antenna, installing cable or satellite television at the affected dwelling, or installing a signal repeater on the opposite side of the Project. DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to DTV signals.

In addition to the mitigation options outlined above, DNV also understands that the Proponent has committed to conducting pre-construction measurements of the average television and radio reception strength in the vicinity of the Project and will establish a process for managing complaints related to impacts on television and radio reception at nearby dwellings once the Project is operational.

While the Project may cause interference to emergency services radiocommunications, mobile phone services, meteorological radar, and trigonometrical stations in the surrounding area, further information from the operators of those services is required to determine the likely impacts. DNV understands that the Proponent has contacted those organisations to seek feedback regarding any potential for EMI-related impact, and no concerns have been raised to date.

The Project is located in an area of high wind farm development activity, with several approved and operating wind farms located nearby. Based on the relative locations of these wind farms, there is a potential for cumulative EMI-related impacts to broadcast DTV signals received at nearby dwellings. However, the results of an assessment conducted by BAI Communications indicate that the overall impact on broadcast DTV signals from the Project in conjunction with the nearby wind farms is likely to be minimal. There is also potential for increased interference to mobile phone and FM radio signals in areas where there may be multiple wind turbines between the user and the transmission tower. Cumulative impacts to other services, including point-to-point links and NBN fixed wireless internet signals, are not expected. It is noted that DNV has not conducted a detailed assessment of the potential for cumulative impact, and further investigation may be required to better understand the potential impacts.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radiocommunication towers	One tower within 2 km of proposed turbine locations, operated by AusNet Transmission Group Pty Ltd (AusNet Services)	Low potential to cause interference	No concerns raised	None required
Fixed point-to-point links	One link crossing Project boundary, operated by AusNet Services Diffraction effects: no turbines in exclusion zone established by DNV or clearance zone requested by AusNet Services (plus additional buffer to account for potential inaccuracies in the tower locations) Reflection/scattering effects: 11 turbines in interference zone established by DNV Near-field effects: no turbines in interference zone established by DNV	Potential to cause interference through reflection or scattering of signals	Potential to cause interference if turbine blades enter a clearance zone of 20 m either side of the link path	None required, requested clearance has been maintained
Fixed point-to-multipoint links	44 assignments within 75 km of Project boundary Three base stations within 20 km of Project boundary, operated by: Aussie Broadband Pty Ltd (Aussie Broadband) Powercor Australia Pty Ltd (Powercor) Wannon Region Water Corporation (Wannon Water)	Potential to cause interference if link paths cross the Project site near turbines	No concerns raised by Aussie Broadband and Powercor Locations of remote supervisory and data acquisition (SCADA) radio sites provided by Wannon Water, but no formal response received	*If required* – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	-	-	-
Emergency services	Point-to-point links: no links crossing boundary Mobile telephony systems: unlikely to be affected	Unlikely to cause interference	Consultation undertaken by the Proponent No concerns raised by the Country Fire Authority and Regional Mobile Radio	Point-to-point links: none required Mobile radio systems: *if required* – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

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

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Meteorological radar	Nearest radar: "Mount Gambier", 122 km from Project	Potential to cause interference if turbines at the Project are visible to radars	Any interference is expected to be manageable	Notify the Bureau of Meteorology prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the Bureau of Meteorology in the event of severe weather conditions
Trigonometrical stations	Trigonometrical stations: unlikely to be affected Survey marks: unlikely to be affected	Unlikely to cause interference	Consultation undertaken by the Proponent No concerns raised by the Department of Environment, Land, Water and Planning No response received from Geoscience Australia	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low potential to cause interference	Consultation undertaken by the Proponent No concerns raised by Optus and Telstra No response received from Vodafone	*If required* – increase signal strength from affected tower or alternative towers, install additional tower

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

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Wireless internet	Likely service providers: Aussie Broadband, mobile phone networks NBN: currently available as a fixed wireless and satellite service	Potential to cause interference to NBN fixed wireless internet signals	No concerns raised by Aussie Broadband Interference not expected by NBN Co for proposed turbine locations Consultation with mobile phone providers undertaken by the Proponent No concerns raised by Optus and Telstra No response received from Vodafone	Mobile phone networks: as for mobile phones NBN: *if required* – re-direct antenna at affected dwelling to alternative tower, change location of antenna, install new tower
Satellite television and internet	Services intended for Australian audiences: signals intercepted at one stakeholder dwelling (understood to be 'dilapidated') Services intended for international audiences: signals intercepted at 8 dwellings (5 stakeholder dwellings)	Low potential to cause interference	Consultation with operators not considered necessary DNV recommends engaging with residents or owners of potentially affected dwellings	*If required* – re-direct satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish

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

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference in close proximity to turbines Digital radio signals: not available in the vicinity of the Project	Low potential to cause interference to FM signals	Consultation not considered necessary	AM signals and digital radio signals: none required FM signals: *if required* – install higher-quality antenna at affected location, increase signal strength from affected tower, move tower to new location, install signal repeater, install additional tower
Television broadcasting	May experience interference in areas with poor or marginal reception			*If required* - re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	Warrnambool tower: 'variable' to 'good' coverage across the site 35 dwellings in potential interference zone	Potential to cause interference	Unlikely to cause interference	
	Portland tower: coverage ranging from 'good' to the west of the site to 'poor' or non-existent to the east of the site 40 dwellings in potential interference zone	Potential to cause interference	Low risk of interference for one resident (based on previous 75-turbine layout)	
	Western Victoria tower: 'poor' to 'variable' coverage across the site 66 dwellings in potential interference zone	Potential to cause interference	Risk of interference for up to 42 residents (based on previous 75-turbine layout), but affected residents are likely to be able to receive alternative signals from the Warrnambool tower	

1 INTRODUCTION

Willatook Wind Farm Pty Ltd ("the Proponent") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Willatook Wind Farm ("the Project") in western Victoria. The results of this work are reported here. This document has been prepared in accordance with DNV proposal L2C-210977-AUME-P-01 Issue B, dated 2 February 2021, and is subject to the terms and conditions in that agreement.

In accordance with the Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (Victorian Guidelines) prepared by the Department of Environment, Land, Water and Planning (DELWP) in July 2021 [1] and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [2], 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 approximately 22 km to the north of Port Fairy and 32 km to the northwest of Warrnambool and extends across both sides of the Woolsthorpe–Heywood Road. The Project is located within an area of private and public land that is largely used for agriculture, predominantly sheep and cattle grazing.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 59 wind turbines [3]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 9. However, DNV notes that the consultation with the operators of nearby radiocommunication services described in this document was undertaken based on a previous layout for the Project consisting of 75 wind turbines.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Proponent [4]. For the purposes of this assessment, DNV has considered all identified dwellings within 5 km of the Project site boundaries. There are 135 dwellings located within 5 km of the proposed turbine locations, 23 of which are stakeholder dwellings belonging to wind farm host landowners or landowners who have entered into a formal agreement with the Proponent The coordinates of these dwellings are presented in Table 10, and the dwellings and site boundaries considered in this assessment are shown in Figure 1.

DNV 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 has assumed that all listed dwellings are inhabited.

3 REGULATORY REQUIREMENTS

There are two sets of guidelines that are potentially relevant to the assessment of EMI impacts for wind farms in Victoria.

The Victorian Guidelines [1] state that "*[t]he effect of wind turbine on electromagnetic waves will usually be relatively limited*" and that "*[t]he potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting*".

Although the Victorian Guidelines state that "*potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, [and] turbine design and location"* they do not provide detailed methodologies for these assessments.

Similarly, the scoping requirements for the environment effects statement for the Project (Scoping Requirements) [5] state that the environment effects statement should *"[i]dentify the potential for electromagnetic interference to radio-communications services"* but do not provide any guidance on how these potential impacts should be assessed.

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) [2]. 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 considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the Victorian Guidelines. 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 terrestrial 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 to complete this assessment based upon a layout provided for the Project consisting of 59 wind turbines, as outlined in Table 9.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 190 m, an upper tip height of 250 m, and a lower tip height of 40 m has been considered. These dimensions represent the maximum rotor diameter, maximum upper tip height, and minimum lower tip height under consideration for the Project. The results generated based on this turbine configuration will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying all of the following criteria:

- a rotor diameter of 190 m or less
- an upper tip height of 250 m or less
- a lower tip height of 40 m or more.

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 then 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 27 January 2022 [6].

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

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. The Proponent has provided DNV with feedback they have received from AusNet Transmission Group Pty Ltd (AusNet Services), Country Fire Authority, Department of Justice and Regulation, Bureau of Meteorology, DELWP, Optus, Telstra, and BAI Communications regarding the potential EMI-related impacts of the Project on their operations and services. DNV has consulted with other organisations operating point-to-multipoint and wireless internet services that may be impacted by the development and operation of the Project. Consultation with these operators was based on a previous layout for the Project consisting of 75 turbines, but DNV notes that the potential EMI-related impacts of the 59-turbine layout considered in this assessment are

expected to be the same or less than the impacts for the previous 75-turbine layout. All consultation responses received to date are summarised in Table 18.

DNV understands that the Proponent has also contacted other organisations operating services that may be impacted by the development and operation of the Project, to disseminate basic information on the Project and request responses from the organisations regarding whether they foresee any potential EMI-related impacts on their operations and services.

The radiocommunication licences and services with potential to experience EMI-related impacts from the proposed Project are considered in the following sections. Each section contains a brief overview of the relevant technology, followed by an assessment of the identified licences and services in the area around the Project and the expected potential for interference. Details of any feedback obtained from the service operators and potential mitigation options are also included where appropriate.

4.1 Radiocommunication towers

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, 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 Therefore 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.

4.1.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 433 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.

There is one radiocommunication tower located within 2 km of the proposed turbine locations. The location of this tower and the consultation zones recommended by the Draft National Guidelines [2] are shown in Figure 3 based on information provided by the operator and extracted from satellite imagery. Each consultation zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower location. The size of the uncertainty buffer is based on deviations between the tower location provided by the operator and the apparent location determined from satellite imagery. Details of the tower are given in Table 1**.** The only licences associated with the tower are fixed point-to-point links operated AusNet Services. The potential for interference to these point-to-point links is discussed further in Section 4.2.

Table 1 Details of radiocommunication towers located within 2 km of turbines at the proposed Project

Site ID	Associated licence types	Operators	Distance to nearest turbine [m]
9009729	Fixed point-to-point links	AusNet Transmission Group Pty Ltd	887

4.1.2 Stakeholder consultation and responses

The Proponent has provided DNV with feedback they have received from AusNet Services regarding the potential for the Project to impact on their operations and services. Based on the correspondence provided, AusNet Services have not expressed any concerns regarding the potential for the Project to cause interference to their services through near-field effects or reflection or scattering of signals.

Feedback obtained from AusNet Services regarding potential impacts to their fixed point-to-point links is summarised in Section 4.2.2.

4.2 Fixed licences of point-to-point type

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.

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.

4.2.1 Locations of point-to-point links and potential for interference

DNV has analysed the registered licences for each radiocommunication tower according to the ACMA RRL database to determine the transmission paths of the licenced links. For this analysis, DNV has used a wider and more conservative frequency range of 0 GHz to 50 GHz.

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 4. 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 is one point-to-point link recorded in the ACMA RRL database that pass over the proposed Project site operated by AusNet Services. The details of the link are provided in Table 11, and the link path is shown in greater detail in Figure 5 based on information obtained from the ACMA RRL database, provided by AusNet Services, and extracted from satellite imagery.

The potential interference mechanisms and interference zones established by DNV for this link are described in Sections 4.2.1.1, 4.2.1.2, and 4.2.1.3, and summarised in Section 4.2.1.4. Feedback

obtained from AusNet Services, including their recommended clearance zone to reduce the potential for interference, is summarised in Section 4.2.2.

4.2.1.1 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 [2] [7] [8], 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 [7], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [9] (although DNV understands that this zone is under review by the authors of that document). For the AusNet Services link, DNV has established a diffraction exclusion zone based on the second Fresnel zone.

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 has been calculated based on the Assignment ID with the lowest frequency.

The potential diffraction exclusion zone in the horizontal plane is shown in Figure 5. The exclusion zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer is based on deviations between the tower locations provided by AusNet Services and the apparent locations determined from aerial or satellite imagery.

DNV has also assessed the potential for the turbine blades to intersect with the diffraction exclusion zone in the vertical plane. This was achieved by examining the elevation and antenna heights at the end of the link, as well as the approximate elevation of areas within the Project boundaries over which the link crosses. It was found that the link crosses the site at a height that has potential to be intersected by the turbine blades.

The results of this analysis are summarised in Table 2. There are no turbines located within the diffraction exclusion zone established by DNV for the point-to-point link operated by AusNet Services. Therefore, it is not expected that the Project will cause interference to this link through diffraction effects.

4.2.1.2 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) [7].

Reference [7] 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.

For the AusNet Services link, DNV has established a reflection/scattering interference zone based on the antenna gains and length of the link, the worst-case RCS for the turbine calculated according to the equation proposed in [10], and an assumed minimum C/I ratio of 20 dB [10]. The radiation patterns for the antennas were approximated using the reference radiation patterns given in the International Telecommunication Union (ITU) Recommendation F.699-8 [11].

The potential reflection/scattering interference zone is shown in Figure 5. The interference zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations, as described in Section 4.2.1.1. For comparison, Figure 5 also shows the 2 km radius consultation zone for reflection or scattering effects as recommended by the Draft National Guidelines, centred on the transmission tower for the point-to-point link.

The results of this analysis are summarised in Table 2. There are seven turbines located within the potential reflection/scattering interference zones for the point-to-point link operated by AusNet Services.

The method used to establish the reflection/scattering interference zones shown in Figure 5 assumes that the direct path for the point-to-point link has a clear line-of-sight with respect to the first Fresnel zone, and that the paths for the reflected or scattered signal from the transmitter to the turbine and from the turbine to the receiver are also line-of-sight [7]. For low frequency links, the direct path between the transmitter and the receiver is often obstructed by terrain. In this situation, a signal that has been reflected or scattered from a wind turbine with a clear line of sight to the transmitter or receiver may be considerably stronger than the direct signal and therefore have greater potential to cause interference [9].

Nevertheless, DNV notes that the reflection/scattering interference zones shown in Figure 5 are approximations only and may be overly conservative [2]. This is especially true for high frequency links where increased antenna directionality (or gain) and narrower scatter regions can make the signal less susceptible to interference caused by reflection or scattering [9]. The turbine RCS and C/I ratios used to establish the interference zones were based on recommendations developed on behalf of the United Kingdom telecommunications regulator Ofcom [10], and may not be appropriate for point-to-point links operating in Australia. Uncertainties are also associated with the assumptions used to derive the Ofcom recommendations, and the use of ITU reference radiation patterns rather than the actual radiation patterns for the transmitting and receiving antennas. To account for these uncertainties, the potential for the Project to cause interference to the fixed point-to-point link passing over the proposed Project site through reflection or scattering has been further assessed through consultation with AusNet Services, as described in Section 4.2.2.

4.2.1.3 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 [7] 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. For the AusNet Services link, DNV has established a near-field interference zone based on the operating frequency and antenna gain.

The potential near-field interference zone is shown in Figure 5. The interference zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations, as described in Section 4.2.1.1.

The results of this analysis are summarised in Table 2. There are no turbines located within the near-field interference zone for the point-to-point link operated by AusNet Services. Therefore, it is not expected that the Project will cause interference to this link through near-field effects.

4.2.1.4 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.

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

Link no.	Operator	Turbines within potential interference zone		
		Diffraction	Reflection/ scattering	Near-field
1	AusNet Transmission Group Pty Ltd	None	11 (turbines T5, T8, T9, T11, T13, T15, T17, T23, T27, T32, T36)	None

4.2.2 Stakeholder consultation and responses

The Proponent has provided DNV with feedback they have received from AusNet, regarding the potential for the Project impact on their operations and services. Based on the proposed Project boundaries and turbine dimensions, AusNet noted the potential for turbines at the Project to interfere with their point-to-point link. To avoid any potential for interference to the link, AusNet requested a clearance of 20 m either side of the link path.

The clearance zone requested by AusNet is shown in Figure 6. The clearance zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer on either side to account for potential inaccuracies in the tower locations, as described in Section 4.2.1.1.

The results of the analysis based on the requested clearance zone is summarised in Table 3. There are no turbines located within the requested clearance zone for the point-to-point link operated by

AusNet Services. Therefore, based on the advice received from AusNet, it is not expected that the Project will cause interference to this link.

Table 3 Details of turbines located within the clearance zones requested by the operators for point-to-point links crossing the proposed Project site

Link no.	Operator	Requested clearance zone	Turbines within requested clearance zone
1	AusNet Transmission Group Pty Ltd	20 m either side of link path	None

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 ACMA RRL database. A point-to-multipoint licence allows communication between one or more static sites and multiple points or between the points, and 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 but does not include the remote stations that communicate with the static station. Hence, the paths of the transmission vectors are not readily identifiable.

4.3.1 Locations of point-to-multipoint licences and potential for interference

From the ACMA RRL database, DNV has identified 44 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project site. These licences are shown in Figure 7. The details of the licence holders as given in the ACMA database are provided in Table 12.

There are three point-to-multipoint base stations within 20 km of the Project boundary. These stations are operated by Aussie Broadband Pty Ltd (Aussie Broadband), Powercor Australia Ltd (Powercor), and Wannon Region Water Corporation (Wannon Water). There are also several point-to-multipoint base stations located more than 20 km from the site.

Wind turbines can cause interference to point-to-multipoint links through the same mechanisms as described for point-to-point links in Section 4.2.1. However, as it is not possible to know the link paths in a point-to-multipoint network without obtaining further information about the locations of each station in the network, consultation with the relevant operators is needed to determine the potential for interference.

4.3.2 Stakeholder consultation and responses

DNV has contacted the operators of all potentially affected base stations within 60 km of the Project to determine the likelihood that the proposed Project will cause interference to their services.

Responses have been received from Aussie Broadband and Powercor, as summarised in Table 18, who have confirmed that they do not expect the Project to cause interference to their services.

Informal advice received from Wannon Water indicates that the link paths associated with their point-to-multipoint licences are unlikely to cross the Project site. Based on the remote supervisory control and data acquisition (SCADA) radio site locations provided by Wannon Water and the

locations of the point-to-multipoint base stations recorded in the ACMA RRL database, DNV also considers it unlikely that any point-to-multipoint links operated by Wannon Water will be impacted by the Project. DNV has provided the results of their review to Wannon Water, and no further response has been received to date.

4.3.3 Mitigation options

As noted above, interference to point-to-multipoint links operated by Aussie Broadband and Powercor is not expected. Interference to the point-to-multipoint links operated by Wannon Water is considered unlikely, however, if interference is experienced, mitigation options may include rerouting the links, installing additional towers, or replacing the affected links with alternative communications infrastructure.

DNV understands that the Proponent has committed to ongoing consultation with the operators of point-to-multipoint links in the vicinity of the Project through the design, pre-construction, and construction phases of the Project, and to implementing mitigation measures, as required, in the event that the Project causes interference to those links.

4.4 Other licence types

Besides fixed point-to-point and point-to-multipoint licences, other licence types recorded in the ACMA RRL database include spectrum licences that permit a range of radiocommunications in a specific geographic area and frequency band, private mobile radio and public telecommunications service (PTS) licences, television and radio broadcasting licences, amateur apparatus licences, and aeronautical licences for ground to aircraft communications.

4.4.1 Locations of other licences and potential for interference

DNV has identified a number of other licences in the ACMA RRL database within 75 km of the proposed Project boundary. The locations of these licences and number of associated Assignment IDs for each licence type are shown in Figure 8 and Table 13.

Most of the licences identified can be broadly described as base to mobile station or point-to-area style communications, including commercial and private mobile telephony and radio and television broadcasting. 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.

The potential for interference to emergency services signals and commercial mobile telephony signals is discussed further in Sections 4.5 and 4.10 respectively, while the potential for interference to radio and television broadcasting services is 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 understands that potential impacts to these services will be considered as part of an aviation impact study.

4.5 Emergency services

Licence types operated by emergency services such as state ambulance, police, fire, and rescue services typically comprise fixed point-to-point link and mobile radio communications.

4.5.1 Locations of emergency services licences and potential for interference

DNV has reviewed the ACMA RRL database to identify emergency services with licences for radiocommunication assets operating in the vicinity of the Project. The groups identified are listed in Table 14 along with their contact details. The nearest licence is associated with a tower located approximately 5 km from the site boundary.

There are no emergency services point-to-point links crossing the proposed Project site, and so there is no potential for interference with point-to-point licences operated by emergency services.

All other licences operated by emergency services in the vicinity of the Project are mobile telephony licences used for mobile radio and paging systems. As discussed in Section 4.4, mobile telephony systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction. Reference [9] provides general guidance regarding the potential for interference with mobile radio systems, and suggests that a clearance of 500 m from the tower is sufficient to avoid significant impacts to these systems. Other references recommend that turbines be kept outside of clearance zones ranging from a distance of 200 m to 1200 m from the tower for point-to-area style services [12].

Given the distance of the emergency services mobile telephony licences from the Project, DNV considers it unlikely that the Project will cause interference to mobile radio and paging systems operated by emergency services.

4.5.2 Stakeholder consultation and responses

DNV understands that the Proponent has contacted the operators of all potentially affected licences within approximately 60 km of the Project to seek feedback regarding any potential impact that the Project could have on their operations and services.

The Proponent has provided DNV with feedback they have received from the Country Fire Authority and Regional Mobile Radio, as summarised in Table 18, who have confirmed that they do not expect the Project to cause interference to their services.

4.5.3 Mitigation options

As noted above, there is no potential for impacts to point-to-point links operated by emergency services, and interference with mobile telephony services is considered unlikely. If localised interference to mobile radio or paging system signals is experienced, this can often be mitigated by the user moving a short distance to a new or higher location to receive a clearer signal or by using an external antenna to improve the signal reception. Other mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower on the opposite side of the Project.

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to mobile telephony services used by emergency services.

4.6 Aircraft navigation systems and radar

DNV understands that a separate aviation impact study will be 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 radars across Australia consisting of high-resolution Doppler radars and standard weather watch or weather surveillance radars. Operation of the BoM's part-time wind finding radar installations ceased in August 2019 [13].

Standard weather watch radars emit pulsed microwave radiation and use reflections or "echoes" of that radiation from water particles in the atmosphere to detect rain and storm activity. Doppler radar installations operate in the same way but are also able to measure the speed of the moving water particles, and therefore can provide information about wind speed and direction [14] [15].

While 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. Because radar installations monitor the current weather situation over a wide area, the information they provide can be used to indicate the possibility and approach of severe storms, tropical cyclones, and flooding events. Wind profile measurements are also 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.

The optimal coverage area for a weather radar generally extends approximately 200 km from the radar installation at a height of around 3000 m [16] [17], and approximately 100 km at a height of 1000 m [17]. Therefore, wind farms can theoretically impact on weather radar operations when located within several hundred kilometres of an installation. However, due to the curvature of the earth and intervening terrain, the range at or near ground level is generally less.

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 complete or partial blockage of the radar signal and subsequent loss of weather data [18] [19]. For wind farms located between 5 km and 20 km of a radar, the WMO recommends consultation and analysis to assess the likelihood of turbines causing reflection or scattering of the radar signals or interfering with Doppler velocity measurements. At distances of between 20 km and 45 km, the presence of a wind farm may produce radar echoes or signal clutter that can cause loss of data or be mistaken for rain. Significant impacts are generally not expected for wind farms located more than 45 km from a meteorological radar, since in most cases the turbine will below the radar scan line of sight. However, the WMO notes that these guidelines are only applicable to typical radar installations in flat terrain and may need to be modified for higher-powered radars or specific situations.

Recent advice received from the BoM also suggests that there may be potential for interference to meteorological radar operations from wind farms over much greater distances than indicated by the WMO guidelines, depending on the relative elevations of the radar and the wind farm and the intervening terrain.

According to the Draft National Guidelines, operators of weather radars within 250 nautical miles (463 km) of the proposed Project should be consulted [2].

4.7.1 Locations of meteorological radars and potential for interference

DNV has identified that the BoM operates eight weather radars within 250 nautical miles of the proposed Project, with the closest radar, "Mount Gambier", located approximately 122 km northwest of the Project site. The locations of these radars are shown in Figure 9 and the details of each radar are given in Table 15.

Although the distance between the Project and the nearest BoM radar is considerably greater than the distances at which the WMO suggests impact may occur, consultation with the BoM is needed to determine the potential for interference.

4.7.2 Stakeholder consultation and response

The Proponent has provided DNV with feedback they have received from the BoM regarding the potential for the Project to interfere with their operations and services. The response received from the BoM indicates that the potential impact of the Project on their meteorological radars will be manageable, and that the BoM has no objections to the Project provided that the following conditions are met:

- the BoM is informed of any changes to the Project design, including changes to the turbine locations or height
- the owner or operator of the Project gives the BoM at least two weeks' notice of any planned shutdown of the Project, to allow the BoM to calibrate their systems while the turbines are not operating and hence account for the presence of the Project in their signal processing and interpretation
- the owner or operator of the Project collaborates with the BoM in the event of severe weather conditions in the interests of community safety.

4.7.3 Mitigation options

According to the WMO, there are currently no automated signal processing techniques available that can be used to effectively filter radar data to remove interference caused by wind farms [19]. However, if analysis indicates there is a potential for the wind farm to cause reflection or scattering of radar signals, the WMO suggests it may be possible to reduce the potential impact through the relocation of individual turbines prior to construction. In situations where the expected interference is limited to signal clutter, the radar operator may also be able to mask these effects in the data or train the users to take the Proponent the locations of the wind farms into account.

DNV understands that the Proponent has committed to meeting the conditions outlined by the BoM, as summarised in Section 4.7.2, which may allow the BoM to account for the presence of the Project in their signal processing and interpretation. However, DNV also recommends that the Proponent seeks further clarification from the BoM regarding what type of collaboration will be required in the event of severe weather conditions.

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 [20].

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 [21]. 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) [22], 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 Victoria, the DELWP also operates a state-wide GNSS CORS network, known as GPSnet, which is used to provide geospatial data for mapping, surveying, agriculture, and industry [23]. 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.

4.8.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [24], there are two trig points within 20 km of the Project site boundary. The details of these trig points are provided in Table 16 and illustrated in Figure 10. There are also 54 permanent survey marks within 2 km of the Project site boundary [25] as shown in Figure 11. The closest survey mark is located 105 m east of the nearest turbine (turbine T55).

DNV has reviewed the primary geodetic network of Australia [26] and 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.

The closest GNSS station is located approximately 22 km south of the Project, at Port Fairy [24]. 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.

4.8.2 Stakeholder consultation and responses

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 understands that the Proponent has contacted Geoscience Australia and the DELWP to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

The Proponent has provided DNV with feedback they have received from the DELWP, as summarised in Table 18, who have confirmed that they do not expect the Project to cause interference to their systems. No response has been received from Geoscience Australia.

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 for a strong signal and is easily hindered by hilly terrain and forested areas. Even in the absence of physical obstructions, UHF CB radio signals generally cannot travel beyond the effective radio horizon, which depends on elevation, antenna height, weather, and atmospheric conditions. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. However, under normal conditions on flat ground, signal range is typically limited to around 5 km. CB repeater stations are often 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.

4.9.1 Locations of CB radio devices and potential for interference

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. Given the limitations of UHF radio signals, CB radio services are typically only intended for local or short-range communications. CB radio signals passing through the Project site are likely to be intercepted by existing obstructions such as terrain and vegetation, and there is little evidence in the literature to suggest that wind turbines pose a particular risk of interference to these systems. Therefore, the impact of the Project on CB radio services is expected to be minimal.

4.9.2 Mitigation options

If interference to CB radio signals is experienced, simple steps such as moving a short distance to a new or higher location until the signal strength improves may help to mitigate the impact. CB radio users can also increase their signal range and improve reception by switching their equipment to a higher power setting, using a longer antenna, or increasing the antenna mounting height.

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 may 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. However, there is little evidence in the literature of wind turbines interfering with mobile phone signals, and DNV notes that previous advice received from mobile phone network operators in Australia has generally indicated that they do not expect wind farm developments to interfere with their services.

4.10.1 Availability of mobile phone services and potential for interference

DNV has reviewed the locations of mobile phone towers in the vicinity of the proposed Project. The locations of these towers are shown in Figure 12. The nearest mobile phone tower is located approximately 10 km northeast of the Project boundary.

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

Figure 13 shows the Optus 3G and 4G network coverage for the Project area [27]. Optus signal coverage is variable across the site, with many small areas within the site boundary and to the north, south, and southwest where coverage is not available or signals can only be received using an external antenna.

Figure 14 and Figure 15 show the Telstra 3G and 4G network coverage for the Project area [28]. Most locations in the vicinity of the Project site are able to receive Telstra 3G signals, although there are some areas within the site boundaries and to the southeast and southwest where coverage is not available. Telstra 4G signal coverage is generally good to the east and south of the site, but is not available in several areas within the site boundaries and to the north and west.

Figure 16 shows the Vodafone network coverage for the Project area [29]. Outdoor Vodafone 3G and 4G coverage is available to the west, south, and southeast of the site, and across most of the area within the site boundaries, but there are areas to the north and east where coverage is not available.

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.

4.10.2 Stakeholder consultation and responses

DNV understands that the Proponent has contacted Optus, Telstra, and Vodafone to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services.

The Proponent has provided DNV with feedback they have received from Optus and Telstra, as summarised in Table 18, who have confirmed that they do not expect the Project to cause interference to their services. No response has been received from Vodafone.

4.10.3 Mitigation options

As noted above, interference with mobile phone signals is considered unlikely in most cases. If localised interference is experienced by mobile phone users, this can often be rectified by the user moving a short distance to a new or higher location until the signal improves, or using an external antenna to improve the signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing an additional tower on the opposite side of the Project.

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to mobile phone signals.

4.11 Wireless internet

Wireless internet services in Australia include wireless broadband provided by mobile phone network operators and other internet service providers, and fixed wireless or satellite internet services through the National Broadband Network (NBN).

4.11.1 Wireless broadband services

Wireless broadband services allow the user to connect to the internet without the need for a phone line or cable connection. The wireless signals may operate by line of sight between a base station and the user's antenna as part of a point-to-multipoint network, or may use point-to-area style transmissions such as mobile phone networks.

4.11.1.1 Availability of wireless broadband services and potential for interference

Aussie Broadband holds point-to-multipoint licences in the vicinity of the Project, with the nearest base station located 18 km southeast of the Project site. As the locations of Aussie Broadband customers are not known, it is not possible to determine whether there is the potential for interference to this service, however it is possible that stations at these distances may be servicing customers in the vicinity of the proposed Project.

Additionally, 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 4.10.3 are applicable here. Specifically, there is a low theoretical potential to cause interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower.

4.11.1.2 Stakeholder consultation and responses

DNV has contacted Aussie Broadband to seek feedback regarding the potential for interference to their services. The response received from Aussie Broadband has indicated that they do not expect the Project to cause interference to their services.

DNV understands that the Proponent has also contacted Optus, Telstra, and Vodafone to seek feedback on the potential for interference to their wireless broadband services. As noted in Section 4.10.2, the responses received from Optus and Telstra have indicated that they do not expect the Project to cause interference to their services. No response has been received from Vodafone.

4.11.1.3 Mitigation options

As noted above, interference with wireless broadband services is considered unlikely. If interference to the wireless broadband services provided by mobile phone networks occurs, the

mitigation options given in Section 4.10.3 may be applicable. Specifically, localised interference can often be rectified by the user moving a short distance or using an external antenna to improve signal reception. For interference over a larger area, or in cases where it would not be possible or practical for the user to change their location, mitigation options may include increasing the signal strength from the affected tower or alternative towers, or installing a signal repeater or additional tower on the opposite side of the Project.

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to mobile phone signals.

4.11.2 National Broadband Network

The NBN is a national wholesale broadband access network, which consists of fixed line, fixed wireless, and satellite internet services.

NBN fixed line services use wired connections to provide internet signals directly to the user. This technology is typically only available in urban areas and is not expected to be affected by wind farm developments.

NBN fixed wireless services are available in many rural and regional areas. The signals operate by line of sight between an NBN tower and the user's antenna, with a maximum range of 14 km [30]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [31].

NBN satellite internet signals are available to rural and remote users in areas that are not able to receive fixed line or fixed wireless services. The potential for interference to satellite internet signals from the NBN Sky Muster I and II satellites is considered in Section 4.12.

4.11.2.1 Availability of NBN services and potential for interference

The National Broadband Network (NBN) website [32] indicates that the network is currently available as a fixed wireless service and satellite internet service using the NBN Sky Muster I and II satellites 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 12, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 17.

The NBN tower servicing the Project area is located at Hawkesdale in the northeast. Given the relative positions of the NBN tower and nearby dwellings, and the fixed wireless coverage areas shown in Figure 17, there is potential for the Project to impact residents who may currently be receiving NBN fixed wireless signals.

4.11.2.2 Stakeholder consultation and response

DNV has contacted NBN Co to seek feedback on whether there is potential for the Project to cause interference to their services, and to allow them to take the presence of the Project into account in their coverage planning maps.

The response received from NBN Co indicates that the current proposed turbine locations are sufficiently clear of the lines of sight between the Hawkesdale NBN tower and any dwellings currently receiving signals from that tower. Based on the previous 75-turbine layout, NBN Co noted that there could be potential for impact to the fixed wireless internet signals received at dwelling D15 if the exact location of a specific turbine in that layout was altered. However, this turbine has

been removed from the 59-turbine layout considered in this assessment. The locations of the remaining turbines in the 59-turbine layout in relation to the lines of sight for the NBN signals from the Hawkesdale tower have not changed, and so DNV expects that there would be no change in the potential for impacts to NBN wireless internet signals compared to the previous 75-turbine layout.

4.11.2.3 Mitigation options

DNV understands that the Proponent has committed to ongoing consultation with NBN Co through the design, pre-construction, and construction phases of the Project, and to implementing mitigation measures, as required, in the event that the Project causes interference to NBN fixed wireless signals.

If interference to NBN fixed wireless signals is experienced at dwellings in the vicinity of the Project after construction, several mitigation options may be available to improve the signal reception. NBN Co has previously advised that in most instances where the signal line of sight from a given tower is obstructed an alternative tower can be used to service the affected dwelling. If an alternative tower is not available, interference can usually be rectified by moving the outdoor antenna at the affected dwelling a short distance from the building, 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]).

DNV understands that the installation process for the NBN fixed wireless internet service at a dwelling requires an approved NBN installer to test for the presence and strength of the available fixed wireless signal. In the event that interference to that signal is experienced once the Project is operational, this testing could theoretically be repeated to confirm whether the available signal strength is still acceptable and to determine a suitable alternative NBN tower or an alternative location for the antenna at the dwelling if required. If a more rigorous approach is required, pre-construction measurements could be undertaken to record and document the existing signal strength for the NBN fixed wireless internet service in the area around the Project (if that information is not already documented).

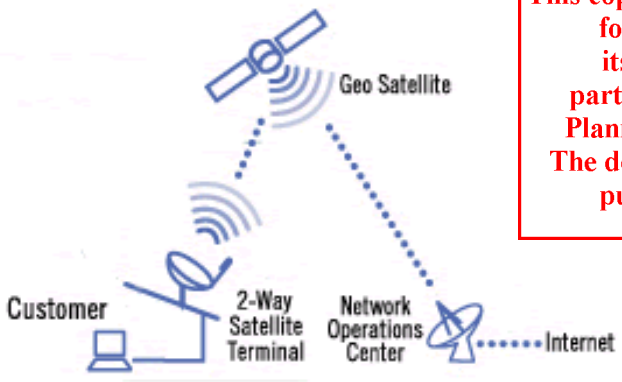
It may also be possible to avoid impact by micro-siting the turbines in some cases, or by installing a new NBN tower to service the affected dwellings. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

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. 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 [34] [35].

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 Thaicom 4 and Optus D2 satellites, and the NBN SkyMuster I and II satellites.



Two-way connection to the internet via satellite [36]

4.12.1 Locations of satellite vectors and potential for interference

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 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 specifically intended for Australia, all theoretically viewable satellites have been considered.

The results of the analysis are shown in Table 4. Based on these results, turbines at the Project may intercept signals from 47 satellites to eight nearby dwellings, five of which are stakeholder dwellings.

All eight dwellings have potential to experience interference to signals from satellites that provide television signals intended for international audiences. Many of these satellites have a low angle of elevation above the horizon at the Project site location, and so degradation caused by atmospheric effects or interference from terrain or other obstacles may already prevent the signals from being received at the affected dwellings. For some of these satellites, the programs transmitted on the beam footprints that cover Australia may also be available through other satellite services which have a higher angle of elevation above the horizon and are not expected to be intercepted by turbines at the Project. DNV recommends that the Proponent engages with these residents to

determine if any are currently receiving signals from these satellites, and to establish an understanding of how any impact to these services may be mitigated.

One stakeholder dwelling (D482) has potential to experience interference to signals from satellites that provide television and internet services intended for Australian audiences, including the NBN SkyMuster II satellite. This dwelling is located approximately 300 m from the nearest turbine and has been identified by the Proponent as 'dilapidated'. DNV recommends that the Proponent engages with the owner of this dwelling to determine whether it is currently inhabited or expected to be inhabited during the lifetime of the Project, and to establish an understanding of how any impact to satellite services may be mitigated.

Table 4 Satellite vectors with potential to be intercepted by the proposed Project

Intercepted satellite	Services provided [37]	Affected dwellings[1]
Eutelsat 70B	Programs intended for international audiences	D11, D17, *D28*, D39, *D460*[1]
Intelsat 22	Programs intended for international audiences	*D6*, *D28*, *D460*[1]
G-Sat 7, G-Sat 11, G-Sat 14, G-Sat 18, ABS 2, ABS 2A	Programs intended for international audiences	*D28*, *D355*, *D460*[1]
Apstar 7	Programs intended for international audiences	*D28*, *D460*[1]
JCSat 16	Programs intended for international audiences	*D460*[1], *D482*[1]
Thaicom 6, Thaicom 8, Express 80, G-Sat 10, G-Sat 6, G-Sat 12, G-Sat 30, Insat 4B, Horizons 2, Intelsat 15, Kazsat 2, ChinaSat 12, ST 2, Yamal 401, Measat 3, Measat 3A, Measat 3B, ChinaSat 9	Programs intended for international audiences	*D460*[1]
Inmarsat-4F1, Superbird C2, PSN 6, JCSat 18, BRIsat, JCSat 2B, Optus 10, Intelsat 1R, Telkom 2, ABS-6, Hylas 1, Superbird B3, Apstar 6, Yamal 202	Programs intended for international audiences	*D482*[1]
NBN-Co 1B (NBN SkyMuster II)	NBN satellite internet for Australian audiences	*D482*[1]
Optus D2	Programs and internet intended for Australian audiences	*D482*[1]
Optus C1, Optus D3, Optus D1	Programs intended for Australian audiences	*D482*[1]

1. Stakeholder dwellings are indicated by *underlined italic text*.
2. Dwelling identified by the Proponent as 'dilapidated' [4].

4.12.2 Mitigation options

If interference to satellite television signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available. If an alternative source of the same programming is available, the satellite dishes at affected dwellings can simply be re-directed to receive signals from the other satellite. In some cases, residents may also be able to access the affected programs directly over the internet. If an alternative source of programming is not available, it may be possible to rectify interference by installing a larger or higher-quality satellite dish, or by changing the height or location of the dish to obtain a stronger signal.

If interference to satellite internet signals is experienced at dwellings in the vicinity of the Project, it may also be possible to rectify interference by installing a larger or higher-quality satellite dish, or by changing the height or location of the dish to obtain a stronger signal.

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to satellite television or internet signals.

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.

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.

4.13.1.1 Locations of AM transmitters and potential for interference

The locations of AM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [38], and are shown in Figure 18.

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]. 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].

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].

4.13.2.1 Locations of FM transmitters and potential for interference

The locations of FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [38], and are shown in Figure 18.

The closest FM broadcast transmission tower is located approximately 20 km from the proposed site boundary. 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.

It is unlikely that any permanent FM radio receivers will be located sufficiently close to the Project to be affected by reflection or scattering of the radio signals from the turbines.

4.13.2.2 Mitigation options

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 or additional tower on the opposite side of the Project.

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to FM radio signals.

In addition to the mitigation options outlined above, DNV also understands that the Proponent has committed to conducting pre-construction measurements of the average radio reception strength in the vicinity of the Project and will establish a process for managing complaints related to impacts on radio reception at nearby dwellings once the Project is operational.

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.

4.13.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search functions available on the ABC website [44] and Digital Radio Plus website [45], digital radio is not yet available in the Project region. Hence, while there are no digital radio broadcasts in the vicinity of the Project, no interference to digital radio signals is possible.

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 [46]. 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 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 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.

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 Availability of DTV broadcasting and potential for interference

The locations of DTV broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [46], and are shown in Figure 18. The main DTV transmitter used by residents in the vicinity of the Project is the Warrnambool transmitter at Tower Hill. However, according to the Australian Government mySwitch website [47], it is also possible that nearby residents are able to receive DTV signals from the Portland transmitter at Narrawong (Mt

Clay) or the Western Victoria transmitter at Mt Dundas. Coverage maps for these broadcast transmitters are reproduced in Figure 19 to Figure 21.

4.14.1.1 Interference caused by large scale effects

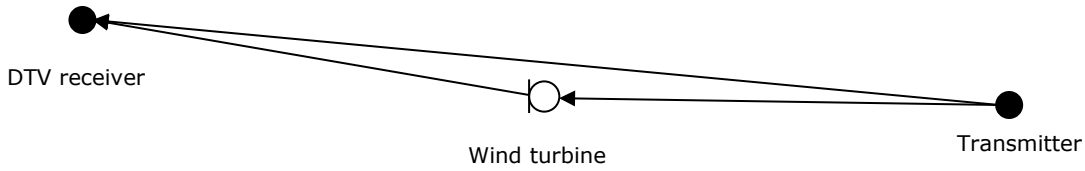
For broadcast signals, large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay transmitters are more commonly found in rural areas. Primary transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay transmitters, while a clearance of at least 6 km is recommended for primary transmitters [8].

The closest DTV transmitter to the Project is the Warrnambool (Tower Hill) transmitter, which is approximately 20 km southeast of the Project boundary. Therefore, it is considered unlikely that the Project will cause large scale interference to DTV signals.

4.14.1.2 Interference caused by forward and back scatter

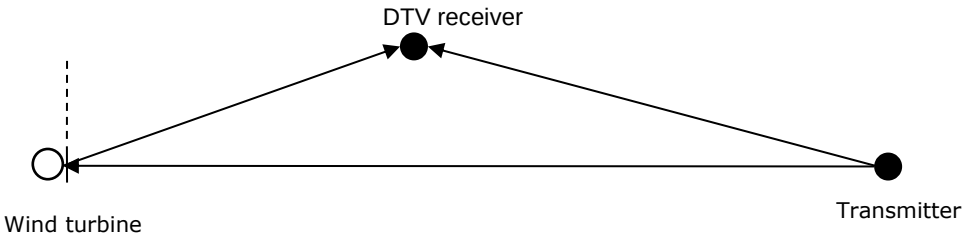
Wind turbines can cause interference to DTV signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A wind turbine has the potential to scatter electromagnetic waves carrying DTV 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 [48]. 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 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).



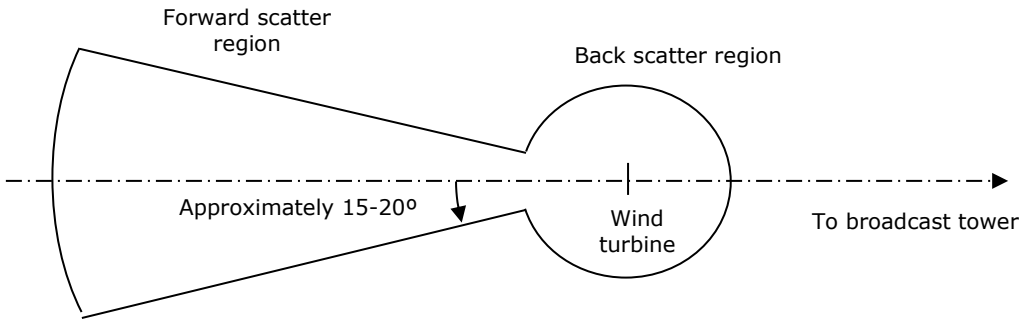
Back scatter signal path

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 [48].

According to Ofcom [40], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [8] [49]. 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 [8] [40], 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, DTV signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [50] 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 [51] 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 [51].

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 4.14.1.4.

4.14.1.3 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 [52]. 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 [50], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally, DNV 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 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 4.14.1.4.

4.14.1.4 Potential impacts for nearby 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.

The coverage maps in Figure 19 to Figure 21 suggest that the primary transmitter for the area is the Warrnambool tower, which offers 'good' to 'variable' coverage across most of the Project site. Coverage from the Portland tower is 'good' to the west of the Project site but 'poor' or non-existent in areas to the east, while coverage from the Western Victoria tower is generally 'poor' to 'variable' across most of the site and surrounding area.

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 17 and Figure 19 to Figure 21. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 5. Due to the reduced number of turbines, the number of dwellings located within each interference zone for the 59-turbine layout considered in this assessment is less than for the previous 75-turbine layout for 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.

Table 5 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 in potential interference zone	Signal coverage in potential interference zone
Warrnambool (Tower Hill)	35 (18 stakeholder dwellings)	Variable to good
Portland (Narrawong / Mt Clay)	40 (19 stakeholder dwellings)	Variable to good, with some areas of non-existent coverage in the east
Western Victoria (Mt Dundas)	66 (8 stakeholder dwellings)	Poor to variable

Dwellings located within the Project boundaries and to the north and west of the Project have increased potential to experience interference to DTV signals from the Warrnambool tower.

particularly in areas to the northwest where the signal is already marginal. However, the coverage maps suggest that these dwellings are likely to be able to receive a stronger signal from the Portland broadcast tower, which would not be affected by interference from the Project. Signal coverage from the Warrnambool tower is generally good in other areas within the potential interference zone shown in Figure 19, and so the overall potential for interference is considered low.

Interference is more likely to be experienced for signals from the Portland and Western Victoria towers, as coverage from these towers is marginal across most of the potentially affected areas. Dwellings within the Project boundaries and to the east of the site may experience interference to signals from the Portland tower, while dwellings to the south of the Project may experience interference to signals from the Western Victoria tower. Nevertheless, in both cases it is likely that the potentially affected dwellings are currently receiving signals from the Warrnambool DTV tower, rather than either the Portland or Western Victoria towers, and therefore will not be impacted by the Project.

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 in most cases as the implications of potential television interference are typically low. If reception difficulties are encountered, there are a number of mitigation options available as discussed in further detail in Section 4.14.3.

4.14.2 Stakeholder consultation and response

The Proponent has provided DNV with feedback they have received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, regarding any potential impact that the Project could have on DTV signals in the surrounding area.

In preparing their feedback, BAI Communications assessed the potential for turbines at the Project to interfere with DTV signals from the Warrnambool (Tower Hill), Portland (Narrawong / Mt Clay) and Western Victoria (Mt Dundas) towers, based on the previous 75-turbine layout [53]. The method used involved modelling the reflection or scattering of DTV signals from the wind turbines, and identifying locations within 10 km of the Project where the resulting C/I ratio for a directional antenna oriented towards the tower of interest would be less than required for adequate signal reception.

The results of the modelling conducted by BAI Communications are compared to the DTV coverage maps and interference zones established by DNV in Figure 19 to Figure 21.

From these results, BAI Communications have advised that they do not expect the Project to cause material interference to DTV signals from the Warrnambool tower, and only minor impact is expected for DTV signals from the Portland tower. Although the modelling predicted that the Project will cause interference to DTV signals from the Western Victoria tower over a relatively large area, BAI Communications noted that the affected area is primarily serviced by the Warrnambool tower, which is not expected to be impacted by the Project. Based on population density data for the areas identified by the modelling, BAI Communications concluded that:

- no residents are at risk of experiencing interference to DTV signals from the Warrnambool tower
- one resident is at low risk of experiencing interference to DTV signals from the Portland tower, and no residents are at high risk of experiencing interference

- 37 residents are at low risk of experiencing interference to DTV signals from the Western Victoria tower, and five residents are at high risk of experiencing interference, with most of the impact confined to within the wind farm boundaries. However, when the Warrnambool tower is considered as an alternative to the Western Victoria tower, all the residents affected by interference to signals from the Western Victoria tower are expected to be able to receive signals from the Warrnambool tower.

Although the results provided by BAI Communications for the previous 75-turbine layout predict impacts to DTV signals in areas to the north and northeast of the Project site, as shown in Figure 19 to Figure 21, turbines in these areas have been removed from the 59-turbine layout considered in this assessment. Therefore, it is expected that the areas at risk of experiencing interference would be smaller for the 59-turbine layout, and that the overall impacts will be the same or less than for the previous 75-turbine layout. Considering that the Warrnambool tower is the primary transmitter for the area with the strongest signal coverage and is not predicted to be affected by interference from turbines at the Project, the results of the BAI Communications modelling suggest that impacts on DTV broadcasting are likely to be minimal.

4.14.3 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 user's television antenna more directly towards their existing transmitter.
2. Tuning the user'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. However, the effectiveness of this mitigation may be reduced if there is no clear line of sight from the antenna to the transmitter. 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 [48], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [51] 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 [54].

DNV understands that the Proponent has committed to implementing mitigation measures, as required, in the event that the Project causes interference to DTV signals.

In addition to the mitigation options outlined above, DNV also understands that the Proponent has committed to conducting pre-construction measurements of the average television reception strength in the vicinity of the Project and will establish a process for managing complaints related to impacts on television reception at nearby dwellings once the Project is operational.

4.15 Cumulative impacts

DNV notes that the Project is located in an area of high wind farm development activity, with multiple approved and operating wind farms nearby. 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 6 and shown in Figure 22, based on information provided by the Proponent [55] and obtained from publicly available sources.

Table 6 Other wind farm developments located in the vicinity of the Project site

Wind farm	Status	Location
Codrington Wind Farm	Operating	16 km southwest of the Project boundaries
Hawkesdale Wind Farm	Approved	3.6 km east of the Project boundaries
Macarthur Wind Farm	Operating	1.6 km north of the Project boundaries
Ryan Corner Wind Farm	Approved	7.5 km south of the Project boundaries
Woolsthorpe Wind Farm	Approved	8.9 km east of the Project boundaries
Yambuk Wind Farm	Operating	15 km southwest of the Project boundaries

The potential cumulative EMI-related impact of the Project in conjunction with the nearby approved and operating wind farms has not been considered in detail in this assessment. However, based on the relative locations of these developments, DNV has conducted a high-level review of the potential for cumulative impacts to the radiocommunication services considered in the previous sections.

Table 7 summarises the anticipated EMI-related impact of the Project in isolation, and the potential for cumulative impacts from the Project in conjunction with the neighbouring wind farms. 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.

The greatest potential for cumulative EMI-related impact is to broadcast DTV signals received at nearby dwellings. Given the close proximity of the Macarthur Wind Farm and the relative locations of the broadcast towers servicing the area, there is potential for increased interference to signals received from the Warrnambool, Portland, and Western Victoria towers at dwellings located between the Macarthur Wind Farm and the proposed Project.

The Proponent has provided DNV with feedback they have received from BAI Communications regarding the potential cumulative EMI-related impact of the Project and other nearby wind farm developments. In preparing their feedback, BAI Communications assessed the cumulative impacts

of the Project in conjunction with the wind farms summarised in Table 6 on DTV signals from the Warrnambool (Tower Hill), Portland (Mt Clay), Western Victoria (Mt Dundas), and Ballarat (Lookout Hill) towers, based on the previous 75-turbine layout and considering the availability of alternative signals from other towers [56].

The results of the modelling conducted by BAI Communications are shown in Figure 23 to Figure 26.

From these results, BAI Communications have advised that they do not expect material cumulative impacts to DTV signals from the Portland and Ballarat towers, and only minor impacts are expected for DTV signals from the Warrnambool and Western Victoria towers. Based on population density data for the areas identified by the modelling, BAI Communications concluded that:

- four residents are at low risk of experiencing interference to DTV signals from the Warrnambool tower caused by any of the wind farms, although satellite imagery indicates that there are no dwellings located in the potential interference area
- three residents are at low risk and four residents are at high risk of experiencing interference to DTV signals from the Western Victoria tower caused by any of the wind farms, although satellite imagery indicates that there are no dwellings located in the potential interference area
- no residents are expected to experience interference to DTV signals from either the Portland or the Ballarat towers.

The results provided by BAI Communications only consider the combined impacts of the Project in conjunction with the nearby wind farms, and do not indicate the extent to which the development of the Project would increase the potential for interference to DTV signals compared to the impacts from wind farms that are already operating or approved. However, the maps presented in Figure 23 to Figure 26 show that the expected impacts to DTV broadcasting are mostly confined to the area within the boundaries of each wind farm, close to the turbine locations. Areas to the north of the Project site that have been identified as at risk of experiencing interference in Figure 23 to Figure 26 correspond to the locations of turbines in the previous 75-turbine layout that have been removed from the 59-turbine layout considered in this assessment. Considering that the overall impact from all seven wind farm developments is predicted to be low, the results of the BAI Communications modelling suggest that the cumulative EMI-related impact of the Project on broadcast DTV signals is likely to be minimal.

As discussed in Section 4.14.3, DNV understands that the Proponent has committed to conducting pre-construction measurements of the average television reception strength in the area around the Project. These pre-construction measurements may help to better understand the DTV signal coverage in the surrounding area and the potential for cumulative impacts at the dwellings located between the Project and the Macarthur Wind Farm. If interference is found to be a problem at these dwellings after construction of the Project, the mitigation options given in Section 4.14.3 may be applicable.

There is also some potential for increased interference to other point-to-area style services, such as mobile phone and FM radio signals, in areas with marginal coverage or where there may be multiple wind turbines between the user and the transmission tower. If interference to these services is experienced, the mitigation options given in Sections 4.10.3 and 4.13.2.2 may be applicable.

The potential for cumulative impacts to BoM radar signals is expected to be low, given that other wind farms in the area do not appear to be visible on publicly available radar images and the BoM has advised that interference from the Project is expected to be manageable. However, DNV recommends that the Proponent clarifies with the BoM whether the impacts of other wind farms were considered in their feedback regarding the potential impacts of the Project.

Cumulative impacts to the AusNet Services point-to-point link crossing the Project site are not expected, as this link does not cross any of the neighbouring wind farm sites. Similarly, the signal lines of sight from the Hawkesdale NBN tower to nearby dwellings do not pass over multiple wind farm sites, and so cumulative impacts to the NBN fixed wireless internet service are not expected.

It is noted that DNV has not conducted a detailed assessment of the potential for cumulative EMI-related impacts from the Project at this stage, and that further investigation may be required to better understand the likely impacts. A detailed assessment of the potential for cumulative impacts may be conducted at a later date if deemed necessary.

Table 7 Potential for cumulative EMI-related impacts from the Project and neighbouring wind farms

Licence or service type	Anticipated impact from the Project in isolation	Potential for cumulative impact from the Project and neighbouring wind farms
Radiocommunication towers	Low potential to cause interference (see Section 4.1)	No cumulative impact
Fixed point-to-point links	Unlikely to cause interference to the AusNet Services point-to-point link crossing the Project site (see Section 4.2)	No cumulative impact, as the link path does not cross neighbouring wind farms
Fixed point-to-multipoint links	Potential for interference if link paths cross the site near turbines (see Section 4.3) DNV has consulted 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	No cumulative impact, based on consultation responses received to date
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	
Emergency services	Unlikely to cause interference (see Section 4.5)	Very low potential for cumulative impact
Meteorological radar	Interference expected to be manageable (see Section 4.7)	Low potential for cumulative impact
Trigonometrical stations	Unlikely to cause interference (see Section 4.8)	Very low potential for cumulative impact
Citizen's band radio	Unlikely to cause interference (see Section 4.9)	Very low potential for cumulative impact
Mobile phones	Low potential for interference in areas with marginal coverage (see Section 4.10)	Potential for cumulative impact where there are multiple turbines between the tower and the user
Wireless internet	Low potential for interference to services provided by mobile phone networks (see Section 4.11.1) Potential for interference to NBN fixed wireless internet signals from the Hawkesdale NBN tower, although feedback from NBN Co indicates that impacts are not expected (see Section 4.11.2)	Potential for cumulative impact to services provided by mobile phone networks where there are multiple turbines between the tower and the user No cumulative impact to NBN fixed wireless signals as the signal lines of sight do not cross multiple wind farms
Satellite television and internet	Low potential for interference (see Section 4.12)	No cumulative impact
Radio broadcasting	Low potential for interference to FM signals received in close proximity to turbines (see Section 4.13)	Potential for cumulative impact where there are multiple turbines between the tower and the user
Television broadcasting	Potential for interference to signals from the Warrnambool, Portland, and Western Victoria towers, although feedback from BAI Communications indicates that impacts are likely to be minimal (see Section 4.14)	Potential for cumulative impact to signals from the Warrnambool, Portland, and Western Victoria towers received at dwellings located between the Macarthur Wind Farm and the Project, although feedback from BAI Communications indicates that cumulative impacts are likely to be minimal

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. The Project will involve the installation of 59 wind turbine generators. DNV has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 190 m or less, an upper tip height of 250 m or less, and a lower tip height of 40 m or more.

The results of this assessment are summarised in Table 8.

There is one fixed point-to-point link passing over the Project boundaries. The link operator, AusNet Services, has advised that interference can be avoided by maintaining a clearance of 20 m either side of the link path. There are no turbines located within the clearance zone requested by AusNet Services or the diffraction interference zone established by DNV. While there is potential for turbines to interfere with the link through reflection or scattering of the signals, the feedback received from AusNet Services suggests that interference is unlikely provided that the requested clearance is maintained.

There is potential for interference to NBN wireless internet signals received from the Hawkesdale NBN tower at dwellings in the vicinity of the Project, although NBN Co has advised that the proposed turbine locations are not expected to cause interference to their services. DNV understands that the Proponent has committed to ongoing consultation with NBN Co, and to implementing mitigation measures, as required, in the event that the Project causes interference to NBN fixed wireless signals.

Signals from satellites that provide television and internet services intended for Australian audiences may be intercepted by turbines at the Project for one stakeholder dwelling, although DNV understands that this dwelling is currently in a 'dilapidated' state. Interference to signals from satellites that transmit programs intended for international audiences is also possible at several nearby dwellings. However, it is considered unlikely that residents will be receiving signals from these satellites due to their low angles of elevation and the availability of alternative services. If interference is experienced, mitigation options could include realigning or upgrading the user's satellite dish or seeking an alternative source of the same programming or service. DNV recommends that the Proponent engages with the residents or owners of potentially affected dwellings to determine if any are currently receiving these satellite signals, and to establish an understanding of how any impacts may be mitigated.

Interference to DTV signals from nearby broadcast towers may be experienced in areas that already have marginal reception. The potential for interference is higher for signals from the Portland and Western Victoria towers, which have poor to marginal coverage across the Project site, than for signals from the Warrnambool tower, which is the primary transmitter for the area and has stronger signal coverage. Feedback received from BAI Communications also suggests that residents in the vicinity of the Project may experience interference to DTV signals from the Portland and Western Victoria towers. However, it is likely that the potentially affected dwellings will be able to receive alternative signals from one of the other towers and the overall impact will be minimal. If interference is experience, mitigation options may include realigning or upgrading the user's antenna, installing cable or satellite television at the affected dwelling, or installing a signal repeater on the opposite side of the Project. DNV understands that the Proponent has committed to

implementing mitigation measures, as required, in the event that the Project causes interference to DTV signals.

In addition to the mitigation options outlined above, DNV also understands that the Proponent has committed to conducting pre-construction measurements of the average television and radio reception strength in the vicinity of the Project and will establish a process for managing complaints related to impacts on television and radio reception at nearby dwellings once the Project is operational.

Since it is not possible to assess the impacts on point-to-multipoint links without obtaining further information from the operators, DNV has consulted with the relevant organisations to determine the potential for the Project to cause interference to these links. Responses received from Aussie Broadband and Powercor indicate that the Project is unlikely to have any impact on their services. Wannon Water has provided information about the locations of their SCADA radio sites in the area around the Project, but no formal response regarding the potential for impact has been received.

Potential EMI impacts on other services considered in this assessment, including emergency services, meteorological radar, trigonometrical stations, CB radio, mobile phones, and broadcast radio, are either considered to be minor or can be assessed through consultation with the service operators. DNV understands that the Proponent has contacted the remaining operators of potentially affected services to seek feedback regarding any potential for EMI-related impacts, and no concerns have been raised to date.

The Project is located in an area of high wind farm development activity, with several approved and operating wind farms located nearby. Based on the relative locations of these wind farms, there is potential for cumulative EMI-related impacts to broadcast DTV signals received at nearby dwellings. However, the results of an assessment conducted by BAI Communications indicate that the overall impact on broadcast DTV signals from the Project in conjunction with the nearby wind farms is likely to be minimal. There is also potential for increased interference to mobile phone and FM radio signals in areas where there may be multiple wind turbines between the user and the transmission tower. Cumulative impacts to other services, including point-to-point links and NBN fixed wireless internet signals, are not expected. It is noted that DNV has not conducted a detailed assessment of the potential for cumulative impact, and further investigation may be required to better understand the potential impacts.

Table 8 Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Radiocommunication towers	One tower within 2 km of proposed turbine locations, operated by AusNet Services	Low potential to cause interference	No concerns raised	None required
Fixed point-to-point links	One link crossing Project boundary, operated by AusNet Services Diffraction effects: no turbines in exclusion zone established by DNV or clearance zone requested by AusNet Services (plus additional buffer to account for potential inaccuracies in the tower locations) Reflection/scattering effects: 11 turbines in interference zone established by DNV Near-field effects: no turbines in interference zone established by DNV	Potential to cause interference through reflection or scattering of signals	Potential for interference if turbine blades enter a clearance zone of 20 m either side of the link path	None required, requested clearance has been maintained
Fixed point-to-multipoint links	44 assignments within 75 km of Project boundary Three base stations within 20 km of Project boundary, operated by Aussie Broadband, Powercor, and Wannon Water	Potential to cause interference if link paths cross the Project site near turbines	No concerns raised by Aussie Broadband and Power Locations of remote SCADA radio sites provided by Wannon Water, but no formal response received	*If required* – reroute affected links, install additional towers, replace affected links with alternative technologies
Other licence types	Point-to-area style communications: see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-	-	-
Emergency services	Point-to-point links: No links crossing boundary Base to mobile station style communications: unlikely to be affected	Unlikely to cause interference	Consultation undertaken by the Proponent No concerns raised by the Country Fire Authority and Regional Mobile Radio	Point-to-point links: none required Mobile radio systems: *if required* – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

Table 8 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Meteorological radar	Nearest radar: "Mount Gambier", 122 km from Project	Potential to cause interference if turbines at the Project are visible to radars	Any interference is expected to be manageable	Notify the BoM prior to any planned shutdown of the Project to allow calibration of systems, collaborate with the Bureau of Meteorology in the event of severe weather conditions
Trigonometrical stations	2 stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by turbines Survey marks: unlikely to be affected	Unlikely to cause interference	Consultation undertaken by the Proponent No concerns raised by the DELWP No response received from Geoscience Australia	None required
Citizen's band radio	Unlikely to be affected	Unlikely to cause interference	Consultation not considered necessary	None required
Mobile phones	Variable coverage across site, with coverage not available in some areas Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	Low potential to cause interference	Consultation undertaken by the Proponent No concerns raised by Optus and Telstra No response received from Vodafone	*If required* – increase signal strength from affected tower or alternative towers, install additional tower

Table 8 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Wireless internet	Likely service providers: Aussie Broadband, mobile phone networks NBN: available as a fixed wireless and satellite service in areas surrounding the Project	Potential to cause interference to NBN fixed wireless internet signals	No concerns raised by Aussie Broadband Interference not expected by NBN CO for proposed turbine locations Consultation with mobile phone providers undertaken by the Proponent No concerns raised by Optus and Telstra No response received from Vodafone	Mobile phone networks: as for mobile phones NBN: *if required* – re-direct antenna at affected dwelling to alternative tower, change location of antenna, install new tower
Satellite television and internet	Services designed for Australian audiences: signals intercepted at one stakeholder dwelling (understood to be 'dilapidated') Services designed for international audiences: signals intercepted at 8 dwellings (5 stakeholder dwellings)	Low potential to cause interference	Consultation with operators not considered necessary DNV recommends engaging with residents or owners of potentially affected dwellings	*If required* – re-direct satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish
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	Low potential to cause interference to FM signals	Consultation not considered necessary	AM signals and digital radio signals: none required FM signals: *if required* – install higher-quality antenna at affected location, increase signal strength from affected tower, move tower to new location, install signal repeater, install additional tower

Table 8 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Assessment findings	Expected impact	Stakeholder feedback (to date)	Potential mitigation options
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception *Warrnambool tower: 'variable' to 'good' coverage across the site* 35 dwellings (19 stakeholder dwellings) in potential interference zone	Potential to cause interference	Unlikely to cause interference	*If required* - re-align antenna at affected dwelling to existing tower, re-direct antenna to alternative tower, install more directional or higher gain antenna, change location of antenna, install cable or satellite television, install relay transmitter
	Portland tower: coverage ranging from 'good' to the west of the site to 'poor' or non-existent to the east of the site 40 dwellings (18 stakeholder dwellings) in potential interference zone	Potential to cause interference	Low risk of interference for one resident (based on 75-turbine layout)	
	Western Victoria tower: 'poor' to 'variable' coverage across the site 66 dwellings (8 stakeholder dwellings) in potential interference zone	Potential to cause interference	High risk of interference for 5 residents, low risk of interference for 37 residents (based on 75-turbine layout) – affected residents are likely to be able to receive alternative signals from the Warrnambool tower	

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LIST OF TABLES

Table 9 Proposed turbine layout for the Project site [3]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
T1	594541	5777512	119	T31	601868	5773034	71
T2	594912	5778008	120	T32	601951	5774373	81
T3	595052	5777437	117	T33	602181	5775353	86
T4	595295	5775292	87	T34	602339	5774680	84
T5	595356	5776399	99	T35	602430	5772374	69
T6	595539	5775736	89	T36	602448	5773726	78
T7	595987	5775116	87	T37	602449	5773036	73
T8	596021	5775883	90	T38	602652	5775570	91
T9	596385	5776184	90	T39	602963	5774822	89
T10	596524	5775138	90	T40	602974	5774260	85
T11	596820	5775529	93	T41	602978	5776744	90
T12	597012	5776114	90	T42	602982	5777383	91
T13	597418	5775401	91	T43	602995	5772439	70
T14	597509	5776428	92	T44	603079	5773025	78
T15	597786	5775729	93	T45	603085	5775834	89
T16	598102	5776261	92	T46	603504	5777464	87
T17	598281	5775070	95	T47	604413	5777218	79
T18	598454	5775587	94	T48	604706	5777584	102
T19	600069	5773733	87	T49	605324	5777145	91
T20	600427	5772376	67	T50	605523	5776474	86
T21	600465	5774158	82	T51	606007	5776591	94
T22	600595	5772972	68	T52	606013	5775518	77
T23	600736	5774616	86	T53	606138	5775999	79
T24	601107	5775130	93	T54	606584	5776429	99
T25	601274	5772373	66	T55	606753	5775545	84
T26	601287	5773051	70	T56	606959	5774946	68
T27	601373	5774416	82	T57	606986	5773741	67
T28	601416	5777791	94	T58	607132	5774276	70
T29	601720	5775145	86	T59	607608	5773622	73
T30	601827	5772400	71				

1. Coordinate system: MGA zone 54, GDA2020 datum.

Table 10 Dwellings in the vicinity of the proposed Project [4]

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
D1	602338	5778517	Stakeholder	1.2
D2	602249	5778671	Stakeholder	1.2
D3	602806	5778870	Stakeholder	1.5
D4	603939	5778286	Stakeholder	0.9
D6	604693	5776249	Stakeholder	0.9
D7	604270	5778099	Stakeholder	0.7
D8	604307	5774639	Stakeholder	1.4
D9	600298	5778839	Non-stakeholder	1.5
D10	599984	5778813	Non-stakeholder	1.8
D11	604612	5774248	Non-stakeholder	1.6
D12	604797	5779067	Stakeholder	1.5
D14	599057	5778429	Stakeholder	2.4
D15	606009	5777950	Stakeholder	1.1
D17	604805	5773236	Non-stakeholder	1.7
D18	604962	5773291	Non-stakeholder	1.9
D19	597861	5778419	Stakeholder	2.0
D21	597313	5778556	Non-stakeholder	2.1
D22	598908	5772235	Non-stakeholder	1.5
D23	597075	5778833	Non-stakeholder	2.3
D24	606570	5780702	Non-stakeholder	3.6
D25	608204	5776320	Non-stakeholder	1.6
D26	604978	5771412	Non-stakeholder	2.2
D27	606675	5780723	Non-stakeholder	3.7
D28	607967	5774731	Stakeholder	1.0
D29	598950	5771721	Non-stakeholder	1.6
D32	596718	5779446	Non-stakeholder	2.3
D33	596404	5778960	Non-stakeholder	1.8
D34	597821	5772016	Non-stakeholder	2.6
D36	605508	5771178	Non-stakeholder	2.8
D39	608652	5775369	Non-stakeholder	1.7
D40	598861	5771212	Non-stakeholder	2.0
D42	606672	5781659	Non-stakeholder	4.5
D44	595730	5778083	Stakeholder	0.8
D45	608163	5780421	Non-stakeholder	4.3
D46	605303	5770376	Non-stakeholder	3.1
D47	601378	5769755	Non-stakeholder	2.6
D48	602014	5769677	Non-stakeholder	2.7
D50	600934	5769675	Non-stakeholder	2.7
D51	602966	5769562	Non-stakeholder	2.9
D52	602079	5769523	Non-stakeholder	2.9
D53	605345	5770163	Non-stakeholder	3.3
D54	602856	5769460	Non-stakeholder	2.9
D55	609519	5777525	Stakeholder	3.1
D57	603650	5769530	Non-stakeholder	3.0
D59	609855	5776451	Non-stakeholder	3.2
D60	609177	5779736	Non-stakeholder	4.2
D61	603954	5769324	Non-stakeholder	3.3
D62	598860	5769956	Non-stakeholder	2.9
D63	604989	5769535	Non-stakeholder	3.5
D64	609959	5776611	Non-stakeholder	3.4
D65	598819	5769883	Non-stakeholder	3.0
D66	609896	5775512	Non-stakeholder	3.0

Table 10 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
D67	596746	5770978	Non-stakeholder	3.9
D68	596931	5770809	Non-stakeholder	3.8
D69	597045	5770678	Non-stakeholder	3.8
D70	596464	5771238	Non-stakeholder	3.9
D72	595722	5772081	Non-stakeholder	3.0
D73	595850	5771868	Non-stakeholder	3.3
D74	596717	5770865	Non-stakeholder	4.0
D75	596409	5771187	Non-stakeholder	4.0
D76	596636	5770938	Non-stakeholder	4.1
D77	596467	5771076	Non-stakeholder	4.1
D78	595010	5773129	Non-stakeholder	2.2
D79	596521	5770935	Non-stakeholder	4.2
D80	596390	5771049	Non-stakeholder	4.1
D81	595419	5772309	Non-stakeholder	2.9
D82	597560	5769991	Non-stakeholder	3.7
D83	596107	5771319	Non-stakeholder	3.8
D85	597946	5769696	Non-stakeholder	3.7
D86	597119	5770291	Non-stakeholder	3.9
D87	595922	5771328	Non-stakeholder	3.8
D88	*594116*	*5778220*	*Stakeholder*	*0.8*
D90	594390	5773941	Non-stakeholder	1.6
D91	594743	5773211	Non-stakeholder	2.2
D94	610688	5774878	Non-stakeholder	3.3
D97	593563	5776282	Non-stakeholder	1.6
D98	598510	5768765	Non-stakeholder	4.1
D99	611025	5775506	Non-stakeholder	3.9
D100	595607	5771108	Non-stakeholder	4.0
D101	595136	5771597	Non-stakeholder	3.6
D102	596133	5770350	Non-stakeholder	4.7
D103	611144	5775855	Non-stakeholder	4.2
D104	609696	5771630	Non-stakeholder	2.9
D105	611245	5775903	Non-stakeholder	4.3
D106	595782	5770559	Non-stakeholder	4.6
D107	593478	5775056	Non-stakeholder	1.8
D108	609722	5771394	Non-stakeholder	3.1
D109	611129	5774330	Non-stakeholder	3.6
D110	598469	5768406	Non-stakeholder	4.4
D111	596386	5769748	Non-stakeholder	4.8
D112	594154	5781128	Non-stakeholder	3.2
D115	610243	5771322	Non-stakeholder	3.5
D116	598523	5767934	Non-stakeholder	4.8
D118	593741	5781151	Non-stakeholder	3.4
D121	608425	5769023	Non-stakeholder	4.7
D123	592583	5777111	Non-stakeholder	2.0
D124	592534	5776194	Non-stakeholder	2.4
D129	609597	5769643	Non-stakeholder	4.4
D134	611979	5773142	Non-stakeholder	4.4
D139	592165	5779222	Non-stakeholder	2.9
D140	592041	5779032	Non-stakeholder	2.9
D141	611721	5771768	Non-stakeholder	4.5
D144	592043	5779600	Non-stakeholder	3.3
D148	593112	5782322	Non-stakeholder	4.7
D152	591885	5779862	Non-stakeholder	3.5

Table 10 Dwellings in the vicinity of the proposed Project [4] (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
D154	591486	5777995	Non-stakeholder	3.1
D159	612189	5771761	Non-stakeholder	4.9
D169	591358	5779778	Non-stakeholder	3.9
D170	591685	5780880	Non-stakeholder	4.3
D175	591067	5780118	Non-stakeholder	4.3
D195	590444	5780127	Non-stakeholder	4.9
D196	590217	5779795	Non-stakeholder	4.9
D199	589671	5778413	Non-stakeholder	5.0
D354	594014	5774302	Non-stakeholder	1.6
D355	*604198*	*5775087*	*Stakeholder*	*1.3*
D356	597839	5771804	Non-stakeholder	2.7
D357	602767	5778969	Non-stakeholder	1.6
D360	591638	5775032	Non-stakeholder	3.7
D373	*604840*	*5779083*	*Stakeholder*	*1.5*
D374	605063	5773027	Non-stakeholder	2.0
D375	*599299*	*5774080*	*Stakeholder*	*0.8*
D376	*609720*	*5777494*	*Stakeholder*	*3.3*
D382	594643	5773413	Non-stakeholder	2.0
D383	598921	5771659	Non-stakeholder	1.7
D399	596720	5770744	Non-stakeholder	4.1
D400	596202	5770950	Non-stakeholder	4.2
D401	596249	5771055	Non-stakeholder	4.1
D460	*600889*	*5772922*	*Stakeholder*	*0.3*
D463	595841	5771707	Non-stakeholder	3.4
D464	596698	5770889	Non-stakeholder	4.0
D466	598815	5768025	Non-stakeholder	4.6
D482	*597337*	*5775111*	*Stakeholder*	*0.3*
D483	596049	5771332	Non-stakeholder	3.8
D484	*603225*	*5775960*	*Stakeholder*	*0.2*
D485	*603199*	*5775999*	*Stakeholder*	*0.2*

1. Coordinate system: MGA zone 54, GDA2020 datum.
Stakeholder dwellings are indicated by *underlined italic text*.

Table 11 Details of point-to-point links crossing the proposed Project site

Link no.	Licence number	Assignment ID	Frequency [MHz]	Licence owner
1	10329947/1	3076595	7821.825	AusNet Transmission Group Pty Ltd SPI PowerNet Pty Limited Locked Bag 1405 Licensing-ICT Business Office MELBOURNE CITY MAIL CENTRE VIC 8001
		3076596	7821.825	
		3076593	8133.145	
		3076594	8133.145	
	10329948/1	3076599	7851.475	
		3076600	7851.475	
		3076597	8162.795	
		3076598	8162.795	

Table 12 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
753445	133844	1182425/1	-38.2402	142.4202	18	Aussie Broadband Pty Ltd PO Box 3351 GIPPSLAND MC VIC 3841
753448	133844	1182425/1	-38.2402	142.4202	18	
753449	133844	1182426/1	-38.2402	142.4202	18	
753454	133844	1182426/1	-38.2402	142.4202	18	
1174798	133844	1920117/1	-38.2402	142.4202	18	
1174795	133844	1920117/1	-38.2402	142.4202	18	
3515620	305783	10404937/1	-38.3130	142.3781	20	Powercor Australia Ltd C/- Commander Enterprise Service Pty Ltd Locked Bag 14090 Attn: Sam Devadason MELBOURNE VIC 8001
3515617	305783	10404937/1	-38.3130	142.3781	20	
3799574	303649	10457449/1	-38.2162	141.7035	33	
3799571	303649	10457449/1	-38.2162	141.7035	33	
3528334	303649	10406309/1	-38.2162	141.7035	33	
3527944	303649	10406308/1	-38.2162	141.7035	33	
3527947	303649	10406308/1	-38.2162	141.7035	33	
3528337	303649	10406309/1	-38.2162	141.7035	33	
923790	305790	1945114/1	-38.0560	142.8116	52	
923787	305790	1945114/1	-38.0560	142.8116	52	
793642	305626	1326838/1	-38.3081	142.3743	19	Wannon Region Water Corporation PO Box 1158 WARRNAMBOOL VIC 3280
793645	305626	1326838/1	-38.3081	142.3743	19	
744711	302384	1143861/1	-38.3865	142.2144	22	
872281	302384	1909709/1	-38.3865	142.2144	22	
872278	302384	1909709/1	-38.3865	142.2144	22	
744716	302384	1143861/1	-38.3865	142.2144	22	
924158	41654	1945301/1	-37.8825	142.3006	29	
924155	41654	1945301/1	-37.8825	142.3006	29	
3711287	40981	10435722/1	-38.3768	142.4883	31	
3711290	40981	10435722/1	-38.3768	142.4883	31	
793641	40981	1326837/1	-38.3768	142.4883	31	
793638	40981	1326837/1	-38.3768	142.4883	31	
2830378	10006368	10277107/1	-38.1311	141.6287	39	
2830375	10006368	10277107/1	-38.1311	141.6287	39	
924163	133996	1945302/1	-38.3856	141.6059	48	
744710	133996	1143860/1	-38.3856	141.6059	48	
744707	133996	1143860/1	-38.3856	141.6059	48	
924166	133996	1945302/1	-38.3856	141.6059	48	
761724	11703	1191982/1	-37.6834	142.0198	51	
761721	11703	1191982/1	-37.6834	142.0198	51	
793653	300876	1326839/1	-38.0642	142.8085	51	
793650	300876	1326839/1	-38.0642	142.8085	51	
878704	9010140	1914276/1	-37.6111	141.6863	68	
878701	9010140	1914276/1	-37.6111	141.6863	68	
793625	46455	1326835/1	-38.4925	142.9805	74	
793622	46455	1326835/1	-38.4925	142.9805	74	
755289	136307	1185110/1	-38.3878	142.4592	31	Warrnambool Golf Club Inc Younger St WARRNAMBOOL VIC 3280
755292	136307	1185110/1	-38.3878	142.4592	31	

Table 13 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	282
2 GHz Band	Spectrum	237
2.3 GHz Band	Spectrum	6620
2.5 GHz Band	Spectrum	202
3.4 GHz Band	Spectrum	1250
700 MHz Band	Spectrum	542
800 MHz Band	Spectrum	288
Aeronautical Assigned System	Aeronautical	8
Amateur Beacon	Amateur	8
Amateur Repeater	Amateur	31
Ambulatory System	Land Mobile	54
AWL - FSS Only	Spectrum	80
AWL - Standard	Spectrum	2
CBRS Repeater	Land Mobile	4
Commercial Radio	Broadcasting	6
Commercial Television	Broadcasting	9
Community Broadcasting	Broadcasting	3
Land Mobile System - > 30MHz	Land Mobile	1069
Land Mobile System 0-30MHz	Land Mobile	152
Limited Coast Assigned System	Maritime Coast	14
Narrowband Area Service station(s)	Broadcasting	3
Narrowcasting Service (Fixed Tax)	Broadcasting	4
Narrowcasting Service (LPON)	Broadcasting	21
National Broadcasting	Broadcasting	15
Paging System - Exterior	Land Mobile	33
Paging System - Interior	Land Mobile	2
PMTS Class B	PTS	206
PMTS Class B (935-960 MHz)	PTS 900 MHz	91
Radiodetermination	Radiodetermination	1
Retransmission	Broadcasting	10

Table 14 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Ambulance Victoria	Ambulance Victoria Attn: Tim McCallum 303 Gillies Street North WENDOUREE VIC 3355	29
Australian Maritime Safety Authority	Australian Maritime Safety Authority GPO Box 2181 Attn: Response Division Administration Canberra ACT 2601	56
Country Fire Authority	Country Fire Authority PO Box 701 MOUNT WAVERLEY VIC 3149	5
Department of Justice and Regulation (Regional Mobile Radio)	Department of Justice and Regulation RMR Regional Mobile Radio C/- Level 2 Bld M5 30 Henderson Rd CLAYTON VIC 3168	18
Department of Justice and Regulation (Visionstream)	Department of Justice and Regulation Visionstream Australia Locked Bag 4001 Attn: Rosario Holden Heatherton VIC 3202	15
St John Ambulance Australia	ST. JOHN AMBULANCE AUSTRALIA INCORPORATED Technical Services 170 Forster Road MOUNT WAVERLEY VIC 3149	27
The Australian Volunteer Coast Guard Association	The Australian Volunteer Coast Guard Association Inc PO Box 64 SANDRINGHAM VIC 3191	33
Victoria State Emergency Service	Victoria State Emergency Service 168 Sturt St SOUTHBANK VIC 3006	21

Table 15 BoM radar sites in the vicinity of the proposed Project

BoM radar site	Radar type	Latitude[1]	Longitude[1]	Distance to Project [km]
Mount Gambier	Standard weather watch	-37.748	140.775	122
Melbourne (Laverton)	Doppler	-37.855	144.755	224
Rainbow (Wimmera)	Doppler	-35.998	142.013	237
Melbourne (Broadmeadows)	Doppler	-37.691	144.946	244
Yarrawonga	Doppler	-36.030	146.023	411
Mildura	Standard weather watch	-34.235	142.086	432
NW Tasmania (West Takone)	Doppler	-41.181	145.579	440
Adelaide (Sellicks Hill)	Standard weather watch	-35.330	138.500	446

1. Coordinate system: Lat/Lon GDA94 datum.

Table 16 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude[1]	Longitude[1]	Distance to Project [km]
Hummocks	AGD66	-38.359	142.101	19
Tower Hill	AGD66, GDA94	-38.321	142.360	19

1. Coordinate system: Lat/Lon GDA94 datum.

Table 17 Dwellings with increased potential to experience EMI to DTV from television broadcast towers

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Warrnambool	Portland	Western Victoria
D1	602338	5778517	X	X	
D2	602249	5778671	X		
D3	602806	5778870	X		
D4	603940	5778286	X	X	
D6	604693	5776249	X	X	X
D7	604270	5778099	X	X	
D8	604307	5774639		X	X
D9	600298	5778839	X		
D10	599984	5778813	X		
D11	604612	5774248		X	X
D12	604797	5779067	X	X	
D14	599057	5778429	X	X	
D15	606009	5777950	X	X	
D17	604805	5773236		X	X
D18	604963	5773291		X	X
D19	597861	5778419	X	X	
D21	597313	5778556		X	
D22	598909	5772235			X
D23	597075	5778833		X	
D25	608204	5776320		X	
D26	604978	5771412		X	X
D28	607967	5774731		X	
D29	598950	5771721			X
D33	596404	5778960	X	X	
D34	597821	5772016			X
D36	605508	5771178		X	X
D39	608652	5775369		X	
D40	598861	5771212			X
D44	595730	5778083	X	X	
D46	605303	5770376			X
D47	601378	5769755			X
D48	602014	5769677			X
D50	600934	5769675			X
D51	602966	5769562			X
D52	602079	5769523			X
D53	605345	5770163			X
D54	602856	5769460			X
D55	609519	5777525		X	
D57	603650	5769530			X
D59	609855	5776451		X	
D60	609177	5779736		X	
D61	603954	5769324			X
D62	598860	5769956			
D63	604989	5769535			X
D64	609959	5776611		X	
D65	598819	5769883			
D66	609896	5775512		X	
D67	596746	5770978			X
D68	596931	5770809			X
D69	597045	5770678			X
D70	596465	5771238			X

Table 17 Dwellings with increased potential to experience EMI to DTV from television broadcast towers (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Warrnambool	Portland	Western Victoria
D72	595722	5772081			X
D73	595850	5771868			X
D74	596717	5770865			X
D75	596409	5771187			X
D76	596636	5770938			X
D77	596467	5771076			X
D78	595010	5773129			X
D79	596521	5770935			X
D80	596390	5771049			X
D81	595420	5772309			X
D82	597560	5769991			
D83	596107	5771319			X
D85	597946	5769696			
D86	597119	5770291			X
D87	595922	5771328			X
D88	*594116*	*5778220*	*X*		
D90	594390	5773941			X
D91	594743	5773211			X
D94	610688	5774878		X	
D97	593563	5776282	X		
D98	598510	5768765			
D99	611025	5775506		X	
D100	595607	5771108			X
D101	595136	5771597			X
D102	596133	5770350			X
D103	611144	5775855		X	
D104	609696	5771630			X
D105	611245	5775903		X	
D106	595782	5770559			X
D107	593478	5775056			
D108	609723	5771394			X
D109	611129	5774330		X	
D110	598469	5768406			
D111	596386	5769748			
D121	608425	5769023			X
D123	592583	5777111	X		
D124	592534	5776194	X		
D129	609597	5769643			X
D134	611979	5773142		X	
D139	592165	5779222	X		
D140	592042	5779032	X		
D144	592043	5779600	X		
D152	591885	5779862	X		
D154	591486	5777995	X		
D169	591358	5779778	X		
D170	591685	5780880	X		
D175	591067	5780118	X		
D195	590444	5780127	X		
D196	590217	5779795	X		
D354	594014	5774302			X
D355	*604198*	*5775087*		*X*	*X*
D356	597839	5771804			X

Table 17 Dwellings with increased potential to experience EMI to DTV from television broadcast towers (continued)

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone		
			Warrnambool	Portland	Western Victoria
D357	602767	5778969	X		
D360	591638	5775032			
D373	*604840*	*5779083*	*X*	*X*	
D374	605063	5773027		X	X
D375	*599299*	*5774080*	*X*		*X*
D376	*609720*	*5777494*		*X*	
D382	594643	5773413			X
D383	598921	5771659			X
D484	*603225*	*5775960*	*X*	*X*	*X*
D485	*603199*	*5775999*	*X*	*X*	*X*

1. Coordinate system: MGA zone 54, GDA94 datum.

Stakeholder dwellings are indicated by *underlined italic text.*

Table 18 Summary of service operators contacted and responses received to date

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
1	Fixed point-to-point	Two turbines (30, 31) in diffraction exclusion zone set by DNV, Six turbines (6, 11, 21, 22, 30, 31) in potential reflection/scattering interference zone set by DNV, No turbines in potential near-field interference zone set by DNV	AusNet Transmission Group Pty Ltd (AusNet Services) Feedback provided by the Proponent	Response received by email on 6/05/2020, based on the proposed Project boundaries and turbine dimensions: *"[We] have confirmed that the wind turbines will interfere and there will need to be separation.* *A 20 m clearance is required from the blade tips in both directions, i.e. a 40 m corridor."* [Screenshots provided showing the link path relative to the Project boundaries in the horizontal and vertical planes, and the coordinates of the link endpoints. Google Earth kmz file showing location of link path also provided.]
2	Fixed point-to-multipoint Wireless internet	18 km	Aussie Broadband Pty Ltd (Aussie Broadband) 10284163-AUME-L-01	Response received by email on 24/03/2021, based on the previous 75-turbine layout: *"We don't have any concerns with the wind farm proposal."*
3	Fixed point-to-multipoint	20 km	Powercor Australia Pty Ltd (Powercor) 10284163-AUME-L-02	Response received by email on 24/03/2021, based on the previous 75-turbine layout: *"I have reviewed the information you sent through for the Willatook Wind Farm EMI assessment. I confirm that we have three Powercor hill top radio sites (as in ACMA database) within the 75 km radius of WWF – these are Mt Clay, Tower Will, Mt Shadwell.* *There are point to multipoint licences for Mt Clay and Mt Shadwell – the existing P-MP links do not cross the Willatook Wind Farm boundaries or skirt the WWF perimeter – all multipoint radio paths are well clear of the WWF boundaries.* *The three radio sites also have point to point digital radio links originating and terminating out of these sites – none of the existing P-P links cross the Willatook Wind Farm boundaries so there is no concerns that WWF will impact on the P-P link radio path corridor.* *So in general the WWF is well clear of Powercor radio links both P-P and P-MP."*

Table 18 Summary of service operators contacted and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
4	Fixed point-to-multipoint	19 km	Wannon Region Water Corporation (Wannon Water) 10284163-AUME-L-03	Informal response received by phone on 28/05/2021: Point-to-multipoint link paths are unlikely to cross the Project site Locations of remote supervisory control and data acquisition (SCADA) radio sites received by email on 28/05/2021 DNV map showing SCADA radio sites and point-to-multipoint base stations relative to the Project site provided on 28/05/2021 No further response received to date
5	Wireless internet	10 km	NBN Co 10284163-AUME-L-04	Response received by email on 24/03/2021, based on the previous 75-turbine layout: *"We have reviewed the data provided based on the proposed wind farm location; the eastern side of which overlaps with the nbn Wireless Coverage Area of… Hawkesdale.* *It would appear the Wind Farm turbine locations have potential line of sight (LOS) impact between two nbn customer locations and the nearby nbn LTE-TDD base station site within the current nbn Wireless Coverage Areas. This can be checked in more detail once exact turbine locations in the RF paths are provided.* [Screenshot provided showing potential for interference to the line of sight from the Hawkesdale NBN tower to two existing NBN customers] *A standard nbn response for wind farm applications regarding potential interference impact on nbn FW network is as follows:* *Referring to an email dated 23 March 2021 regarding the application for the Willatook Wind Farm.* *We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licences within 75 km of the proposed ... Wind Farm.* *nbn have strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place.* *nbn will be forced to consider its position as part of the planning should there be an interference issue.* *If the Application is amended before it is lodged we request that we are sent any amended Application so we can determine whether we have any objections to the amended Application.*

Table 18 Summary of service operators contacted and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
			NBN Co (continued)	*We note that, as you would be aware, under section 197 of the Radiocommunications Act 1992 (Cth) it is an offence to knowingly or recklessly do anything likely to interfere substantially with radiocommunications or otherwise substantially disrupt or disturb radiocommunications."* <u>Response received by email on 21/04/2021, based on the previous 75-turbine layout following more detailed review undertaken by NBN Co:</u> *"The following turbine tower is ~29m from the RF Profile boresight line.* [Screenshots provided showing the location of a turbine in the 75-turbine layout in relation to the line of sight from the Hawkesdale NBN tower to dwelling D15 – this turbine has been removed from the 59-turbine layout] *If built exactly as shown it should pose no impact to service. However given the close proximity to the boresight, should the exact tower location be varied, there is a risk to impacting the nbn service. For this turbine, is there a possibility to move it further north away from the boresight and reduce any risk?* *The following shows two towers near the boresight line however both are 112m or greater from the RF Profile so pose no real threat to nbn service.* [Screenshot provided showing the locations of turbines T52 and T55 in the current 59-turbine layout in relation to the line of sight from the Hawkesdale NBN tower to dwelling D11 – the locations of these turbines have not been changed compared to the 75-turbine layout]
6	Emergency service	5 km	Country Fire Authority (CFA) Feedback provided by the Proponent	<u>Response received by email on 9/04/2021, based on the previous 75-turbine layout:</u> *"I confirm that the CFA radio services (fixed radio links and land mobile services) are not affected by the proposed wind turbines at Willatook wind farm, based on the attached wind farm boundary details supplied by Willatook Wind Farm Pty Ltd."*
7	Emergency service	18 km	Department of Justice and Regulation (Regional Mobile Radio) Feedback provided by the Proponent	<u>Response received by email on 23/04/2021, based on the previous 75-turbine layout:</u> *"Thanks for the GIS data. A check of it shows no issue with overlap with the RMR Regional Mobile Radio network."*

Table 18 Summary of service operators contacted and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
8	Meteorological radar	122 km	Bureau of Meteorology (BoM) Feedback provided by the Proponent	Response received by email on 27/04/2021, based on the previous 75-turbine layout: *"…our analysis shows that the proposed wind farm in Willatook has a manageable impact on our Mt Gambier weather radar on normal weather conditions. Therefore, the Bureau is ready to agree with your proposed wind farm should the farm operator/owner agree with the following conditions:* *1- To inform the Bureau of any changes in the wind farm including varying the layout of the farm, changing the location of each turbine more than 100 metres or altering the turbine's height.* *2- Notify the Bureau at least two weeks before any planned shut-down of the farm (for maintenance or any other reason). This enables the Bureau to calibrate its radar system without the effect of rotating turbines.* 3- *Collaborates with the Bureau on the event of severe weather condition to assist in endeavours of community safety."*
9	Trigonometrical stations	19 km	Department of Environment, Land, Water and Planning (DELWP) Feedback provided by the Proponent	Response received by email on 20/04/2021, based on the previous 75-turbine layout: *"I have assessed the proposed area and can advise that the proposed Willatook Wind Farm will not adversely impact the positioning infrastructure in Victoria. The project area is clear of our primary positioning infrastructure.."*
10	PMTS/spectrum (mobile phone)	10 km	Optus Feedback provided by the Proponent	Response received by email on 24/05/2021, based on the previous 75-turbine layout: *"We have completed a technical assessment based on the provided details. While there may be some impacts on Optus network and services in the area, the impacts is not expected to be unacceptable. Hence, Optus does not have any objection to the proposed Wind Farm.* *It should be noted that the assessment has been done based on the details provided and changes in the proposed plan will require a re-assessment."*

Table 18 Summary of service operators contacted and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
11	PMTS/spectrum (mobile phone)	10 km	Telstra Feedback provided by the Proponent	<u>Response received by email on 10/09/2021, based on the previous 75-turbine layout:</u> *"We have reviewed the planned wind turbine locations at the proposed Willatook Wind Farm.* *In the general area of Willatook, a limited outdoor 4g network coverage and marginal indoor 4g coverage is available to our customer. The major Telstra mobile network sites serving this area are located at a radius of between approximately 16 and 18 km of the proposed wind turbines.* *We would not expect the structures as described to have a significant impact to overall network coverage in this area; [I] am not aware of any specific confirmed instances of wide area mobile network coverage degradation in connection with wind far installations at this time."*

Table 18 Summary of service operators contacted and responses received to date (continued)

	Licence/service type	Distance of closest site	Operator and DNV reference	Response received to date
12	Television broadcasting	20 km	BAI Communications Feedback provided by the Proponent	<u>Response received by email on 8/02/2021, based on the previous 75-turbine layout:</u> *"I refer to your communications with BAI Communications (BAI) regarding the proposed Willatook windfarm… Radiocommunication assets owned by BAI Communications have been identified in the vicinity of the proposed wind farm. The three broadcast sites that have been identified providing coverage around the wind farm area are Mt Dundas (ACMA Site ID 38531), Tower Hill (ACMA Site ID 51181) and Mt Clay (ACMA Site ID 42517). BAI has undertaken an assessment of the proposed Willatook Wind Farm and the likelihood of it impacting upon digital television broadcast transmission from these sites either operated by BAI or services that BAI are responsible for in this region.* *In summary, the result shows that for Mt Dundas, 37 persons are predicted to be at low risk whilst 5 persons are predicted to be in high risk of interference to digital television services due to the scatter interference effects of the wind farm. In the event that service degradation is experienced for services operating from the Broadcast Facilities as a result of the development, BAI would be looking to [Willatook Wind Farm Pty Ltd] for solutions to rectify any resulting issues.* *BAI do not believe there are any point to point comms links affected from any of our three sites mentioned above. FM radio transmission was not considered in this assessment as any impact is considered a low risk. It is recommended however that appropriate due diligence is undertaken by [Willatook Wind farm Pty Ltd] to address any possible impacts to the FM transmissions associated with the development of this wind farm."*

BAI Communications (continued) Feedback provided by the Proponent	<u>Detailed assessment report dated 3/02/2021 based on the previous 75-turbine layout:</u> *"BAI Communications has done a study on the proposed wind farm located in Willatook… The impact on three broadcast facilities were studied, all digital television. The result shows that for Mt Dundas, 37 persons are predicted to be at low risk whilst 5 persons are predicted to bin in high risk of interference to digital television services due to the scatter interference effects of the wind farm. However, the people affected are covered by alternative broadcast service from Tower Hill. For Mt Clay, 1 person is in low risk of scatter interference due to the windfarm. In the event that service degradation is experienced for services operating from the Broadcast Facilities as a result of the development, BAI would be looking to [Willatook Wind Farm Pty Ltd] for solutions to rectify any resulting issues."* <u>Detailed assessment report dated 24/22/2021 based on the previous 75-turbine layout:</u> *"BAI Communications (BAI) has done a cumulative study on the windfarms (WFs) located around Willatook WF in Victoria. The surrounding WFs are Codrington WF, Hawkesdake WF, Macarthur WF, Ryan Corner WF, Woolsthorpe WF and Yambuk WF. The interference impact on four broadcast facilities was studied, all of which are broadcast digital television (DTV) facilities. The DTV coverage from two broadcast facilities is predicted to be impacted. Overall, a total of 7 people are predicted to be at low risk and 4 people are predicted to be at high risk of DTV interference due to the cumulative scatter interference effects from all of the WFs. Any remediation required to rectify DTV degradation to the viewers, is expected to form part of the WF project.* *…BAI have modelled the surrounding WFs (Codrington EF, Hawkesdale WF, Macarthur WF, Ryan Corner WF, Woolsthorpe WF and Yambuk WF) of Willatook WTGs to assess how they will affect DTV services broadcast from Mt Dundas (ACMA Site ID 38531), Lookout Hill (ACMA Site ID 36240), Tower Hill (ACMA Site ID 51181) and Mt Clay (ACMA Site ID 42517).* *After doing a DTV best-server analysis, a total of 7 people are predicted to be at low risk and 4 people are predicted to be at high risk of DTV interference due to the cumulative scatter interference effects from all of the WFs.* *Whilst there are few persons predicted to be impacted by the WFs, any degradation of DTV services caused by the WF development would be expected to be rectified as part of the project.* *Visual inspections in Google Earth does not show any buildings in the interference area for Mt Dundas and Tower Hill."*

LIST OF FIGURES

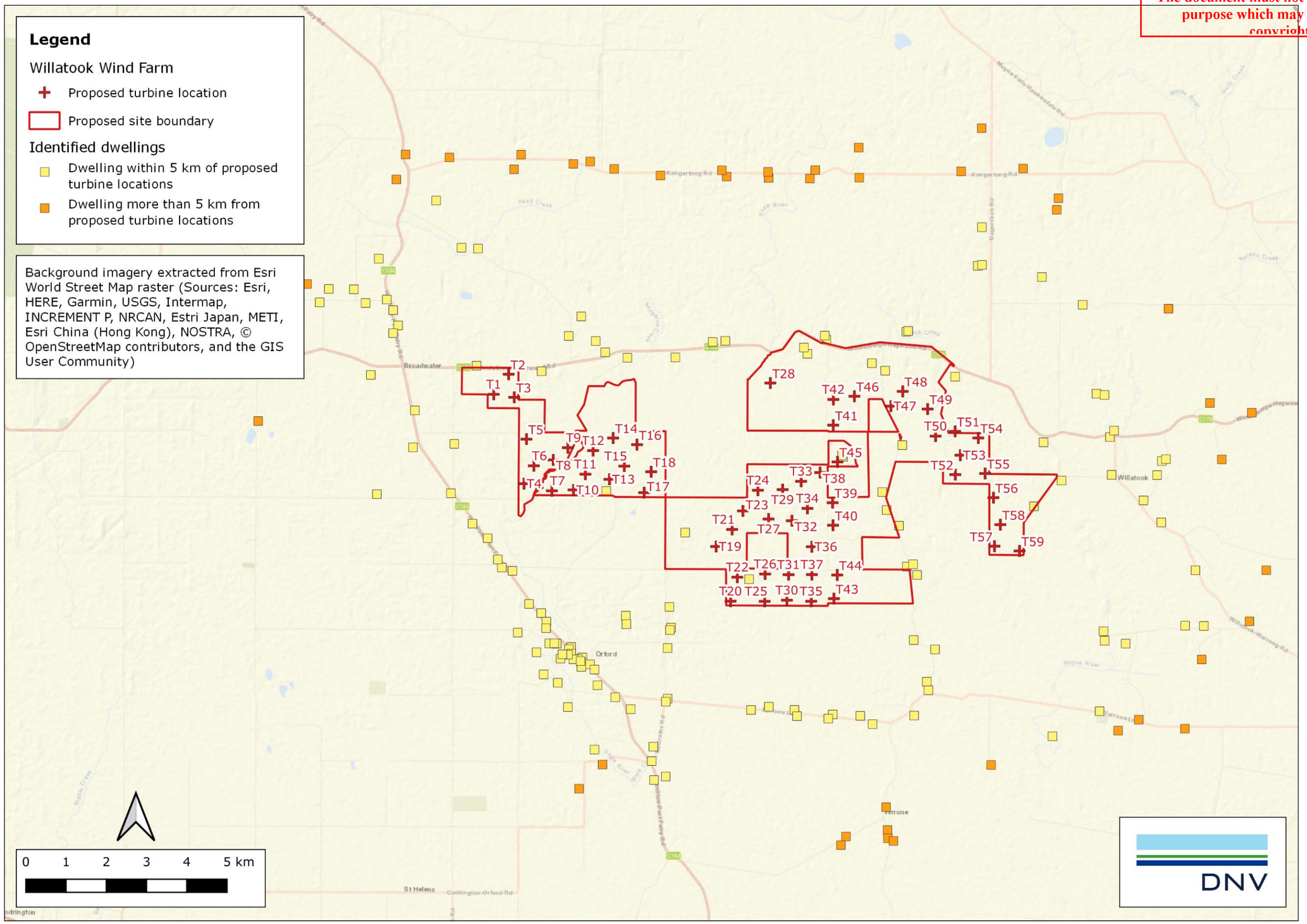

Figure 1 Map of the proposed Project, showing site boundaries, turbine locations, and locations of nearby dwellings

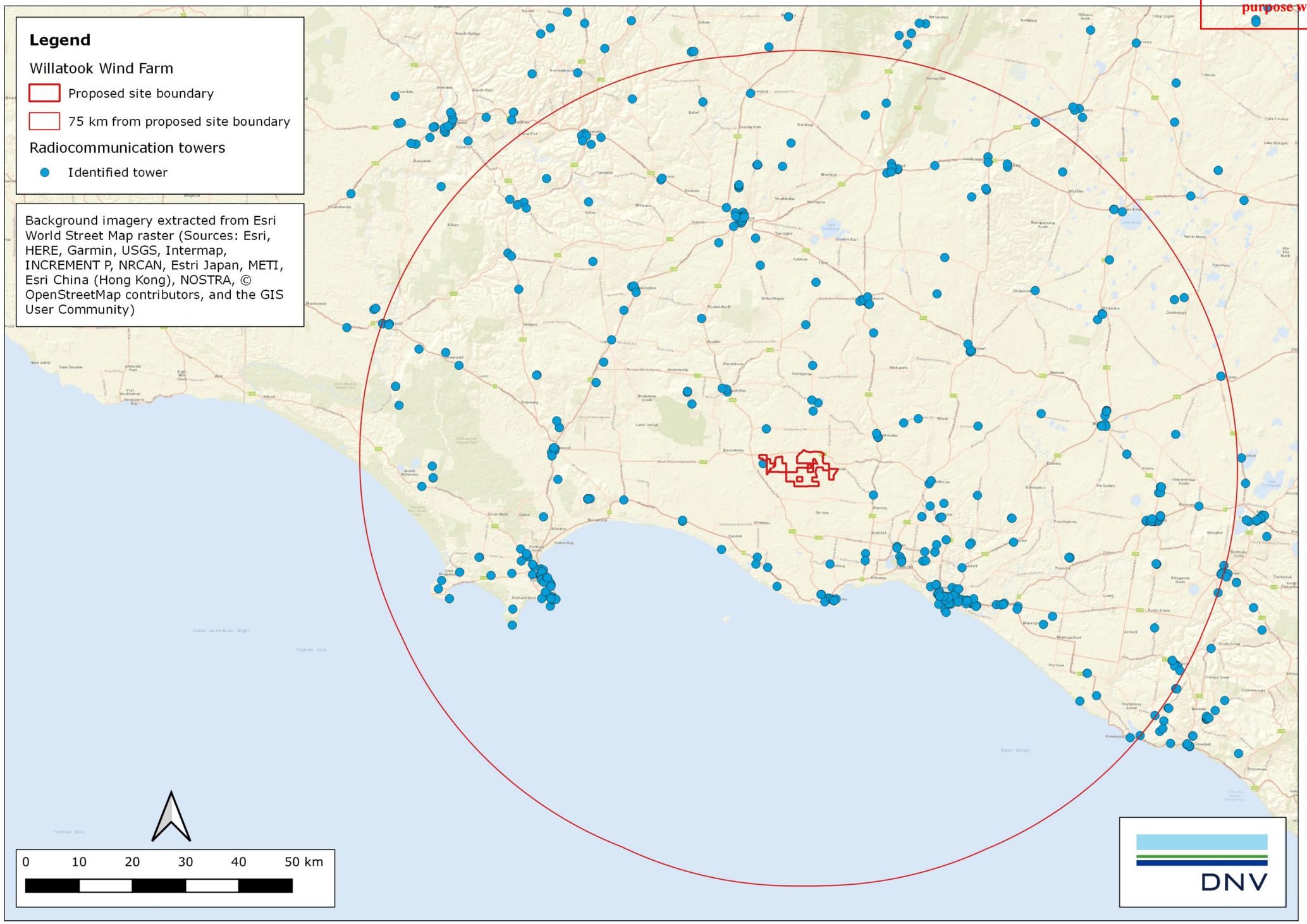

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

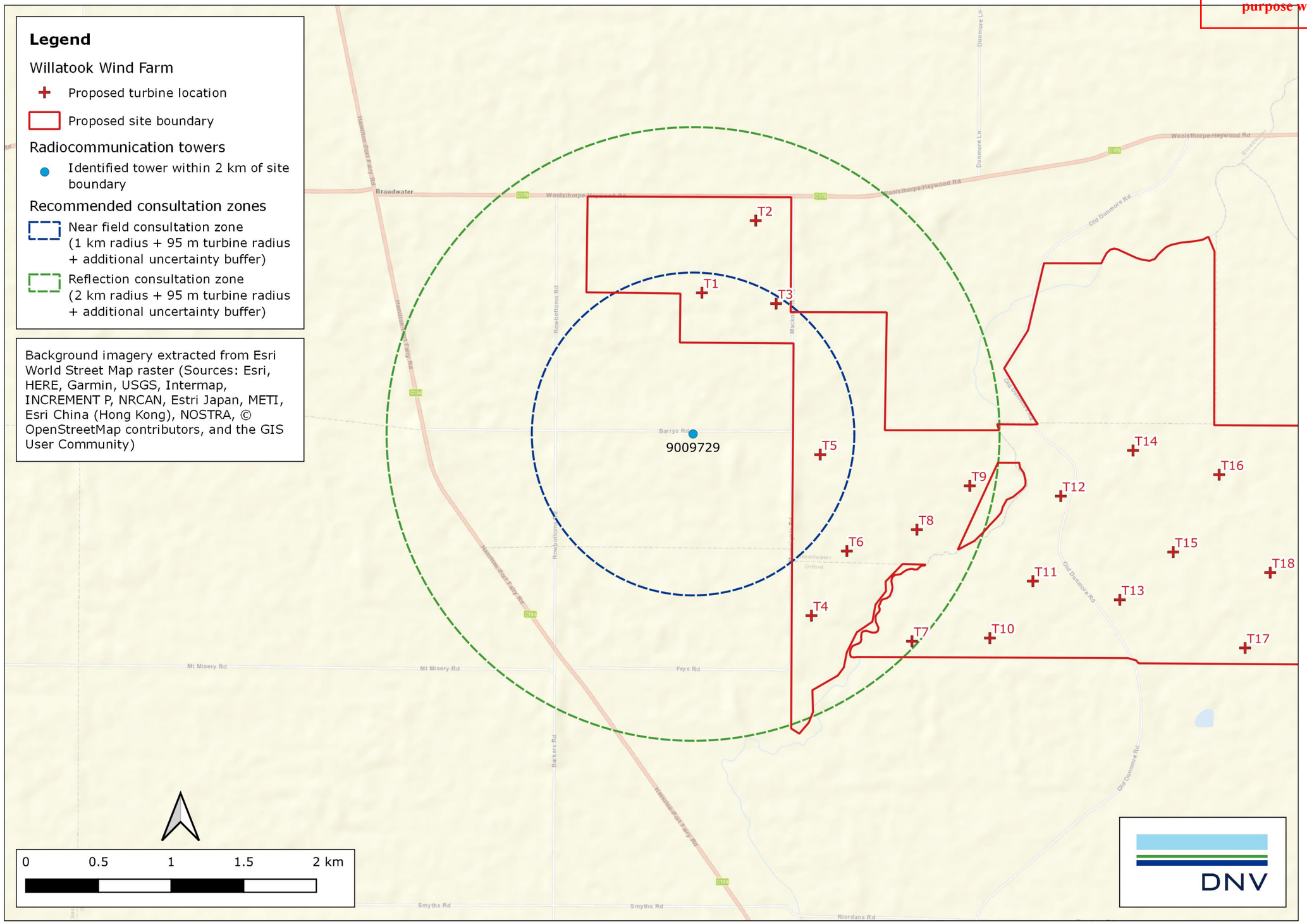

Figure 3 Identified radiocommunication sites within 2 km of the turbine locations for the proposed Project

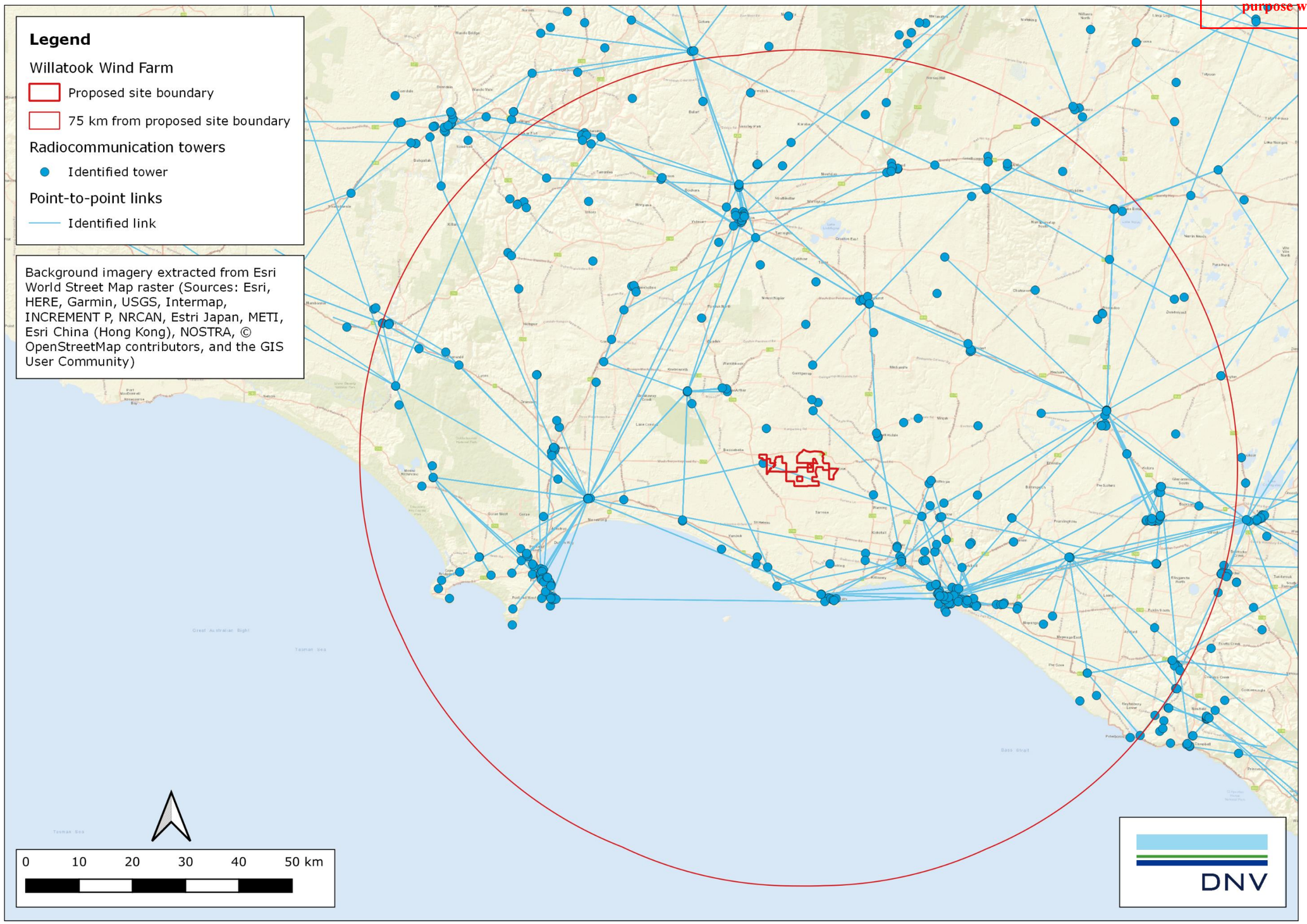

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

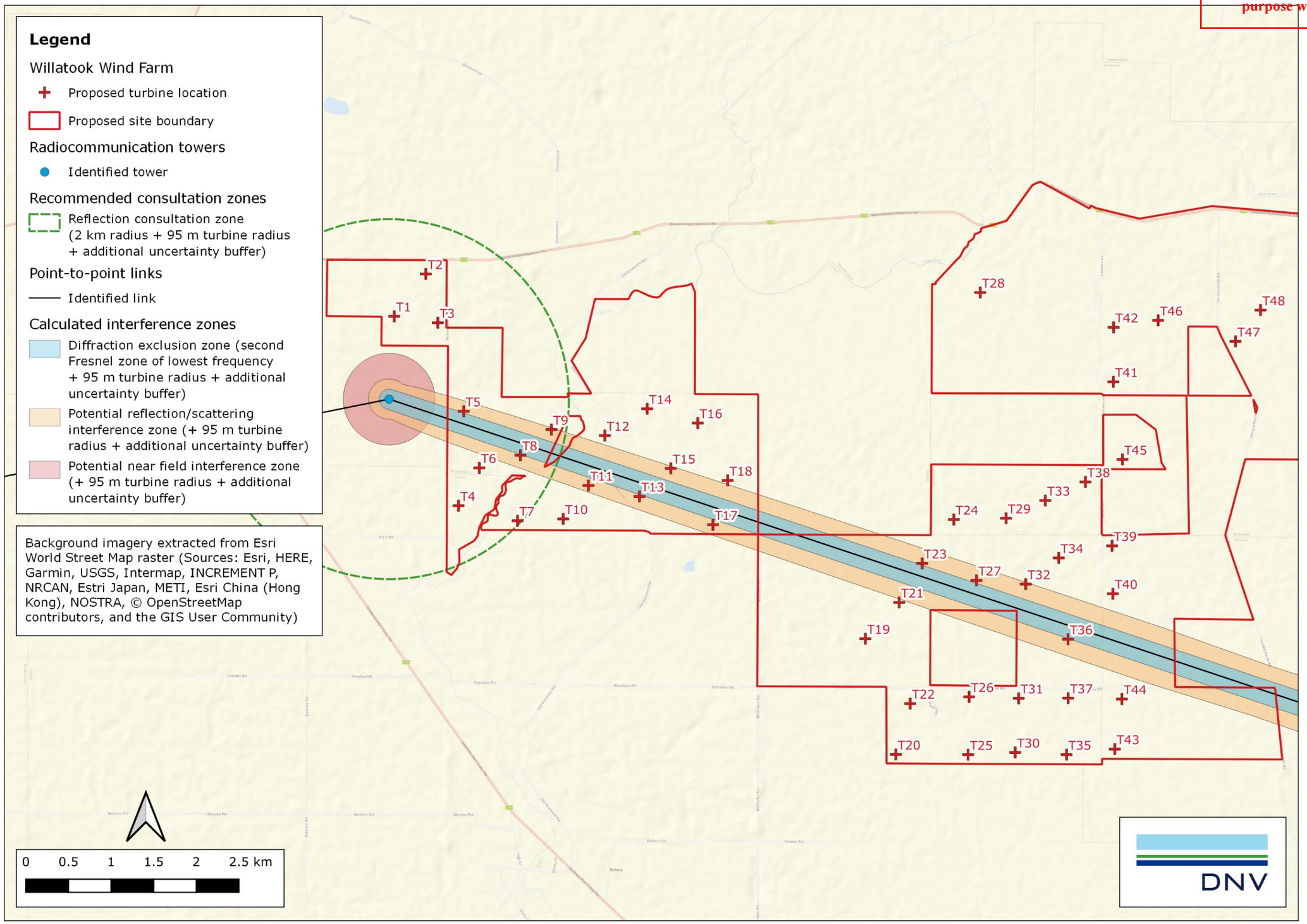

Figure 5 Identified point-to-point radiocommunication vectors and calculated interference zones for the proposed Project

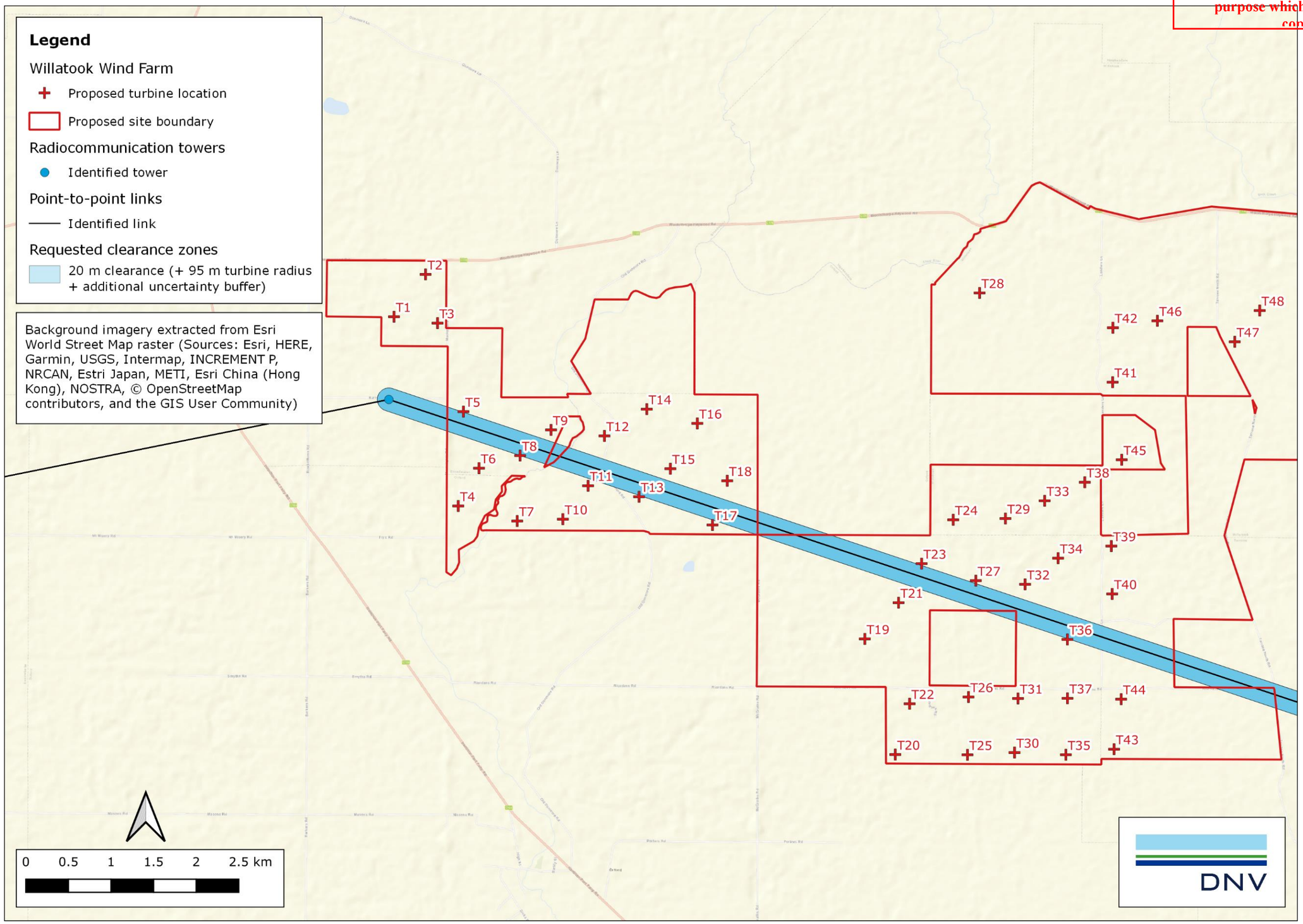

Figure 6 Identified point-to-point radiocommunication vectors and requested clearance zones for the proposed Project

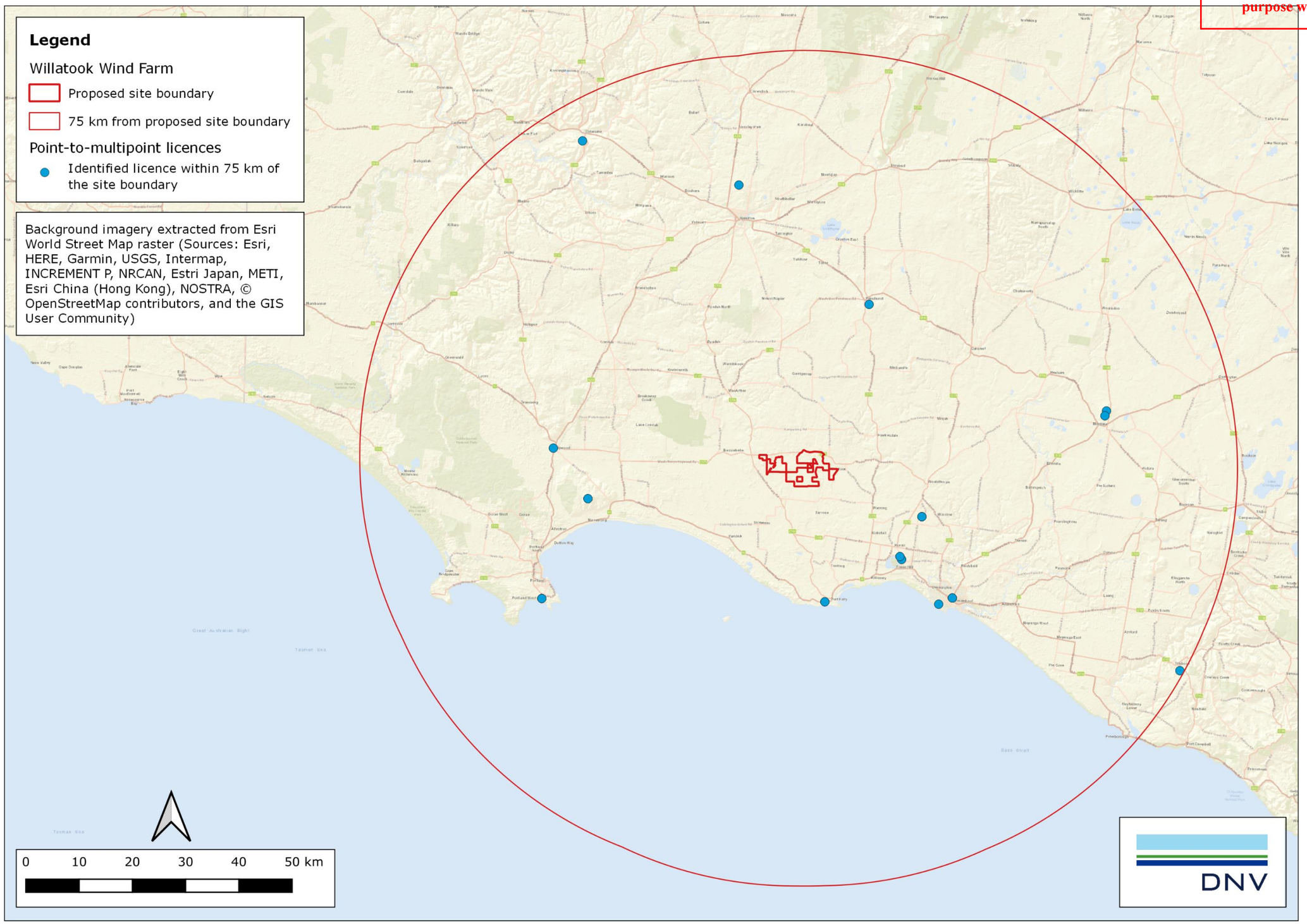

Figure 7 Location of point-to-multipoint licences in the vicinity of the proposed Project

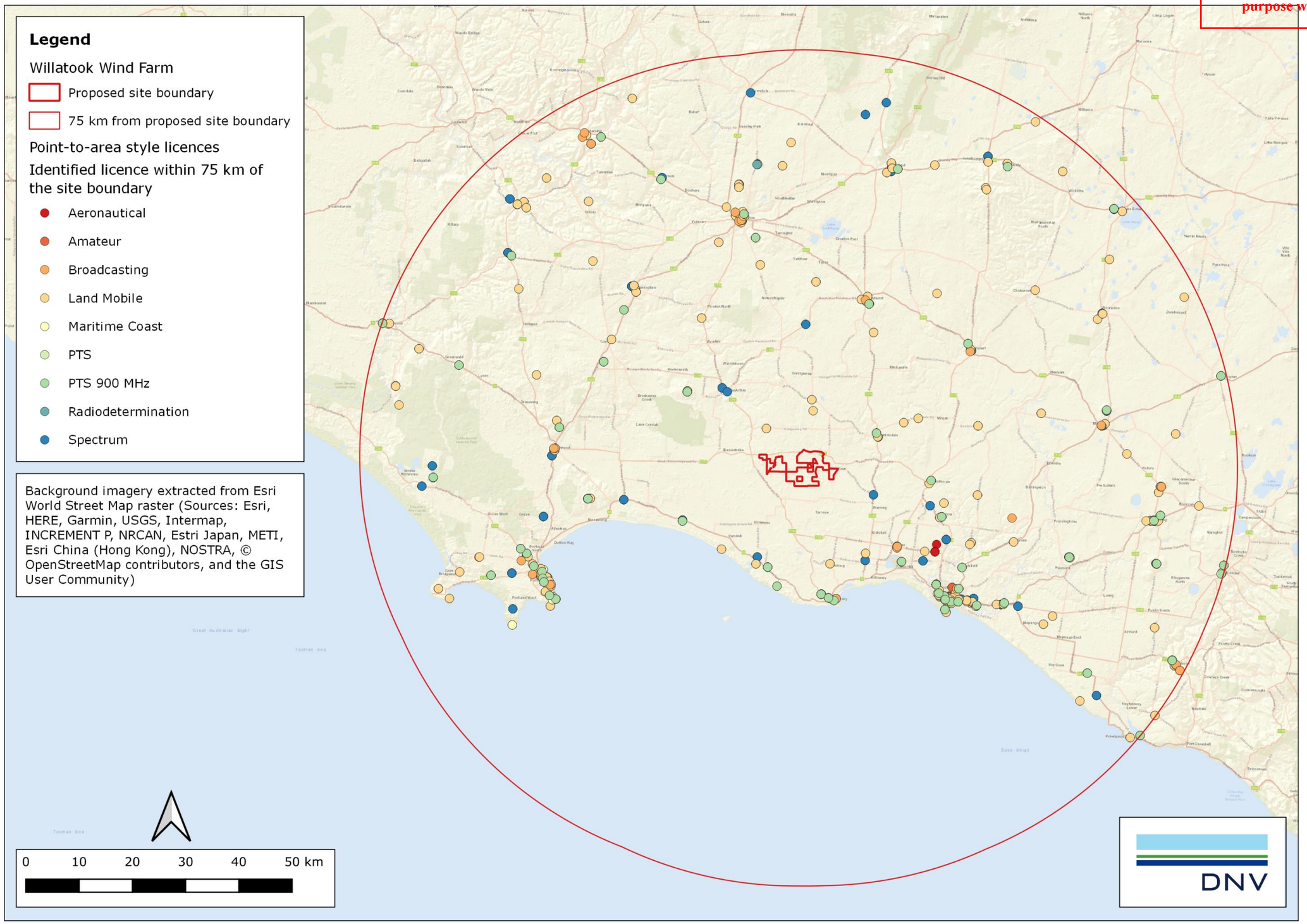

Figure 8 Location of general point-to-area style licences within 75km of the proposed Project

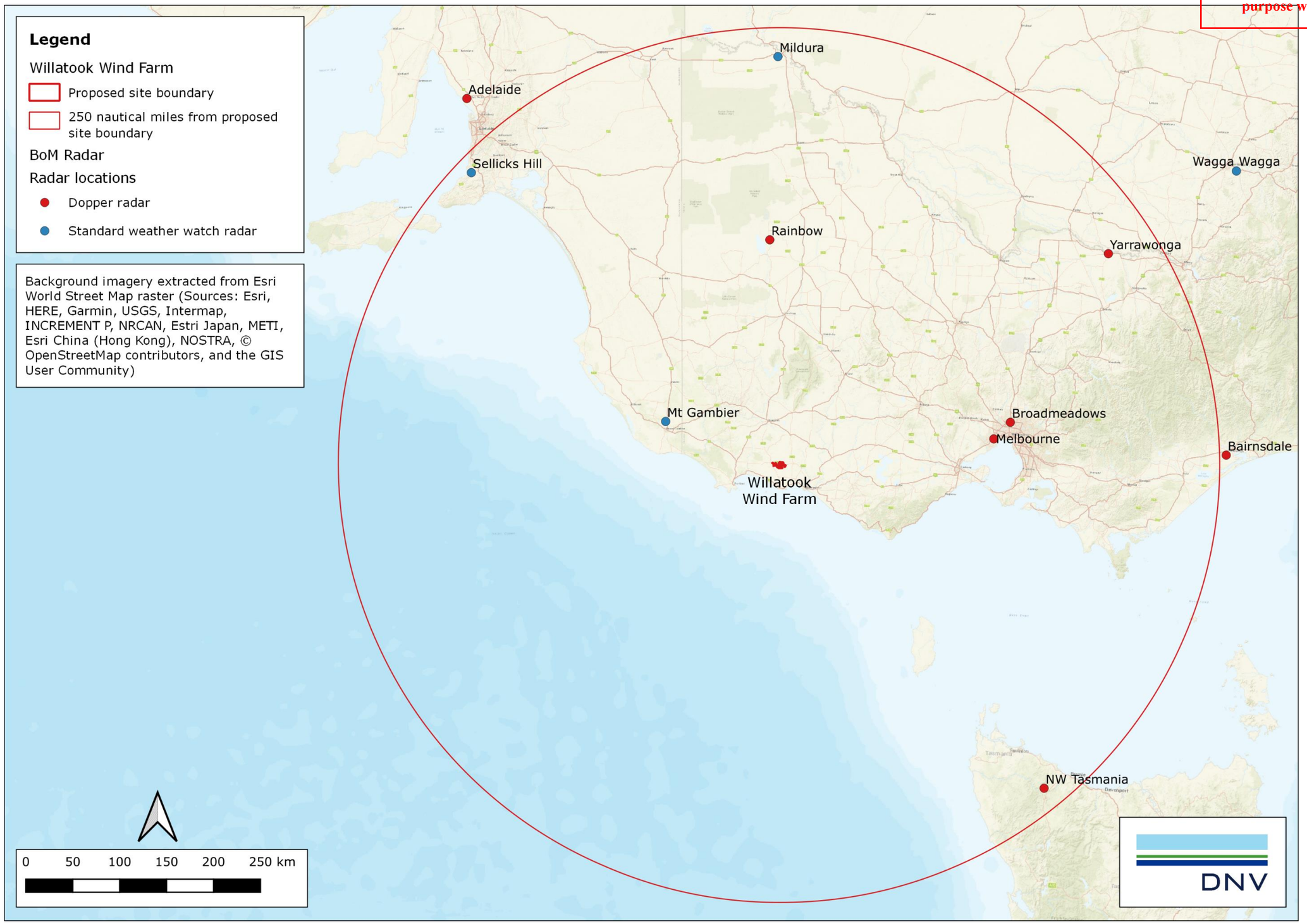

Figure 9 Location of meteorological radar sites within 250 nautical miles of the proposed Project

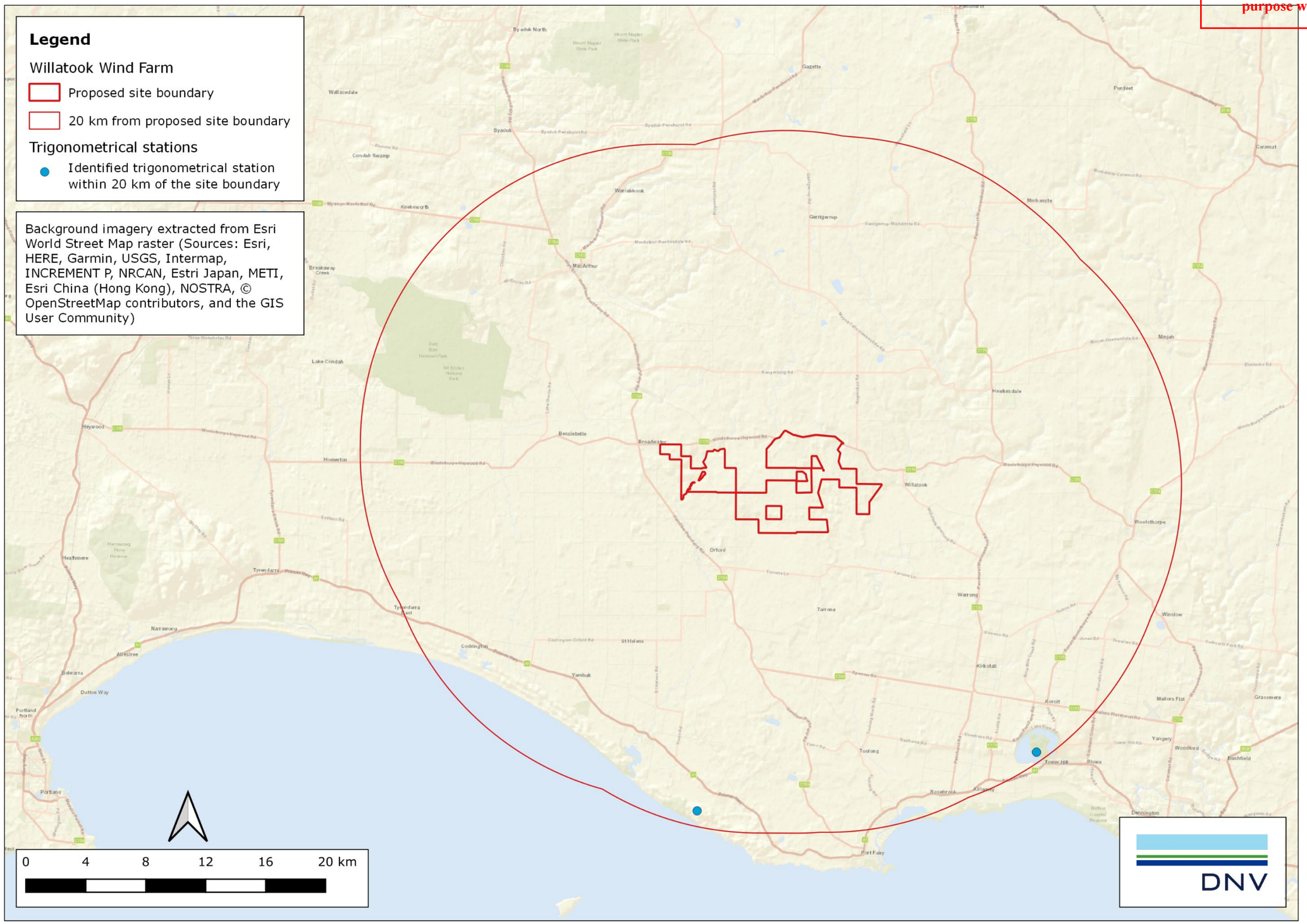

Figure 10 Location of trigonometrical stations within 20 km of the proposed Project

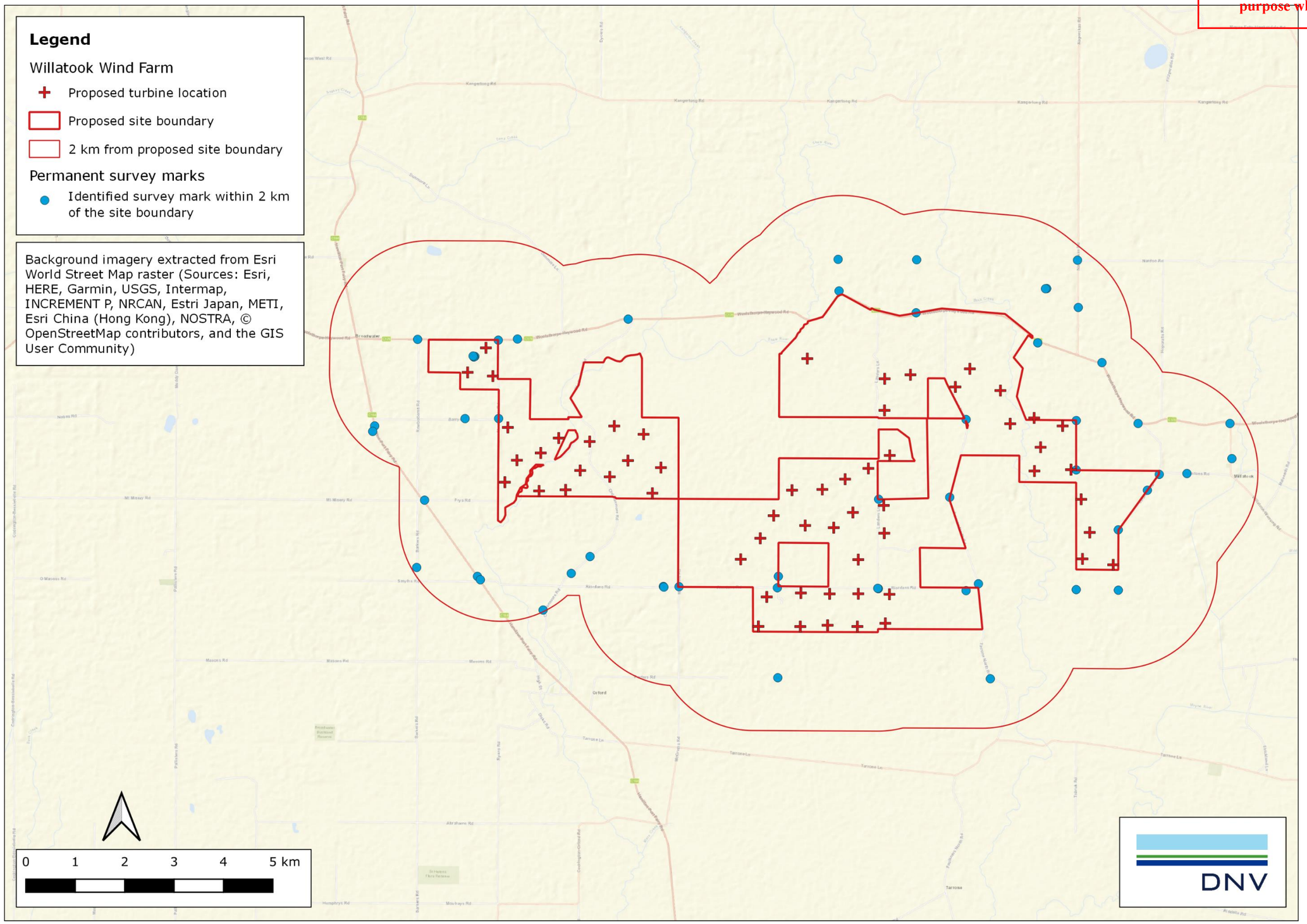

Figure 11 Location of permanent survey marks within the proposed Project boundaries

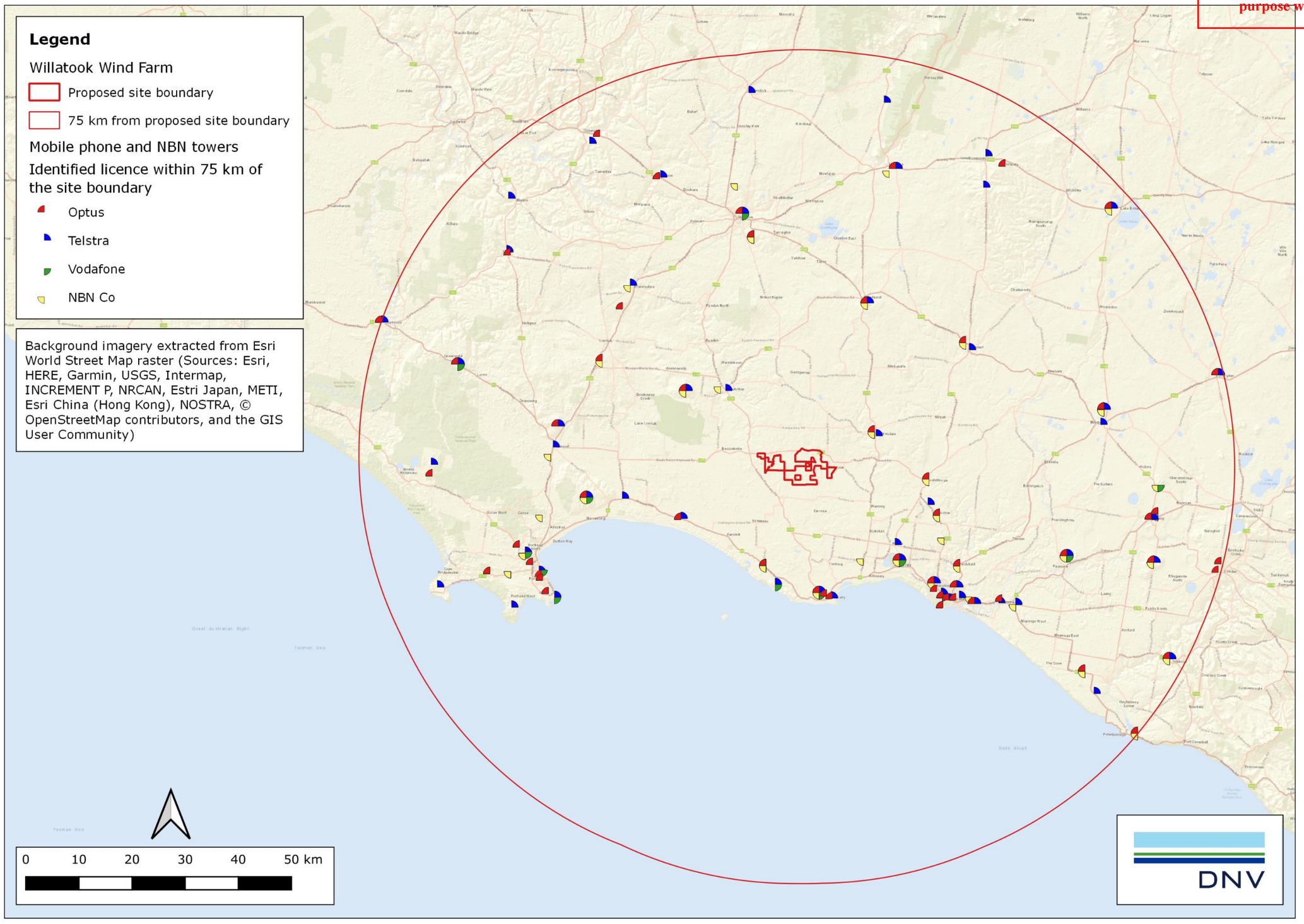

Figure 12 Location of mobile phone and NBN towers within 75 km of the proposed Project

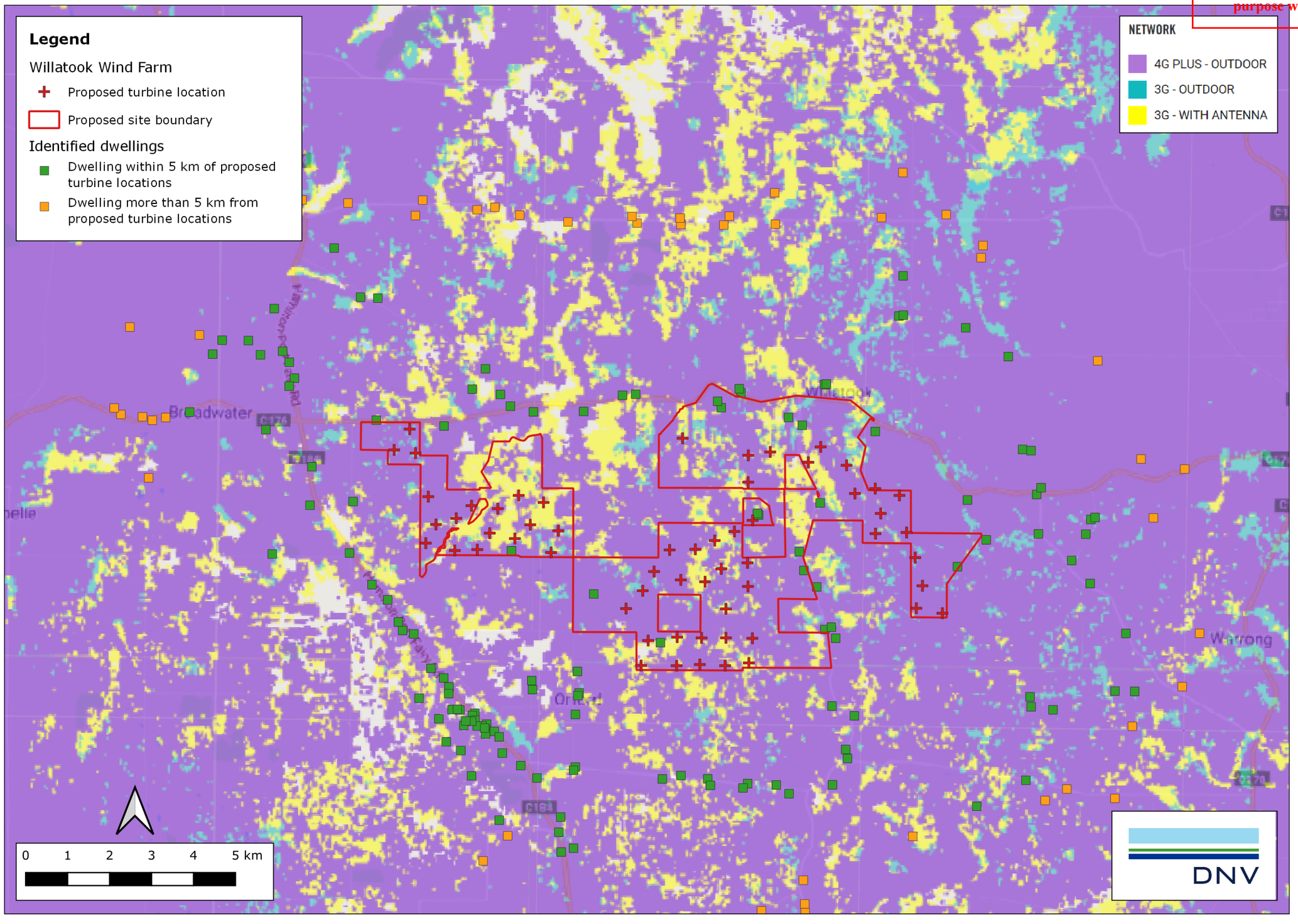

Figure 13 Optus network coverage for the proposed Project

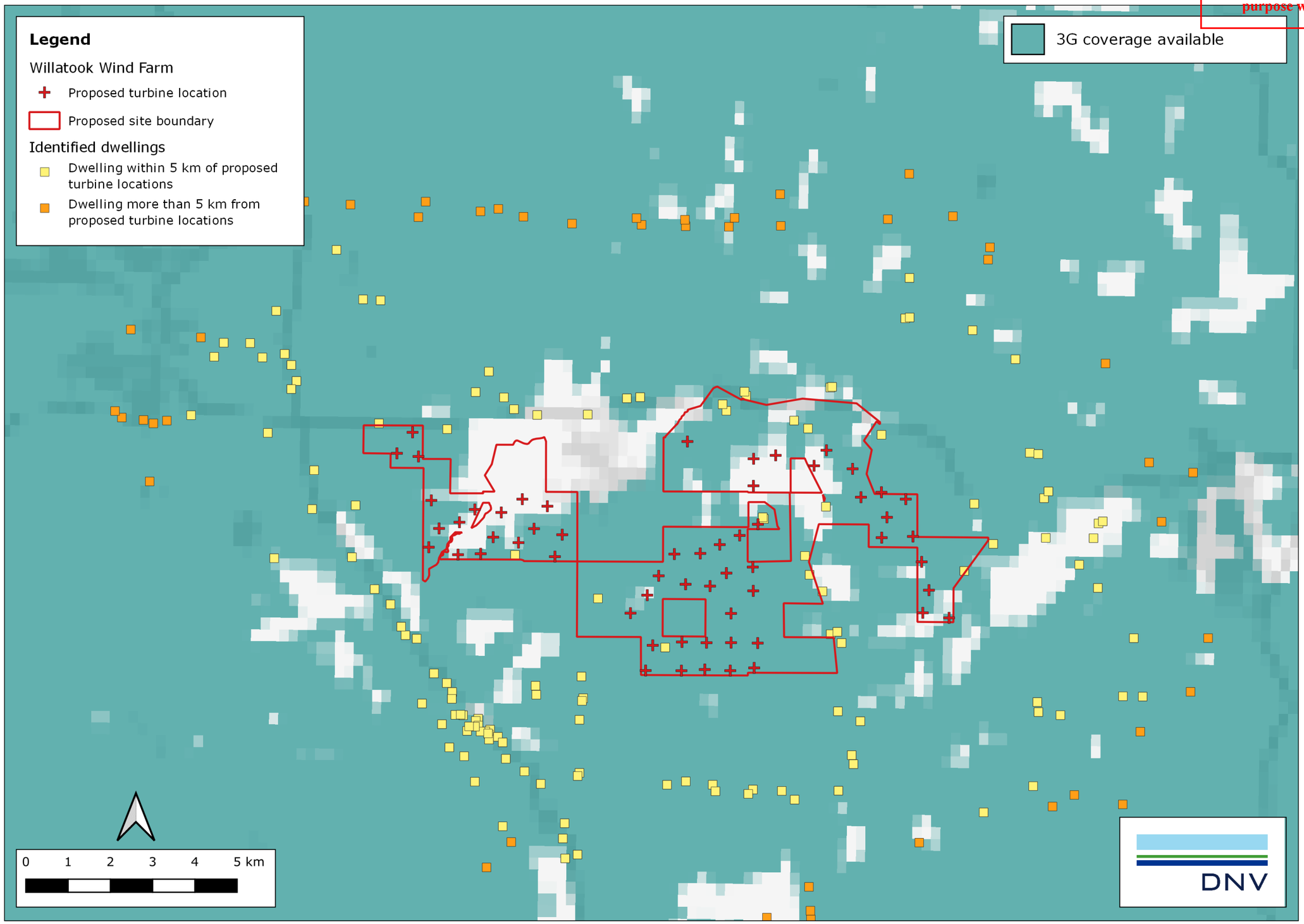

Figure 14 Telstra 3G network coverage for the proposed Project

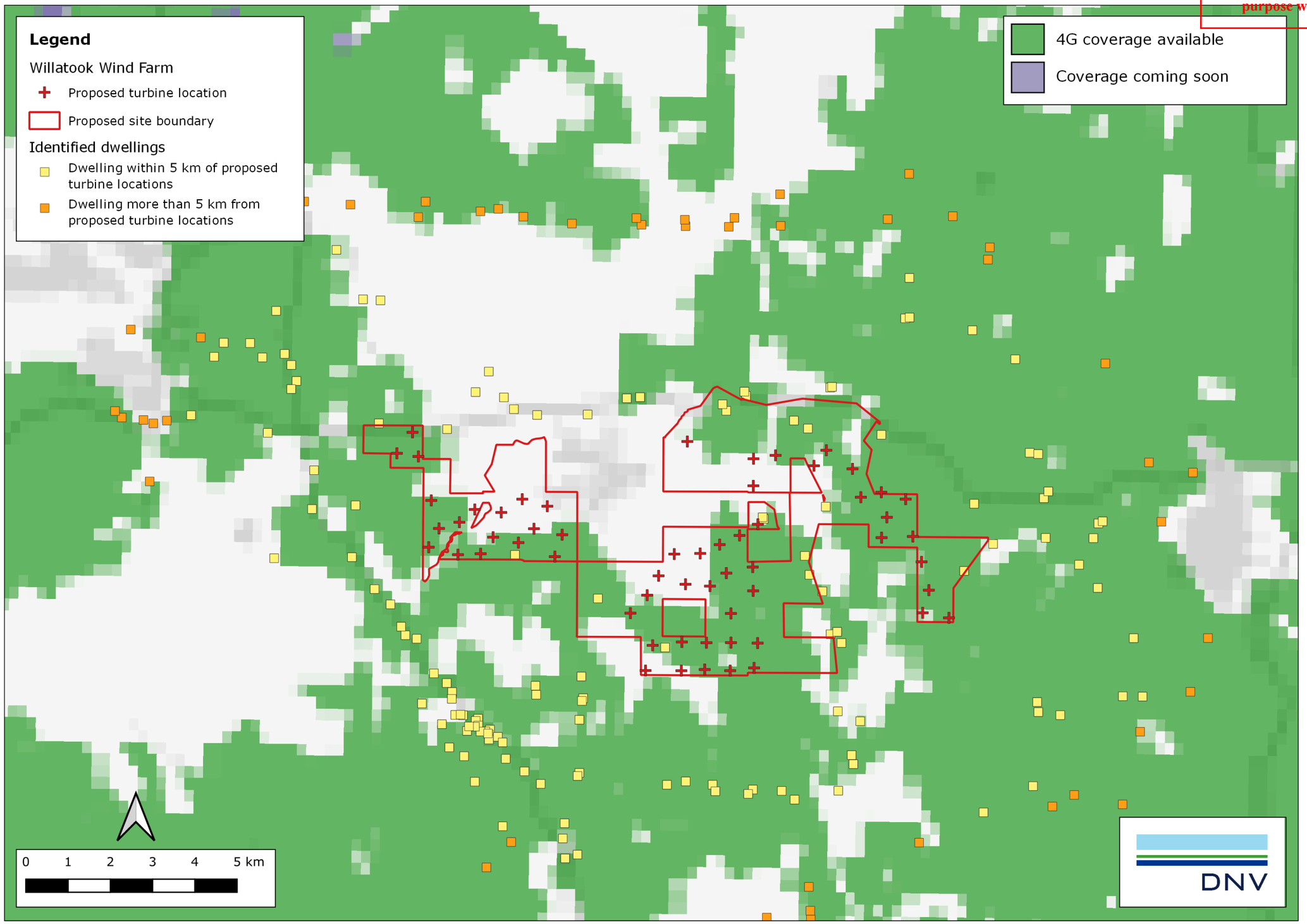

Figure 15 Telstra 4G network coverage for the proposed Project

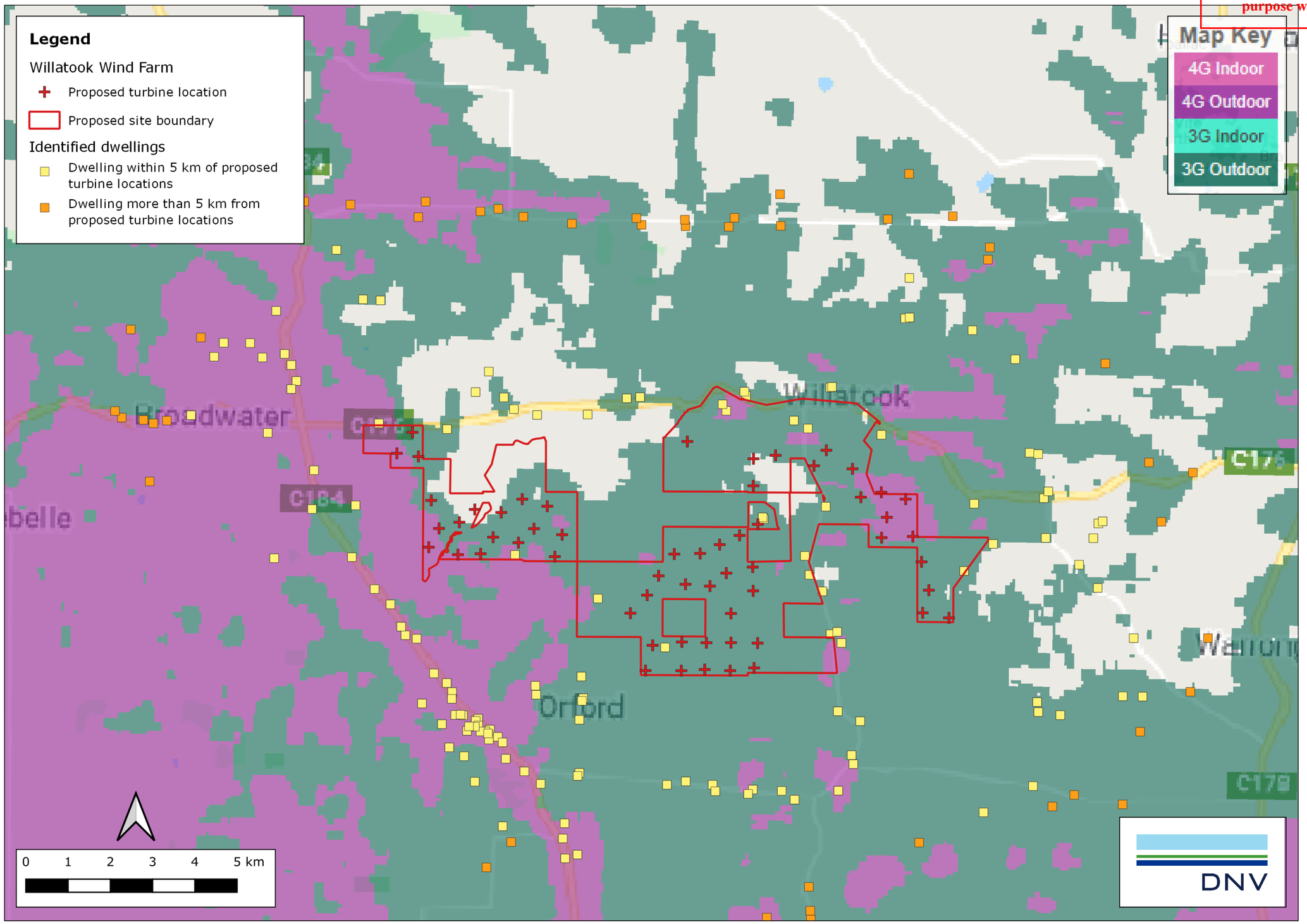

Figure 16 Vodafone network coverage (Apple iPhone 12 handset) for the proposed Project

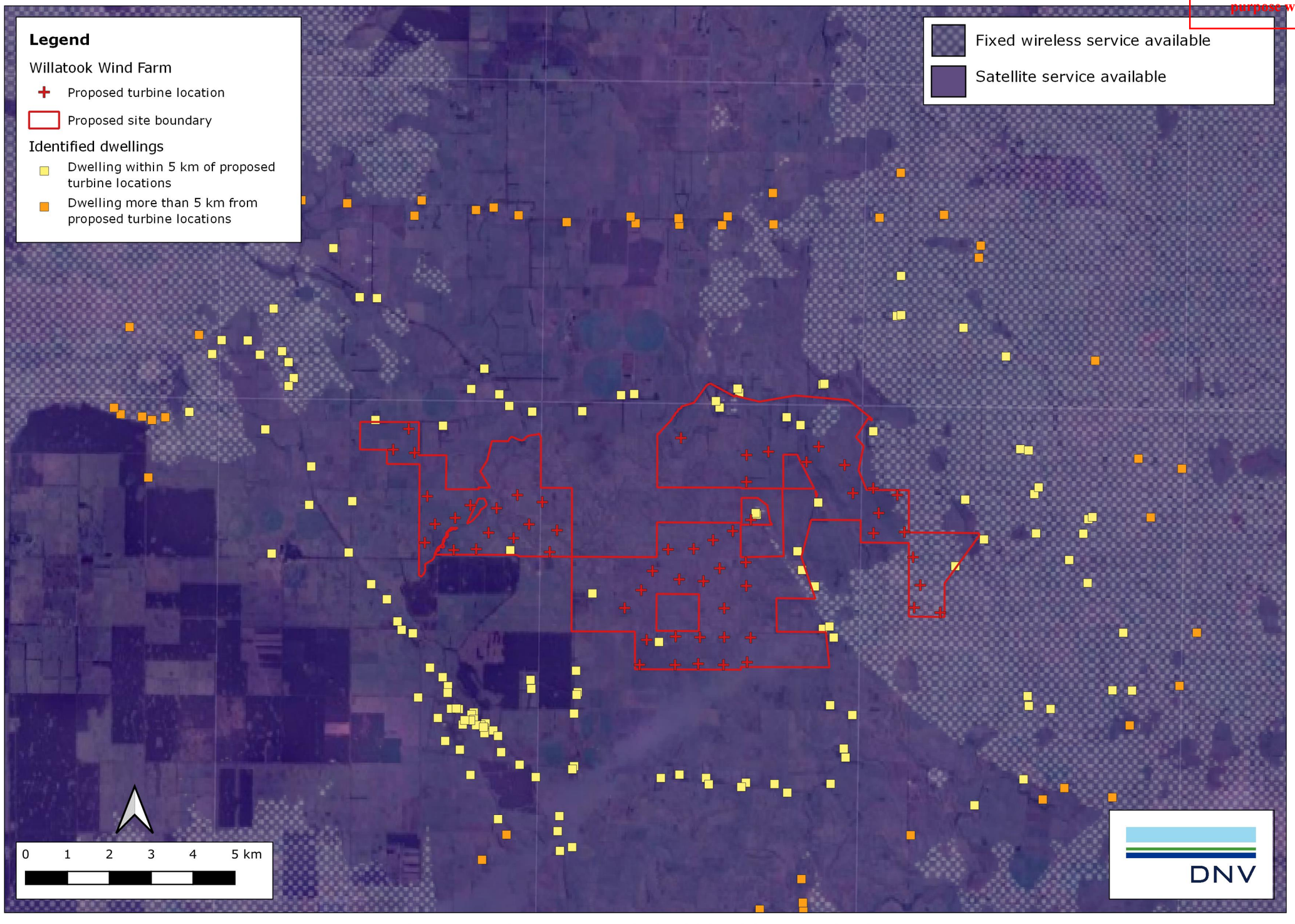

Figure 17 NBN internet coverage in the vicinity of the proposed Project

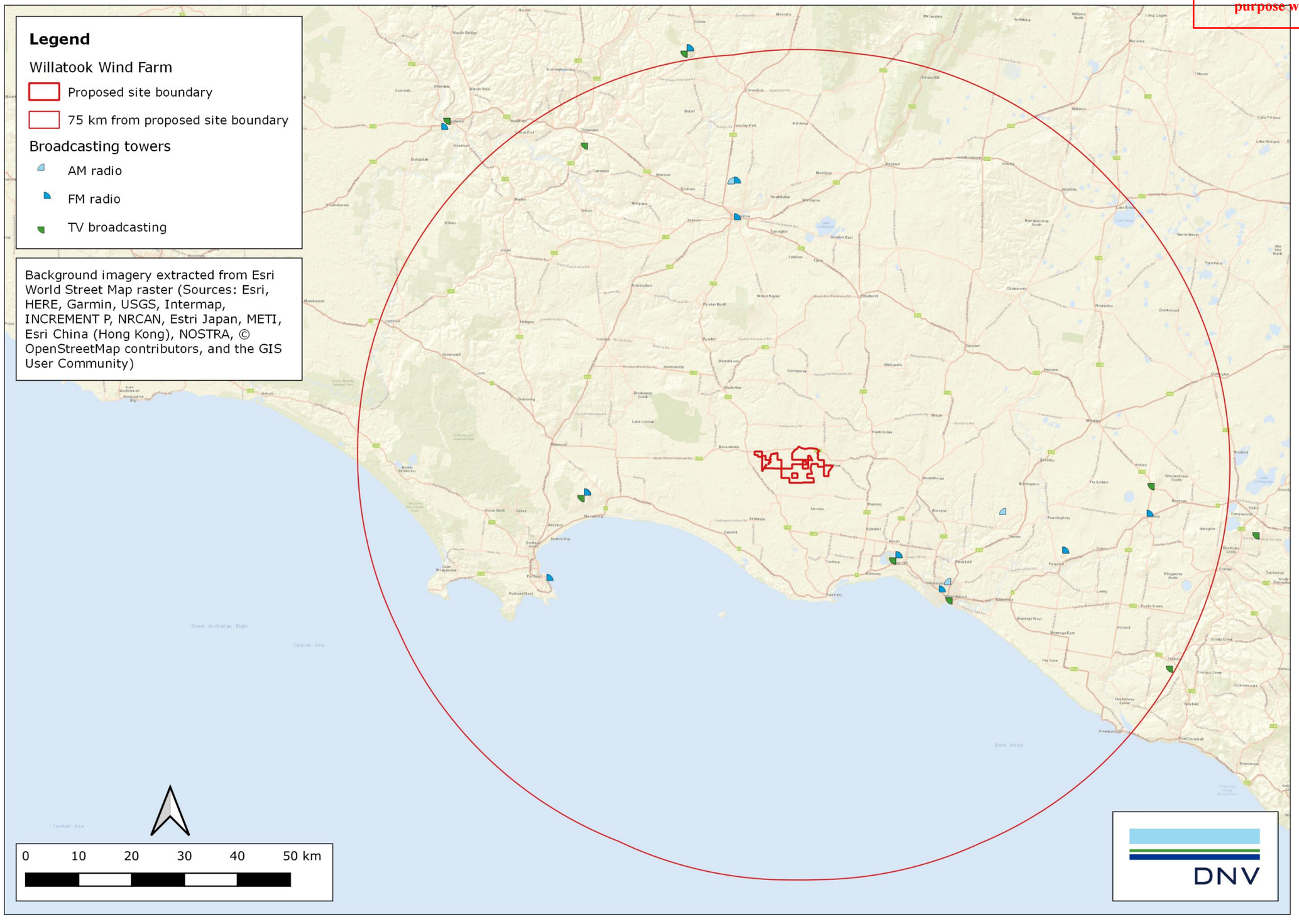

Figure 18 Location of broadcast transmitters in the vicinity of the proposed Project

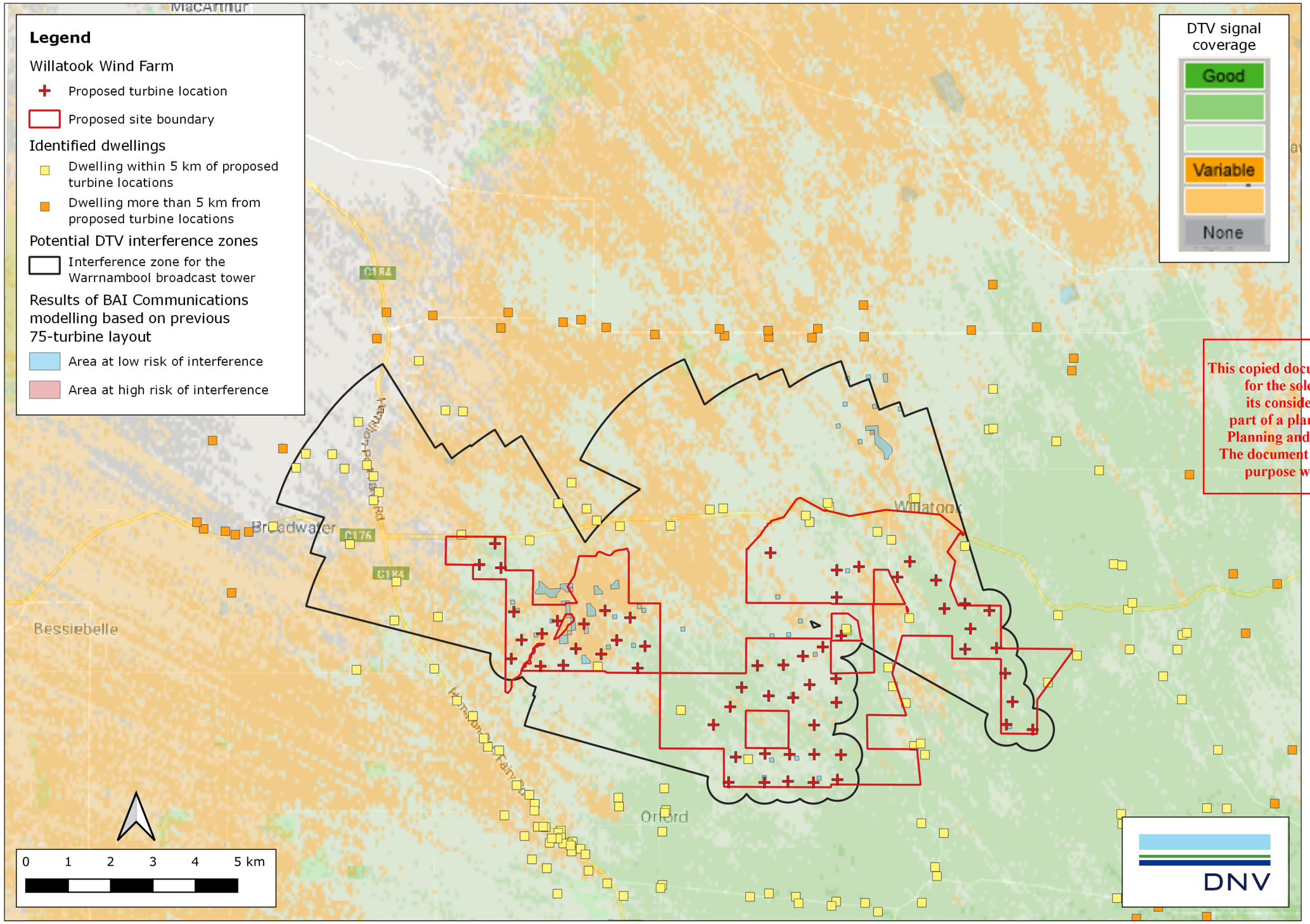

Figure 19 Potential television EMI zones for the Warrnambool (Tower Hill) broadcast tower from the proposed Project

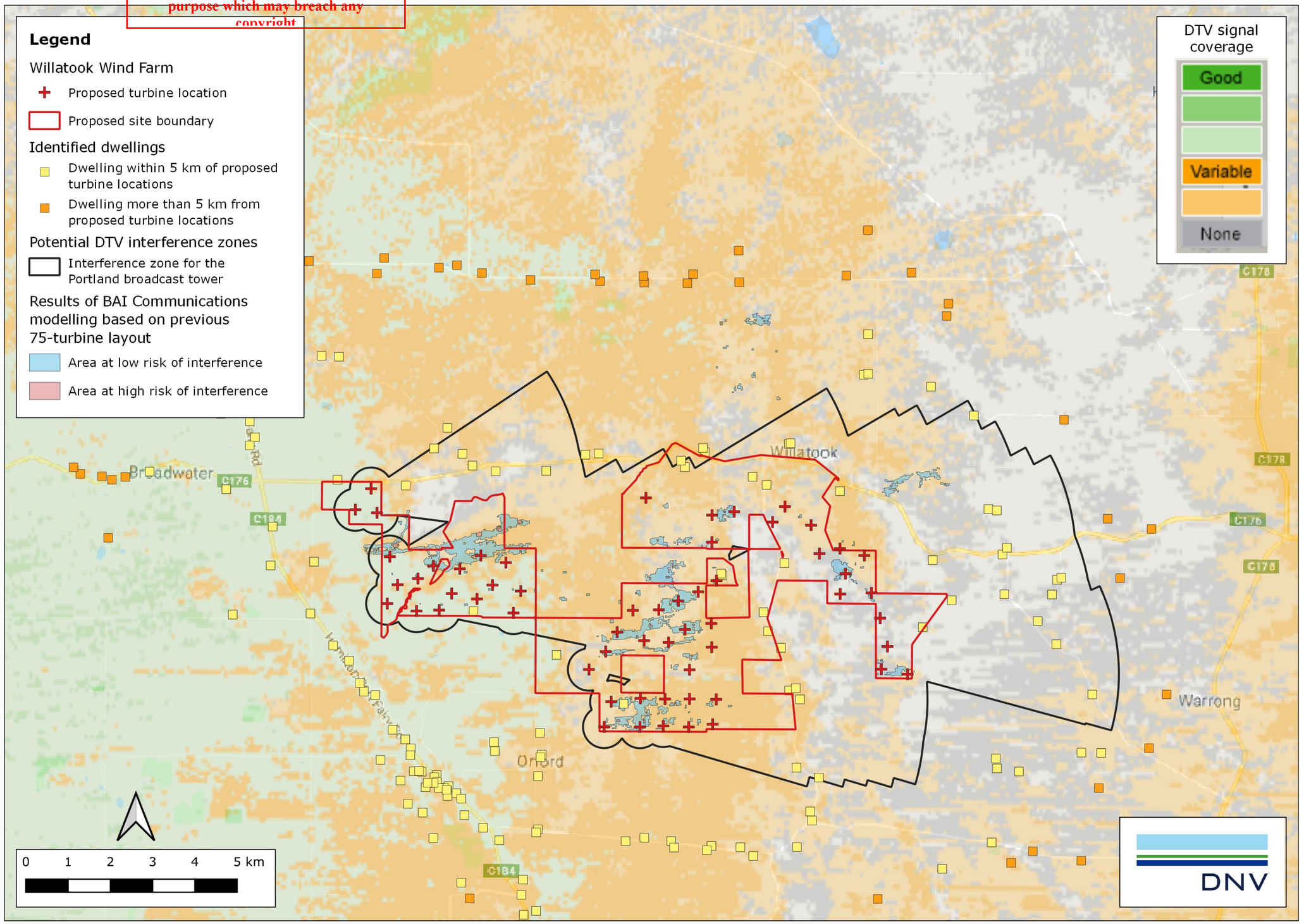

Figure 20 Potential television EMI zones for the Portland (Narrawong / Mt Clay) broadcast tower from the proposed Project

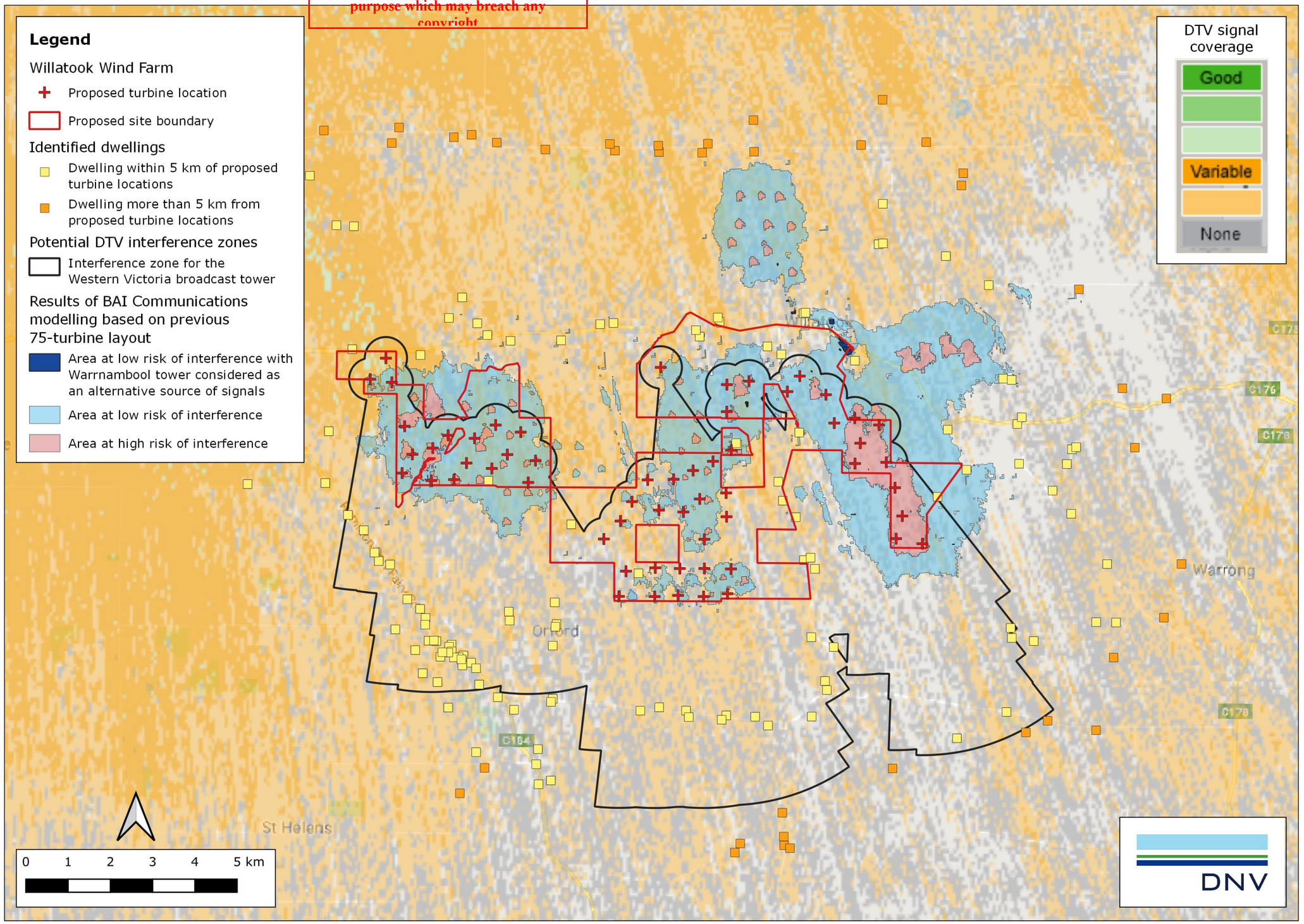

Figure 21 Potential television EMI zones for the Western Victoria (Mt Dundas) broadcast tower from the proposed Project

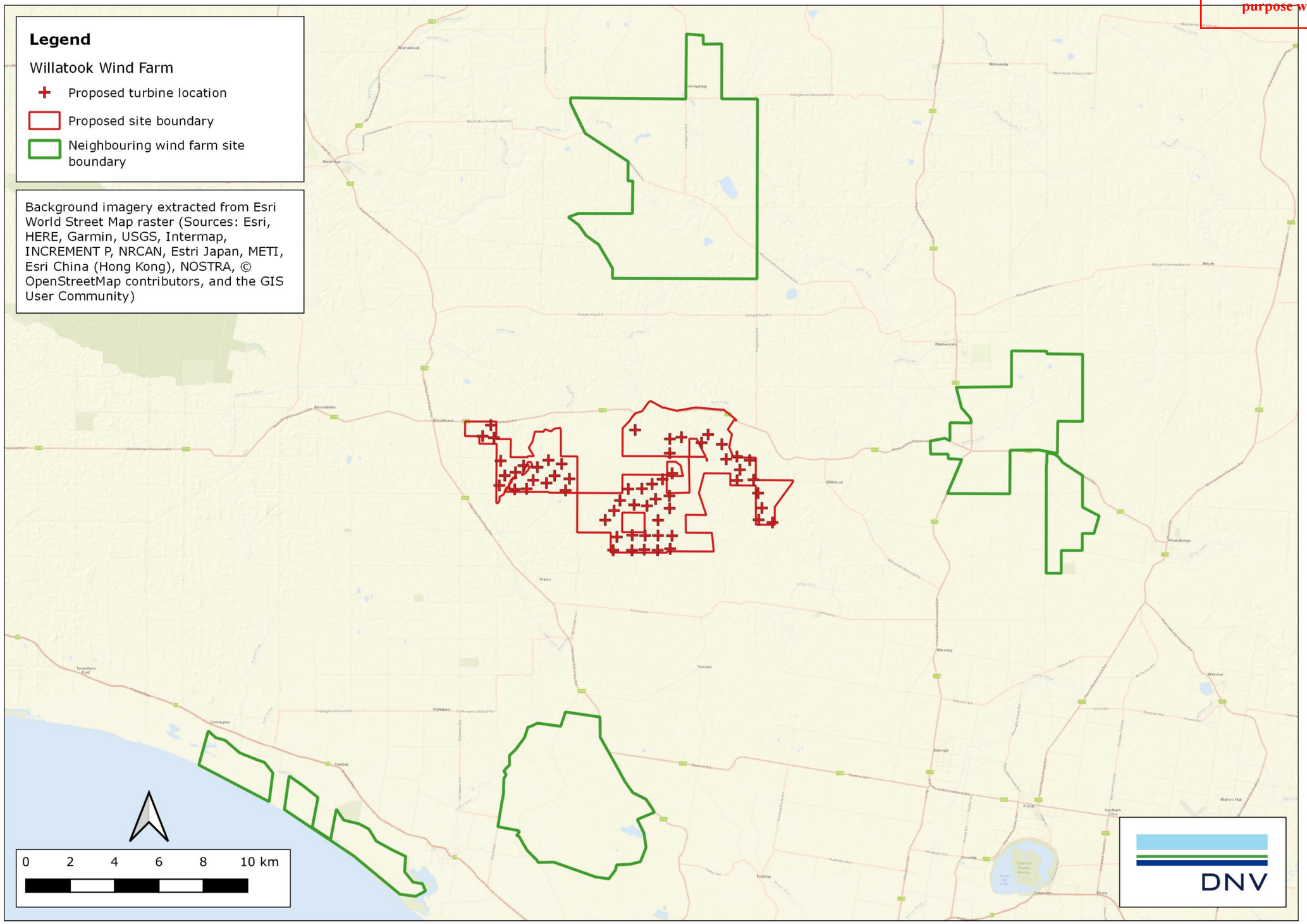

Figure 22 Map of the proposed Project, showing neighbouring wind farm developments

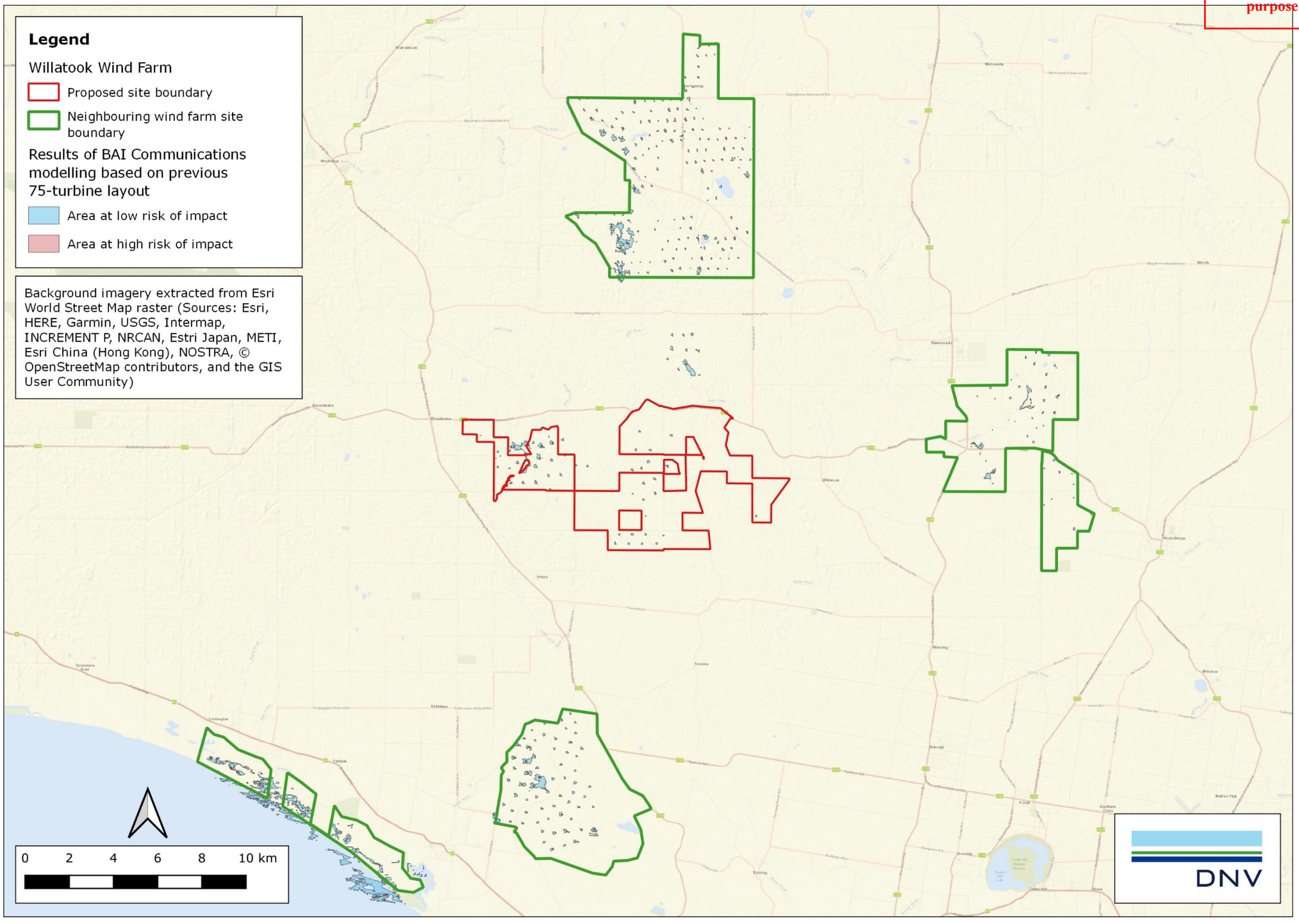

Figure 23 Potential television EMI zones for the Warrnambool (Tower Hill) broadcast tower from the proposed Project in conjunction with neighbouring wind farm developments, considering the availability of alternative signals from other towers

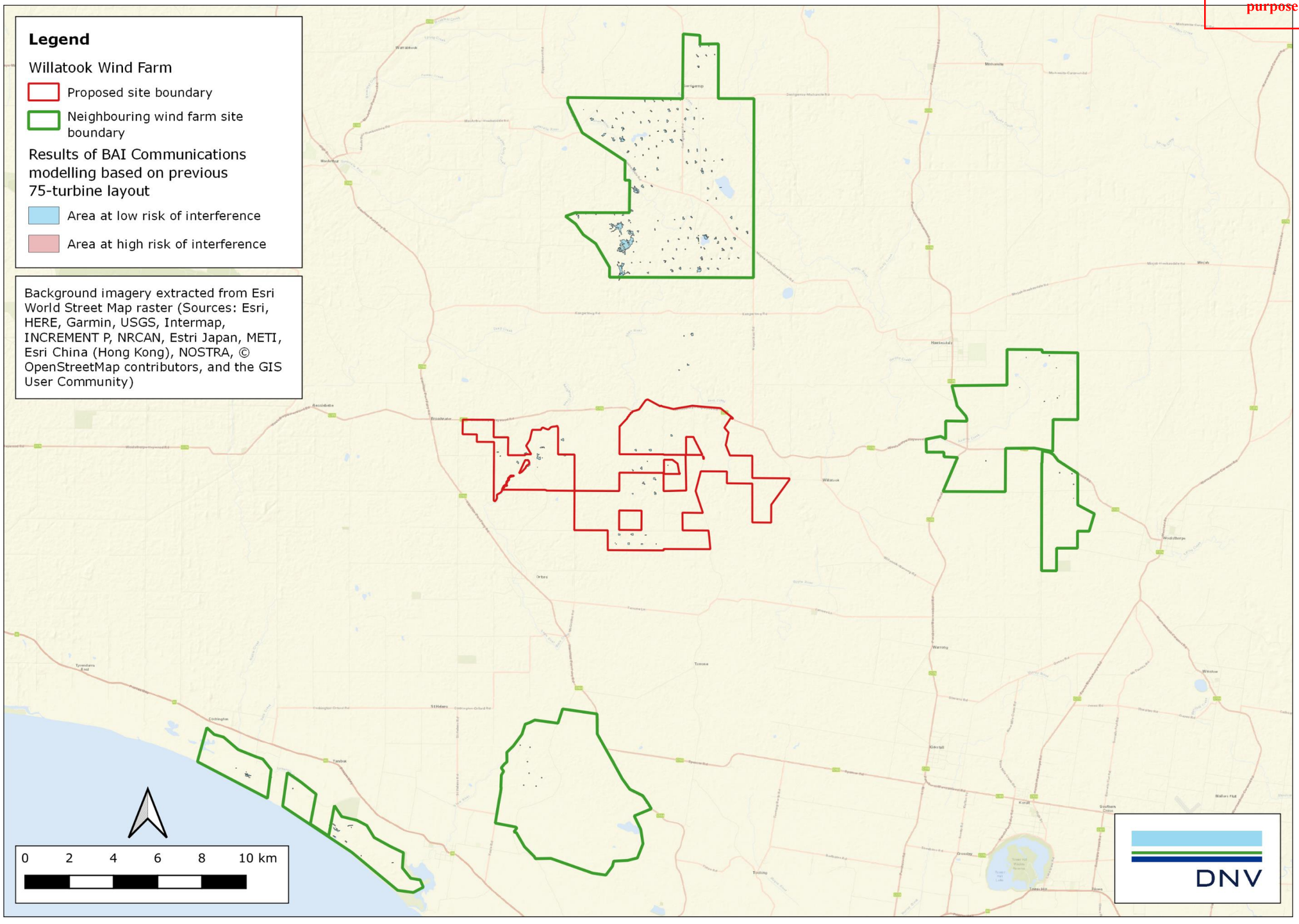

Figure 24 Potential television EMI zones for the Portland (Narrawong / Mt Clay) broadcast tower from the proposed Project in conjunction with neighbouring wind farm developments, considering the availability of alternative signals from other towers

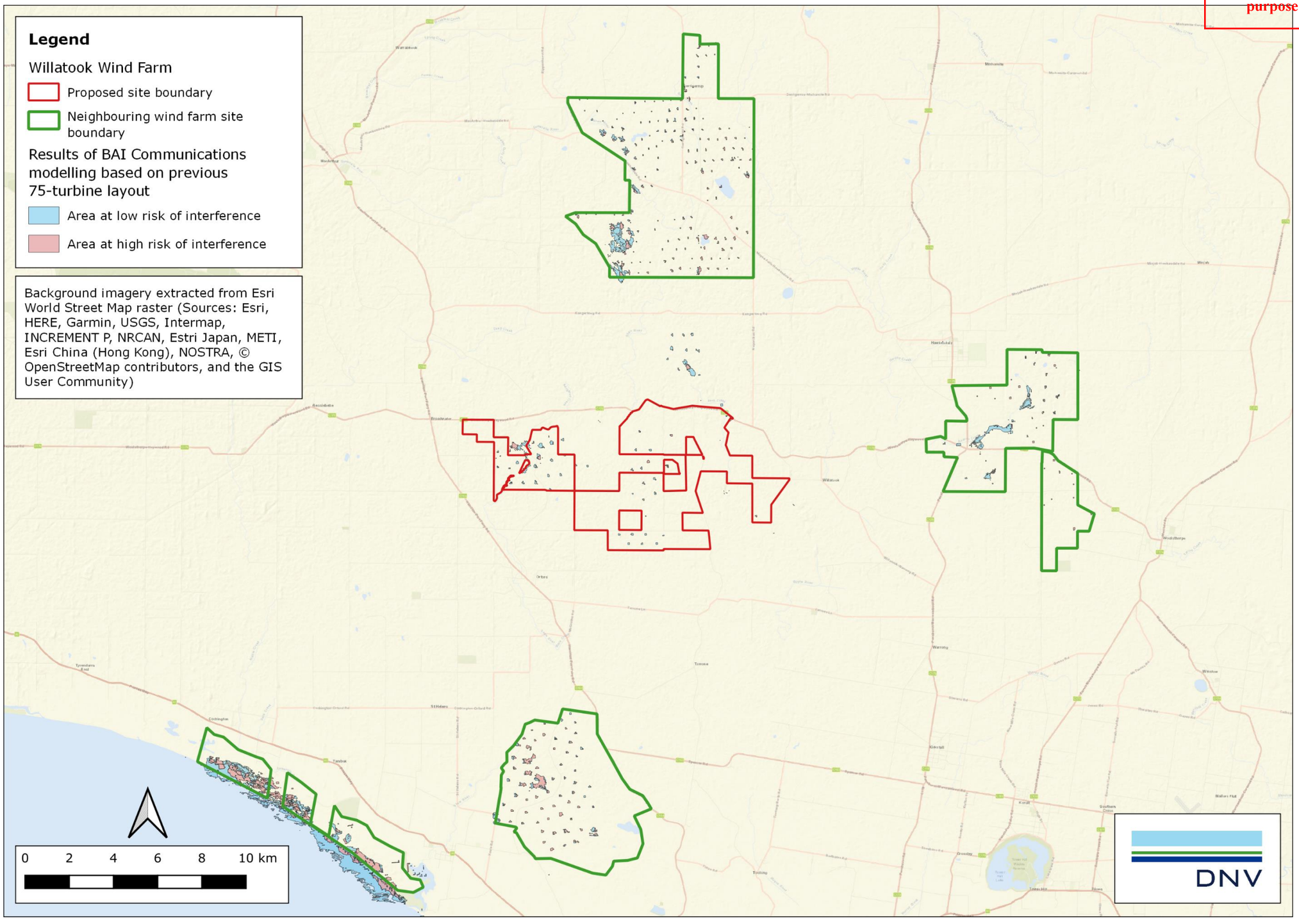

Figure 25 Potential television EMI zones for the Western Victoria (Mt Dundas) broadcast tower from the proposed Project in conjunction with neighbouring wind farm developments, considering the availability of alternative signals from other towers

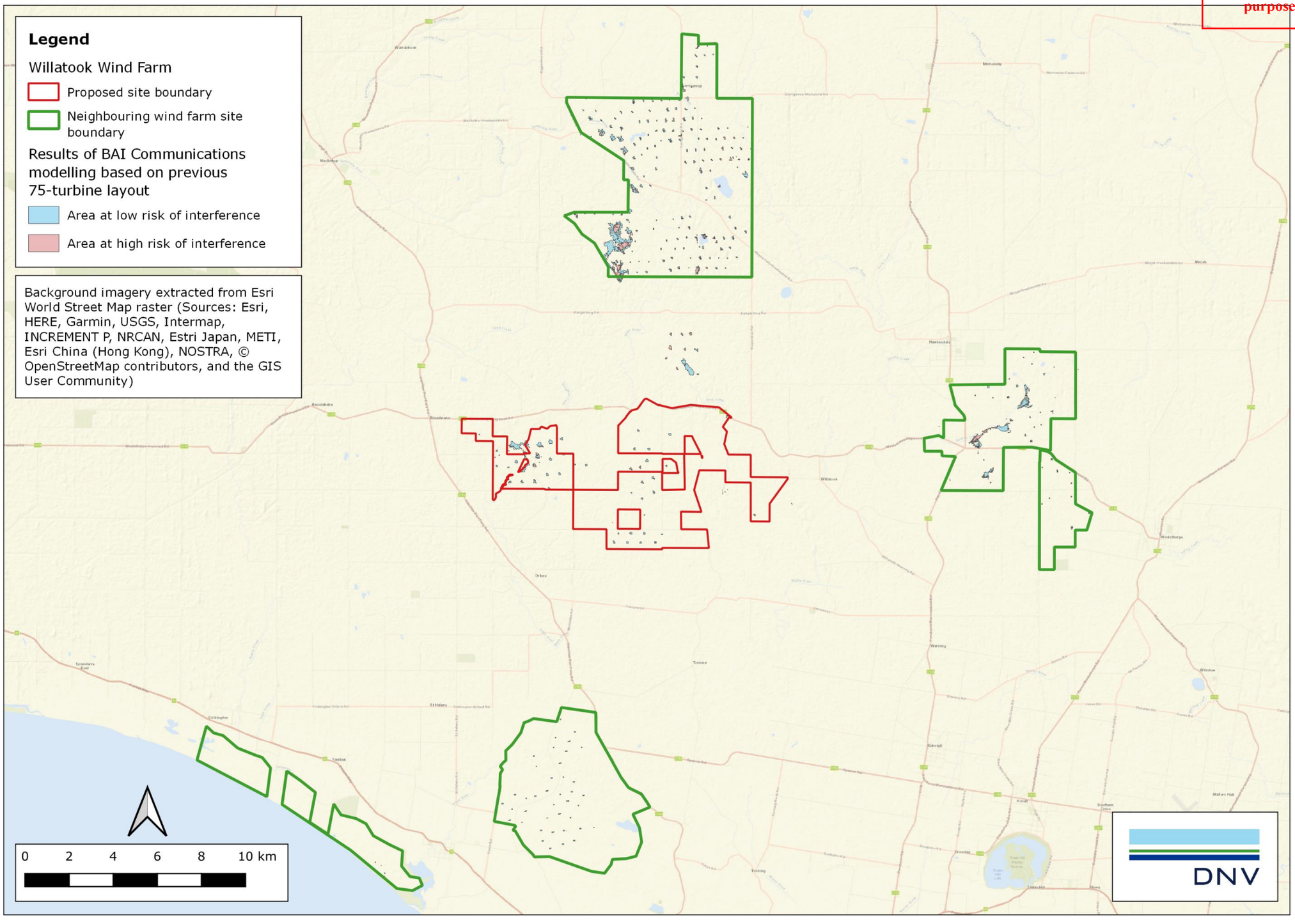

Figure 26 Potential television EMI zones for the Ballarat (Lookout Hill) broadcast tower from the proposed Project in conjunction with neighbouring wind farm developments, considering the availability of alternative signals from other towers

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimising the performance of a wind farm, analysing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

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