HEXHAM WIND FARM

EMI Assessment

Hexham Wind Farm Pty Ltd

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EXECUTIVE SUMMARY

DNV has been commissioned by Hexham Wind Farm Pty Ltd ("the Proponent") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Hexham Wind Farm ("the Project") in Victoria. The results of the EMI assessment are described in this document, which is intended to address the Scoping Requirements for the Project [2] that are relevant to EMI impacts as part of an environment effects statement (EES), as required under the *Environment Effects Act 1978*.

Background and methodology

DNV has assessed the potential EMI impacts for the Project in accordance with the Scoping Requirements [2], Planning Guidelines for Development of Wind Energy Facilities in Victoria [3] and Draft National Wind Farm Development Guidelines [4]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

A Project layout consisting of up to 106 wind turbines with a rotor diameter of 190 m and tip height of 260 m has been considered. These dimensions represent the maximum overall tip height within the maximum rotor and tower hub height dimensions.

There are 301 identified dwellings within 5 km of the Project, 49 of which are stakeholder dwellings.

Outcomes of the assessment

The results of the EMI assessment are summarised in the table at the end of this section.

DNV's analysis has found potential for turbines at the Project to interfere with NBN fixed wireless internet signals received from the Caramut, Woolsthorpe and Mortlake towers. However, consultation with NBN Co has indicated that interference caused by the Project is not expected. If interference is experienced, it is possible that problems could be rectified by relocating or realigning the antennas to achieve a clearer signal from an alternative tower, if available.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. Dwellings in the vicinity of the Project may experience interference to digital television (DTV) broadcast signals from the Ballarat (Lookout Hill), which is the primary transmitter for the area. Although interference is possible for signals from the Western Victoria (Mt Dundas), Warrnambool (Tower Hill) and Warrnambool City broadcast transmitters, most of the potentially-affected dwellings are located in areas with limited to no signal coverage and therefore may not be currently receiving signals from those transmitters. Feedback received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, suggests that impacts to DTV signals are unlikely and are predicted to be confined to within the Project boundary.

The Bureau of Meteorology (the Bureau) has advised that impacts on their meteorological radars are considered to be low risk and that the Bureau have no objections to the proposed Project. To help mitigate any interference with meteorological radar operations once the Project is operational, the Bureau previously asked that the owner or operator of the Project agrees to advise them of any changes to the turbine layout or tip height prior to construction, notify them prior to any planned shutdown of the Project to allow recalibration of systems, and collaborate with them in the event of severe weather conditions. DNV recommends that the Proponent engages again with the Bureau prior to the construction of Project to determine whether these conditions are still applicable.

Signals from one geostationary satellite that transmits programs intended for Australian audiences and one that provides private communication services may be intercepted by turbines at the Project for one stakeholder dwelling. Interference to signals intended for international audiences is also possible at several nearby dwellings, but it is considered unlikely that residents will be receiving signals from these satellites. 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.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely impacts. DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact. Apart from the feedback received from NBN Co and the Bureau, no concerns have been raised to date.

DNV notes that the Project is located in an area of high wind farm development activity, with several proposed, approved, and operating wind farms located nearby. DNV has conducted an assessment of potential cumulative impacts to nearby radiocommunication services from the Project in conjunction with other nearby wind farms. DNV has noted a potential for cumulative impact to DTV broadcasting services and has contacted BAI Communications to seek feedback. Feedback received from BAI Communications suggests that impacts to DTV signals are unlikely. There is potential for increased interference to mobile phone signals where coverage is marginal and there are multiple turbines between the mobile phone tower and the user. However, current feedback from Optus and Vodafone indicates no concern and no response has been received from Telstra. Cumulative impacts to meteorological radars may occur, but are expected to be manageable.

Table 1 Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Radio-communication towers	1 tower within 2 km of proposed turbine locations, operated by: Country Fire Authority (CFA) Nearest tower: 1990 m from turbines	No concerns raised	Low likelihood of interference	Very low potential for cumulative impact	None required
Fixed point-to-point links	8 links crossing Project boundary, operated by: AusNet Transmission Group Pty Ltd (Ausnet Services) NBN Co Ltd (NBN Co) Vertical Telecoms Pty Ltd (VerTel)	No concerns raised	Unlikely to cause interference	None	None required
Fixed point-to-multipoint links	40 assignments within 75 km of Project boundary 1 base station within 20 km of Project boundary, operated by: Wannon Region Water Corporation (Wannon Water)	No concerns raised	None	None	None required
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 **Point-to-area style communications:** Low likelihood of interference to signals from CFA tower within 2 km, unlikely to cause interference to other services	No concerns raised	**Point-to-point links:** None **Point-to-area style communications:** Low likelihood of interference	**Point-to-point links:** none **Point-to-area style communications:** very low potential for cumulative impact	**Point-to-point links:** none required **Point-to-area style communications:** if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

Table 1 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Meteorological radar	Nearest radar: 154 km from Project	Impacts are expected to be low risk	Potential for low risk interference	Potential for low risk cumulative impact	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	No concerns raised	Unlikely to cause interference	Very low potential for cumulative impact	None required
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	Very low potential for cumulative impact	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Optus and Vodafone:** No concerns raised **Telstra:** No response received	Low likelihood of interference	Low potential for cumulative impact where there are multiple turbines between the tower and the user	If required – increase signal strength from affected tower or alternative towers, install additional tower
Wireless internet	**Wireless broadband service providers:** mobile phone networks, NBN Co **NBN:** available as a fixed wireless and satellite service	**Optus, Vodafone and NBN:** No concerns raised **Telstra:** No response received	**Mobile phone networks**: see findings for mobile phones **NBN:** None	**Mobile broadband services:** low potential for cumulative impact where there are multiple turbines between the tower and the user **NBN:** none	**Mobile phone networks:** as for mobile phones **NBN:** none required

Table 1 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Satellite television and internet	**Geostationary satellites:** Services intended for Australian audiences: signals from 1 satellite intercepted at 1 stakeholder dwelling Services intended for private communications: signals from 1 satellite intercepted at 1 stakeholder dwelling Services intended for international audiences: signals from 17 satellites intercepted at 9 stakeholder dwellings **Low Earth orbit (LEO) satellites:** unlikely to be affected	Consultation with operators not considered necessary	**Geostationary satellites:** High likelihood of interference **LEO satellites:** unlikely to cause interference	None	**Geostationary satellites:** If required – redirect satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish **LEO satellites:** none required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	Consultation not considered necessary	**AM and FM signals:** low likelihood of interference **Digital radio signals:** None	Low potential for cumulative impact where there are multiple turbines between the tower and the user	**AM and FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** none required

Table 1 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Ballarat (Lookout Hill) transmitter:** *'variable' to 'good' coverage across most areas* 65 dwellings (28 stakeholder dwellings) in potential interference zone **Western Victoria (Mt Dundas) transmitter:** *'poor' to 'variable' coverage in most areas, no coverage in the east and southeast* 67 dwellings (29 stakeholder dwellings) in potential interference zone, but signal coverage is limited in that area **Warrnambool (Tower Hill) transmitter:** *No coverage across most areas, 'poor' to 'variable' coverage in the west and southwest* 99 dwellings (29 stakeholder dwellings) in potential interference zone, but signal coverage is limited in that area **Warrnambool City transmitter:** *No coverage across most areas, 'poor' to 'variable' coverage in the south* 95 dwellings (27 stakeholder dwellings) in potential interference zone	**Lookout Hill transmitter**: interference unlikely **Mt Dundas transmitter**: susceptible to scatter interference within the site boundary **Tower Hill and Warrnambool City transmitter:** not assessed Areas at risk are expected to be served by an alternate transmitter with no interference	**Lookout Hill transmitter**: Likely to cause interference at some dwellings within approximately 5-10 km, if those dwellings are currently receiving a weak signal **Mt Dundas transmitter**: Low likelihood of interference, as dwellings may not be currently receiving a signal **Tower Hill and Warrnambool City transmitter:** Low likelihood of interference, as dwellings may not be currently receiving a signal	Some potential for cumulative impact at dwellings located to the southwest of the Project, and in areas with poor or marginal coverage located within 10 km of multiple wind farms	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

1 INTRODUCTION

Hexham Wind Farm Pty Ltd ("the Proponent") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Hexham Wind Farm ("the Project") in western Victoria. The results of this work are reported in this document, which is intended to address the Scoping Requirements for the Project [2] that are relevant to EMI impacts as part of an environment effects statement (EES), as required under the *Environment Effects Act 1978*. This document has been prepared in accordance with DNV proposal L2C-242166-AUMEL-P-01-B, dated 25 January 2023, and is subject to the terms and conditions in that agreement.

In accordance with the Scoping Requirements Hexham Wind Farm Environment Effects Statement (Scoping Requirements) issued by the Minister for Planning in September 2024 [2], Planning Guidelines for Development of Wind Energy Facilities in Victoria (Victorian Guidelines) prepared by the Department of Transport and Planning in September 2023 [3], and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [4], 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.

The sections of this document that are intended to address each of the items set out in the Scoping Requirements in relation to EMI impacts are outlined in Table 2 on the following page. To ensure clarity given their landscape orientation and size, the accompanying figures referenced in this report are presented from page 67 onwards.

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

Table 2 Sections of this document addressing the relevant matters set out in the Scoping Requirements for the Project [2]

Category	Requirement relevant to EMI	Sections addressing this requirement
Key issues	Potential interference with communication systems that use electromagnetic waves as the transmissions medium (e.g. television, radio, mobile reception)	Section 4.1 (further details for specific licence and service types are given in subsequent sections as referenced below)
Existing environment	Characterise current local television and radiocommunication services within the project area and surrounding areas	Nearby towers: Sections 4.2.1 and 4.2.2 Point-to-point links: Sections 4.3.1 and 4.3.2 Point-to-multipoint links: Sections 4.4.1 and 4.4.2 Other licence types: Section 4.5.1 Emergency services: Sections 4.6.1 and 4.6.2 Meteorological radar: Sections 4.8.1 and 4.8.2 Trigonometrical stations: Sections 4.9.1 and 4.9.2 CB radio: Section 4.10.1 Mobile phones: Sections 4.11.1 and 4.11.2 Wireless internet: Sections 4.12.1.1, 4.12.1.2, 4.12.2.1 and 4.12.2.2 Satellite television and internet: Section 4.13.1.1 Radio broadcasting: Sections 4.14.1.1, 4.14.2.1 and 4.14.3.1 Television broadcasting: Sections 4.15.1 and 4.15.2 Cumulative impacts: Sections 4.16.1 and 4.16.2
Likely effects	Identify the potential for electromagnetic interference to radiocommunications services from the project	
Design and mitigation	Describe and evaluate potential design responses and/or other mitigation measures (e.g. installation of additional transmitter masts) to reduce potential electromagnetic interference to radiocommunications services	Nearby towers: not required Point-to-point links: not required Point-to-multipoint links: not required Other licence types: not required Emergency services: Section 4.6.3 Meteorological radar: Section 4.8.3 Trigonometrical stations: not required CB radio: Section 4.10.2 Mobile phones: Section 4.11.3 Wireless internet: Sections 4.12.1.3 and 4.12.2.3 Satellite television and internet: Section 4.13.1.3 Radio broadcasting: Sections 4.14.1.2 and 4.14.2.2 Television broadcasting: Section 4.15.3 Cumulative impacts: Section 4.16.3
Performance	Outline and evaluate any proposed measures designed to manage and monitor residual electromagnetic interference… and describe contingency measures for responding to unexpected impacts	

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The Project is located approximately 15 km west of Mortlake and approximately 15 km northeast of Woolsthorpe in the Moyne Shire of southwest Victoria. The closest townships are Hexham, Caramut and Ellerslie, located approximately 3 km northeast, 4 km northwest and 3 km southwest, respectively. Agriculture is the predominant land use in the Project area, consisting mostly of grazing (cattle and sheep) along with some cropping.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of up to 106 wind turbines [5]. A map of the site with the proposed turbine layout is shown in Figure 2, and the coordinates of the proposed turbine locations are presented in Table 10.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Proponent [6]. For the purposes of this assessment, DNV has evaluated the potential for EMI-related impacts at identified dwellings within 5 km of the Project boundary. The locations of identified dwellings more than 5 km from the Project boundary have also been shown, where available, but impacts at these dwellings have not been considered in detail. There are 301 dwellings located within 5 km of the Project boundary, 49 of which are stakeholder dwellings. The dwellings and Project boundary considered in this assessment are shown in Figure 2.

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

The Scoping Requirements [2] set out the specific matters to be investigated and documented in the EES, in accordance with the *Environment Effects Act 1978*. With regard to potential EMI impacts, the Scoping Requirements state that the evaluation objective for the EES is *"[t]o avoid and minimise adverse effects on… electromagnetic interference during construction, operation and decommissioning of the project"* where EMI is defined as *"interference with communications systems that use electromagnetic waves as the transmissions medium"*.

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

The Victorian Guidelines [3] state that "*a wind energy facility can affect the amenity of the surrounding area due to … electromagnetic interference*" 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.

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) [4]. 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 EMI CAUSED BY THE PHYSICAL PRESENCE OF WIND TURBINES

4.1 Assessment approach

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

The Proponent has asked DNV to complete this assessment based upon a layout provided for the Project consisting of up to 106 wind turbines, as outlined in Table 10.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 190 m and a tip height of 260 m has been considered. These dimensions represent the maximum tip height and rotor diameter 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 260 m or less.

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, and then assess the radiocommunication licences attached to these towers. This reduces the likelihood that radiocommunication links crossing the Project are inadvertently excluded from the assessment.

To conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project was obtained from a copy of the Australian Communications and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database dated 28 May 2025 [7].

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 (see section 4.2.1), within the second Fresnel zone of a point-to-point link (see section 4.3.1.1), or within 250 nautical miles of an aeronautical or meteorological radar site (see section 4.8.1). DNV has consulted with 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 organisations that have been contacted and all responses received to date are summarised in Table 17. Consultation with these operators has been undertaken in three stages:

1. consultation with all identified organisations based on a previous turbine layout consisting of up to 109 turbines with a rotor diameter of 190 m and an upper tip height of 260 m ("the preliminary turbine layout")
2. further consultation with those organisations that had had not previously responded or had requested to be contacted if the turbine layout changed, based on an interim turbine layout and dimensions ("the interim turbine layout", consisting of up to 106 turbines with a rotor diameter of 190 m and an upper tip height of 260 m).
3. further consultation with those organisations that had had not previously responded or had requested to be contacted if the turbine layout changed, based on the turbine layout and dimensions considered in this assessment ("the current turbine layout", consisting of up to 106 turbines with a rotor diameter of 190 m and an upper tip height of 260 m).

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.

DNV notes that the Project is located in an area of high wind farm development activity, with several approved and operating wind farms located nearby. An assessment of potential cumulative impacts to nearby radiocommunication services from the Project in conjunction with other nearby wind farms will be included in a subsequent issue of this document.

4.2 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 [4], 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 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.

4.2.1 Locations of radiocommunication towers and potential for interference

From the ACMA RRL database, there are 460 radiocommunication towers within a nominal 75 km of the Project boundary. The locations of these radiocommunication towers relative to the Project are shown in Figure 3.

There is one radiocommunication tower located within 2 km of the proposed turbine locations. This tower and the consultation zones recommended by the Draft National Guidelines [4] are shown in Figure 4. Each consultation zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer of 25 m to account for potential inaccuracies in the tower locations given in the ACMA RRL database.

Details of the licences associated with this radiocommunication tower are given in Table 3**.** These licences are all point-to-area style communications, comprising land mobile licences used for private mobile telephony (mobile radio systems).

Table 3 Details of radiocommunication towers located within 2 km of turbines at the proposed Project

Site ID	Operator	Licence/service types	Distance to nearest turbine [m]
46246	Country Fire Authority (CFA)	Point-to-area (land mobile)	1990

Point-to-area style radiocommunications such as mobile radio systems are typically designed to operate in a range of environments and 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. However, interference caused by reflection or scattering of signals or near-field effects can be a problem if the turbines are located close to the transmission tower. Reference [8] 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 due to reflection or scattering of signals. 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 these types of services [9].

Given that there are no proposed wind turbine locations within 1200 m of the tower shown in Table 3, there is a low likelihood for the Project to interfere with the Country Fire Authority (CFA) point-to-area style communications through reflection or scattering of the signals. However, as there is one turbine located within the 2 km consultation zone, DNV deems consultation with the Country Fire Authority necessary. Near-field zones for these types of systems are typically only a few metres in radius, and so it is considered unlikely that the Project will cause interference to the services associated with this tower through near-field effects.

4.2.2 Stakeholder consultation

DNV has contacted the CFA to determine the likelihood that the proposed Project will cause interference to their services through near-field effects or reflection or scattering of signals.

Based on the preliminary turbine layout and the site boundary, the CFA has confirmed that their radio services will not be affected by the Project. Further consultation with CFA is not considered necessary.

4.3 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.

4.3.1 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 5. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some emergency services towers.

There are eight point-to-point links recorded in the ACMA RRL database that pass over the proposed Project boundary, operated by AusNet Transmission Group Pty Ltd (AusNet Services), Vertical Telecoms Pty Ltd (VerTel) and NBN Co Ltd (NBN Co). The details of the links are provided in Table 11, and the link paths are shown in greater detail in Figure 6.

The potential interference mechanisms and interference zones established by DNV for these links are described in Sections 4.3.1.1, 4.3.1.2, and 4.3.1.3.

4.3.1.1 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 [4, 10, 11], 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 [10], or potentially 60% of the first Fresnel zone for links below 1,000 MHz with a clear line of sight as suggested in [8] (although DNV understands that this zone is under review by the authors of that document). For each of the links crossing the proposed Project boundary, DNV has established a diffraction exclusion zone based on the second Fresnel zone for that link.

It is common practice to have multiple Assignment IDs for the same physical link to cover practicalities such as licensing for sending or receiving signals. Accordingly, the second Fresnel zone for each link has been calculated based on the Assignment ID with the lowest frequency.

The potential diffraction exclusion zones in the horizontal plane are shown in Figure 6. Each exclusion zone includes the rotor radius for turbines with a 190 m rotor diameter, and an additional buffer of 25 m to account for potential inaccuracies in the tower locations given in the ACMA RRL database.

As shown in Figure 6, there are no turbines located within the diffraction exclusion zones for the point-to-point links passing over proposed Project site. Therefore, it is not expected that the Project will cause interference to the point-to-point link through diffraction of the signals.

4.3.1.2 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) [10].

Reference [10] describes a methodology for calculating the C/I ratio that might be expected at a receiver in the presence of a reflected or scattered signal from a wind turbine at a specified location. By evaluating the C/I ratio for incremental changes in the distances between the transmitter, receiver, and wind turbine, and comparing this to the required C/I ratio, a potential interference zone can be defined.

DNV considers that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid reflection or scattering effects. Therefore, it is not expected that the Project will cause interference to the point-to-point links through this reflection or scattering of the signals.

4.3.1.3 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 [10] presents an equation for estimating the radius of the near-field zone for a point-to-point link from the properties of the transmitting or receiving antenna.

DNV considers that the transmission towers for all of the point-to-point links crossing the Project boundary are sufficiently far from the proposed turbine locations to avoid near-field effects. Therefore, it is not expected that the Project will cause interference to the point-to-point links through this near-field effects

4.3.2 Stakeholder consultation

DNV has contacted the operators of the point-to-point links crossing the proposed Project boundary to determine the likelihood that the proposed Project will cause interference to their operations and services through diffraction, reflection or scattering, or near-field effects.

A response has been received from AusNet based on the current turbine layout, in which AusNet advised that the current turbine layout remains clear of AusNet's point-to-point link paths and services and therefore no impact is expected.

A response has been received from NBN Co who indicated that the interim turbine locations do not pose a risk to their point-to-point links in the vicinity of the Project. Based on the preliminary turbine layout, the response from VerTel indicated that they do not expect the Project to interfere with their point-to-point links crossing the boundary.

The current turbine layout has also been provided to NBN Co and VerTel for their review and feedback, but no further responses have been received to date.

4.4 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.

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

From the ACMA RRL database, DNV has identified 40 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 7. The details of the licence holders as given in the ACMA RRL database are provided in Table 12.

There is one point-to-multipoint base station within 20 km of the Project boundary, operated by Wannon Region Water Corporation (Site ID 300876). There are also several point-to-multipoint base stations located more than 20 km from the Project.

Wind turbines can cause interference to point-to-multipoint links through the same mechanisms as described for point-to-point links in Section 4.3.1. 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.

4.4.2 Stakeholder consultation

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

A response was received from Wannon Water based on the interim turbine layout and no concerns were raised. The current turbine layout has been provided to Wannon Water for review and no response has been received to date.

Based on the preliminary turbine layout, Lochard Energy have expressed that they have no concerns regarding interference to their services. In response to the preliminary turbine layout Powercor listed their nearby point-to-multipoint links, and mentioned that their links do not cross

the proposed site boundary and that the Project will not cause interference to their services. Further consultation with these operators is not considered necessary.

4.5 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.

4.5.1 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 4.6 and 4.11 respectively, while the potential for interference to radio and television broadcasting services is considered in Sections 4.14 and 4.15.

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 have been considered as part of an aviation impact study.

4.6 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.

4.6.1 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 1 km from the Project 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 4.5, mobile telephony systems are generally not affected by the presence of wind turbines any more than other forms of signal obstruction. Reference [8] 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 [9].

As mentioned in Section 4.2.1, the nearest licence is associated with a tower approximately 1 km from the site boundary. However, this tower is 1.9 km from the nearest turbine and therefore the potential for interference to the associated signals is low. DNV considers it unlikely that the Project will cause interference to mobile radio and paging systems operated by emergency services from towers at greater distances from the Project.

4.6.2 Stakeholder consultation

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

Responses based on the preliminary turbine layout have been received from all operators, as summarised in Table 17, and no concerns have been raised. Further consultation with the operators is not considered necessary.

4.6.3 Mitigation options

As noted above, there is no potential for interference 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.

4.7 Aircraft navigation systems and radar

DNV understands that a separate aviation impact study has been undertaken to assess the impact of the Project on nearby aviation navigation systems and radar [12].

4.8 Meteorological radar

The Bureau of Meteorology ("the Bureau") 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 Bureau'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 Bureau'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 potential for 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 Bureau 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 [4].

4.8.1 Locations of meteorological radars and potential for interference

DNV has identified that the Bureau operates 13 weather radars within 250 nautical miles of the proposed Project, with the closest radar located approximately 154 km west of the Project at Mount Gambier. 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 Bureau radar is considerably greater than the distances at which the WMO suggests impact may occur, consultation with the Bureau is needed to determine the potential for interference.

4.8.2 Stakeholder consultation

DNV has contacted the Bureau regarding the Project, as recommended by the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely.

The response received from the Bureau, based on the preliminary turbine layout, indicated that the potential impact of the Project on their meteorological radars would be manageable under normal atmospheric conditions, and that the Bureau had no objections to the Project provided that the following conditions are agreed to in writing and met:

- the Bureau is informed of any changes to the turbine tip height or significant changes to the turbine layout (relocation of turbines by more than 100 m) prior to construction of the Project

- the owner or operator of the Project gives the Bureau advance notice of any planned shutdown of the Project for more than 12 hours, to allow the Bureau to recalibrate 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 Bureau in the event of severe weather conditions in the interests of community safety.

The Bureau have been provided with the current turbine layout for review and the response received indicates that the potential impact of the Project on their meteorological radars is low risk, and that the Bureau has no objections to the Project. DNV recommends that the Proponent engages again with the Bureau prior to the construction of Project, to determine whether the conditions outlined above are still applicable and, if so, to establish an understanding of how a commitment to those conditions can be formalised.

4.8.3 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 locations of the wind farms into account.

DNV understands that the Proponent has committed to meeting the conditions outlined by the Bureau, as summarised in Section 4.8.2, which may allow the Bureau 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 Bureau regarding whether these conditions are still applicable and, if so, what type of collaboration will be required in the event of severe weather conditions.

4.9 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes.

Some trig points may host surveying equipment such as 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 potential for 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, and several private and state-based GNSS CORS networks. 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.

4.9.1 Locations of trigonometrical stations and potential for interference

According to Geoscience Australia [23], there is one trig point within 20 km of the Project boundary. It is located 16 km east of the nearest proposed turbine location. The details of this trig point are provided in Table 16 and its location is illustrated in Figure 10. There are also a number of permanent survey marks within 5 km of the Project boundary [24] as shown in Figure 11. The closest survey mark is located 244 m south of the nearest turbine.

DNV has reviewed the primary geodetic network of Australia [25] 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 15 km east of the Project, at Mortlake [26]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network.

4.9.2 Stakeholder consultation

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 has contacted Geoscience Australia and the Department of Transport and Planning to inform them of the Project, share the preliminary turbine layout, and seek feedback regarding whether interference to their systems is possible.

The Department of Transport and Planning has indicated that they have reviewed the proposed Project wind turbine and site boundary locations and have determined that interference to survey control marks or positioning infrastructure in the area is unlikely. Geoscience Australia has indicated that they do not foresee any interference to their infrastructure caused by the Project.

Further consultation with The Department of Transport and Planning and Geoscience Australia is not considered necessary.

4.10 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.

4.10.1 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 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.

4.10.2 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.

4.11 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 provided that appropriate clearances from the mobile phone towers are maintained.

4.11.1 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 1.4 km north of the Project boundary.

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

Figure 13 show the Optus Mobile network coverage for the Project area [27]. Optus 4G coverage is available within and around the site, where outdoor coverage is mostly available, with some areas in the centre, west and south where coverage is limited.

Figure 14 shows the Telstra network coverage for the Project area [28]. Telstra 4G coverage is available everywhere across the site and surrounds. Telstra 4G coverage is good outside of the site, except for some small areas to the north.

Figure 15 shows the Vodafone network coverage for the Project area [29]. Outdoor Vodafone 4G coverage is available on the eastern side of the site particularly in the south-east, which continues out to Ballangeich and Ellerslie. Although the coverage map also shows areas where Vodafone 3G coverage is available, this service was turned off in January 2024.

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.

Based on Figure 13 to Figure 15Figure 15, the services with an increased potential for interference from the Project due to existing marginal coverage include:

- Optus Mobile 4G signals in isolated areas to the areas to the south, southwest, and west of the Project, and within the Project boundaries
- Vodafone signals within the Project boundaries, and to the west, north, and northeast of the Project.

However, DNV notes that the overall potential for the Project to interfere with these services is still low. Given the generally good Telstra 4G coverage in the areas around the Project, the potential for interference to Telstra mobile phone services is considered very low.

4.11.2 Stakeholder consultation

DNV 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. Based on the preliminary turbine layout, Optus expressed no concern regarding interference to their services from the Project. Vodafone reviewed the preliminary turbine locations provided and determined that they do not expect any interference due to the Project. Further consultation with Optus and Vodafone is not considered necessary. To date, no response has been received from Telstra.

4.11.3 Mitigation options

As noted above, interference with mobile phone signals may theoretically occur in areas where reception is poor or marginal. 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.

4.12 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).

4.12.1 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.

4.12.1.1 Availability of wireless broadband services and potential for interference

Residents in the vicinity of the Project may use wireless broadband services provided by Optus, Telstra, and Vodafone. These wireless broadband services use the same networks as mobile phone services, and therefore the comments made in Section 4.11.1 are applicable here. Specifically, there is a low theoretical potential for interference in areas with marginal reception if a wind turbine intercepts the signal between a receiver and the tower, although there may be an increased potential for interference in areas where the existing reception is poor or marginal.

4.12.1.2 Stakeholder consultation

DNV has contacted Telstra, Optus, and Vodafone, as discussed in Sections 4.4.2 and 4.11.2, to seek feedback on any potential impact that the Project could have on their services. Based on the preliminary turbine layout Optus expressed no concern regarding interference to their services from the Project. Vodafone reviewed the preliminary turbine locations provided and determined that they do not expect any interference due to the Project. To date, no response has been received from Telstra.

4.12.1.3 Mitigation options

As noted above, interference with wireless broadband services may theoretically occur in areas where reception is poor or marginal. If interference to the wireless broadband services provided by mobile phone networks occurs, the mitigation options given in Section 4.11.3 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 wireless broadband signals.

4.12.2 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 in most cases [30] although DNV understands that this range has been extended for some towers. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [31].

For rural and remote users in areas that are not able to receive fixed line or fixed wireless services, NBN satellite internet signals are available from the NBN Sky Muster I and II satellites.

4.12.2.1 Availability of NBN services and potential for interference

The NBN website [32] indicates that the network is currently available as a fixed wireless and satellite internet service within the Project boundaries and area surrounding the Project. It is therefore likely that some residents are currently accessing the internet via the NBN. The locations of NBN fixed wireless internet towers within 75 km of the Project boundaries are shown in Figure 12, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 16.

The NBN fixed wireless towers servicing the Project area are located at Caramut, Woolsthorpe and Mortlake. Based on the relative positions of these towers and the nearby dwellings, and the fixed wireless coverage areas shown in Figure 16, there is potential for turbines at the Project to intercept the line of sight between these towers and nearby dwellings. The potential for interference has been assessed through consultation with NBN Co, as described in 4.12.2.2.

DNV understands that NBN Co is planning to extend the fixed wireless coverage range for some towers from 14 km to 29 km [33]. In addition to the NBN fixed wireless internet towers at Caramut, Woolsthorpe and Mortlake, there are other NBN fixed wireless internet towers located within 29 km of the proposed turbine locations at Penshurst, Hawkesdale, and various other areas surrounding the Project. If the coverage from these towers is extended and additional residents in the vicinity of the Project begin receiving fixed wireless internet signals prior to the construction of the Project, there may be potential for interference to the NBN fixed wireless service at other dwellings. Conversely, in the event that interference to NBN fixed wireless internet signals from the towers at

Caramut, Woolsthorpe and Mortlake is experienced, extension of the coverage from the other nearby towers may allow affected dwellings to receive signals from an alternative tower. However, the assessment presented here is based on the current network availability, as shown in Figure 16.

The potential for interference to satellite internet signals from the NBN Sky Muster I and II satellites is considered in Section 4.13.

4.12.2.2 Stakeholder consultation

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 from NBN Co, based on the interim turbine layout, indicates that although there are several connected dwellings within the Project boundaries, the proposed turbines do not pose a risk of physically obstructing any of the customer connection paths. However, NBN Co has asked to be advised if the proposed turbine locations change so that they can reassess the potential for impact to their services if necessary. NBN Co has been provided with the current turbine layout and no response has been received to date.

NBN Co has also asked to be provided with the details of any radiofrequency transmission equipment planned to be installed or used during the construction or operation of the Project so that they can assess the potential for the associated signals to interfere with their services. DNV recommends that the Proponent engages again with NBN Co prior to construction of the Project, once the details of any such equipment are known, to allow NBN Co to determine the potential for interference and to establish an understanding of how any impacts can be mitigated.

4.12.2.3 Mitigation options

As noted above, there is a low potential for interference with NBN fixed wireless internet signals received from the Caramut, Woolsthorpe and Mortlake NBN towers at dwellings within the Project boundaries. If interference to NBN fixed wireless signals is experienced at dwellings in the vicinity of the Project, several mitigation options may be available to improve the signal reception. 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 another location on the property, 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" [30]). 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.

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

4.13 Satellite television and internet

In some rural or remote areas, television and internet access can only be provided through satellite signals. There are two types of satellite that are typically used to provide commercial telecommunication services: geostationary satellites and low Earth orbit (LEO) satellites.

4.13.1 Geostationary satellite communication services

Geostationary satellites orbit the earth directly above the equator, at a height of 35,786 km above the Earth's surface [34]. At this altitude, the satellites travel at the same rate as the Earth's rotational speed and therefore appear to remain stationary at the same point in the sky relative to an observer at a fixed location. Additionally, due to their high altitude, each satellite can view (and therefore provide coverage to) a large portion of the Earth's surface. Geostationary orbits are typically used for weather monitoring satellites that continually observe a specific area of the Earth and for satellites that provide telecommunication services, since the satellite dish or antenna used on Earth to receive and transmit signals can be permanently pointed to the correct location in the sky. Both satellite television and satellite internet services are currently available in Australia via geostationary satellites.

Satellite television signals are delivered via a geostationary 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 geostationary satellites that transmit Australian free-to-air or subscription television channels are the Optus C1, D1, and D3 satellites and the Intelsat 19 satellite [35, 36].

In the case of internet services provided by geostationary satellites, 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 geostationary satellites for providing satellite internet in Australia are the IPSTAR (THAICOM-4) and Optus D2 satellites, and the NBN Sky Muster I and II satellites.

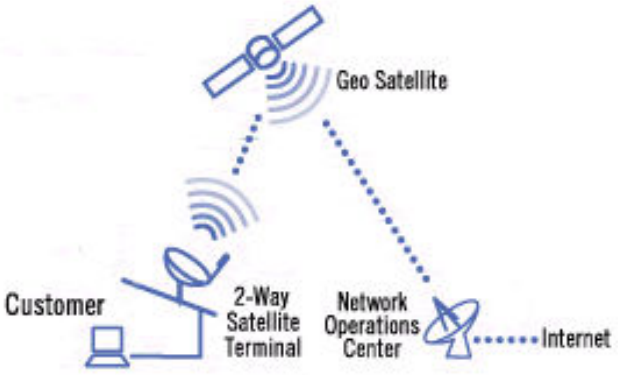

Figure 1 Two-way connection to the internet via satellite [1]

4.13.1.1 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. Although only a small number of satellites are likely to be providing services specifically intended for Australian audiences, DNV has considered the line of sight to dwellings in the vicinity of the Project from all theoretically viewable satellites.

The results of the analysis are summarised in Table 4. Based on these results, turbines at the Project may intercept signals from 19 satellites at 9 nearby dwellings, all of which are stakeholder dwellings.

One stakeholder dwelling (D438) has potential to experience interference to signals from the NSS 9 satellite, which provides television signals with coverage over the east coast of Australia. DNV has not been advised whether this dwelling will be inhabited while the Project is operational. If the dwelling will not be inhabited, or if the residents are not intending to use the NSS 9 satellite service, there will be no potential for the Project to impact on that service.

The results also show that signals from one satellite used for private communication has potential to be intercepted by turbines at dwelling D438. It is likely that this satellite is used by governments or private organisations [37] and it is therefore unlikely that this satellite will be used by nearby residents.

DNV understands that the remaining 17 potentially affected satellites provide television signals intended for international audiences and considers it unlikely that residents in the vicinity of the Project will currently be receiving signals from these satellites. Many of the satellites have a low angle of elevation above the horizon at the wind farm 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. If residents are not currently receiving signals from these satellites, either by choice or because those signals are not available due to existing degradation or interference, there will be no potential for the Project to impact on those services.

Table 4 Number of satellites with potential for signals to nearby dwellings to be intercepted by the proposed Project

Satellite service	Number of potentially affected satellites	Number of potentially affected dwellings
Services intended for Australian audiences	1	1 (stakeholder dwelling)
Services intended for private communications	1	1 (stakeholder dwelling)
Services intended for international audiences	17	9 (all stakeholder dwellings)

4.13.1.2 Stakeholder consultation

As discussed in Section 4.13.1.1, one stakeholder dwelling has the potential to experience interference to NSS 9 satellite services. DNV recommends that the Customer engages with the owners of this dwelling prior to construction of the Project to determine whether it is currently inhabited or expected to be inhabited during the lifetime of the Project and whether the residents are currently receiving or intending to receive signals from the NSS 9 satellite, and to establish an understanding of how any impact to those services may be mitigated.

As discussed in Section 4.13.1.1, it is unlikely that nearby residents are currently receiving signals from satellites that may be affected by interference from turbines at the Project. If desired by the Proponent, the potential for impact could be confirmed by engaging with the residents of nearby dwellings prior to construction of the Project to determine if any are currently receiving signals from the satellites providing services intended for international audiences, and to establish an understanding of how any impact to these services may be mitigated.

4.13.1.3 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.

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.

4.13.2 Low Earth orbit satellite communication services

Satellites in LEO occupy heights between 160 km and 1000 km above the Earth's surface [34] . At these altitudes, the satellites travel significantly faster than the Earth's rotational speed and typically compete a full orbit in approximately 90 minutes. Unlike geostationary satellites, LEO satellites do not have to follow a particular path around the Earth and their orbits are usually tilted with respect to the equator. However, due to their low altitude, each satellite can only observe or communicate with a small portion of the Earth's surface at a time and this, together with their fast movement across the sky, can limit the usefulness of LEO satellites in some situations.

For telecommunication applications, satellites in LEO offer lower latency and better performance than geostationary satellites, due to the reduced distance for the signal to travel. However, using a single LEO satellite to provide telecommunication services is often impractical due to the relatively small coverage area and significant effort required to track the satellite from the ground. To compensate for this, LOE satellites used for telecommunications usually operate as part of a large network or "constellation" of multiple satellites that work together to provide continuous coverage to large areas simultaneously. As satellites within the constellation move through the field of view of a satellite dish on Earth, the dish detects and connects to the satellite with the strongest signal and then automatically switches over to another satellite as the first moves out of view. Nevertheless, these services may be sensitive to physical obstructions such as terrain, vegetation, buildings, and other structures such as wind turbines, which can unexpectedly interrupt the signal from the connected satellite and cause the service to temporarily drop out until a new satellite can be found.

4.13.2.1 Availability of low Earth orbit services and potential for interference

Starlink is the only LEO satellite internet service currently available to customers in Australia. The current Starlink LEO constellation consists of several thousand satellites orbiting the Earth at a height of approximately 550 km [38], although this may increase to tens of thousands of satellites in the future. Starlink offers two classes of satellite dish to users of their services: a standard dish that is considered suitable for most residential applications, and a high performance dish that has a wider field of view (enabling it to connect to more satellites, even in the presence of obstructions), a higher gain antenna, and improved performance under extreme environmental conditions [39, 40].

In the southern hemisphere, Starlink satellite dishes currently require a relatively clear view of the sky within a field of view of 100° tilted towards the south, with a minimum elevation angle of 25° above the southern horizon [41]. Although some obstructions can be tolerated, the impact of these obstacles will depend on their apparent size, their distance and direction relative to the satellite dish, and the proportion of the sky already obstructed. Obstacles below an elevation angle of 25° in the south, 40° in the east and west, and 40° in the north (allowing for locations where no tilt of the satellite dish is required) will not pose any obstruction to the field of view. However, as more satellites are launched and join the Starlink constellation, it is expected that the required angle of tilt towards the south will reduce until dishes can be pointed directly upwards, with elevation angles above the horizon of 40° in all directions [42], and the service will become less sensitive to obstructions due to the increased number of visible satellites at each location.

DNV has considered the potential for turbines at the Project to obstruct Starlink signals received at nearby dwellings, based on the relative locations of the dwellings and the nearby turbines, the elevations of the dwellings and turbines, and a turbine tip height of 260 m.

At all dwellings in the vicinity of the Project, the turbines are expected to be below an elevation angle of 25° above the horizon in all directions. Therefore, based on this analysis, it is not expected that turbines at the will obstruct Starlink signals for any nearby dwellings.

4.14 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.

4.14.1 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.

However, as noted above, the presence of physical obstructions such as turbines is unlikely to cause significant interference to AM radio signals. Due to the long wavelength of the signal, interference is likely to be localised to several meters from the turbine, although distances may vary depending on the terrain, signal strength and turbine location [43].

4.14.1.1 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 [44], and are shown in Figure 17.

It is unlikely that any permanent AM radio receivers will be located sufficiently close to the Project to be affected by interference to the radio signals from the turbines.

4.14.1.2 Mitigation options

In the event that localised interference to AM radio signals is experienced, this can potentially be rectified by installing a high-quality antenna or amplifier at the affected residence.

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

4.14.2 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. Instead, the waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon. However, FM radio signals 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 [45]. 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 [43, 46].

Wind turbines located close to an FM transmitter may also present a physical obstruction to the radio signal. If the line-of-sight between the transmitter 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 [45]. 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 transmitter [47].

4.14.2.1 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 [44], and are shown in Figure 17.

The closest FM broadcast transmitter is located approximately 21 km from the proposed Project boundary. Therefore, it is considered unlikely that the Project will cause interference to the FM radio signals from this transmitter.

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.

4.14.2.2 Mitigation options

In the event that localised interference to FM radio signals is experienced, this can potentially be rectified by installing a high-quality antenna or amplifier at the affected residence.

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

4.14.3 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 [48]. 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.

The UK telecommunications regulator Ofcom [45] states that *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*. DNV has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

4.14.3.1 Availability of digital radio services and potential for interference

According to the digital radio coverage search function available on the Digital Radio Plus website [49], the Project is outside the intended service area for digital radio broadcasts. Since it is therefore unlikely that residents in the vicinity of the Project are currently receiving digital radio signals, it is not expected that the Project will cause interference to these services.

4.15 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in Australia are now digital broadcasts [50]. 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 susceptibility of DTV signals to interference from wind turbines is discussed further in Section A.1 of Appendix A.

4.15.1 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 [50], and are shown in Figure 17. The main DTV transmitter used by residents in the vicinity of the Project is the Ballarat (Lookout Hill) transmitter. However, according to the Australian Government mySwitch website [51], it is also possible that residents within the area around the Project could receive DTV signals from the Western Victoria (Mt Dundas), Warrnambool (Tower Hill), and Warrnambool City transmitters. Coverage maps for these broadcast transmitters are reproduced in Figure 18 to Figure 21.

Good to variable coverage is available from the Ballarat (Lookout Hill) transmitter for most dwellings within 5 km of the site. Dwellings outside 5 km from the site are more likely to experience poorer service, particularly dwellings southwest of Mortlake, north of Hexham, and to the southwest of the Project area.

There is limited coverage from the Western Victoria (Mt Dundas) transmitter near the site, and coverage that is available is mostly located in around Purdeet, Minhamite and north-west corner of the site.

The Warrnambool (Tower Hill) transmitter provides some variable coverage to dwellings in the west and southwest of the site, which becomes sparser moving northeast and stronger moving southwest. There is very limited coverage to the east and northeast of the site.

Lastly, the Warrnambool City transmitter provides very limited coverage to a small number of dwellings in the south of the site. Outside the site, further south, dwellings are more likely to be receiving signals from this transmitter, however there is effectively no coverage to the north, east and west of the site.

4.15.1.1 Interference caused by large scale effects

For broadcast signals, large scale interference can generally be avoided by placing the wind turbines at some distance from the transmitter. Broadcast transmitters may be either relay or primary transmitters. Relay transmitters are more commonly found in rural areas. Primary transmitters 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 [11].

The closest DTV transmitter to the Project is the Terang relay transmitter, which is approximately 25 km away. Therefore, it is considered unlikely that the Project will cause large scale interference to signals from this transmitter.

4.15.1.2 Interference caused by reflection or scattering

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.

Due to the lack of an accurate theoretical scattering model, DNV has not performed detailed scatter calculations to predict DTV interference. Instead, dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine at 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 in Section A.3 of Appendix A, with a forward-scatter distance of 5 km and a back-scatter distance of 500 m.

The results of the analysis can be seen in Figure 18 to Figure 21. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 5.

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 at dwellings outside of the identified interference zones. Circumstances under which interference may occur outside the interference zones typically established using the 'keyhole' approach are discussed further in Section A.2 of Appendix A. In particular, although DNV has considered the potential for interference to DTV signals at dwellings within 5 km of the proposed turbine locations, previous advice received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, has indicated that interference to DTV broadcasting may be experienced at distances of up to 10 km from turbines. For comparison, Figure 18 to Figure 21 also show the area within 10 km of the proposed turbine locations, although a more detailed assessment would be required to determine whether there is any potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

Based on the analysis presented here, there is increased potential for turbines at the Project to cause interference to signals received from the Ballarat (Lookout Hill) transmitter. To the south and west of the site, both inside and outside of the site boundary, there are a number of dwellings within the Ballarat DTV potential interference zone. From the coverage map for the Ballarat transmitter, some of these dwellings are expected to receive variable to no coverage and therefore have an increased potential to experience interference.

As there is limited to no coverage from the Western Victoria (Mt Dundas) and Warrnambool (Tower Hill) transmitters within the potential interference zones, it unlikely that any dwellings located within the potential interference zones are currently receiving signals from these transmitters. It is also possible that dwellings within the potential interference zone for the Warrnambool and Western Victoria transmitters will be able to receive a stronger alternative signal from the Ballarat transmitter that is less likely to be subject to interference. Lastly, as there appears to be no signal coverage from the Warrnambool City transmitter within its potential interference zone, the Project is unlikely to affect any dwellings currently receiving signals from this transmitter.

However, as noted above and in Appendix A, there is potential for interference to DNV signals received at dwellings outside of the 'keyhole' interference zones shown in Figure 18 to Figure 21 in situations where the signal has already been degraded by other factors. This may occur due to terrain obstructions or scattering of signals from turbines at other nearby wind farms. While this section has considered the expected impact on DTV signals for the Project in isolation, the potential for cumulative impacts from the Project in conjunction with other nearby wind farms is discussed in Section 4.16.

Table 5 Number of dwellings located within potential interference zones for digital television broadcast transmitters in the vicinity of the Project

DTV broadcast transmitter	Number of dwellings in potential interference zone	Signal coverage in potential interference zone
Ballarat (Lookout Hill)	65 (28 stakeholder dwellings)	Generally good, with some areas of variable coverage to west and southwest
Western Victoria (Mt Dundas)	67 (29 stakeholder dwellings)	Limited – most dwellings in the potential interference zone are unlikely to be receiving signals from this transmitter
Warrnambool (Tower Hill)	99 (29 stakeholder dwellings)	Limited – most dwellings in the potential interference zone are unlikely to be receiving signals from this transmitter
Warrnambool City	95 (27 stakeholder dwellings)	None – dwellings in the potential interference zone are not expected to be receiving signals from this transmitter

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 4.15.3.

4.15.2 Stakeholder consultation

DNV has contacted BAI Communications, who are responsible for broadcasting of national public television services in Australia, to inform them of the proposed Project and seek feedback on any potential impact that the Project could have on DTV signals in the surrounding area.

Based on the preliminary turbine layout, BAI communications have assessed the potential for the turbines at the Project to interfere with DTV signals from the Mt Dundas and Lookout Hill transmitters [52]. The method used by BAI Communications 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 transmitter of interest would be less than required for adequate signal reception.

From the results of their modelling, BAI Communications have advised that they do not expect the Project to cause interference to DTV signals from the Lookout Hill transmitters. The Mt Dundas services may be susceptible to interference within the wind farm boundary. Based on population density data for the areas identified as potentially affected by interference to DTV signals from the Mt Dundas transmitter, BAI Communications concluded that up to three residents are at low risk of experiencing interference. However, BAI also noted that alternate DTV services are available from Lookout Hill which are not predicted to be impacted and are predicted to adequately serve all areas of risk.

BAI Communications have reviewed the interim turbine locations and determined that there will be negligible changes to their previous findings and that any DTV impacts are considered to be minor. Further consultation is not considered necessary.

4.15.3 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 transmitter.

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 [53], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [54] 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 [55].

In addition to the mitigation options outlined above, the Victorian Guidelines [56] include example permit conditions stating that, prior to commencing development, a survey must be undertaken to determine the average television and radio reception strength within 5 km of the wind farm site. If a complaint is later received regarding the effect of the wind farm on television or radio reception at a pre-existing dwelling within 5 km of the site, the operator must investigate that complaint. If the investigation finds that the wind farm has had a detrimental impact on the quality of television or radio reception, the operator must then restore reception at the affected dwelling to at least the quality determined in the pre-development survey to the satisfaction of the responsible authority.

DNV understands that the Proponent has committed to meeting the example permit conditions set out in the Victorian Guidelines and 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.

4.16 Cumulative impacts

DNV notes that the Project is located in an area of high wind farm development activity. Consequently, it is possible that some radiocommunication services could experience cumulative impacts from the proposed Project.

4.16.1 Locations of nearby wind farms and potential for cumulative impacts

The nearest wind farm developments are the Mt Fyans Wind Farm, Salt Creek Wind Farm, Mortlake South Wind Farm, Hawkesdale Wind Farm, Woolsthorpe Wind Farm and Mortons Lane Wind Farm, all of which are located within 20 km of the Project site. Details of these wind farms are summarised in Table 6 and their locations relative to the Project are shown in Figure 22, based on information provided by the Proponent [57].

Table 6 Neighbouring wind farm developments located within 20 km of the Project [57]

Wind farm	Status	Number of turbines	Location relative to the Project
Mt Fyans Wind Farm	Proposed	80	10 km east
Salt Creek Wind Farm	Operating	14	15 km northeast
Mortlake South Wind Farm	Approved	35	16 km southeast
Hawkesdale Wind Farm	Approved	23	16 km southwest
Woolsthorpe Wind Farm	Approved	13	17 km southwest
Mortons Lane Wind Farm	Operating	13	17 km northwest

Table 7 summarises the anticipated EMI-related impact of the Project in isolation, as discussed in Sections 4.1 to 4.15 and the potential for cumulative impacts from the Project in conjunction with the nearby wind farms listed in Table 6. 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.

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 likelihood of interference (see Section 4.2)	Very low potential for cumulative impact
Fixed point-to-point links	Unlikely to cause interference (see Section 4.3)	No cumulative impact, as the link paths do not cross multiple wind farms near turbines
Fixed point-to-multipoint links	None (see Section 4.4)	No cumulative impact, as the link paths do not cross multiple wind farms near turbines
Other licence types	See findings for emergency services, mobile phones, radio broadcasting, and television broadcasting	
Emergency services	No impact expected for point-to-point links (see Section 4.3) Low likelihood of interference to point-to-area style communications (see Section 4.6)	No cumulative impact to point-to-point links Very low potential for cumulative impact to point-to-area style communications
Meteorological radar	Potential for low risk interference, based on advice received from the Bureau (see Section 4.8)	Potential for low risk cumulative impact if turbines at multiple wind farms can be detected by radars
Trigonometrical stations	Unlikely to cause interference (see Section 4.9)	Very low potential for cumulative impact
Citizens band radio	Unlikely to cause interference (see Section 4.10)	Very low potential for cumulative impact
Mobile phones	Low likelihood of interference in areas with marginal coverage (see Section 4.11)	Low potential for cumulative impact where there are multiple turbines between the tower and the user
Wireless internet	Low likelihood of interference to wireless broadband services (see Section 4.12) Low likelihood of interference to NBN fixed wireless internet signals (see Section 4.2)	Low potential for cumulative impact to wireless broadband 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	Potential for interference to services intended for Australian audiences at one stakeholder dwelling Low likelihood of interference to services intended for international audiences (see Section 4.13) Low likelihood of interference to LEO satellites (see Section 4.13)	No cumulative impact
Radio broadcasting	Low likelihood of interference to AM and FM signals received in close proximity to turbines (see Section 4.14)	Low potential for cumulative impact where there are multiple turbines between the tower and the user

Television broadcasting	Some likelihood of interference to signals from the Ballarat transmitter at dwellings located to the south and west of turbines, low likelihood or unlikely to cause interference to signals from the Western Victoria, Warrnambool, Warrnambool City transmitters (see Section 4.15)	Some potential for cumulative impact to signals from the Ballarat transmitter at dwellings located to the southwest of the Project, where there are multiple turbines between the transmitter and the user, and in areas with poor or marginal coverage located within 10 km of multiple wind farms

There is some potential for increased interference to point-to-area style services such as mobile phone and radio broadcasting signals in areas with marginal coverage, or where there may be multiple wind turbines between the user and the transmission tower. Based on the coverage maps shown in Figure 14 to Figure 15, and the relative locations of the mobile phone towers shown in Figure 12, cumulative impacts are considered unlikely for the Optus and Telstra mobile phone networks. Vodafone mobile phone signals may be more susceptible to cumulative impacts than the Optus and Telstra networks, due to the small number of towers servicing the area and existing poor coverage in areas to the north and west of the Project and within the Project boundaries, although it is also less likely that residents will be using this service.

Similarly, there is some potential for increased interference to DTV broadcasting signals in areas where there are multiple wind farms between the user and the transmission tower. As discussed in Section 4.15.1 the DTV transmission towers identified to be servicing the area are the Ballarat (Lookout Hill), Western Victoria (Mt Dundas), Warrnambool (Tower Hill) and Warrnambool City transmitters. As it is expected that most residents in the vicinity of the Project will be receiving signals from the Ballarat transmitter, impact to the service from the Ballarat transmitter is considered more likely.

Figure 23 to Figure 26 show the potential DTV interference zones for all neighbouring wind farms along with the signal coverage near the Project for the Ballarat, Western Victoria, Warrnambool and Warrnambool City DTV transmitters. Dwellings to the southwest of the Project may receive signals from the Ballarat transmitter that have passed through the Salt Creek Wind Farm or Mt Fyans Wind Farm prior to passing through the Project. This may increase the potential for interference to be experienced at dwellings in this area. However, DNV notes that all the proposed turbine locations for the Project are more than 10 km from turbines at the Salt Creek Wind Farm and Mt Fyans Wind Farm, which may reduce the overall potential for cumulative impact through this mechanism. For all other transmitters, there are no areas in the vicinity of the Project which are likely to be receiving signals that have passed through multiple wind farms.

There are also several areas located within 10 km of both a neighbouring wind farm and the Project that are expected to be receiving signals from at least one of the four transmitters servicing the area around the Project. Signals in these areas have the potential to be degraded due to a combination of scattered signals from different wind farms in different directions, and therefore dwellings in these areas may have an increased potential to experience interference. This is summarised for each transmitter and neighbouring wind farm in Table 8. In general, there may be potential for cumulative impacts in areas within 10 km of multiple wind farms where the existing DTV signal coverage is poor or marginal. If the existing DTV signal coverage is good, cumulative impacts are less likely, and there is no potential for impact in areas where the signals are not currently available. From the coverage maps shown in Figure 23 to Figure 26, some potentially affected areas may be able to receive a stronger signal from an alternative transmitter that may be less susceptible to interference, which would decrease the overall potential for cumulative impact.

However, DNV notes that this assessment is based on an assumed potential interference distance of 10 km, as suggested by BAI Communications, and does not include detailed analysis of the existing DTV signal coverage in the area around the Project. Consultation with BAI Communications, as described in Section 4.16.2, may help to determine the likelihood of such cumulative impacts.

Table 8 Potential for cumulative impacts to DTV signals in areas within 10 km of both the Project and a neighbouring wind farm

Neighbouring wind farm and location of overlap of 10 km zones	DTV signal coverage in area within overlap of 10 km zones for the Project and the neighbouring wind farm, and potential for cumulative impact in that area			
	Ballarat (Lookout Hill)	**Western Victoria (Mt Dundas)**	**Warrnambool (Tower Hill)**	**Warrnambool City**
Mt Fyans Wind Farm (east of Project)	Good to variable – potential for cumulative impact in some areas	None – no cumulative impact	Poor to none – no cumulative impact	None – no cumulative impact
Salt Creek Wind Farm (northeast of Project)	Good to variable – potential for cumulative impact in some areas	None – no cumulative impact	None – no cumulative impact	None – no cumulative impact
Mortlake South Wind Farm (southeast of Project)	Good to variable – low potential for cumulative impact in some areas	None – no cumulative impact	Variable to none – potential for cumulative impact in some areas	None – no cumulative impact
Hawkesdale Wind Farm (southwest of Project)	Good to poor – potential for cumulative impact in some areas	Poor to none – very low potential for cumulative impact (unlikely to be used)	Variable to none – potential for cumulative impact in some areas	Poor to none – very low potential for cumulative impact (unlikely to be used)
Woolsthorpe Wind Farm (southwest of Project)	Good to poor – potential for cumulative impact in some areas	Poor to none – very low potential for cumulative impact (unlikely to be used)	Good to none – potential for cumulative impact in some areas	Variable to none – potential for cumulative impact in some areas
Mortons Lane Wind Farm (north of Project)	Good to variable – potential for cumulative impact in some areas	Poor to none – very low potential for cumulative impact (unlikely to be used)	Variable to none – potential for cumulative impact in some areas	None – no cumulative impact

There may be potential for cumulative impacts to point-to-multipoint links if the link paths pass over the Project and a neighbouring wind farm in the vicinity of the turbines at both sites. This may be determined through consultation with the operators of the nearby point-to-multipoint base stations, as discussed in Section 4.16.2. Similarly, feedback from the Bureau is needed to determine whether there is potential for their meteorological radars to detect turbines at both the Project and the neighbouring wind farms.

Cumulative impacts to point-to-point links crossing the proposed Project are not expected. Although three of the identified links also pass over the Mt Fyans Wind Farm, all of the turbines at both wind farms are well outside the calculated interference zones. Similarly, the locations of the NBN fixed wireless internet towers and the fixed wireless coverage areas in the vicinity of the Project, as shown in Figure 12 and Figure 16 respectively, suggest that the signal lines of sight

from those towers to nearby dwellings will not pass over multiple wind farm sites. Therefore, cumulative impacts to the NBN fixed wireless internet service are also not expected.

4.16.2 Stakeholder consultation

As discussed in Section 4.4, DNV has contacted the operators of nearby point-to-multipoint base stations to confirm the link paths associated with their point-to-multipoint licences and hence determine the potential for cumulative impact to those links. The responses from Lochard Energy, Powercor and Wannon Water indicated that no interference to their services is expected.

DNV has also contacted the Bureau to seek feedback on whether interference to their operations and services and services is likely, as discussed in Section 4.8.2. The Bureau's response, based on the current turbine layout, indicated that any interference to their service will be low risk, and it can therefore be assumed that any cumulative impacts will also be low risk.

Similarly, consultation with BAI Communications, as outlined in Section 4.15.2, has been conducted to confirm whether there is any likelihood of cumulative EMI-related impacts to DTV broadcast services. Based on the interim turbine layout, BAI did not raise any concerns of cumulative impacts and suggested that any interference experienced will be able to be supplemented with signals from alternate transmitters.

Responses received from the operators of other services have indicated that they do not expect the Project in isolation to impact on their services, and therefore it can be assumed that the potential for cumulative impact is also low.

4.16.3 Mitigation options

For most radiocommunication services, cumulative impacts from the Project in conjunction with other nearby wind farms are either not expected or are expected to be minimal. In the event that interference to mobile phone signals, radio broadcasting, or DTV broadcasting is experienced as a result of cumulative impacts after construction of the Project, the mitigation options given in Sections 4.11.3, 4.14.2, and 4.15.3 may be applicable. Mitigation options to resolve cumulative impacts for other services, such as point-to-multipoint links or meteorological radar, may include the options outlined in the previous sections or can be developed through consultation with the relevant operator if required.

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, in order to address the relevant Scoping Requirements for the Project [2] as part of an environment effects statement (EES), as required under the *Environment Effects Act 1978*. The Project will involve the installation of up to 106 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 and an upper tip height of 260 m or less.

The results of this assessment are summarised in Table 9.

DNV's analysis has found potential for turbines at the Project to interfere with NBN fixed wireless internet signals received from the Caramut, Woolsthorpe and Mortlake towers. However, consultation with NBN Co has indicated that interference caused by the Project is not expected. If interference is experienced, it is possible that problems could be rectified by relocating or realigning the antennas to achieve a clearer signal from an alternative tower, if available.

Turbines at the Project may also interfere with point-to-area style services such as mobile phone signals and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. Dwellings in the vicinity of the Project may experience interference to digital television broadcast signals from the Ballarat (Lookout Hill), which is the primary transmitter for the area. Although interference is possible for signals from the Western Victoria (Mt Dundas), Warrnambool (Tower Hill) and Warrnambool City broadcast transmitters, most of the potentially-affected dwellings are located in areas with limited to no signal coverage and therefore may not be currently receiving signals from those transmitters. Feedback received from BAI Communications, who are responsible for broadcasting of national public television services in Australia, suggests that impacts to DTV signals are unlikely and are predicted to be confined to within the Project boundary.

The Bureau of Meteorology (the Bureau) has advised that impacts on their meteorological radars are considered to be low risk and that the Bureau have no objections to the proposed Project. To help mitigate any interference with meteorological radar operations once the Project is operational, the Bureau previously asked that the owner or operator of the Project agrees to advise them of any changes to the turbine layout or tip height prior to construction, notify them prior to any planned shutdown of the Project to allow recalibration of systems, and collaborate with them in the event of severe weather conditions. DNV recommends that the Proponent engages again with the Bureau prior to the construction of Project to determine whether these conditions are still applicable.

Signals from one geostationary satellite that transmits programs intended for Australian audiences and one that provides private communication services may be intercepted by turbines at the Project for one stakeholder dwelling. Interference to signals intended for international audiences is also possible at several nearby dwellings, but it is considered unlikely that residents will be receiving signals from these satellites. 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.

While the Project may cause interference to other radiocommunication services in the surrounding area, further information from the operators of those services is required to determine the likely

impacts. DNV has consulted with organisations operating services that may be affected by the Project to seek feedback regarding any potential for EMI-related impact. Apart from the feedback received from NBN Co and the Bureau, no concerns have been raised to date. Any additional feedback that is received from the relevant operators will be incorporated into a future revision of this document.

DNV notes that the Project is located in an area of high wind farm development activity, with several proposed, approved, and operating wind farms located nearby. DNV has conducted an assessment of potential cumulative impacts to nearby radiocommunication services from the Project in conjunction with other nearby wind farms. DNV has noted a potential for cumulative impact to DTV broadcasting services and has contacted BAI Communications to seek feedback. Feedback received from BAI Communications suggests that impacts to DTV signals are unlikely. There is potential for increased interference to mobile phone signals where coverage is marginal and there are multiple turbines between the mobile phone tower and the user. However, current feedback from Optus and Vodafone indicates no concern and no response has been received from Telstra. Cumulative impacts to meteorological radars may occur, but are expected to be manageable.

Table 9 Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Radio-communication towers	1 tower within 2 km of proposed turbine locations, operated by: Country Fire Authority (CFA) Nearest tower: 1990 m from turbines	No concerns raised	Low likelihood of interference	Very low potential for cumulative impact	None required
Fixed point-to-point links	8 links crossing Project boundary, operated by: AusNet Transmission Group Pty Ltd (Ausnet Services) NBN Co Ltd (NBN Co) Vertical Telecoms Pty Ltd (VerTel)	No concerns raised	Unlikely to cause interference	None	None required
Fixed point-to-multipoint links	40 assignments within 75 km of Project boundary 1 base station within 20 km of Project boundary, operated by: Wannon Region Water Corporation (Wannon Water)	No concerns raised	None	None	None required
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 **Point-to-area style communications:** Low likelihood of interference to signals from CFA tower within 2 km, unlikely to cause interference to other services	No concerns raised	**Point-to-point links:** None **Point-to-area style communications:** Low likelihood of interference	**Point-to-point links:** none **Point-to-area style communications:** very low potential for cumulative impact	**Point-to-point links:** none required **Point-to-area style communications:** if required – increase signal strength from affected tower or alternative towers, install signal repeater, install additional tower

Table 9 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Meteorological radar	Nearest radar: 154 km from Project	Impacts are expected to be low risk	Potential for low risk interference	Potential for low risk cumulative impact	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	No concerns raised	Unlikely to cause interference	Very low potential for cumulative impact	None required
Citizen's band radio	Unlikely to be affected	Consultation not considered necessary	Unlikely to cause interference	Very low potential for cumulative impact	None required
Mobile phones	Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Optus and Vodafone:** No concerns raised **Telstra:** No response received	Low likelihood of interference	Low potential for cumulative impact where there are multiple turbines between the tower and the user	If required – increase signal strength from affected tower or alternative towers, install additional tower

Table 9 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Wireless internet	**Wireless broadband service providers:** mobile phone networks, NBN Co **NBN:** available as a fixed wireless and satellite service	**Optus, Vodafone and NBN:** No concerns raised **Telstra:** No response received	**Mobile phone networks**: see findings for mobile phones **NBN:** None	**Mobile broadband services:** low potential for cumulative impact where there are multiple turbines between the tower and the user **NBN:** none	**Mobile phone networks:** as for mobile phones **NBN:** none required
Satellite television and internet	**Geostationary satellites:** Services intended for Australian audiences: signals from 1 satellite intercepted at 1 stakeholder dwelling Services intended for private communications: signals from 1 satellite intercepted at 1 stakeholder dwelling Services intended for international audiences: signals from 17 satellites intercepted at 9 stakeholder dwellings **Low Earth orbit (LEO) satellites:** unlikely to be affected	Consultation with operators not considered necessary	**Geostationary satellites:** High likelihood of interference **LEO satellites:** unlikely to cause interference	None	**Geostationary satellites:** If required – redirect satellite dish to alternative satellite, install larger or higher-quality satellite dish, change location or height of satellite dish **LEO satellites:** none required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** Project is outside the intended coverage area	Consultation not considered necessary	**AM and FM signals:** low likelihood of interference **Digital radio signals:** None	Low potential for cumulative impact where there are multiple turbines between the tower and the user	**AM and FM signals:** if required – install higher-quality antenna at affected location **Digital radio signals:** none required

Table 9 Summary of EMI assessment results for the proposed Project (continued)

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential for cumulative impact	Potential mitigation options
Television broadcasting	May experience interference in areas with poor or marginal reception **Ballarat (Lookout Hill) transmitter:** *'variable' to 'good' coverage across most areas* 65 dwellings (28 stakeholder dwellings) in potential interference zone **Western Victoria (Mt Dundas) transmitter:** *'poor' to 'variable' coverage in most areas, no coverage in the east and southeast* 67 dwellings (29 stakeholder dwellings) in potential interference zone, but signal coverage is limited in that area **Warrnambool (Tower Hill) transmitter:** *No coverage across most areas, 'poor' to 'variable' coverage in the west and southwest* 99 dwellings (29 stakeholder dwellings) in potential interference zone, but signal coverage is limited in that area **Warrnambool City transmitter:** *No coverage across most areas, 'poor' to 'variable' coverage in the south* 95 dwellings (27 stakeholder dwellings) in potential interference zone	**Lookout Hill transmitter**: interference unlikely **Mt Dundas transmitter**: susceptible to scatter interference within the site boundary **Tower Hill and Warrnambool City transmitter:** not assessed Areas at risk are expected to be served by an alternate transmitter with no interference	**Lookout Hill transmitter**: Likely to cause interference at some dwellings within approximately 5-10 km, if those dwellings are currently receiving a weak signal **Mt Dundas transmitter**: Low likelihood of interference, as dwellings may not be currently receiving a signal **Tower Hill and Warrnambool City transmitter:** Low likelihood of interference, as dwellings may not be currently receiving a signal	Some potential for cumulative impact at dwellings located to the southwest of the Project, and in areas with poor or marginal coverage located within 10 km of multiple wind farms	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

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[58] International Telecommunications Union (ITU), "Assessment of the impairment caused to analogue television reception by a wind turbine," Recommendation ITU-R BT.805, March 1992.

[59] International Telecommunications Union (ITU), "Assessment of impairment caused to digital television reception by a wind turbine," Recommendation ITU-R BT.1893, October 2015.

[60] I. Angulo, et al., "An empirical comparative study of prediction methods for estimating multipath due to signal scattering from wind turbines on Digital TV Services," *IEEE Transactions on Broadcasting,* vol. 57, no. 2, June 2011.

[61] NBN Co Ltd, "nbn Fixed Wireless explained," 2019. [Online]. Available: https://www.nbnco.com.au/residential/learn/network-technology/fixed-wireless-explained. [Accessed 25 July 2019].

APPENDIX A – TELEVISION INTERFERENCE CAUSED BY REFLECTION OR SCATTERING OF SIGNALS

A.1 Susceptibility of DTV signals to reflection or scattering

The United Kingdom telecommunications regulator Ofcom [45] 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 turbines to the television broadcast transmitter
- the proximity of turbines to receivers (dwellings)
- the location of turbines in relation to dwellings and television broadcast transmitters
- 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.

A.2 Forward and back scatter of DTV signals

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 turbines, and receiver are almost aligned as shown in Figure A.1. 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 [53]. Both of these effects can potentially degrade the DTV signal quality.

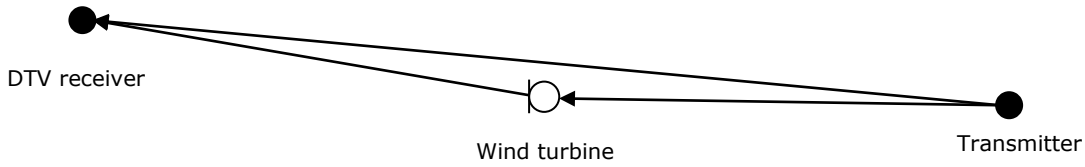


Figure A.1 Forward scatter signal path for DTV signals

Back scatter from wind turbines occurs when DTV signals are reflected from turbine towers and blades onto a receiver as shown in Figure A.2. 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).

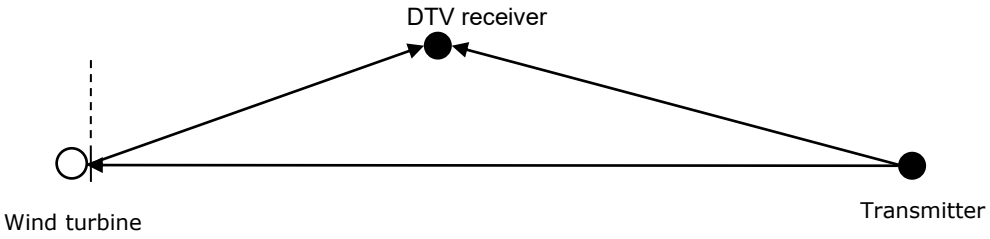


Figure A.2 Back scatter signal path for DTV signals

Interference to DTV signals from wind turbines can potentially occur in both the forward and backward scatter region. The effect of a turbine on a DTV signal can be different depending on the scattering region where the receiver is located [53].

According to Ofcom [45], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [11, 58]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the turbines [45]. 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 transmitter. The back scatter region generally does not extend further than 500 m [11, 45], 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 Figure A.3, resembles a keyhole.

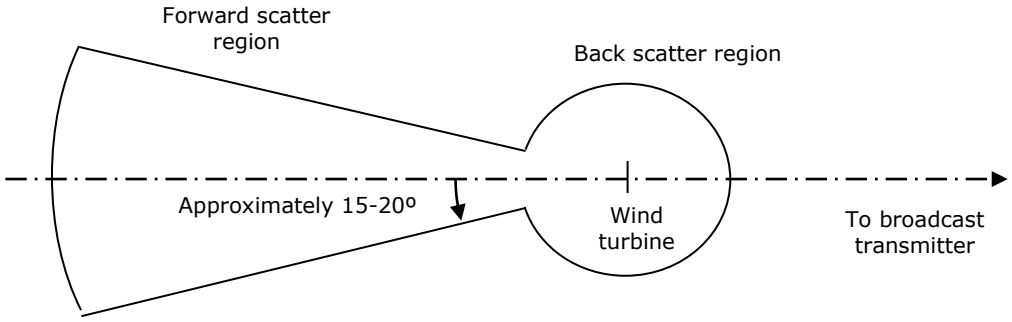


Figure A.3 Potential television interference zones around a wind turbine

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 [59] 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 [54] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more 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 [54].

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 turbines, which effectively means that interference is more likely to occur as coverage quality decreases.

A.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 [60]. 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 [59], 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.

As an alternative to signal scattering models, 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 and shown in Figure A.3, 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 [45]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

Table 10 Proposed turbine layout for the Project [5]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]
T1	631862	5789892	141	T47	638320	5781750	126
T2	632200	5788753	144	T48	638475	5778854	124
T3	632333	5790112	139	T49	638634	5790779	131
T4	633171	5788889	138	T50	638580	5780023	127
T5	632443	5789164	140	T51	638914	5781027	127
T6	632757	5793217	152	T52	638753	5787932	130
T7	632789	5789521	140	T53	638227	5781232	124
T8	632990	5789976	133	T54	638544	5790092	131
T9	633021	5792595	150	T55	639032	5781819	131
T10	633424	5792977	147	T56	638618	5779397	123
T11	633436	5790223	132	T57	639187	5786346	132
T12	633526	5789350	139	T58	639084	5787185	131
T13	633505	5790760	138	T59	639221	5788428	129
T14	633600	5791667	143	T60	639230	5791268	124
T15	634023	5788719	139	T61	639473	5781170	128
T16	634158	5791938	143	T62	639523	5790309	123
T17	634274	5789629	137	T63	639642	5780462	125
T18	634305	5790915	140	T64	640111	5792009	126
T19	634541	5792663	135	T65	639861	5786879	129
T20	634134	5790261	140	T66	639995	5787460	129
T21	634766	5790223	134	T67	639941	5788617	121
T22	635097	5791963	137	T68	640139	5781006	131
T23	635429	5786042	135	T69	639911	5789511	122
T24	635477	5791222	136	T70	640243	5792613	126
T25	635650	5785388	135	T71	640267	5790395	124
T26	635943	5786238	135	T72	640824	5793138	125
T27	635899	5791618	135	T73	640430	5791017	123
T28	636381	5786493	132	T75	640904	5785913	123
T29	636175	5793239	133	T76	640902	5780505	130
T30	636339	5792104	126	T77	640826	5788463	123
T31	636775	5785204	129	T78	640967	5781114	133
T32	636561	5793934	129	T79	640910	5791252	125
T33	636593	5786933	134	T80	641092	5787655	129
T34	636646	5792503	129	T81	641126	5786951	125
T35	636732	5785827	130	T82	641620	5792130	123
T36	636831	5793126	131	T83	641447	5786069	114
T37	637019	5784553	133	T84	641535	5781388	125
T38	637377	5785295	130	T86	641679	5792672	126
T39	637536	5781503	134	T87	639013	5789221	123
T40	637717	5790893	133	T88	641827	5782024	120
T41	637825	5788915	131	T89	641865	5780489	123
T42	637891	5788158	122	T90	642134	5778497	124
T43	637866	5784612	135	T91	640955	5792252	126
T44	638038	5789709	129	T92	642286	5792020	125
T45	638239	5780683	127	T93	642595	5781417	119
T46	638212	5778399	127	T94	642799	5779990	121

Table 10 Proposed turbine layout for the Project [5] (continued)

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]
T95	642781	5778309	125	T104	643421	5778825	128
T96	642662	5780714	118	T105	643480	5780308	117
T97	642975	5782460	106	T106	643666	5782434	105
T98	642912	5778743	126	T107	642941	5791923	123
T101	643098	5781831	113	T108	643576	5780833	105
T102	643169	5783075	108	T109	643809	5781229	104
T103	643445	5779748	118	T110	639566	5791709	125

1. Coordinate system: MGA zone 54, GDA94 datum. Coordinates were provided by the Proponent in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Base elevations have been determined by DNV based on publicly available SRTM1 data.

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

Link no.	Licence number	Assignment ID	Frequency [Hz]	Licence owner
1	10329949/1	3076601	8073845000	AusNet Transmission Group Pty Ltd SPI Powernet Pty Ltd Locked Bag 1405 Licensing-ICT Business Office Melbourne City Mail Centre VIC 8001
		3076602	8073845000	
		3076603	7762525000	
		3076604	7762525000	
2	10329950/1	3076605	8044195000	
		3076606	8044195000	
		3076607	7732875000	
		3076608	7732875000	
3	10728607/2	10279516	11245000000	NBN Co Ltd Level 13 100 Arthur Street North Sydney NSW 2060
		10279517	11245000000	
		10279518	10755000000	
		10279519	10755000000	
4	11970026/1	10279528	11405000000	
		10279529	11405000000	
		10279530	10915000000	
		10279531	10915000000	
5	12451849/1	12334844	11245000000	
		12334845	11245000000	
		12334846	10755000000	
		12334847	10755000000	
6	12451850/1	12334848	11405000000	
		12334849	11405000000	
		12334850	10915000000	
		12334851	10915000000	
7	1316585/1	787573	8118320000	Vertical Telecoms Pty Limited PO Box 126 Rosebery NSW 2018
		787574	8118320000	
		787575	7807000000	
		787576	7807000000	
8	1931701/1	904629	8088670000	
		904630	8088670000	
		904631	7777350000	
		904632	7777350000	

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
3331259	11733	10378121/1	-37.2950	142.6037	75	Bureau of Meteorology GPO Box 1289 Melbourne VIC 3001
3331262	11733	10378121/1	-37.2950	142.6037	75	
832968	9004396	1566084/1	-37.6733	143.3544	69	Central Highlands Region Water Corporation Central Highlands Water PO Box 152 Ballarat VIC 3353
832971	9004396	1566084/1	-37.6733	143.3544	69	
6309956	11733	10895501/1	-37.2950	142.6037	75	Grampians Wimmera Mallee Water Authority GWM Water PO Box 481 Horsham VIC 3400
6309959	11733	10895501/1	-37.2950	142.6037	75	
2208175	302343	10143098/1	-38.5729	143.0409	60	Iona Operations PTY LTD Iona Gas Plant 285 Waarre Road Port Campbell VIC 3269
2208178	302343	10143098/1	-38.5729	143.0409	60	
3515617	305783	10404937/1	-38.3130	142.3781	25	Powercor Australia Ltd Locked Bag 14090 Manager Communications Network Provisioning Melbourne VIC 8001
3515620	305783	10404937/1	-38.3130	142.3781	25	
3527944	303649	10406308/1	-38.2162	141.7035	71	
3527947	303649	10406308/1	-38.2162	141.7035	71	
3528334	303649	10406309/1	-38.2162	141.7035	71	
3528337	303649	10406309/1	-38.2162	141.7035	71	
3799571	303649	10457449/1	-38.2162	141.7035	71	
3799574	303649	10457449/1	-38.2162	141.7035	71	

Table 12 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
793650	300876	1326839/1	-38.0642	142.8085	13	Wannon Region Water Corporation PO Box 1158 Warrnambool VIC 3280
793653	300876	1326839/1	-38.0642	142.8085	13	
924155	41654	1945301/1	-37.8825	142.3006	21	
924158	41654	1945301/1	-37.8825	142.3006	21	
793642	305626	1326838/1	-38.3081	142.3743	25	
793645	305626	1326838/1	-38.3081	142.3743	25	
793638	40981	1326837/1	-38.3768	142.4883	27	
793641	40981	1326837/1	-38.3768	142.4883	27	
3711287	40981	10435722/1	-38.3768	142.4883	27	
3711290	40981	10435722/1	-38.3768	142.4883	27	
744711	302384	1143861/1	-38.3865	142.2144	41	
744716	302384	1143861/1	-38.3865	142.2144	41	
872278	302384	1909709/1	-38.3865	142.2144	41	
872281	302384	1909709/1	-38.3865	142.2144	41	
793630	42618	1326836/1	-38.2378	143.1220	42	
793633	42618	1326836/1	-38.2378	143.1220	42	
793622	46455	1326835/1	-38.4925	142.9805	49	
793625	46455	1326835/1	-38.4925	142.9805	49	
761721	11703	1191982/1	-37.6834	142.0198	54	
761724	11703	1191982/1	-37.6834	142.0198	54	
5832502	10017714	10757780/1	-38.6206	143.0052	63	
5832505	10017714	10757780/1	-38.6206	143.0052	63	
755289	136307	1185110/1	-38.3878	142.4592	29	Warrnambool Golf Club Inc Younger St Warrnambool VIC 3280
755292	136307	1185110/1	-38.3878	142.4592	29	

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	466
2 GHz Band	Spectrum	377
2.3 GHz Band	Spectrum	8793
2.5 GHz Band	Spectrum	314
3.4 GHz Band	Spectrum	16691
700 MHz Band	Spectrum	1184
800 MHz Band	Spectrum	472
850/900 MHz Band	Spectrum	561
AWL - FSS Only	Spectrum	127
AWL - Standard	Spectrum	44
Aeronautical Assigned System	Aeronautical	15
Amateur Beacon	Amateur	8
Amateur Repeater	Amateur	44
Ambulatory System	Land Mobile	68
CBRS Repeater	Land Mobile	4
Commercial Radio	Broadcasting	6
Commercial Television	Broadcasting	15
Community Broadcasting	Broadcasting	3
Earth Receive	Earth Receive	5
Fixed Earth	Earth	3
Fixed Receive	Fixed Receive	1
Land Mobile System - > 30MHz	Land Mobile	1055
Land Mobile System 0-30MHz	Land Mobile	144
Narrowband Area Service station(s)	Broadcasting	3
Narrowcasting Service (Fixed Tax)	Broadcasting	3
Narrowcasting Service (LPON)	Broadcasting	19
National Broadcasting	Broadcasting	18
PMTS Class B	PTS	240
Paging System - Exterior	Land Mobile	26
Paging System - Interior	Land Mobile	1
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	21
Country Fire Authority	Country Fire Authority PO Box 701 MOUNT WAVERLEY VIC 3149	1
DEPARTMENT OF ENVIRONMENT LAND WATER AND PLANNING	DEPARTMENT OF ENVIRONMENT LAND WATER AND PLANNING DEPARTMENT OF ENERGY ENVIRONMENT AND CLIMATE ACTION DELWP Accounts Payable Locked Bag 32017 Collins Street East VIC 8003	54
RMR Regional Mobile Radio	DEPARTMENT OF JUSTICE AND COMMUNITY SAFETY RMR Regional Mobile Radio C/- Level 2 Bld M5 30 Henderson Rd CLAYTON VIC 3168	13
Visionstream Australia	DEPARTMENT OF JUSTICE AND COMMUNITY SAFETY Visionstream Australia 167-169 Cremorne Street CREMORNE VIC 3121	11
Grampians Wimmera Mallee Water Authority	Grampians Wimmera Mallee Water Authority GWM Water PO Box 481 HORSHAM VIC 3400	75
ST. JOHN AMBULANCE AUSTRALIA INCORPORATED	ST. JOHN AMBULANCE AUSTRALIA INCORPORATED ST JOHN AMBULANCE AUSTRALIA (VICTORIA) INC. PO Box 573 MT WAVERLEY VIC 3149	21
The Australian Volunteer Coast Guard Association Inc	The Australian Volunteer Coast Guard Association Inc The Australian Volunteer Coast Guard Association Inc PO Box 64 SANDRINGHAM VIC 3191	30
Victoria State Emergency Service	Victoria State Emergency Service Victoria State Emergency Service Authority 168 Sturt St SOUTHBANK VIC 3006	25

Table 15 Bureau of Meteorology radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
23944	Meteorology Radar Site Airport MOUNT GAMBIER	-37.7478	140.7746	154
49834	Met Bureau Radar Site RAAF Base LAVERTON	-37.8552	144.7552	183
302559	Met Rd MELBOURNE AIRPORT	-37.6656	144.8320	193
49723	Met Bureau Glenlitta Ave BROADMEADOWS	-37.6902	144.9435	202
49837	Met Bureau BMTC Annex Glenlitta Ave BROADMEADOWS	-37.6905	144.9470	202
134173	Met Bureau S1 Doppler Radar Training Facility Glenlitta Avenue BROADMEADWS	-37.6911	144.9480	203
10012512	Wimmera Radar Pullut West Road PULLUT	-35.9977	142.0134	223
304566	Met Bureau Site YARRAWONGA AIRPORT	-36.0297	146.0227	369
136780	Wind Profiler Radar Site RAAF Base EAST SALE	-38.1156	147.1329	391
141677	Meteorological Office Mildura Airport MILDURA	-34.2353	142.0873	416
10019217	Mildura Radar off Sturt Highway CULLULLERAINE	-34.2871	141.6077	417
700224	Weather Radar Site WEST TAKONE	-41.1791	145.5797	422
136953	Weather Radar site Bairnsdale Aerodrome Aerodrome Road BAIRNSDALE	-37.8875	147.5755	431

Table 16 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to nearest turbine [km]
Shadwell	AGD66, AGD84, GDA94	-38.0575	142.8106	16

Table 17 Summary of service operators contacted by DNV and responses received to date

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
1	Fixed point-to-point: 2 links crossing the Project site No turbines in either diffraction exclusion zone established by DNV	AusNet Transmission Group Pty Ltd (AusNet Services) 10429837-AUMEL-L-01-A	Response received by email on 26 May 2023, based on the preliminary layout: *"As for the Hexam Wind Farm, I can confirm that the proposed turbines (used the two most adjacent ones) have enough clearance from our Mt Taurus and Mt Shadwell microwave link."* Response received by email on 03 June 2025, based on the current layout: *"I've reviewed the new proposed turbine locations and can confirm that the updated layout remains clear of AusNet Services' microwave radio line of sight paths. As such, we do not foresee any impact to our microwave communications from the revised turbine positions."*
2	Fixed point-to-point: 4 links crossing the Project site No turbines in diffraction exclusion zone established by DNV Spectrum (wireless internet): 2.7 km from Project boundary	NBN Co Ltd (NBN Co) 10429837-AUMEL-L-02-A	Response received by email on 15 January 2025, based on the interim layout: *"I have reviewed the data provided based on the proposed wind farm location; most of the proposed towers are inside existing nbn wireless coverage boundaries and there are several existing **nbn** customers inside the wind farm boundary. However, the proposed wind tower locations pose no risk of introducing a physical obstruction along any customer RF profiles…* *… It is also noted that none of the wind tower locations are in, or near, any boresight paths of existing nbn microwave links…* *… Once known, please provide information on any RF transmission equipment planned to be used during construction or permanently installed so a potential interference impact can be assessed. This information should include as a minimum the operating transmission frequency and transmit power, channel bandwidths, antenna types and radiation patterns as well as the exact location with antenna height, boresight azimuth and tilt [mechanical and electrical tilt].* *A standard nbn response for wind farm applications regarding potential interference impact on the nbn Fixed Wireless network is as follows:* *Potential Impacts of the Proposed Hexham Wind Farm on NBN Co Spectrum Communication Assets* *Referring to your email dated 9th January 2025 regarding the application for the Hexham Wind Farm.* *We confirm that NBN Co Spectrum Pty Ltd (**nbn Spectrum**) has a number of spectrum licenses within 75 km of the proposed Hexham 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*

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
			place. *nbn will be forced to consider its position as part of the planning should there 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.* *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…"* Current turbine layout provided on 02 June 2025, no response received to date
3	Fixed point-to-point: 2 links crossing the Project site No turbines in either diffraction exclusion zone established by DNV	Vertical Telecoms Pty Limited (VerTel) 10429837-AUMEL-L-02-A	Response received by email on 17 April 2023, based on the preliminary layout: *"Based on the preliminary analysis, the proposed wind turbines at Hexham wind farm will not affect our existing microwave links licenced: 1316585/1 and 1931701/1."* Current turbine layout provided on 06 June 2025, no response received to date
4	Fixed point-to-multipoint: 60 km from Project boundary	Iona Operations Pty Ltd (Lochard Energy) 10429837-AUMEL-L-05-A	Response received by email on 19 April 2023, based on the preliminary layout: *"Based on the information you provided, we have no concerns of the proposed wind farm causing any interference to our radio communications. i.e. our signals are not expected to pass over the wind farm site."* **Further consultation not considered necessary**

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
5	Fixed point-to-multipoint: 25 km from Project boundary	Powercor Australia Ltd (Powercor Australia) 10429837-AUMEL-L-06-A	Response received by email on 5 April 2023, based on the preliminary layout: *"I have mapped line of sight of two Point to Point links from Mt. Shadwell which are close to the Hexham Wind Farm boundary. The two P-P Links are Mt. Shadwell – NRB (Nareeb) and Mt. Shadwell – Tower Hill. The line of sight of these two P-P Links are outside of the Hexham Wind Farm boundary and pose no issues with encroachment into the Wind Farm bounded area.* *We have a Point to Multipoint service Mt. Clay – HYTS (Heywood Terminal Station) and this does not cross the wind farm bounded area.* *We have Point to Point UHF Link Mt. Shadwell – COB (Cobden) which is to the South East of Mt. Shadwell and clear of the Hexham wind farm bounded area.* *We don't have any active Point to Multipoint services out of Tower Hill. There are two Point to Point links that transit Tower Hill [Mt. Shadwell – Tower Hill and Tower Hill – Mt. Clay] Again these two P-P Links are South East of the Hexham Windfarm bounded area and therefore do not present an issue...* *From information you have provided, the Hexham Wind Farm will not cause interference to existing Powercor radio links and services."* **Further consultation not considered necessary**
6	Fixed point-to-multipoint: 13 km from Project boundary	Wannon Region Water Corporation (Wannon Water) 10429837-AUMEL-L-07-A	Response received by email on 14 January 2025, based on the interim layout: *"We have reviewed the attached mapping - we can't foresee any the potential impact to Wannon Water radiocommunication assets with the proposed layout."* Current turbine layout provided on 06 June 2025, no response received to date

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
7	Emergency services point-to-area: 21 km from Project boundary	Ambulance Victoria 10429837-AUMEL-L-08-A	Response received by email on 5 April 2023, based on the preliminary layout: *"Thanks for your email regarding the proposed Hexham Wind Farm Development.* *Ambulance Victoria communications facilities [are] designed to provide targeted portable communications coverage by means of a UHF gateway and repeater targeting major population centres. These installations are designed to overlay Telstra's VHF SMR radio traffic (aka RAVnet) via UFH into these areas.* *Notwithstanding EMI potentially introduced into the Telstra SMR network, it is unlikely your proposed Hexham Wind Farm development will impact the Ambulance Victoria local UHF communications provided at these locations.* *I expect Telstra will have received the same information and will be invited to comment regarding any potential EMI impacts to any SMR (RAVnet) network infrastructure identified in the vicinity of the proposed wind farm."* **Further consultation not considered necessary**
8	Emergency services point-to-area: 1993 m from the nearest turbine	Country Fire Authority (CFA) 10429837-AUMEL-L-09-A	Response received by email on 24 March 2023, based on the preliminary layout: *"I confirm that the CFA radio services are not affected by the proposed wind turbines at Hexham Wind Farm. This conclusion was based on the provided windfarm locations and the site boundary."* **Further consultation not considered necessary**
9	Emergency services point-to-area: 13 km from Project boundary	RMR Regional Mobile Radio 10429837-AUMEL-L-10-A	Response received by email on 13 November 2024, based on the preliminary layout: *"Based on our findings from the EMI evaluation for the proposed wind farm at Hexham site, we provide the following feedback:* *1. Potential for Interference: The proposed wind farm at the Hexham region poses no interference with our current network and services.* *2. Clearance Criteria: The wind farm satisfies the clearance criteria, maintaining a distance from our currently operating sites that is well above the required minimum.* *3. Risk of Interference: There are no risks of interference identified. Consequently, no recommendations or actions are required.* *We appreciate the opportunity to review this development and are confident that our current network and services will remain unaffected by the proposed wind farm."* **Further consultation not considered necessary**

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
10	Emergency services point-to-area: 11 km from Project boundary	Visionstream Australia (VisionStream) 10429837-AUMEL-L-11-A	Response received by email on 29 March 2023, based on the preliminary layout: *"There are 4 Fire Brigades located close to the proposed Wind farm:* *• Hexham – 500m from the NE corner of the site boundary,* *• Caramut – 1.7km from the NW corner of the site boundary,* *• Spring Creek – 4km from the west site boundary, and* *• Ellerslie – 4km from the SE corner of the site boundary* *The EAS is provided to the Brigades through a combination of coverage from the following sites:* *• Hawkesdale – Site ID 302532* *• Mt Warrnambool – Site ID 153176* *• Mt Shadwell – Site ID 43030* *• Glenthompson – Site ID 36007* *Based on past experience, with Wind Farms located near Agency locations and EAS sites, we have not experienced any degradation to signal levels around existing locations with Wind Farm turbines. I am also unaware of any examples or evidence to support any interference claims.* *As with previous Wind Turbine Farms installations constructed across the State and having no examples or evidence of interference to the EAS network, I would expect that the proposed Hexham Wind Farm would also not have any impact to coverage of the EAS network to the Emergency Service Organisations based in the area surrounding the turbine locations."* **Further consultation not considered necessary**
11	Emergency services point-to-area: 54 km from Project boundary	Department of Energy, Environment and Climate Action (DEECA) 10429837-AUMEL-L-12-A	Response received by email on 24 March 2023, based on the preliminary layout: *"…Knowing where this is, I am not anticipating any issues, but I will get back to you and confirm shortly…"* **Further consultation not considered necessary**

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
12	Emergency services point-to-area: 21 km from Project boundary	St. John Ambulance Australia Incorporated (St John Ambulance) 10429837-AUMEL-L-13-A	Response received by email on 25 March 2023, based on the preliminary layout: *"Thanks for the information in relation to the proposed Hexham Wind Farm. I can confirm that there are no St John Ambulance radio link paths passing through the wind farm area. St John Ambulance do not see any potential for the proposed wind farm to interfere with its assets or services."* **Further consultation not considered necessary**
13	Emergency services point-to-area: 25 km from Project boundary	Victoria State Emergency Service (VICSES) 10429837-AUMEL-L-14-A	Response received by email on 29 October 2024, based on the preliminary layout: *"I can confirm that VICSES don't have concerns regarding our communications assets and proposed wind farm locations at Hexham. We primarily now operate on the RMR Network, managed and operated by Telstra"* **Further consultation not considered necessary**
14	Meteorological radar: 154 km from Project boundary	Bureau of Meteorology 10429837-AUMEL-L-15-A	Response received by email on 31 March 2023, based on the preliminary layout: *"We have finalized our assessment through desktop analysis for the proposed Hexham windfarm. The assessment shows [the] proposed wind farm has manageable impact on the Bureau of Meteorology's assets, specifically on its weather radar network, in normal atmospheric/propagation conditions. As such, the Bureau could conditionally agree to this project. The Bureau requires a letter from the farm developer/owner to acknowledge that the operation of the proposed wind farm will include the following commitments: 1. Informing the Bureau of significant variation of turbine layout (i.e. by more than 100 m in any lateral direction, or alteration of tip height) between the initial plan and construction. 2. Providing advance notice (one week preferably) to the Bureau of any planned wind farm shutdown events for more than 12 hours, to allow the recalibration of radar systems. 3. Collaborate with the Bureau in the event of severe weather conditions to assist in endeavour of community safety. Please let me know if you need any further information related to this assessment."* Response received by email on 20 March 2025, based on the interim layout: *"Our assessment of the current Hexham wind farm proposal (updated layout provided 9 January 2025) has determined it poses a low risk to our weather radars.*

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
			As a result, the Bureau has no objections to the proposed development proceeding, as detailed in the documentation provided for assessment..." Response received by email on 03 June 2025, based on the current turbine layout *"… based on our current review, the risk to the Bureau's assets remains low for this project.* *Again, any further modifications to the wind farm parameters, we'll need to reassess."*
15	GNSS station: 15 km from Project boundary Trigonometrical station: 15 km from Project boundary	Geoscience Australia 10429837-AUMEL-L-16-A	Response received by email on 11 April 2023, based on the preliminary layout: *"Geoscience Australia does not foresee any impact on our trigonometrical or GNSS infrastructure from the proposed Hexham Wind Farm located near Mortlake in Victoria."* **Further consultation not considered necessary**
16	GNSS station: 15 km from Project boundary Trigonometrical station: 15 km from Project boundary Survey mark: 244 m from nearest turbine	Department of Transport and Planning 10429837-AUMEL-L-17-A	Response received by email on 5 April 2023, based on the preliminary layout: *"I have reviewed the proposed wind farm locations and site boundary.* *I can advise that this is not expected to impact the DTP managed survey control mark or positioning infrastructure in this region."* **Further consultation not considered necessary**
17	PMTS/spectrum (mobile phone): 3 km from Project boundary	Optus Mobile Pty Ltd (Optus Mobile) 10429837-AUMEL-L-18-A	Response received by email on 29 March 2023, based on the preliminary layout: *"From the mobile coverage point of view, Optus do not have any concerns regarding the impacts of Hexham Wind Farm."* **Further consultation not considered necessary**
18	PMTS/spectrum (mobile phone): 4.5 km from Project boundary	Telstra Corporation Limited (Telstra) 10429837-AUMEL-L-19-A	Current turbine layout provided on 06 June 2025, no response received to date

Table 17 Summary of service operators contacted by DNV and responses received to date (continued)

	Licence/service type and distance of closest site	Operator name and DNV reference	Response received to date
19	PMTS/spectrum (mobile phone): 21 km from Project boundary	Vodafone Australia Pty Limited (Vodafone) 10429837-AUMEL-L-20-A	Response received by email on 29 March 2023, based on the preliminary layout: *"After reviewing the locations provided for Hexham Wind Farm, I can confirm that there will be no interference to Vodafone's Radio Mobile network from the physical infrastructure at this location."* Response received by email on 24 January 2024, based on the preliminary layout: *"No issues with Hexham. The red line crossing is Leased Line service no Mw impact."* **Further consultation not considered necessary**
20	DTV broadcasting: 25 km from Project boundary	BAI Communications 10429837-AUMEL-L-21-A	Response received by email on 29 October 2024, based on the preliminary layout: *"BAI has modelled the proposed Hexham wind turbines to assess how they will affect DTV services broadcast from Mt Dundas and Lookout Hill in ATDI. Interference analysis predicts that Mt Dundas DTV services are susceptible to scatter interference within the confines of the wind farm boundary. Population analysis (ABS Census 2021 Data) concludes that three people are estimated to be at low risk of DTV degradation due to the proposed wind farm. The alternate DTV services from Lookout Hill are not predicted to be impacted by the wind farm installation and are predicted to serve all identified areas of risk without issue. Any degradation of DTV services caused by the wind farm development would be expected to be rectified as part of the project."* Response received by email on 14 January 2025, based on the interim layout: *"We have reviewed the turbine location changes you sent through below and have determined that this will result in a negligible change to what we had previously stated in our report dated 19th June 2023. Any DTV impacts are considered minor and will remain within the confines of the wind farm boundary."* **Further consultation not considered necessary**

Figure 2 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby dwellings

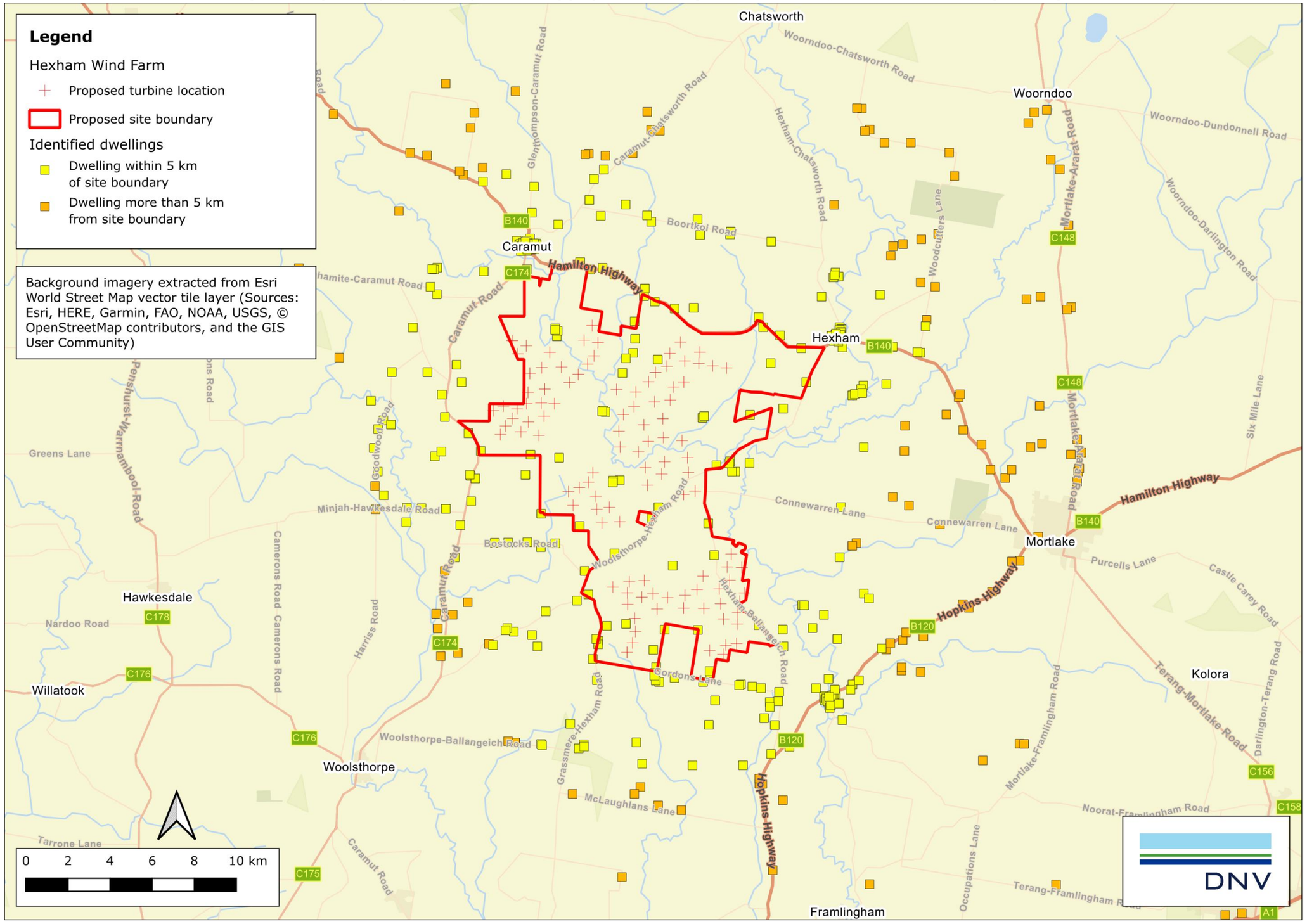


Figure 3 Location of the proposed Project and identified nearby radiocommunication sites

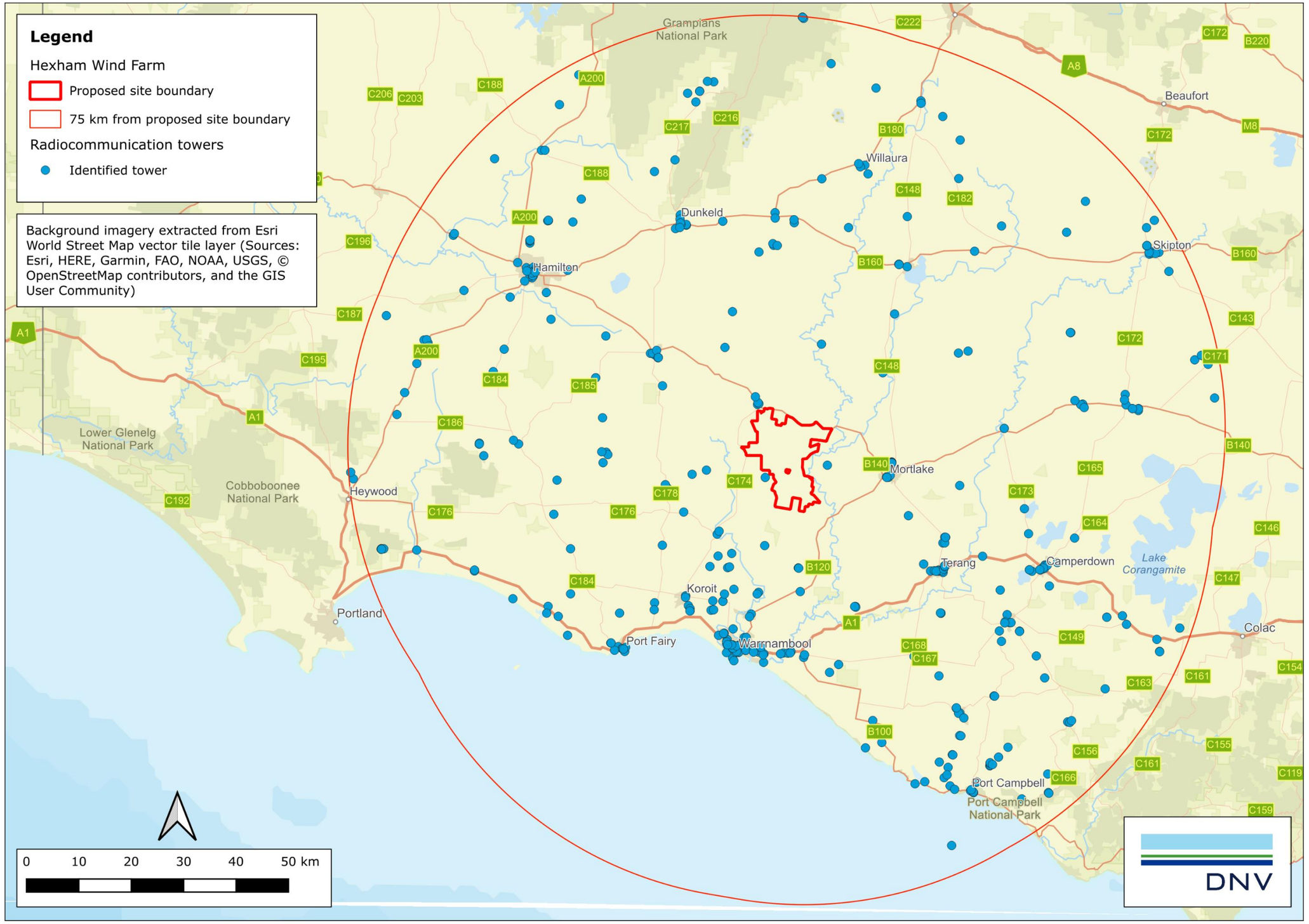


Figure 4 Identified radiocommunication sites within 2 km of the turbine locations for the proposed Project

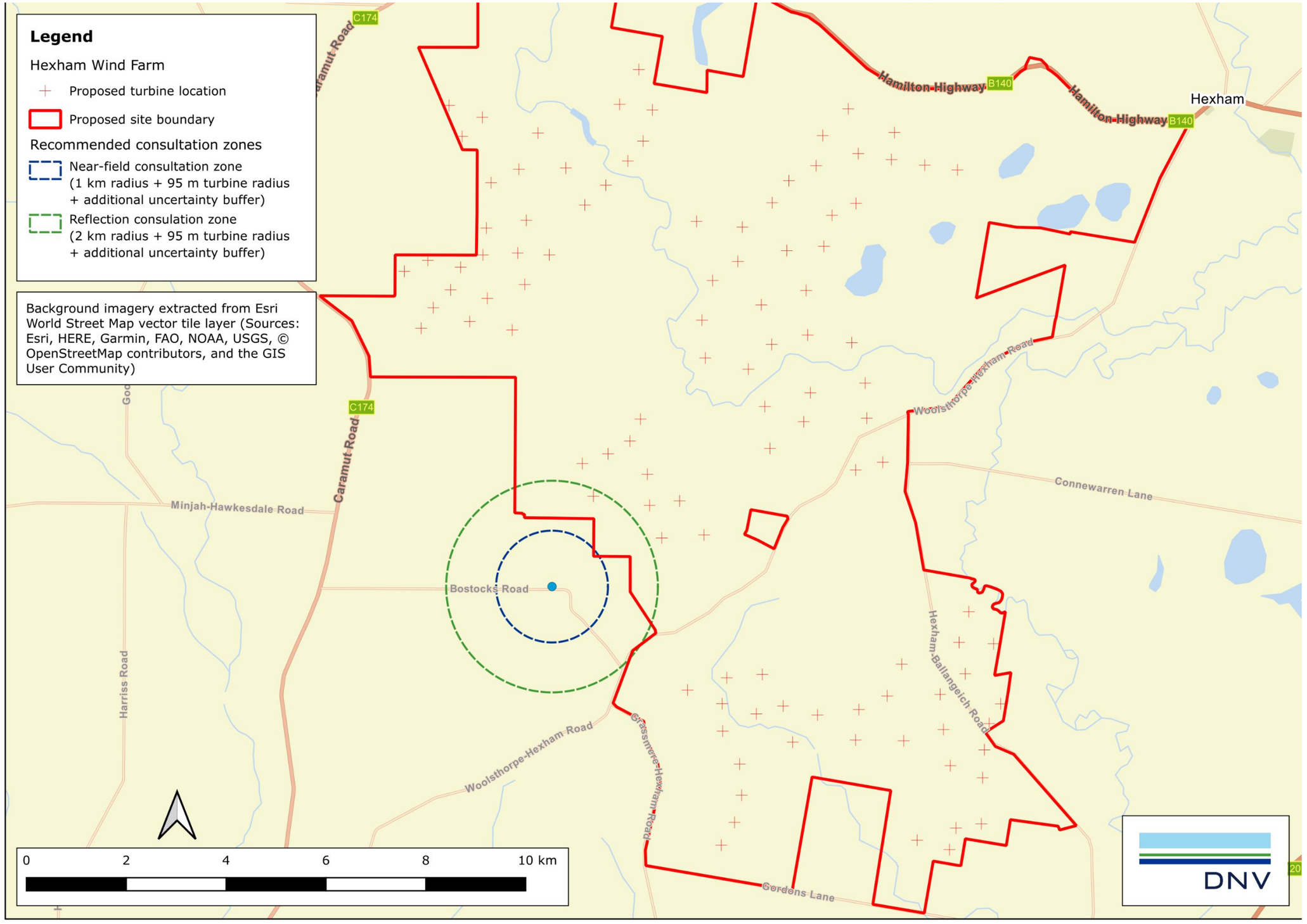


Figure 5 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

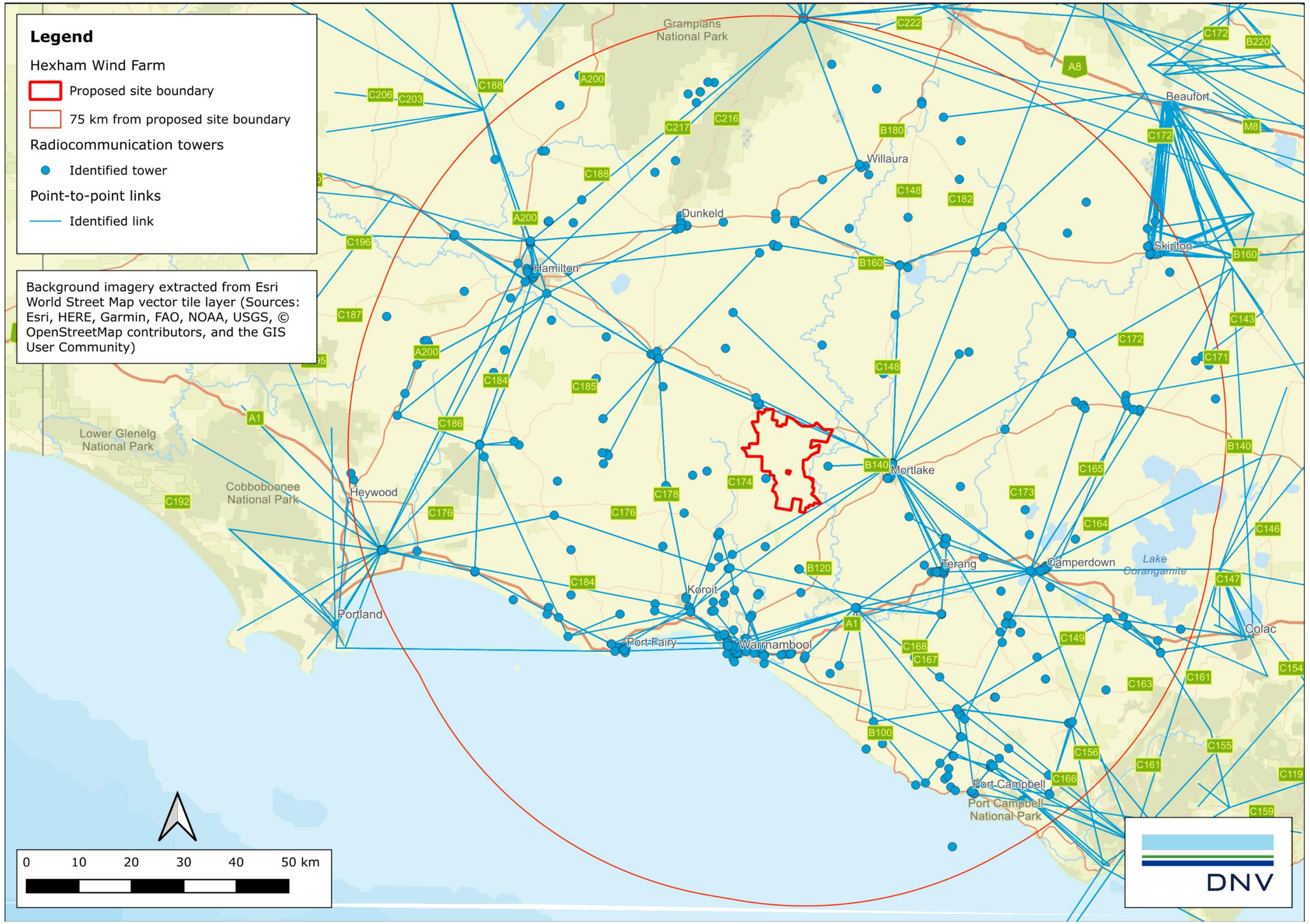


Figure 6 Identified point-to-point radiocommunication vectors crossing the proposed Project and calculated interference zones

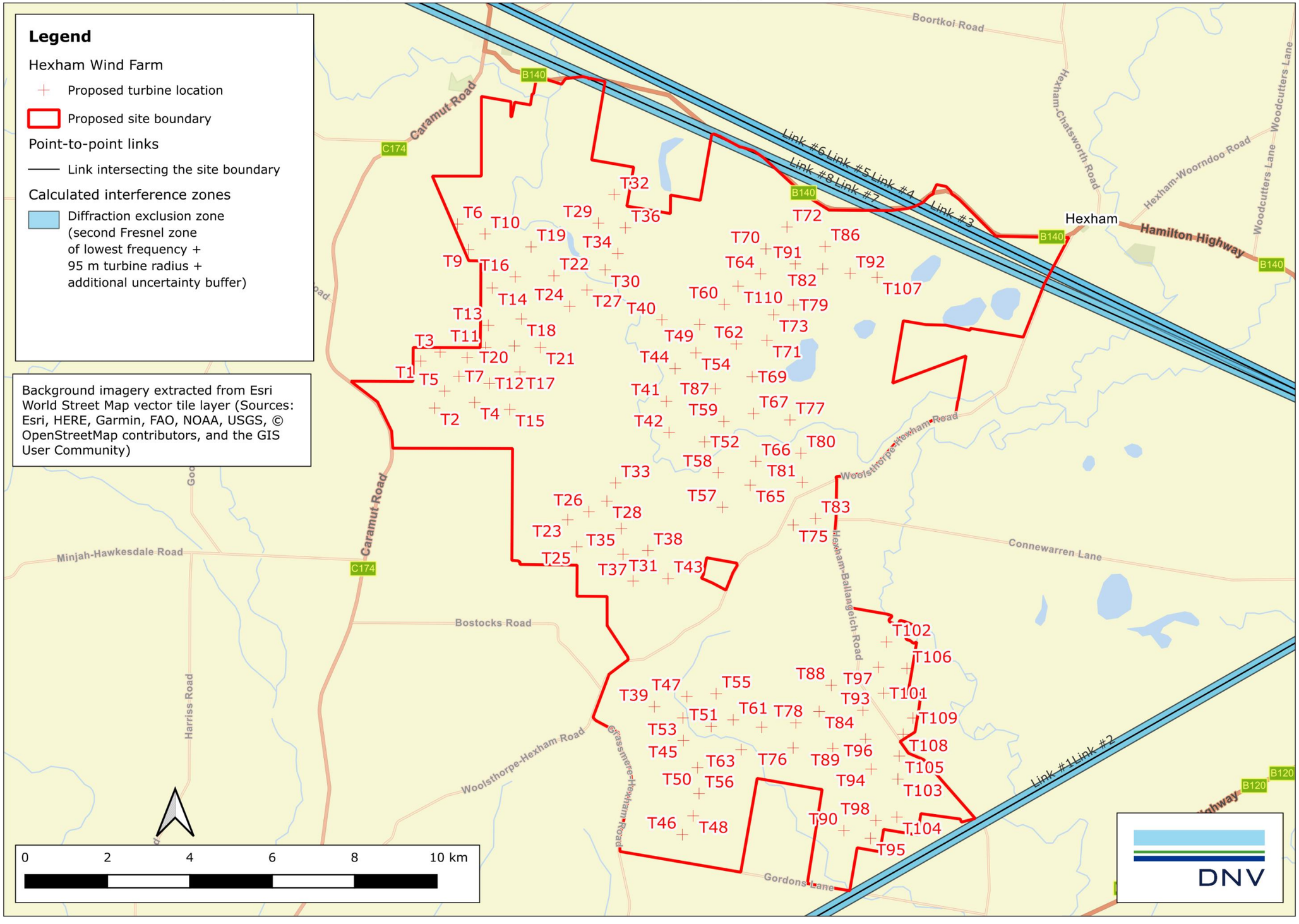


Figure 7 Location of point-to-multipoint licences in the vicinity of the proposed Project

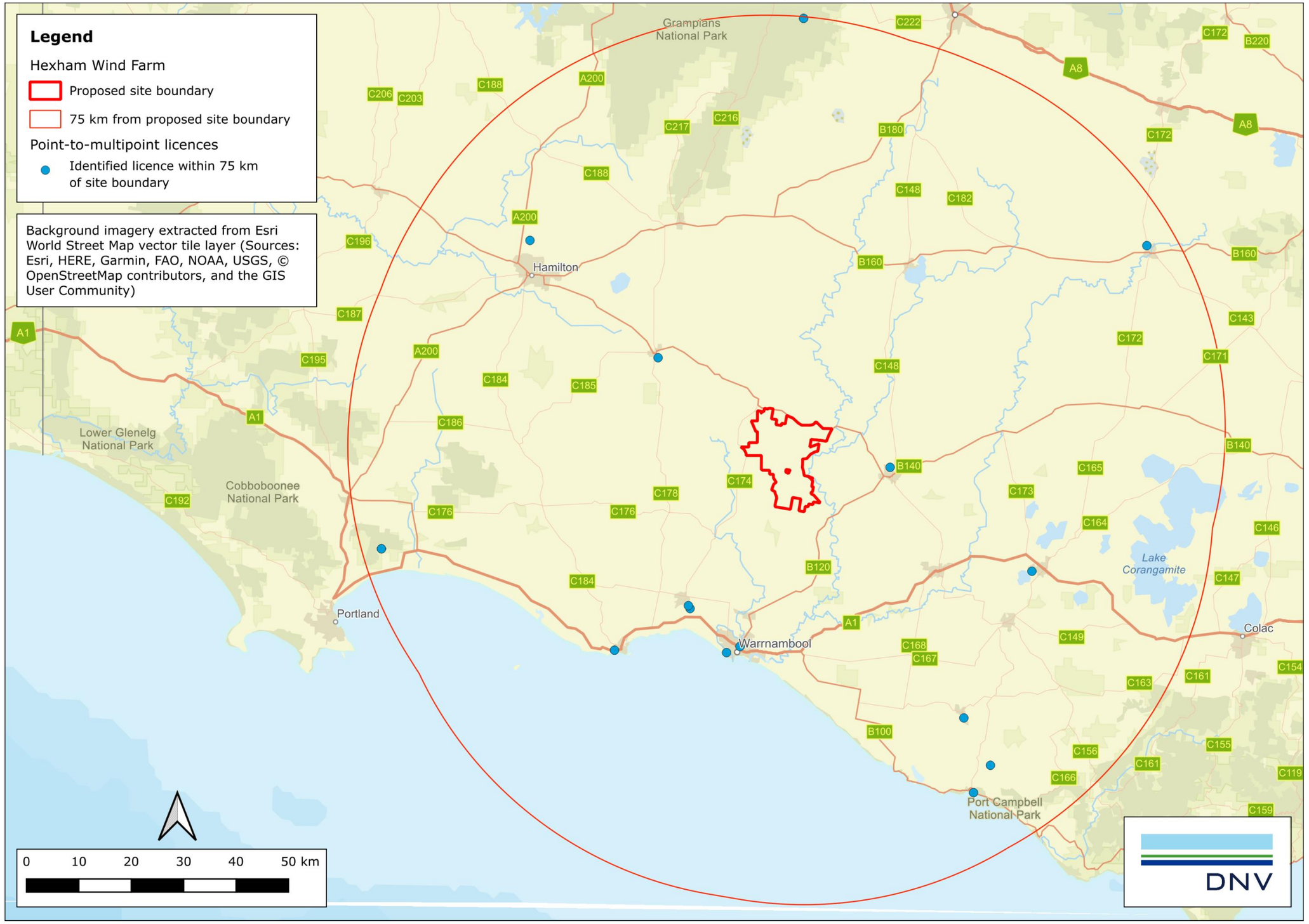


Figure 8 Location of general point-to-area style licences within 75 km of the proposed Project

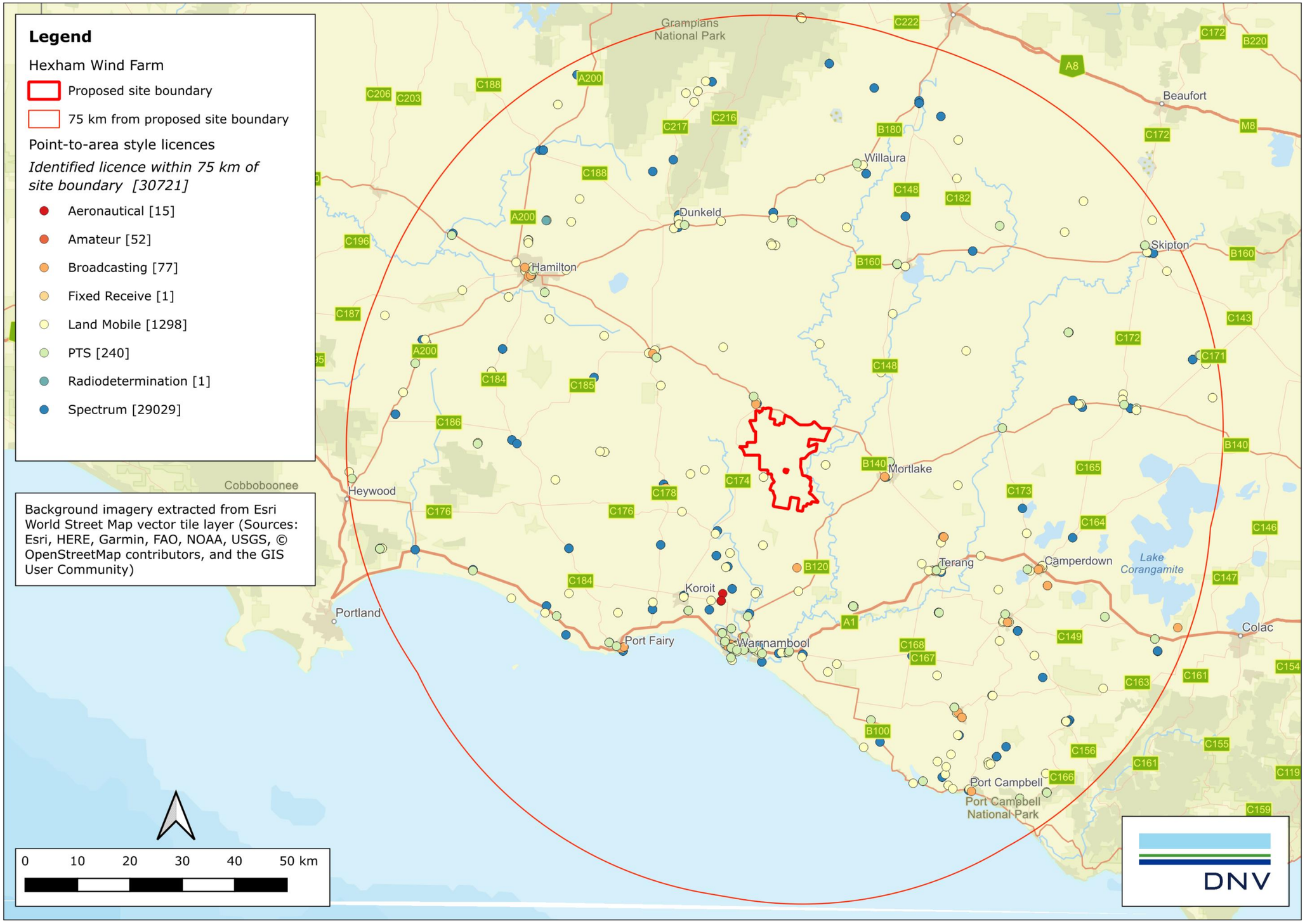


Figure 9 Location of meteorological radar sites within 250 nautical miles of the proposed Project

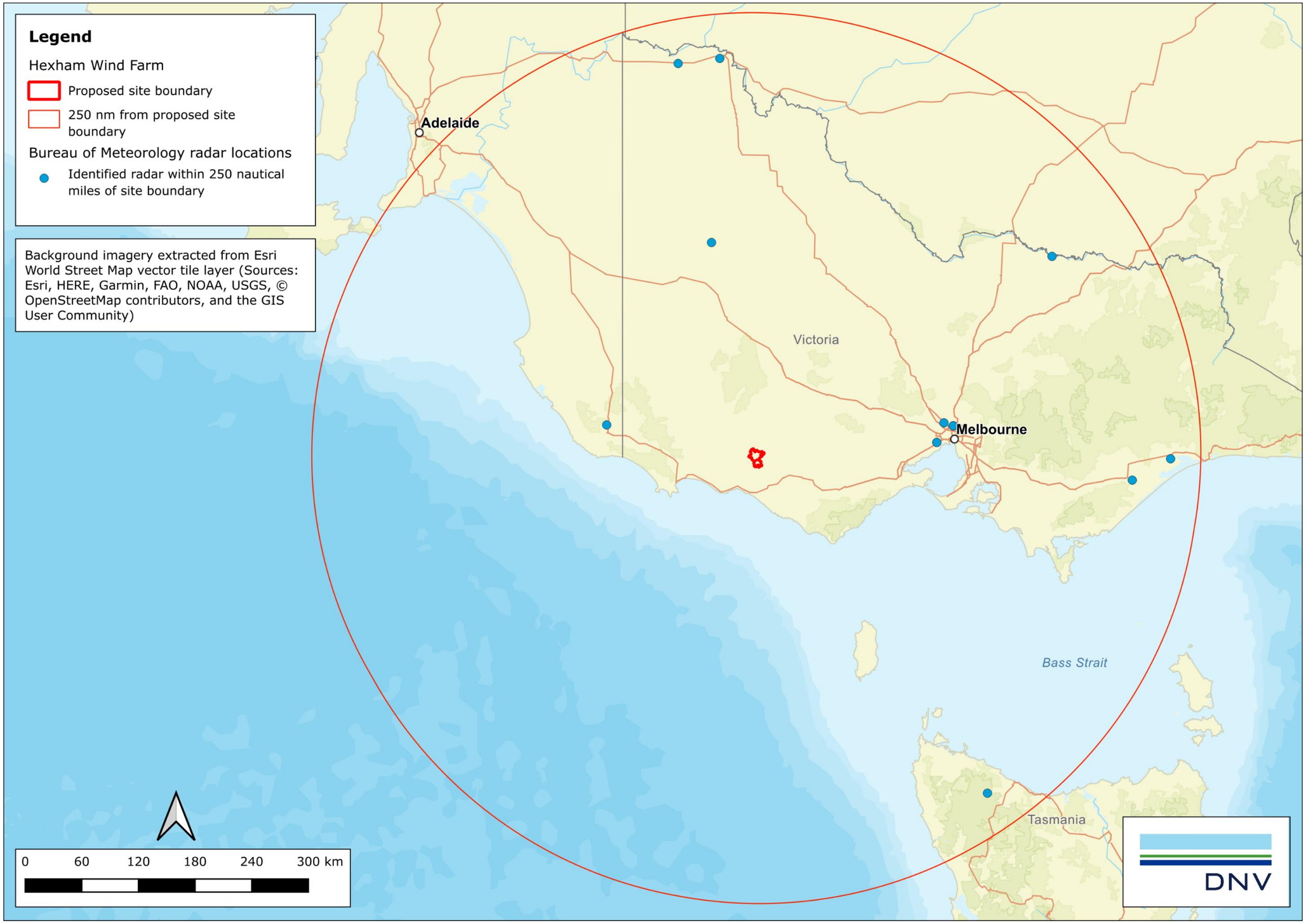


Figure 10 Location of trigonometrical stations within 20 km of the proposed Project

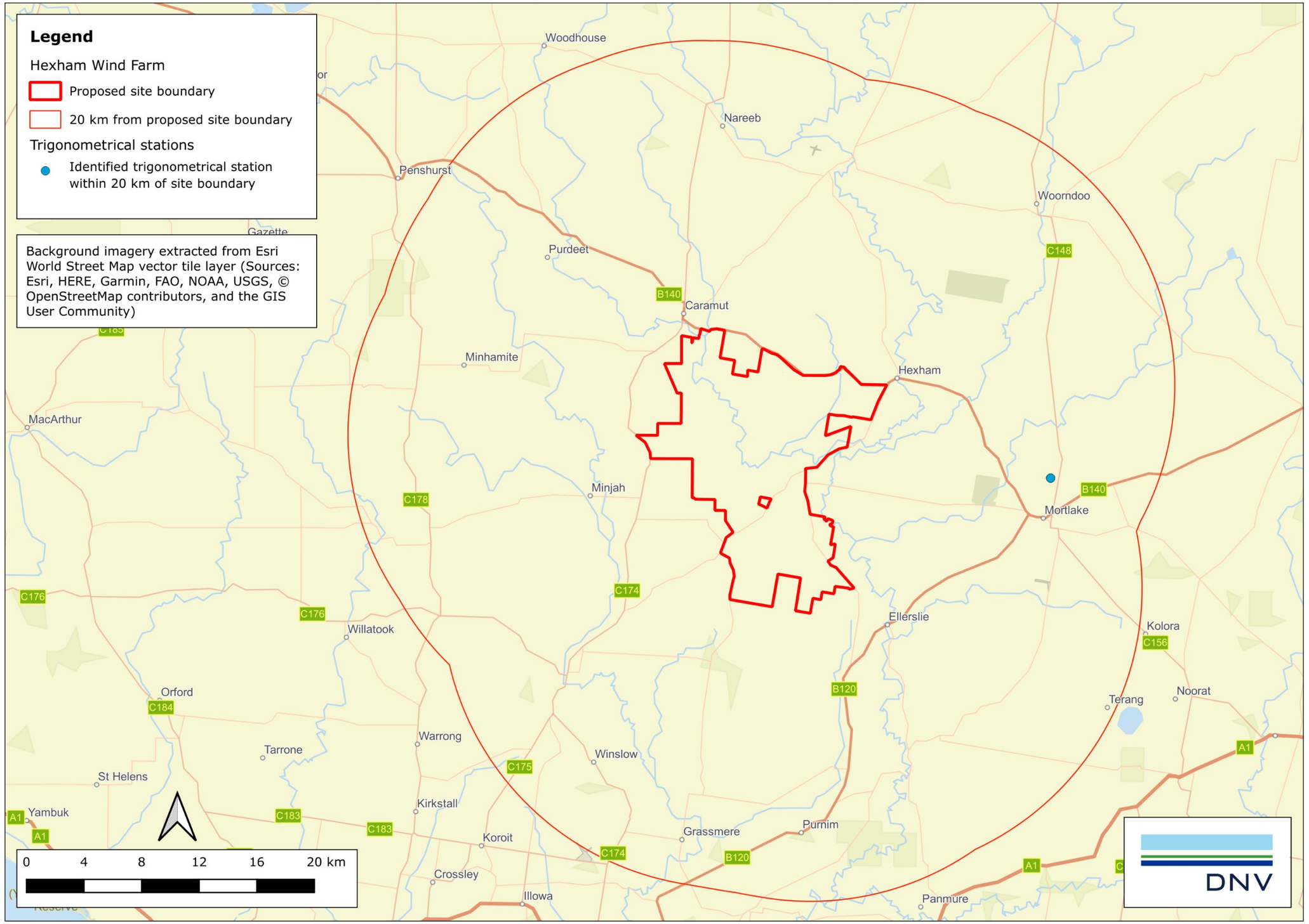


Figure 11 Location of permanent survey marks within 5 km of the proposed Project boundary

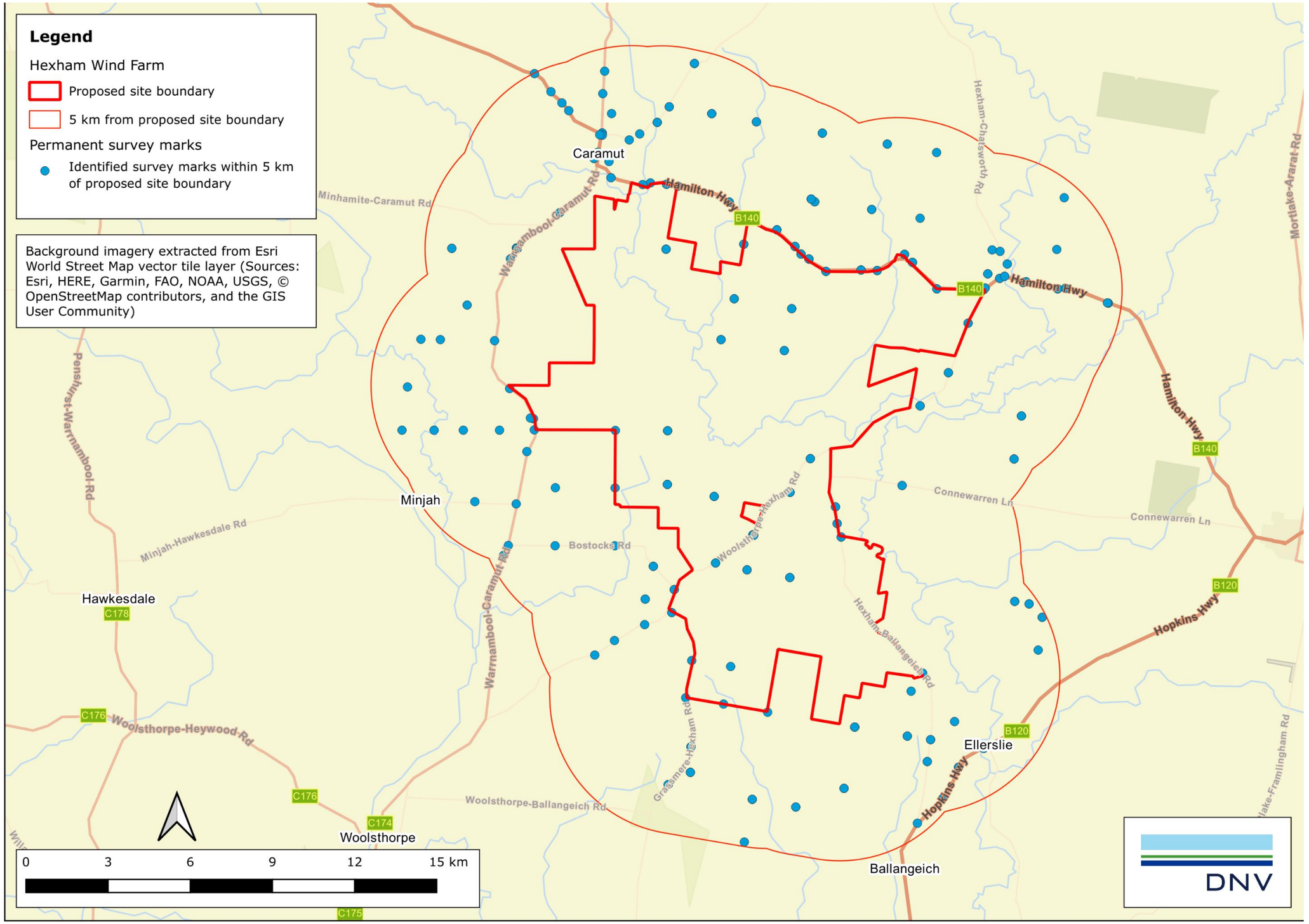


Figure 12 Location of mobile phone and NBN towers within 75 km of the proposed Project

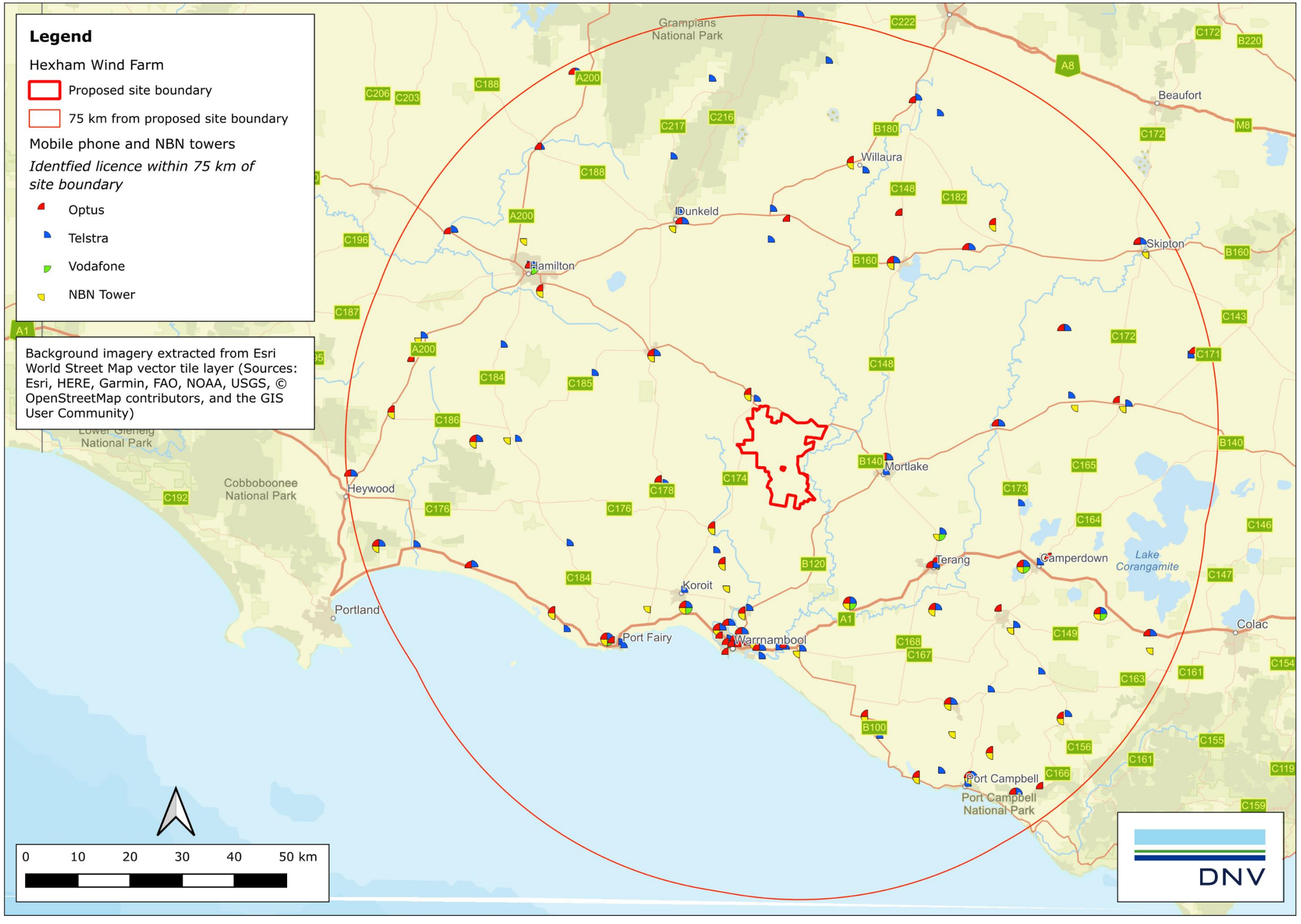


Figure 13 Optus Mobile 4G network coverage for the proposed Project

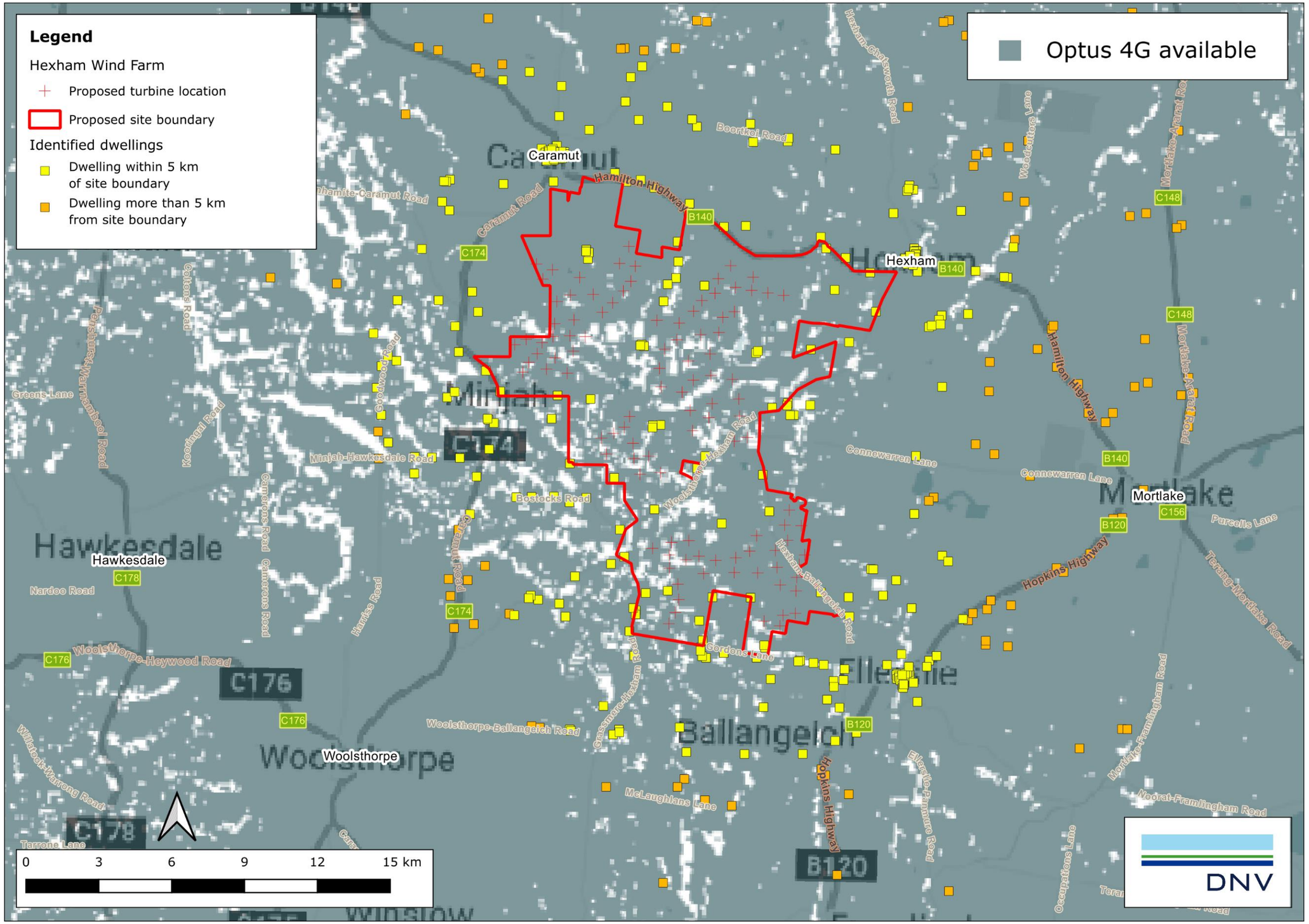


Figure 14 Telstra 4G network coverage for the proposed Project

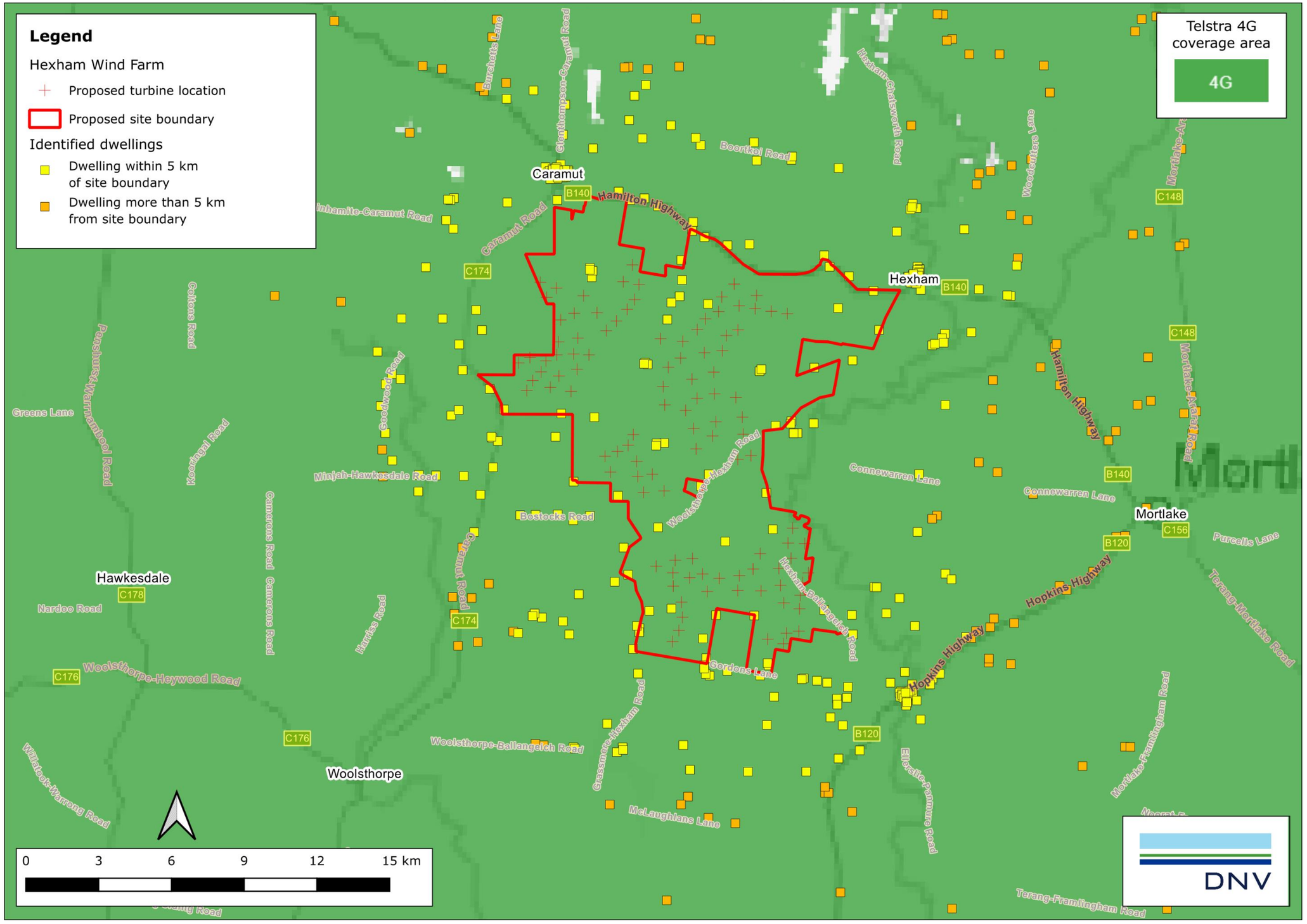


Figure 15 Vodafone network coverage (Apple iPhone 14 Pro Max handset) for the proposed Project

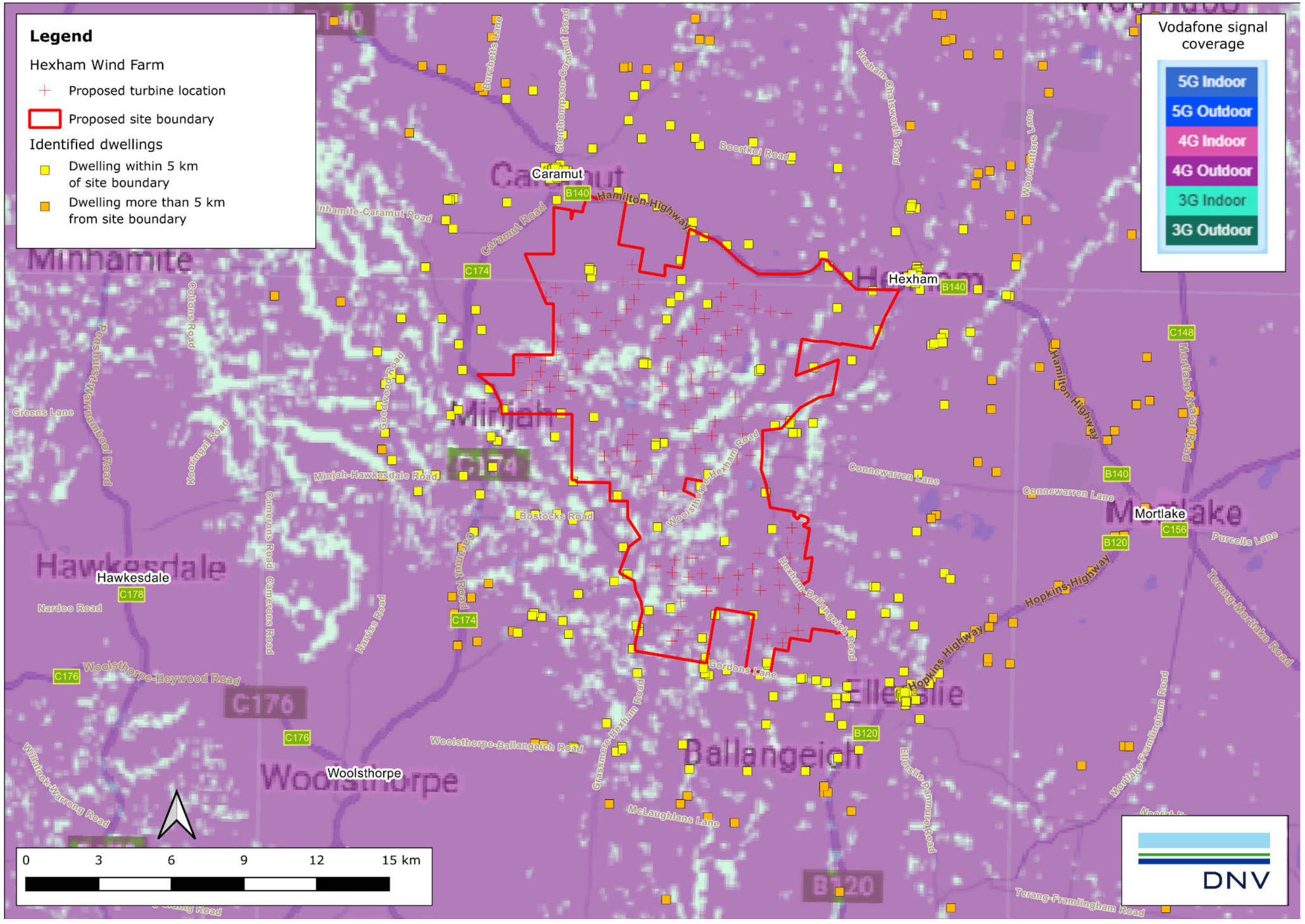


Figure 16 NBN internet coverage in the vicinity of the proposed Project

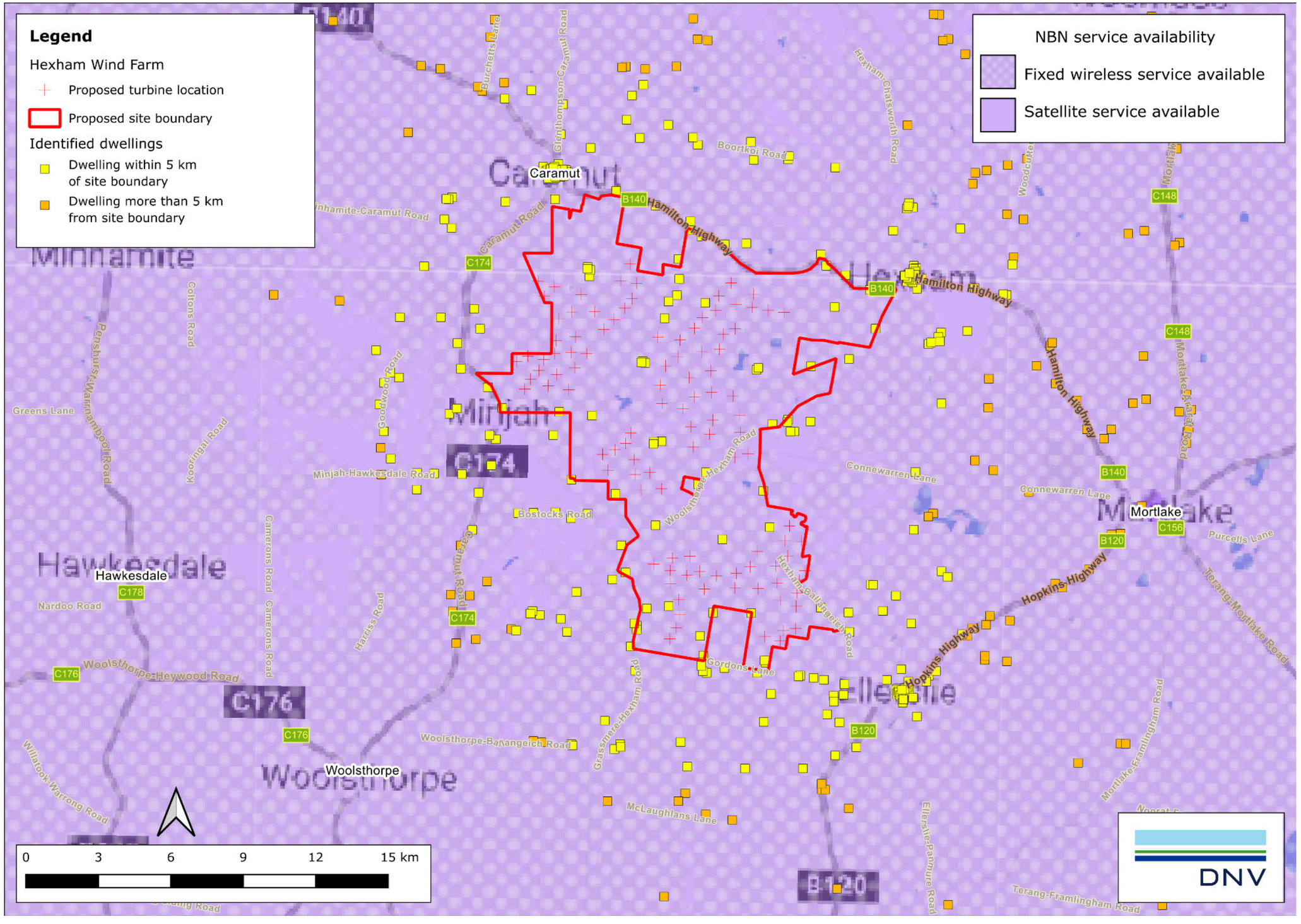


Figure 17 Location of broadcast transmitters in the vicinity of the proposed Project

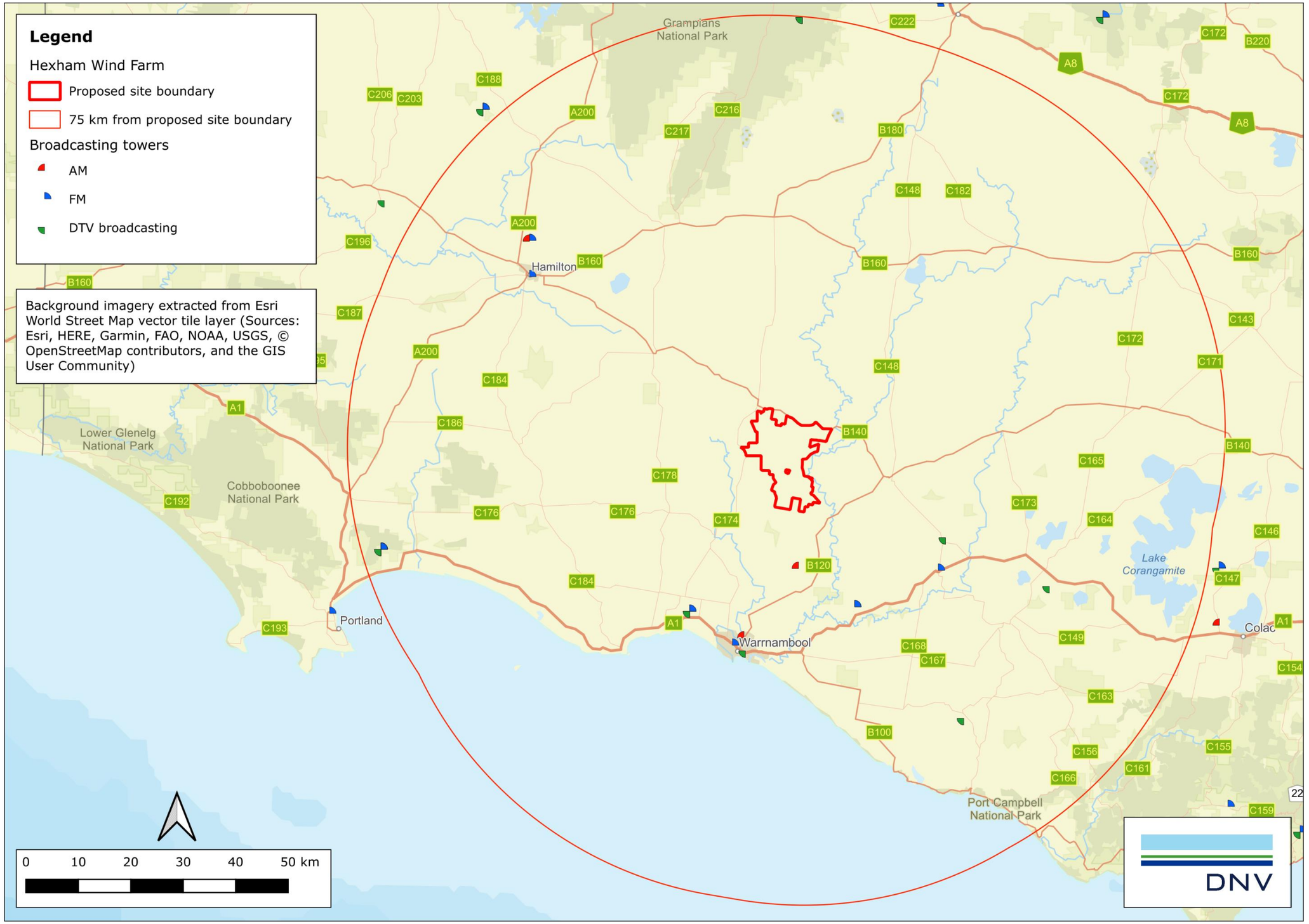


Figure 18 Potential television EMI zones for the Ballarat broadcast transmitter from the proposed Project

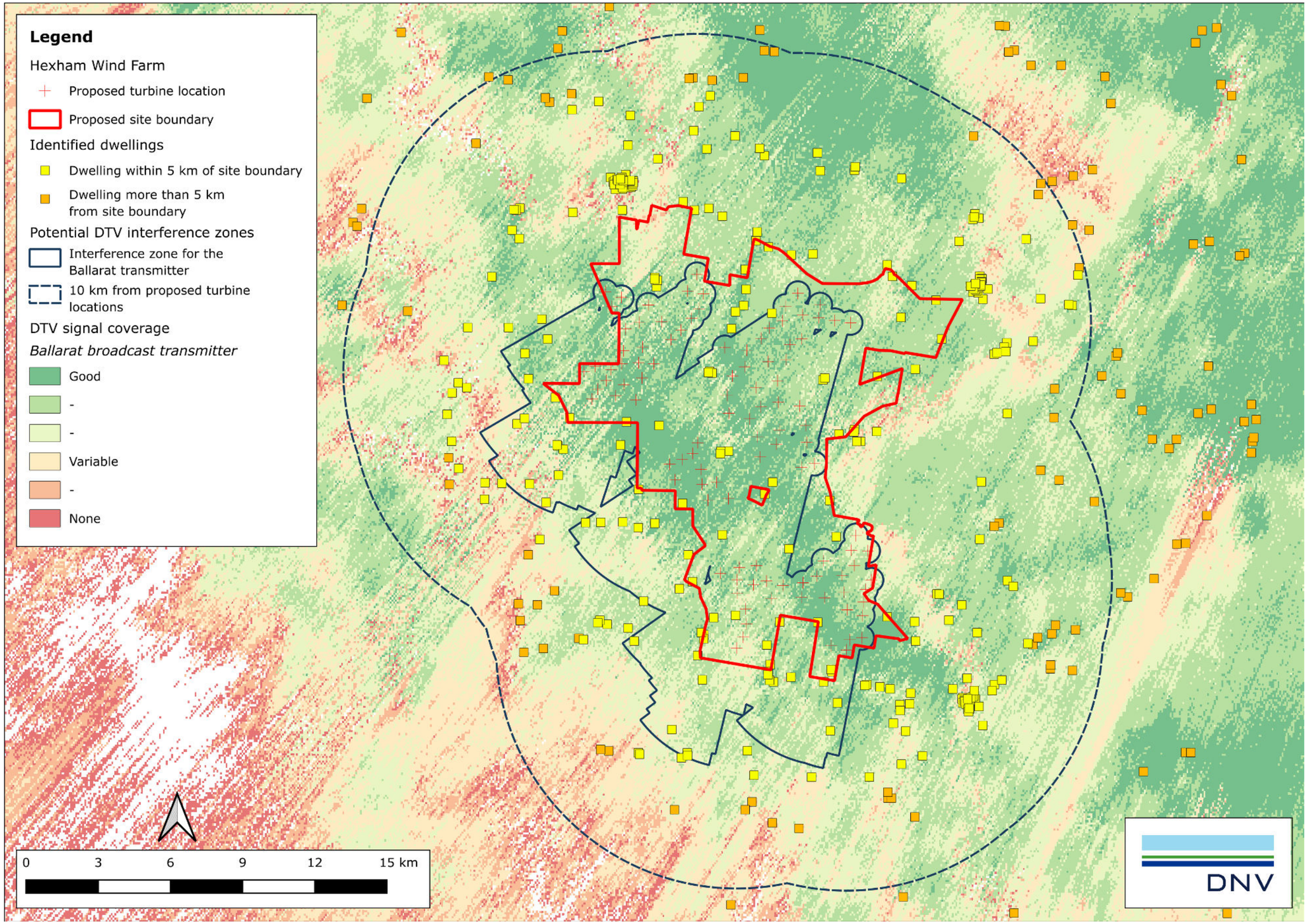


Figure 19 Potential television EMI zones for the Western Victoria broadcast transmitter from the proposed Project

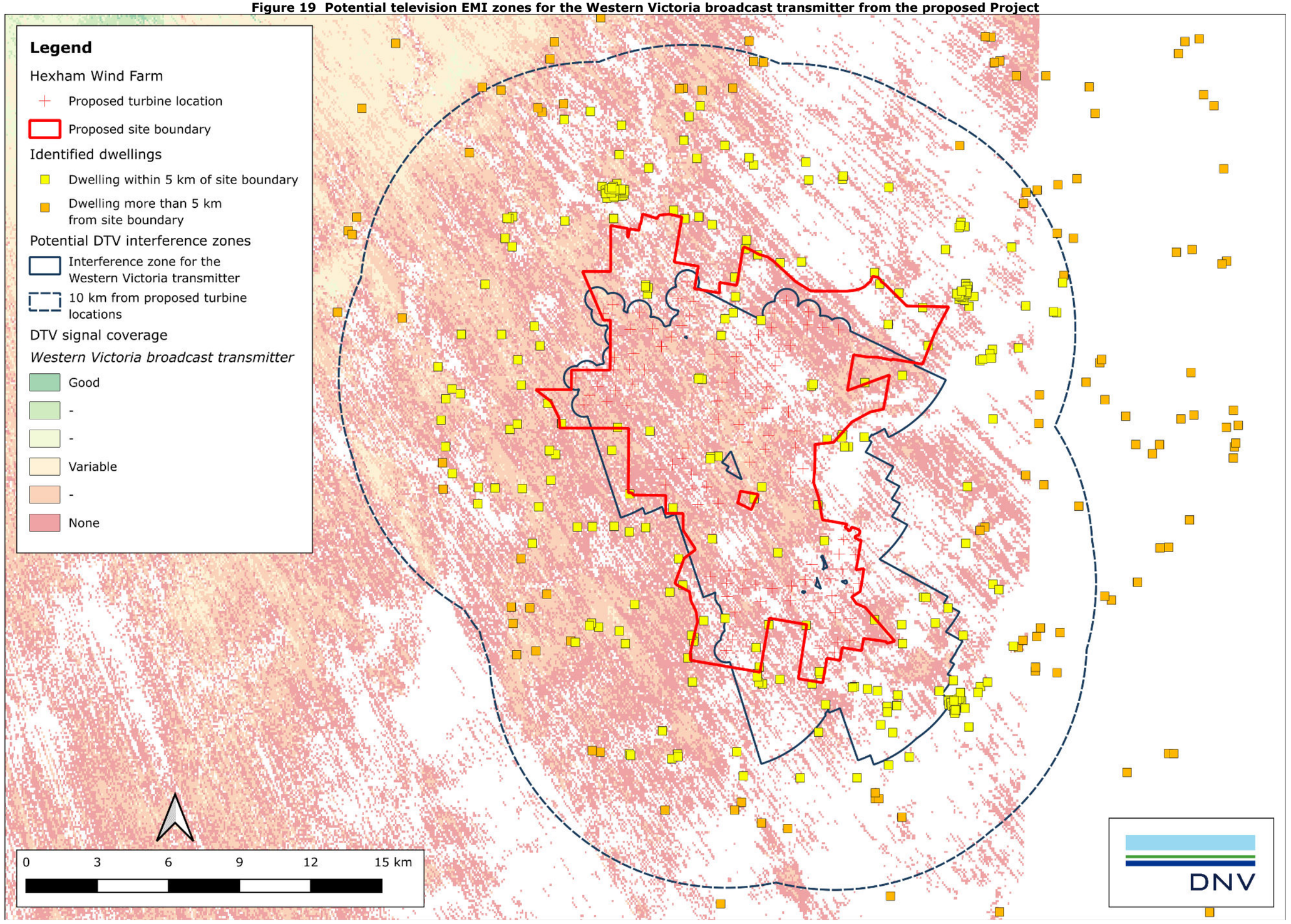


Figure 20 Potential television EMI zones for the Warrnambool broadcast transmitter from the proposed Project

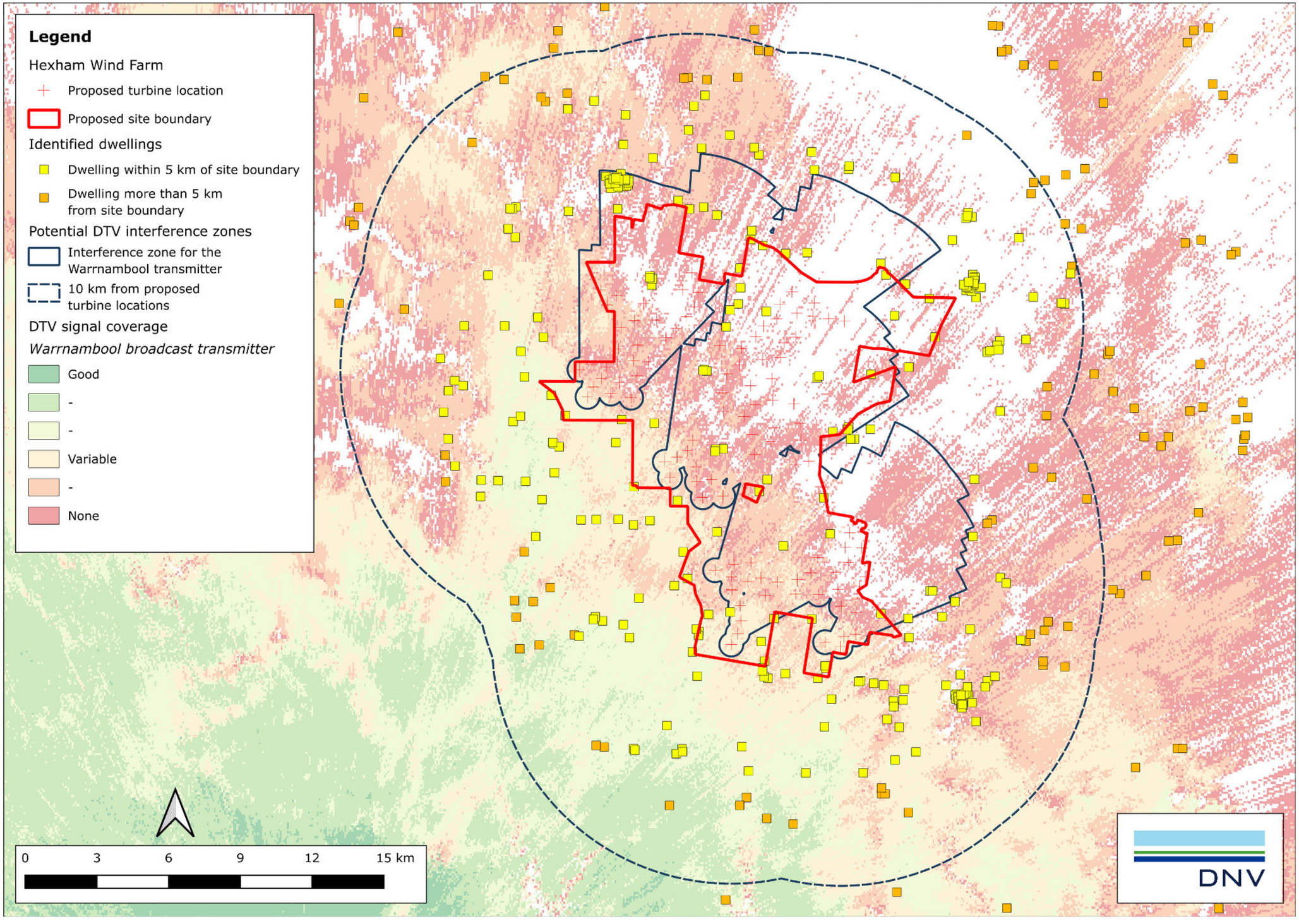


Figure 21 Potential television EMI zones for the Warrnambool City broadcast transmitter from the proposed Project

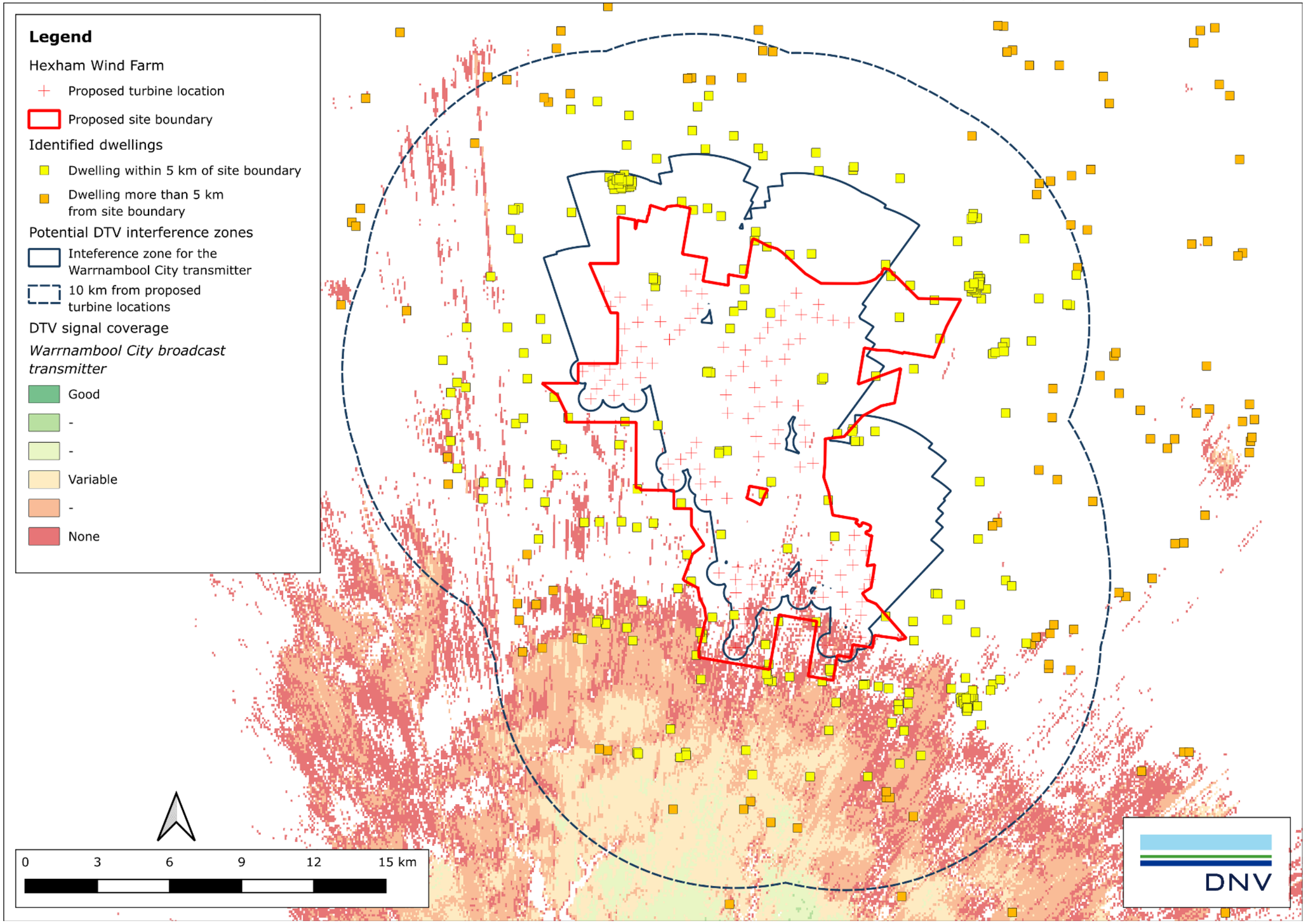


Figure 22 Location of nearby wind farm developments in relation to the proposed Project

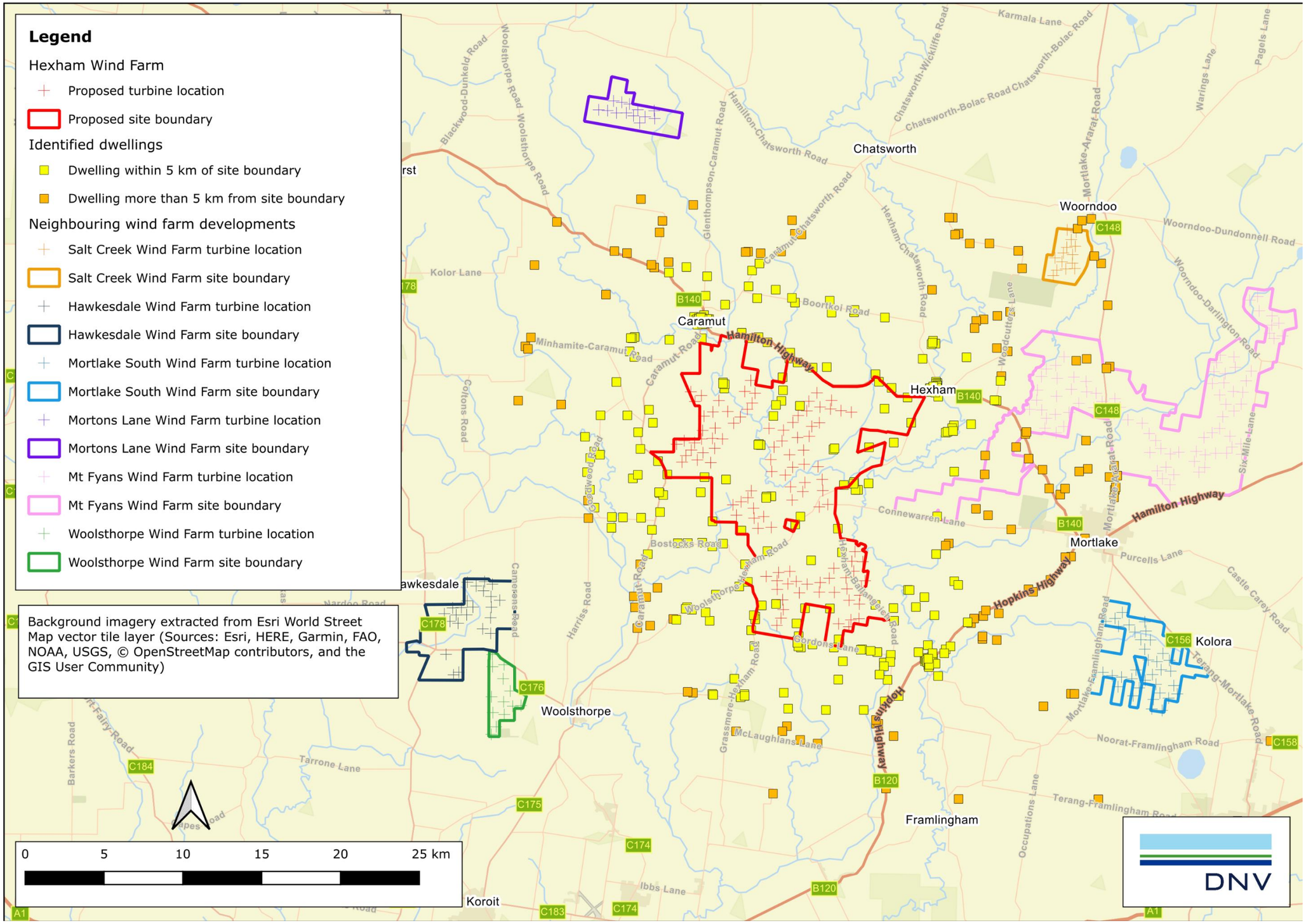


Figure 23 Location of nearby wind farm developments, showing locations of nearby dwellings and potential television EMI zones for the Ballarat broadcast transmitter from the proposed Project

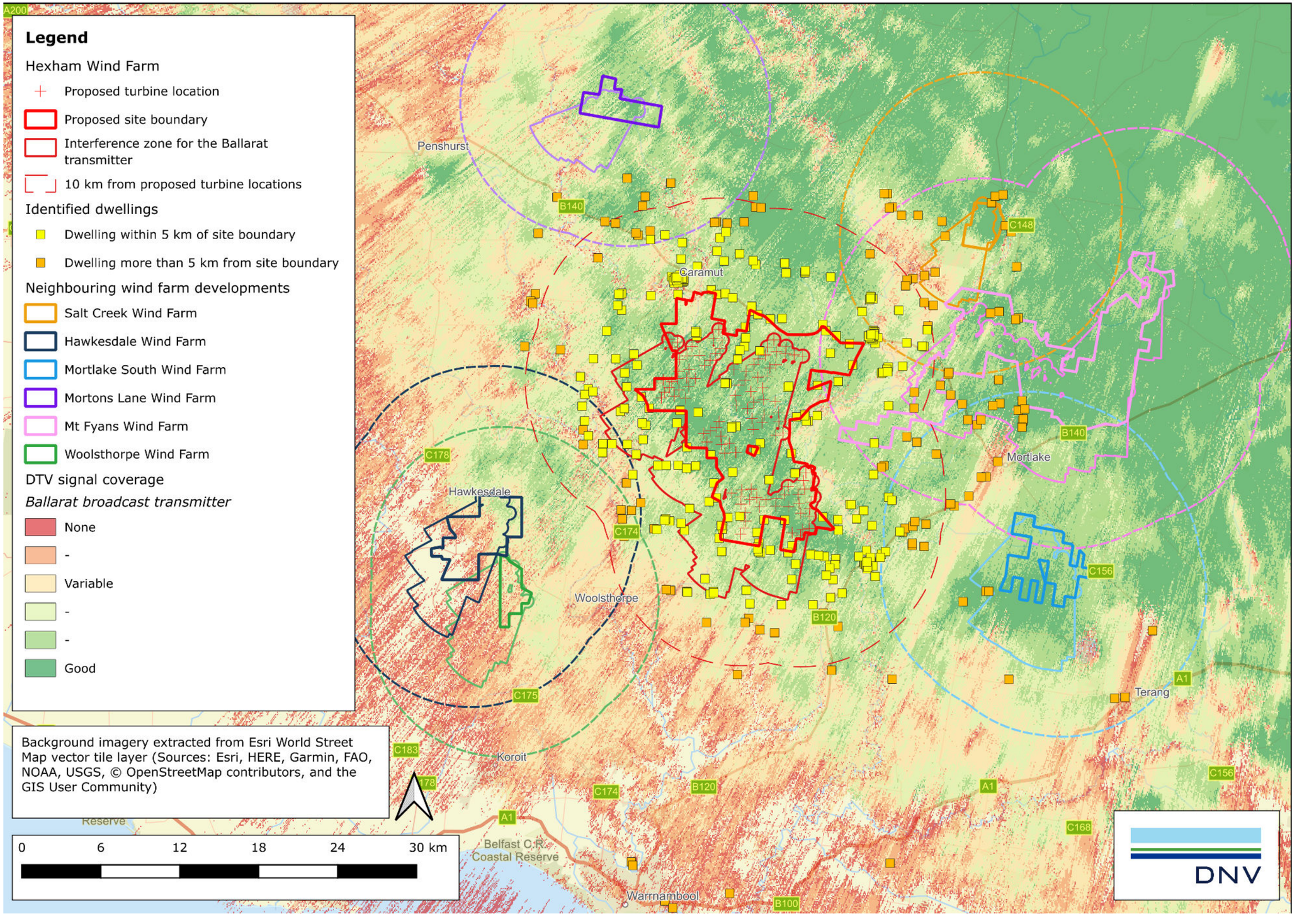


Figure 24 Location of nearby wind farm developments, showing locations of nearby dwellings and potential television EMI zones for the Western Victoria broadcast transmitter from the proposed Project

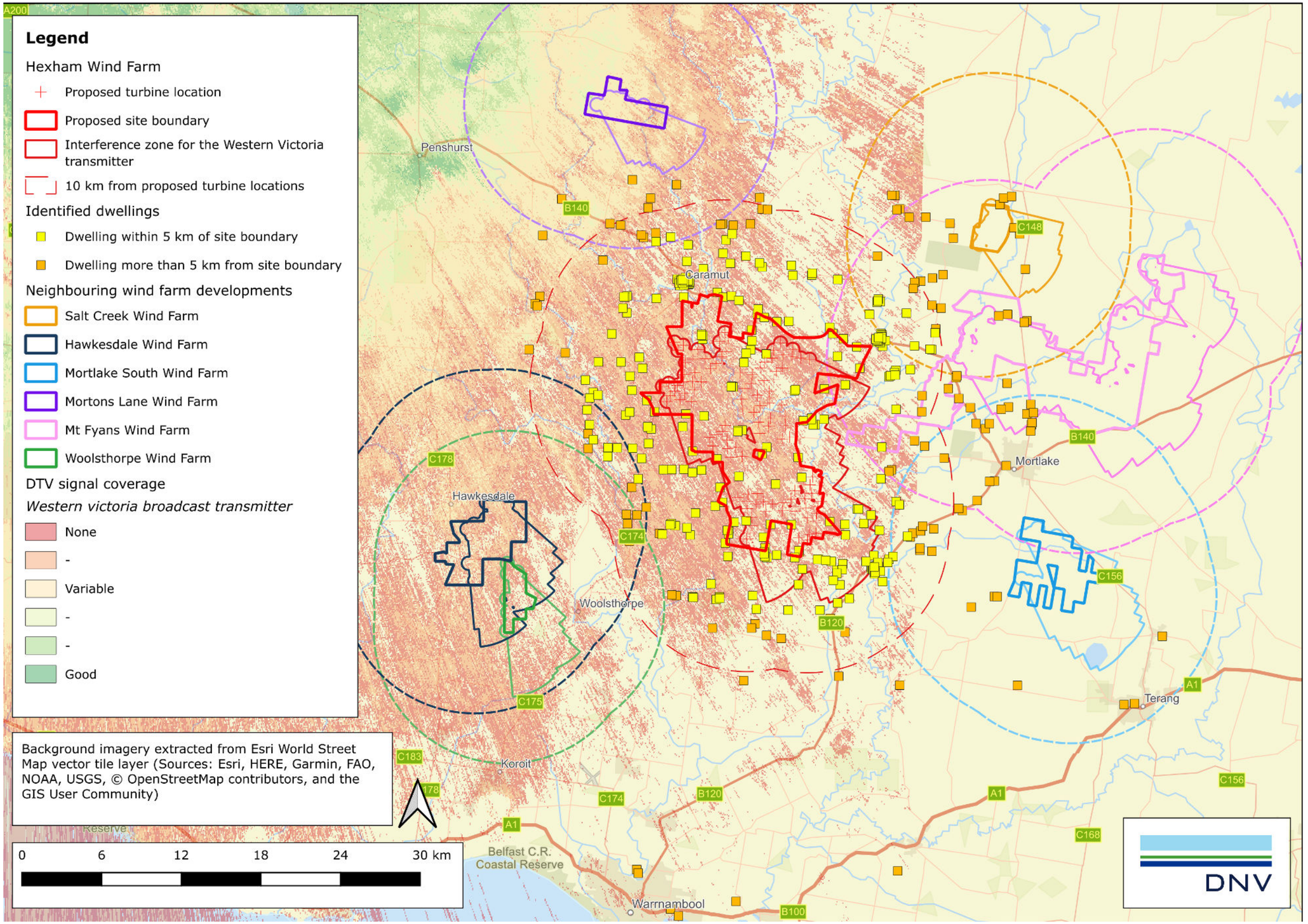


Figure 25 Location of nearby wind farm developments, showing locations of nearby dwellings and potential television EMI zones for the Warrnambool broadcast transmitter from the proposed Project

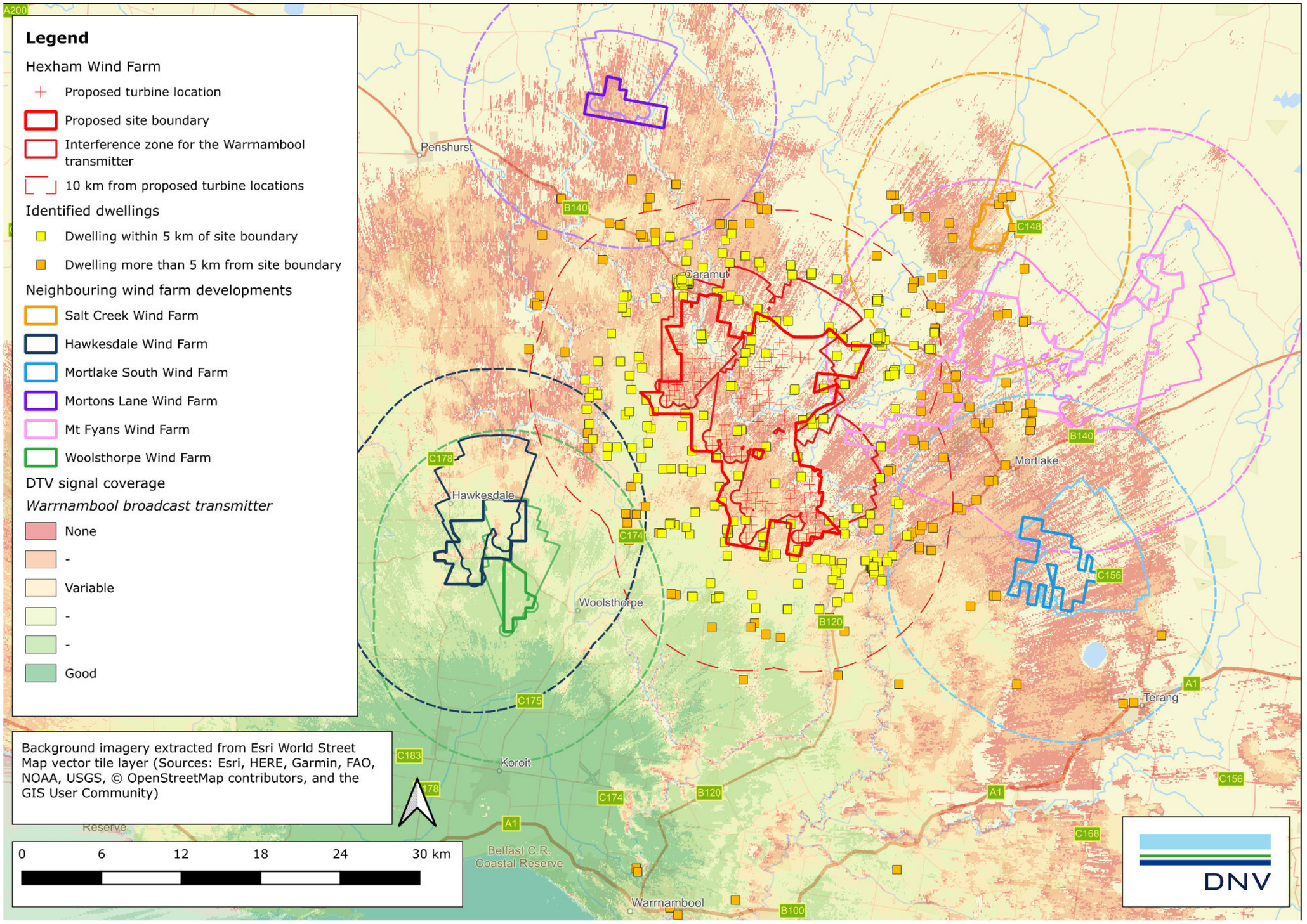
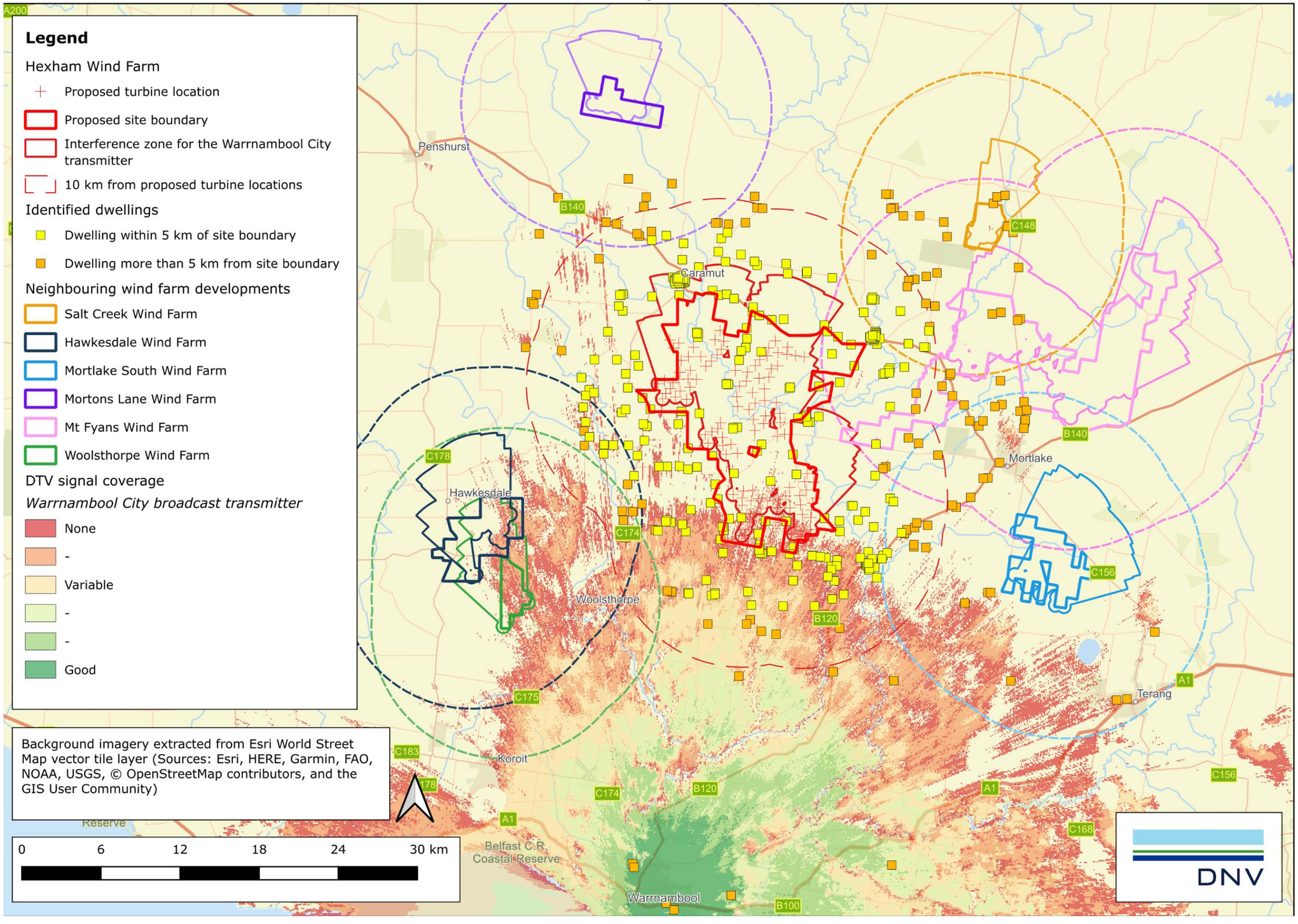


Figure 26 Location of nearby wind farm developments, showing locations of nearby dwellings and potential television EMI zones for the Warrnambool City broadcast transmitter from the proposed Project



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.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.