KOJONUP WIND FARM

EMI Assessment

Kojonup Wind Farm Pty Ltd

Report No.: 10557557-AUMEL-R-01, Rev. D
Document No.: 10557557-AUMEL-R-01-D
Date: 23 October 2025
Status: Final

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Project name:	Kojonup Wind Farm	DNV Energy Systems
Report title:	EMI Assessment	Level 12, 350 Queen Street
Report addressee:	Kojonup Wind Farm Pty Ltd	Melbourne Vic 3000
	5 Barnfield Road Claremont	Australia
	WA 6010	Tel: +61 3 8615 1515
Customer contact:	Sarah Rankin	ABN: 14 154 635 319
Date of issue:	23 October 2025	
Project No.:	10557557	
Organisation unit:	E-KA-ST	
Report No.:	10557557-AUMEL-R-01, Rev. D	
Document No.:	10557557-AUMEL-R-01-D	

Applicable contract(s) governing the provision of this Report:
DNV proposal OPP-00396038-AUMEL-SFA-01-A, dated 17 March 2025

Objective: Kojonup Wind Farm EMI Assessment

Prepared by:	Verified by:	Approved by:
Peter Degorski Engineer Energy Analytics (ANZ)	Ellanor Tomlinson Engineer,Technical Planning Energy Analytics (ANZ)	Kevin Bleibler Head of Section Energy Analytics & Measurements (ANZ)

Document classification:

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Keywords:
Kojonup Wind Farm EMI Assessment

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2025-06-03	First issue - DRAFT	P Degorski	E Tomlinson	N Brammer
B	2025-09-25	Final issue	P Degorski	E Tomlinson	K Bleibler
C	2025-10-14	Final issue – administrative change	P Degorski	E Tomlinson	K Bleibler
D	2025-10-23	Final issue - consultation and summary table updates	P Degorski	E Tomlinson	K Bleibler

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EXECUTIVE SUMMARY

DNV has been commissioned by Moonies Hill New Energy Pty Ltd ("the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Kojonup Wind Farm ("the Project") in Western Australia. The customer has requested this report be addressed to Kojonup Wind Farm Pty Ltd.

The results of the EMI assessment are described in this document.

Background and methodology

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

A Project layout consisting of 33 wind turbines with a rotor diameter of 162 m, upper tip height of 206 m, and lower tip height of 44 m has been considered. These dimensions represent the maximum and minimum overall tip heights and maximum rotor diameter under consideration for the Project.

There are 58 identified dwellings within 5 km of the Project, 15 of which are project participants.

Outcomes of the assessment

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

There is potential for the Project to interfere with point-to-area style communication services hosted by one radiocommunication tower to the east of the Project area. Consultation with the operators of these services, Shire of Kojonup and the Department of Fire and Emergency Services of Western Australia (DFES), has commenced to confirm the required clearances and potential for impact. Concerns were initially raised by DFES due to the proximity of the turbines to their assets and the potential for EMI effects to be generated by the turbines. Concerns raised by DFES have since been addressed by the Customer through correspondence with the turbine manufacturer. No response has been received from the Shire of Kojonup to date.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. Based on BAI's consultation response and detailed assessment, they have identified that there are no dwellings within their calculated potential interference zone. Dwellings within approximately 5-10 km of the Project that are currently receiving weak signals from the Wagin, Kojonup or Southern Agricultural television broadcast transmitters may experience interference to those services. If interference to these services is experienced, a range of options is available to rectify difficulties.

Interference to signals from a geostationary satellite that transmits programs intended for Australian audiences is possible at one nearby dwelling. The Customer has engaged with the residents of the dwelling and determined that the residents are currently receiving signals from low earth orbit satellites, which are not expected to experience interference from Project.

Since it is not possible to determine the potential EMI impacts on point-to-multipoint links, emergency services, and meteorological radar without obtaining further information from the relevant operators, DNV has consulted with organisations operating services that may be affected

by the Project. Apart from the feedback received from DFES, and which has been addressed by the Customer to the satisfaction of DFES as outlined above, no concerns have been raised.

Feedback received from the Bureau indicates that impacts are expected to be manageable in normal atmospheric conditions.

Potential EMI impacts on other services considered in this assessment, including fixed point-to-point links, trigonometrical stations and survey marks, and CB radio, are not expected or are considered to be minor.

DNV notes that the Project is located in an area of high wind farm development activity, with an operating wind farm located less than 20 km from the proposed Project. The potential cumulative impacts of the Project in conjunction with the nearby wind farm have not been considered in detail in this assessment. However, 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 impacts.

Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	2 towers within 2 km of proposed turbine locations: Shire of Kojonup – licence category a CBRS Repeater Department of Fire and Emergency Services of Western Australia (DFES)- service identified through consultation MT McGuire Nearest tower: 945 m from turbines	**Shire of Kojonup:** No response received **MT McGuire:** The Customer has determined through consultation that the radiocommunication tower no longer exists **DFES:** Concerns raised around near field interference effects, resolved through Customers interaction with DFES and Customers turbine manufacturer.	**Shire of Kojonup and DFES**: Low likelihood of interference **Mt McGuire:** None	**Shire of Kojonup and DFES:** <u>if required</u> – increase signal strength from affected tower or alternative towers, install additional electromagnetic shielding equipment within turbine, install signal repeater, install additional tower **MT McGuire:** None
Fixed point-to-point links	No links crossing Project boundary	-	None	None required
Fixed point-to-multipoint links	26 assignments within 75 km of Project boundary operated by Electricity Networks Corporation (Western Power), Quenby Viticultural Services Pty Ltd and Water Corporation No base stations within 20 km of Project boundary	**Western Power:** No concerns raised **Quenby Viticultural Services Pty Ltd:** Consultation not considered necessary **Water Corporation:** No response received	**Western Power:** None **Other operators:** Potential for interference if link paths cross the Project near turbines, although this is considered unlikely based on distances of base stations	<u>If required</u> – reroute affected links, install additional towers, replace affected links with alternative technologies

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 mitigation options
Other licence types	**Point-to-area style communications:** see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting **Aeronautical and radiodetermination:** to be considered as part of an aviation impact assessment	-	-	-
Emergency services	**Point-to-point links:** No links crossing boundary **Point-to-area style communications:** operated by DFES, Department of Biodiversity Conservation and Attractions, St John Ambulance, Western Australia Police	**Department of Biodiversity Conservation and Attractions:** No concerns raised **St John Ambulance and Western Australia Police:** No concerns raised **DFES:** Concerns have been addressed based on turbine manufacturers advice provided to the operator.	**Point-to-point links:** None **Point-to-area style communications:** Low likelihood of interference	**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
Meteorological radar	Nearest radar: 120 km from Project	Impacts are expected to be manageable The Bureau has no objections to the proposed development proceeding	Manageable impact	If required – to be determined through consultation with the Bureau of Meteorology
Trigonometrical stations	15 stations within 20 km of Project boundary **Electronic equipment:** unlikely to be affected **Survey marks:** unlikely to be affected **Sight lines to other stations:** may be blocked by turbines	No response received	Unlikely to cause interference	None required
Citizen's band radio	**User devices:** Unlikely to be affected **CB repeater:**	**User devices:** Consultation not considered necessary	**User devices:** Unlikely to cause interference	**User devices:** None required

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 mitigation options
	Shire of Kojonup licence within 2 km of nearest turbines	**Shire of Kojonup**: No response received	**CB repeater within 2 km:** Low likelihood of interference	**CB repeater within 2 km:** see findings for Shire of Kojonup radiocommunication tower above
Mobile phones	Fair to good coverage across Project Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Telstra:** No response received **Vodafone and Optus:** No concerns raised **Pivotel:** No response received	Low likelihood of interference	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, Pivotel **NBN:** Available as a fixed wireless and satellite service in areas surrounding the Project	**NBN:** No concerns raised **Pivotel:** No response received **Telstra:** No response received **Vodafone and Optus:** No concerns raised	**Wireless broadband services**: see findings for mobile phones **NBN:** Unlikely to cause interference	**Wireless broadband services:** as for mobile phones **NBN:** if required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install a new tower
Satellite television and internet	**Geostationary satellites:** signals from one satellite providing services intended for Australian audiences may be affected at one nearby dwelling; no signals from satellites providing services intended for international audiences intercepted at nearby dwellings **Low Earth orbit (LEO) satellites:** unlikely to be affected	The developer has contacted the potentially affected dwelling and confirmed that geostationary satellites are not in use. Low earth orbit satellites are used for communications at the dwelling.	**Geostationary satellites:** None **LEO satellites:** unlikely to cause interference	**LEO and Geostationary satellites:** none required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** unlikely to be affected	Consultation not considered necessary	**AM and FM signals:** low likelihood of interference **Digital radio signals:** Low likelihood of interference	**AM and FM signals:** if required – install higher-quality antenna at affected location

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 mitigation options
				Digital radio signals: none required
Television broadcasting	May experience interference in areas with poor or marginal reception **Kojonup transmitter:** *'poor' to 'none' coverage in region* 18 dwellings (10 Project participants) in potential interference zone **Wagin transmitter:** *'poor' to 'variable' coverage in region* 14 dwellings (8 Project participants) in potential interference zone **Southern Agricultural transmitter:** *'variable' to 'good' coverage in region* 18 dwellings (13 Project participants) in potential interference zone	**Kojonup, Wagin and Southern Agricultural transmitter** No concerns raised.	**Kojonup transmitter:** Unlikely to cause interference, as nearby dwellings are not expected to be receiving signals **Wagin and Southern Agricultural transmitters:** Likely to cause interference at some dwellings within approximately 5-10 km, if those dwellings are currently receiving a weak signal	<u>If required</u> – 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

Moonies Hill New Energy Pty Ltd ("the Customer") has commissioned DNV to independently assess the potential electromagnetic interference (EMI) related impacts associated with the proposed Kojonup Wind Farm ("the Project") in Western Australia. The results of this work are reported here. This document has been prepared in accordance with DNV proposal OPP-00396038-AUMEL-P-01-A Issue A, dated 30 January 2025, and is subject to the terms and conditions in that agreement. The Customer has requested this report be addressed to Kojonup Wind Farm Pty Ltd.

In accordance with the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [1], this assessment investigates the potential EMI impact of the Project on:

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

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

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The project is located approximately 260 km south-east of Perth and 15 km south of the township of Kojonup. The site is comprised of agricultural land with pockets of forest and shrubs throughout.

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 33 wind turbines [2]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 6.

2.2.2 Dwelling locations

The locations of dwellings in the vicinity of the Project have been provided by the Customer [3].

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. There are 58 dwellings located within 5 km of the Project boundary, 15 of which are Project participants. The coordinates of these dwellings are presented in Table 7, and the dwellings and Project boundary considered in this assessment are shown in Figure 1. 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.

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

3 REGULATORY REQUIREMENTS

The development of wind farms in Western Australia is governed by the Western Australian Planning Commission's Position Statement on renewable energy facilities ("the WA Position Statement"), published in March 2020 [4]. However, the WA Position Statement does not address the potential for wind farms to cause EMI-related impacts on nearby radiocommunication services.

The Environment Protection and Heritage Council (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) [1]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development, and the assessment methodologies they recommend have been referenced in current wind farm development guidance in some other Australian states.

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.

Since the WA Position Statement does not provide any guidance on the assessment of EMI-related impacts, DNV considers that the recommendations of the Draft National Guidelines are relevant to the assessment of EMI impacts for wind farms in Western Australia. 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 Customer has asked DNV to complete this assessment based upon a layout provided for the Project consisting of 33 wind turbines, as outlined in Table 6.

For the purpose of the EMI assessment, a hypothetical turbine with a rotor diameter of 162 m, an upper tip height of 206 m, and a lower tip height of 44 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 162 m or less
- an upper tip height of 206 m or less
- a lower tip height of 44 m.

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 4 April 2025 [5].

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

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

The radiocommunication licences and services with potential to experience EMI-related impacts from the proposed Project are considered in the following sections. Each section contains a brief

overview of the relevant technology, followed by an assessment of the identified licences and services in the area around the Project and the expected potential for interference. Details of any 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 an operating wind farm, Flat Rocks Wind Farm, located less than 20 km from the proposed Project. The potential cumulative impacts of the Project in conjunction with the nearby wind farm have not been considered in detail in this assessment. However, 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 impacts.

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 [1], 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 216 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 2.

In the ACMA RRL database there are two radiocommunication towers located within 2 km of the proposed turbine locations. These towers and the consultation zones recommended by the Draft National Guidelines [1] are shown in Figure 3 based on information obtained from the ACMA RRL database, and extracted from aerial or satellite imagery. Each consultation zone includes the rotor radius for turbines with a 162 m rotor diameter, and an additional buffer to account for potential inaccuracies in the tower locations. The size of the uncertainty buffer in each case is based on the deviations between the tower locations given in the ACMA RRL database and the apparent locations determined from aerial or satellite imagery.

Details of the licences associated with these radiocommunication towers are given in Table 1**.** These licences and services include point-to-area style communications, comprising land mobile licences used for private mobile telephony (such as mobile radio and paging systems) and a Citizen's band radio repeater licence.

Table 1 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]
29039	MT McGuire	Point-to-area (land mobile)	959
10036639	Shire of Kojonup	Point-to-area (land mobile and CBRS repeater)	1020
10036639	Department of Fire Emergency Services (DFES)	Point-to-area (VHF mid-band service)[1]	1020

1. License is not registered in the ACMA database, determined through consultation with Department of Fire Emergency Services, see section 4.6.2 for more information.

Point-to-area style radiocommunications such as mobile radio and paging 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 [6] 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 [7].

Given the proximity of the proposed wind turbine locations to the towers shown in Table 1, there is a potential for the Project to interfere with the associated point-to-area style communications through reflection or scattering of the signals. 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 these towers through near-field effects.

The tower with site ID 29039 and associated licence is operated by MT McGuire. Following conversation with the operator, the Customer has informed DNV that the tower and associated licence at site ID 29039 is no longer in use. Therefore, there is no potential for interference to the services licenced to site ID 29039.

4.2.2 Stakeholder consultation

The Customer has established through communication with the operator of services licenced to site ID 29039, that the tower hosting the radiocommunication services no longer exists and therefore there is no potential for interference.

DNV has contacted the Shire of Kojonup who operate services licenced to site ID 10036639 shown in Table 1. DNV has sought to determine if the Shire of Kojonup considers it likely that the proposed Project will cause interference to their services through near-field effects or reflection or scattering of signals. No response has been received to date.

Stakeholder consultation responses from DFES are summarised in Section 4.6.2.

4.2.3 Mitigation options

Mitigation measures to avoid potential for impacts to the point-to-area style communications from the tower at site ID 10036639 would need to be determined in consultation with operator of this tower, Shire of Kojonup, but may include increasing the signal strength from the affected tower or

alternative towers, or installing additional towers in the vicinity of the Project or, if necessary relocating Project turbines.

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

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 26 point-to-multipoint Assignment IDs within approximately 75 km of the proposed Project boundary. These licences are shown in Figure 5. The details of the licence holders as given in the ACMA RRL database are provided in Table 8.

There are no point-to-multipoint base stations within 20 km of the Project boundary. However, there are 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 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. As such, there may be potential for interference to point-to-multipoint links if those links cross the Project near the turbines. Based on the distances between the point-to-multipoint base stations and the Project, DNV considers it unlikely that any links will be crossing the Project boundary. 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.

Feedback provided by Western Power concludes, the Project should not cause any EMI impact on any of Western Power's existing and currently proposed point-to-point links. The response received from Western Power, is summarised in Table 15. There have been no responses to date from the other operators contacted.

4.4.3 Mitigation options

In the event that interference to point-to-multipoint links is experienced after the Project is operational, mitigation options would need to be confirmed through consultation with the relevant operators but may include re-routing the affected links via an existing or new tower, installing additional towers, or replacing the links with alternative communications technologies.

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 6 and Table 9.

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 have been identified. DNV expects that potential impacts to these services will be 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 10 along with their contact details. The nearest licence is associated with a tower located approximately 3.1 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 [6] 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 [7].

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

4.6.2 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 have been received from several operators, as summarised in Table 15.

There have been no concerns raised from consultation feedback provided by St John Ambulance, Western Australian Police and the Department of Biodiversity Conservation and Attractions.

Concerns have been raised by DFES about EMI emissions from nearby turbines impacting services operated and hosted on the tower with site ID 10036639. The services identified by DFES are not registered to licences within the ACMA database at the time of the assessment.

DNV understands that further consultation between the developer, turbine manufacturer and the DFES was undertaken to understand the potential for interference, including determining the frequency of the VHF radio communications located at the tower. Feedback provided by the turbine manufacturer confirms that the nearest wind turbine should not impact the DFES services licensed to site ID 10036639. The Customer has shared the advice received from the turbine manufacturer with DFES, who have confirmed that they are now satisfied with the current clearances from the tower.

4.6.3 Mitigation options

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

4.7 Aircraft navigation systems and radar

DNV expects that a separate aviation impact study will be undertaken to assess the impact of the Project on nearby aviation navigation systems and radar.

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 [8].

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 [9, 10].

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 [11, 12], and approximately 100 km at a height of 1000 m [12]. 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 [13, 14]. 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 be 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 [1].

4.8.1 Locations of meteorological radars and potential for interference

DNV has identified that the Bureau operates 8 weather radars within 250 nautical miles of the proposed Project, with the closest radar located approximately 120 km south-east of the Project at Albany airport. The locations of these radars are shown in Figure 7 and the details of each radar are given in Table 11.

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

The Customer 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 Bureau's advice shared with DNV by the Customer, indicates no concerns have been raised and that the Project poses a manageable risk to Bureau radar and radiocommunication assets under normal atmospheric conditions.

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 [14], However, had analysis indicated there was 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.

If required, mitigation options should be determined through consultation with the Bureau.

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 [15].

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 [16]. 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) [17], 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 [18], there are 15 trig points within 20 km of the Project boundary. One trig point, NT11, is located inside the Project boundary 219 m west of the turbine T18. The details of these trig points are provided in Table 12 and their locations are illustrated in Figure 8.

There are also 6 permanent survey marks within 2 km of the Project boundary [19] as shown in Figure 9. The closest survey mark is NT11, which is the same as the trig point located 219 m west of turbine T18.

DNV has reviewed the primary geodetic network of Australia [20] and observed that the Project is located within the second-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 47 km north-east of the Project, at Katanning [21]. 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 to inform them of the Project, and seek feedback regarding whether interference to their systems is possible.

There have been no concerns raised from consultation feedback provided by Geoscience Australia.

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 10. The nearest mobile phone tower is located approximately 5.7 km west of the Project boundary.

Mobile phone 4G network coverage maps have been obtained for Optus, Telstra, and Vodafone/TPG. None of the service providers offer 5G in the region.

Figure 11 shows the Optus Mobile network coverage for the Project area [22]. Signal coverage is generally good towards the north of the site toward Kojonup. Coverage across the Project and neighbouring townships Jingalup and Lumeah is mixed with patches where Optus service is not available.

Figure 12 shows the Telstra network coverage for the Project area [23]. There is broad extent of service coverage across the Project region, with limited to no coverage south-east of the site and some pockets around the centre of the Project region. There is increased coverage towards the towns of Kojonup and north of Lumeah.

Figure 13 shows the Vodafone/TPG network coverage for the Project area [24]. Signal coverage is generally good towards the north of the site toward Kojonup. Coverage across the Project and neighbouring townships Jingalup and Lumeah is mixed with patchy coverage.

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

4.11.2 Stakeholder consultation

DNV has contacted Optus, Telstra, and Vodafone/TPG to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. Responses have been received from several operators, as summarised in Table 15, and no concerns have been raised to date.

4.11.3 Mitigation options

As noted above, interference with mobile phone signals is considered unlikely. 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.

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

Pivotel Mobile hold point-to-area licences in the vicinity of the Project, with base stations located 34 km south-west of the Project. As the location of Pivotel Mobile customers are not known, it is not possible to determine whether there is the potential for interference to this service, however it is possible that stations at these distances may be servicing customers in the vicinity of the proposed Project.

Additionally, residents in the vicinity of the Project may use wireless broadband services provided by Optus, Telstra, and Vodafone/TPG[1]. 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.

4.12.1.2 Stakeholder consultation

DNV has contacted Optus, Telstra, Vodafone/TPG and Pivotel to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. Responses have been received from several operators, as summarised in Table 15, and no concerns have been raised to date.

[1] Mobile JV Pty Ltd both also have point-to-area licences in the area, these entities provide internet services under Vodafone which is discussed separately.

4.12.1.3 Mitigation options

As noted above, interference with wireless broadband services is considered unlikely. If interference to the wireless broadband services provided by mobile phone networks occurs, the mitigation options given in Section 4.11.3 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.

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 [25]. Consequently, the signals may be affected by physical obstructions such as terrain, vegetation, and wind turbines [26].

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 [27] indicates that the network is currently available as a fixed wireless and satellite internet service in the area surrounding the Project. It is therefore likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. The locations of NBN fixed wireless internet towers within 75 km of the Project boundaries are shown in Figure 10, and a map of NBN service coverage in the vicinity of the Project is shown in Figure 14.

The NBN fixed wireless tower servicing the Project area is located at Kojonup. Based on the relative position of this tower and the nearby dwellings, and the fixed wireless coverage areas shown in Figure 14, there is potential for turbines at the Project to intercept the line of sight between this tower and nearby dwellings. Further investigation would be required to determine which dwellings are likely to be receiving NBN fixed wireless signals from the tower, and whether the lines of sight from that tower to those dwellings have potential to be intercepted by turbines at the Project. Alternatively, further advice could be sought from NBN Co as described in Section 4.12.2.2.

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 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.

No concerns have been raised regarding impacts to radio frequency profiles servicing NBN customers or to any existing or planned microwave links in the area. NBN has requested, that once known, details be provided about radio frequency transmission equipment planned during construction or permanently installed.

4.12.2.3 Mitigation options

As noted above, interference with NBN fixed wireless internet services is considered possible and further consultation or analysis is necessary to determine if services would be affected. If interference to NBN fixed wireless signals is experienced at nearby dwellings as a result 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 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" [25]). It may also be possible to avoid impact by micro-siting the turbines in some cases, or by installing a new NBN tower to service the affected dwellings. Although the NBN Sky Muster satellite internet service is a potential alternative to the fixed wireless internet service, NBN Co have previously advised that the Sky Muster service cannot be considered as a mitigation option for dwellings affected by interference from wind turbines.

4.13 Satellite television and internet

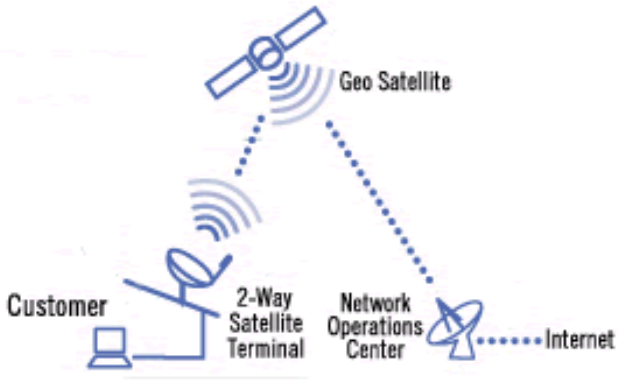
In some rural or remote areas, television and internet access can only be provided through satellite signals. There are two types of satellite that are typically used to provide commercial telecommunication services: geostationary satellites and low Earth orbit (LEO) satellites.

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 [28]. 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 [29, 30].

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.



Two-way connection to the internet via satellite [31]

4.13.1.1 Locations of geostationary 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 this analysis are shown in Table 13 and summarised in Table 2. Based on these results, turbines at the Project may intercept signals from one satellite (NSS9) at one nearby dwelling (dwelling 18). The potentially affected dwelling is a Project participant. DNV understands that the NSS9 satellite provides services that may be intended for Australian audiences. However, if the residents of dwelling 18 do not use services provided by the NSS9 satellite there will be no potential for impact to that service.

Table 2 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 (NSS9)	1 (Dwelling 18)[1]
Services intended for international audiences	None	None

1. Affected dwelling is Project participant.

4.13.1.2 Stakeholder consultation

As discussed in Section 4.13.1.1, one Project participant dwelling has the potential to experience interference to satellite services. DNV understands that the customer has engaged with the occupant of this dwelling, and established that the owner does not use the potentially impacted satellite service and instead uses low earth orbit satellite communication services [32]. Low earth orbit satellite communications are discussed in Section 1.1.1.

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 [28]. 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 [33], 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 [34, 35].

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 [36]. 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 [37], 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 206 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 Project 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 only likely in the immediate vicinity of a turbine [38].

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 [39], and are shown in Figure 15.

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.

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 [40]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [38, 41].

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 [40]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmitter [42].

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 [39], and are shown in Figure 15.

The closest FM broadcast transmitter is located approximately 43.9 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.

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 [43]. Digital radio broadcasts in Australia operate in the VHF band at frequencies between 174 MHz and 230 MHz, and therefore tend to have only local coverage within the visual horizon.

The UK telecommunications regulator Ofcom [40] 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 [44], 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 [45]. 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 [45], and are shown in Figure 15. The Southern Agricultural and Wagin broadcast transmitters service the most dwellings in the vicinity of the Project. However, according to the Australian Government mySwitch website [46], it is also possible that residents in the vicinity of the Project are able to receive DTV signals from other nearby transmitters.

The DTV broadcast transmitters likely to be servicing the area around the Project are summarised in Table 3 below. Coverage maps for these broadcast transmitters are reproduced in Figure 16 to Figure 17.

Table 3 DTV broadcast transmitters servicing the Project area

DTV broadcast transmitter	Signal coverage in the vicinity of the Project	Figure containing coverage map
Kojonup	Good coverage around the township of Kojonup. Signal strength reduces rapidly with distance from tower. Provides no coverage south of tower and toward the Project boundary.	Figure 16
Wagin	Provides variable coverage north-west of Project boundary, good coverage to the east of the Project boundary. Provides variable to poor coverage in and around the Project boundary.	Figure 17
Southern Agricultural (Mount Barker)	Provides good coverage to the south-east of Project. Provides variable coverage in and around the Project boundary with strongest signal over the south of the Project boundary.	Figure 18

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 [47].

The closest DTV transmitter to the Project is the relay transmitter at Kojonup, which is approximately 6.5 km from the project boundary. 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.

From analysis conducted using the keyhole approach, dwellings in the vicinity of the proposed wind farm project, are most likely to experience interference to the DTV services from the broadcast transmitters Wagin and Southern Agricultural. The Kojonup tower does not service any of the dwellings neighbouring the project, and so interference with the DTV service provided by Kojonup broadcast tower is not expected.

The results of the analysis can be seen in Table 14 and Figure 16 to Figure 18. The dwellings most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 4.

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 16 to Figure 18 also shows the area within 10 km of the proposed turbine locations. DNV recommends contacting BAI Communications, as discussed in Section 4.15.2 to confirm the potential for interference to DTV signals received at dwellings outside the 'keyhole' interference zones.

Table 4 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
Kojonup	18 (10 Project participants)	Based on the coverage map these dwellings are not expected to be receiving signals from the Kojonup transmitter.
Wagin	14 (8 Project participants)	Coverage is variable for dwellings in the north of the potential interference zone. In the south of the potential interference zone the coverage is poor and it is unlikely dwellings will be receiving signals from this transmitter.
Southern Agricultural (Mount Barker)	18 (13 Project participants)	Coverage is variable for dwellings in the south of the potential interference zone. In the north of the potential interference zone most of the coverage is poor, although the western edge of the interference zone will be receiving variable 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.

BAI Communications has conducted an assessment of the potential for turbines at the Kojonup Wind Farm to interfere with DTV signals from the Southern Agricultural, Wagin and Kojonup broadcast towers, based on the current turbine layout and dimensions [48]. The method used involved modelling the reflection or scattering of DTV signals from the turbines, and identifying locations within 10 km of the Kojonup Wind Farm where the resulting C/I ratio would be less than required for adequate signal reception.

Based on population density data for the area around the Kojonup Wind Farm, BAI Communications concluded that if using the Southern Agricultural transmitter up to two dwellings are at low risk of experiencing DTV interference from the Kojonup Wind Farm. Based on satellite imagery BAI communication concluded that no dwellings were contained within the high or low risk areas.

Further, BAI Communications concluded that if using Wagin or Kojonup transmitter no dwellings were in the high or low risk areas.

The results of the modelling conducted by BAI Communications are compared to the interference zones established by DNV for the Kojonup, Wagin and Southern Agricultural broadcast tower in Figure 16, Figure 17 and Figure 18. The assessment of high and medium risk is broadly consistent across both analysis, with the greatest impact expected to be confined to the central part of the Kojonup wind farm site and immediate surrounds.

4.15.3 Mitigation options

In the event that DTV interference is experienced at nearby dwellings as a result of the Project, potential mitigation options may include:

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, realigning the antenna or installing 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 these cases, it may be more effective to move the antenna to a location where there is a clearer line of sight to the transmitter or to tune the antenna into an alternative or substitute signal (if one is available).

In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more aligned or directional antenna may not alleviate a forward scatter issue. Alternative mitigation measures to resolve issues caused by forward scatter could include tuning the antenna into an alternative signal (if one is available) or installing cable or satellite television at the affected dwelling. However, as noted in [49], DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [50] identified that the receiver height can also affect interference. In areas that are relatively flat and free of vegetation, reflections can enhance or decrease the received signal strength relative to the free path signal strength. The ITU found that the received signal strength may not increase monotonically with receiver height. In other words, lowering the receiver height can improve reception in some cases.

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription-based broadcasts. Residents in areas which are unable to receive DTV through their

normal television antenna due to local interference, terrain, or distance from the transmitter in their area may be eligible to access the Australian Government funded Viewer Access Satellite Television (VAST) service [51].

5 CONCLUSIONS

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

There is potential for the Project to interfere with point-to-area style communication services hosted by one radiocommunication tower to the east of the Project area. Consultation with the operators of these services, Shire of Kojonup and the Department of Fire and Emergency Services of Western Australia (DFES), has commenced to confirm the required clearances and potential for impact. Concerns were initially raised by DFES due to the proximity of the turbines to their assets and the potential for EMI effects to be generated by the turbines. Concerns raised by DFES have since been addressed by the Customer through correspondence with the turbine manufacturer. No response has been received from the Shire of Kojonup to date.

Turbines at the Project may interfere with point-to-area style services such as mobile phone signals, radio broadcasting, and terrestrial television broadcasting, particularly in areas with poor or marginal signal coverage. Based on BAI's consultation response and detailed assessment they have identified that there are not dwellings within their calculated potential interference zone. Dwellings within approximately 5-10 km of the Project that are currently receiving weak signals from the Wagin, Kojonup or Southern Agricultural television broadcast transmitters may experience interference to those services. If interference to these services is experienced, a range of options are available to rectify difficulties.

Interference to signals from a geostationary satellite that transmits programs intended for Australian audiences is possible at one nearby dwelling. The Customer has engaged with the owner or residents of the dwelling and determined that the residents are currently receiving signals from low earth orbit satellites, which are not expected to experience interference from the proposed turbines.

Since it is not possible to determine the potential EMI impacts on point-to-multipoint links, emergency services, and meteorological radar without obtaining further information from the relevant operators, DNV has consulted with organisations operating services that may be affected by the Project. Apart from the feedback received from DFES, and which has been addressed by the Customer to the satisfaction of DFES as outlined above, no concerns have been raised.

Feedback received from the Bureau indicates that impacts are expected to be manageable in normal atmospheric conditions.

Potential EMI impacts on other services considered in this assessment, including fixed point-to-point links, trigonometrical stations and survey marks, and CB radio, are not expected or are considered to be minor.

DNV notes that the Project is located in an area of high wind farm development activity, with an operating wind farm located less than 20 km from the proposed Project. The potential cumulative impacts of the Project in conjunction with the nearby wind farm have not been considered in detail in this assessment. However, 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 impacts.

Table 5 Summary of EMI assessment results for the proposed Project

Licence or service type	Results of DNV assessment	Stakeholder feedback (to date)	Expected impact	Potential mitigation options
Radio-communication towers	2 towers within 2 km of proposed turbine locations: Shire of Kojonup – licence category a CBRS Repeater Department of Fire and Emergency Services of Western Australia (DFES)- service identified through consultation MT McGuire Nearest tower: 945 m from turbines	**Shire of Kojonup:** No response received **MT McGuire:** The Customer has determined through consultation that the radiocommunication tower no longer exists **DFES:** Concerns raised around near field interference effects, resolved through Customers interaction with DFES and Customers turbine manufacturer.	**Shire of Kojonup and DFES**: Low likelihood of interference **Mt McGuire:** None	**Shire of Kojonup and DFES:** <u>if required</u> – increase signal strength from affected tower or alternative towers, install additional electromagnetic shielding equipment within turbine, install signal repeater, install additional tower **MT McGuire:** None
Fixed point-to-point links	No links crossing Project boundary	-	None	None required
Fixed point-to-multipoint links	26 assignments within 75 km of Project boundary operated by Electricity Networks Corporation (Western Power), Quenby Viticultural Services Pty Ltd and Water Corporation No base stations within 20 km of Project boundary	**Western Power:** No concerns raised **Quenby Viticultural Services Pty Ltd:** Consultation not considered necessary **Water Corporation:** No response received	**Western Power:** None **Other operators:** Potential for interference if link paths cross the Project near turbines, although this is considered unlikely based on distances of base stations	<u>If required</u> – reroute affected links, install additional towers, replace affected links with alternative technologies

Table 5 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 mitigation options
Other licence types	**Point-to-area style communications:** see findings for emergency services, mobile phones, radio broadcasting, and television broadcasting **Aeronautical and radiodetermination:** to be considered as part of an aviation impact assessment	-	-	-
Emergency services	**Point-to-point links:** No links crossing boundary **Point-to-area style communications:** operated by DFES, Department of Biodiversity Conservation and Attractions, St John Ambulance, Western Australia Police	**Department of Biodiversity Conservation and Attractions:** No concerns raised **St John Ambulance and Western Australia Police:** No concerns raised **DFES:** Concerns have been addressed based on turbine manufacturers advice provided to the operator.	**Point-to-point links:** None **Point-to-area style communications:** Low likelihood of interference	**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
Meteorological radar	Nearest radar: 120 km from Project	Impacts are expected to be manageable The Bureau has no objections to the proposed development proceeding	Manageable impact	If required – to be determined through consultation with the Bureau of Meteorology
Trigonometrical stations	15 stations within 20 km of Project boundary **Electronic equipment:** unlikely to be affected **Survey marks:** unlikely to be affected **Sight lines to other stations:** may be blocked by turbines	No response received	Unlikely to cause interference	None required

Table 5 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 mitigation options
Citizen's band radio	**User devices:** Unlikely to be affected **CB repeater:** Shire of Kojonup licence within 2 km of nearest turbines	**User devices:** Consultation not considered necessary **Shire of Kojonup**: No response received	**User devices:** Unlikely to cause interference **CB repeater within 2 km:** Low likelihood of interference	**User devices:** None required **CB repeater within 2 km:** see findings for Shire of Kojonup radiocommunication tower above
Mobile phones	Fair to good coverage across Project Unlikely to be affected in areas with good coverage, may experience interference in areas with marginal coverage	**Telstra:** No response received **Vodafone and Optus:** No concerns raised **Pivotel:** No response received	Low likelihood of interference	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, Pivotel **NBN:** Available as a fixed wireless and satellite service in areas surrounding the Project	**NBN:** No concerns raised **Pivotel:** No response received **Telstra:** No response received **Vodafone and Optus:** No concerns raised	**Wireless broadband services**: see findings for mobile phones **NBN:** Unlikely to cause interference	**Wireless broadband services:** as for mobile phones **NBN:** if required – redirect antennas at affected dwellings to alternative towers, change location of antenna, install a new tower

Table 5 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 mitigation options
Satellite television and internet	**Geostationary satellites:** signals from one satellite providing services intended for Australian audiences may be affected at one nearby dwelling; no signals from satellites providing services intended for international audiences intercepted at nearby dwellings **Low Earth orbit (LEO) satellites:** unlikely to be affected	The developer has contacted the potentially affected dwelling and confirmed that geostationary satellites are not in use. Low earth orbit satellites are used for communications at the dwelling.	**Geostationary satellites:** None **LEO satellites:** unlikely to cause interference	**LEO and Geostationary satellites:** none required
Radio broadcasting	**AM and FM signals:** may experience interference in close proximity to turbines **Digital radio signals:** unlikely to be affected	Consultation not considered necessary	**AM and FM signals:** low likelihood of interference **Digital radio signals:** Low likelihood of interference	**AM and FM signals:** <u>if required</u> – install higher-quality antenna at affected location **Digital radio signals:** none required
Television broadcasting	May experience interference in areas with poor or marginal reception **Kojonup transmitter:** *'poor' to 'none' coverage in region* 18 dwellings (10 Project participants) in potential interference zone **Wagin transmitter:** *'poor' to 'variable' coverage in region* 14 dwellings (8 Project participants) in potential interference zone **Southern Agricultural transmitter:** *'variable' to 'good' coverage in region* 18 dwellings (13 Project participants) in potential interference zone	**Kojonup, Wagin and Southern Agricultural transmitter** No concerns raised.	**Kojonup transmitter:** Unlikely to cause interference, as nearby dwellings are not expected to be receiving signals **Wagin and Southern Agricultural transmitters:** Likely to cause interference at some dwellings within approximately 5-10 km, if those dwellings are currently receiving a weak signal	<u>If required</u> – 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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[51] Australian Government, "VAST - Viewer Access Satellite Television," [Online]. Available: https://www.myvast.com.au/. [Accessed 7 December 2015].

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

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

[54] 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.

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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 [40] states the following with regard to interference to DTV reception:

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

DNV has drawn two conclusions from this report:

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

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

- the proximity of 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 [49]. Both of these effects can potentially degrade the DTV signal quality.

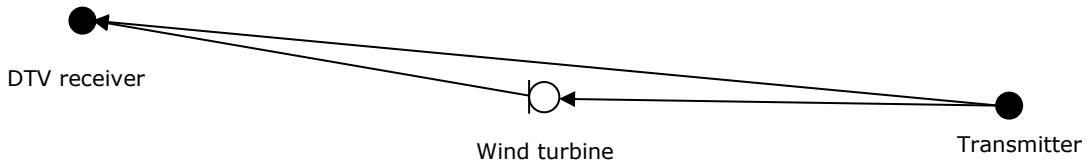

Figure A.1 Forward scatter signal path for DTV signals

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).

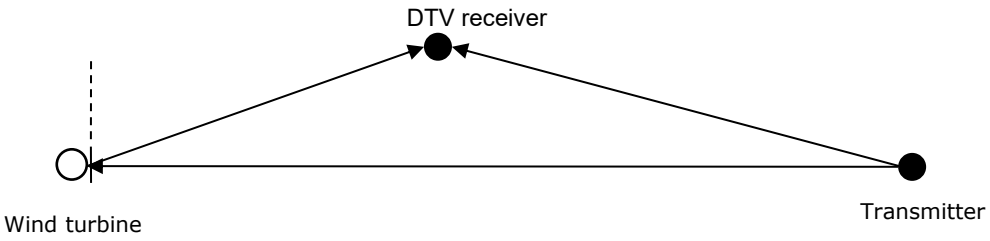

Figure A.2 Back scatter signal path for DTV signals

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 [49].

According to Ofcom [40], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [47, 52]. Interference may extend beyond 5 km if the dwellings are screened from the broadcast transmitter, but do have line-of-sight to the turbines [40]. The shape of this region, assuming a relatively high gain, directional antenna, can be represented by a circular segment with an azimuthal range of approximately ±15° to ±20°, corresponding to the beam width of the antenna. If a lower gain or omni-directional antenna is being used, this region is likely to be larger.

Back scattered signals arrive at the dwelling delayed relative to the source signal from the broadcast transmitter. The back scatter region generally does not extend further than 500 m [47, 40], assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio, or an omni-directional antenna is used, this region is likely be larger.

The combination of the forward and back scatter regions, as shown in Figure A.3, resembles a keyhole.

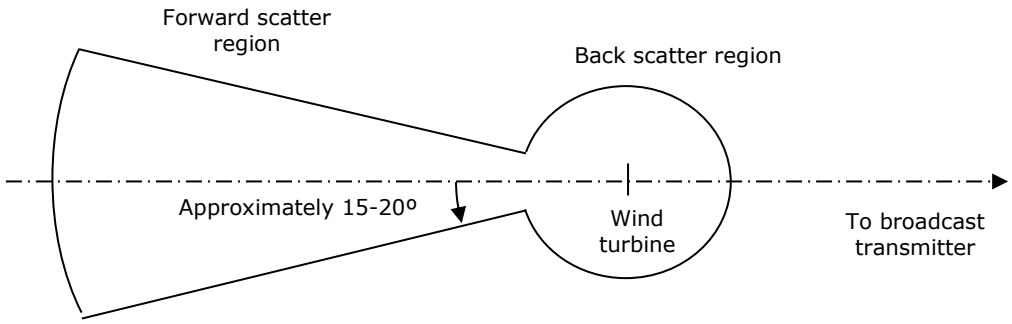

Figure A.3 Potential television interference zones around a wind turbine

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 [53] 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 [50] 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 [50].

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 [54]. 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 [53], 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 [40]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

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Table 6 Proposed turbine layout for the Project [2]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation[2] [m]
T01	511793	6246626	350	T18	511840	6241639	374
T02	512289	6245670	360	T19	512700	6241211	370
T03	511332	6245747	342	T20	513509	6240997	372
T04	512091	6244646	346	T21	512295	6240979	366
T05	511400	6244934	347	T22	511492	6240417	366
T06	511361	6243131	347	T23	510837	6240988	342
T07	512562	6243769	344	T24	513168	6240310	378
T08	513448	6243714	355	T25	511446	6239717	358
T09	513619	6243050	361	T26	511600	6238792	347
T10	514798	6242430	357	T27	512370	6238638	355
T11	513617	6242225	380	T28	512022	6237851	351
T12	512216	6242161	348	T29	511102	6238495	348
T13	511270	6242263	362	T30	510545	6237941	359
T14	510288	6242753	345	T31	509485	6237940	357
T15	509244	6242775	317	T32	510300	6237162	353
T16	509593	6242116	337	T33	509462	6237113	357
T17	510670	6241802	348				

2. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer 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.
3. Base elevations have been determined by DNV based on publicly available SRTM data.

Table 7 Dwellings within 5 km of the proposed Project boundary [3]

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
1	*514474*	*6243010*	*Project participant*	*0.7*
2	*514104*	*6241464*	*Project participant*	*0.8*
3	*509187*	*6247267*	*Project participant*	*2.6*
4	*509385*	*6247137*	*Project participant*	*2.4*
5	507510	6242858	Not Project participant	1.7
6	*508214*	*6238071*	*Project participant*	*1.3*
7	515794	6239708	Not Project participant	2.6
8	*512059*	*6247860*	*Project participant*	*1.3*
9	*511465*	*6244182*	*Project participant*	*0.8*
10	*512476*	*6239944*	*Project participant*	*0.8*
11	516411	6242077	Not Project participant	1.7
12	516826	6242597	Not Project participant	2.0
14	*510096*	*6239305*	*Project participant*	*1.3*
15	516903	6244382	Not Project participant	2.9
16	*508552*	*6242094*	*Project participant*	*1.0*
17	*508333*	*6242258*	*Project participant*	*1.0*
18	*509753*	*6240705*	*Project participant*	*1.1*
19	*509758*	*6240878*	*Project participant*	*1.1*
20	507264	6240722	Not Project participant	2.7
21	516125	6248508	Not Project participant	4.7
22	515698	6248505	Not Project participant	4.3
23	516205	6248460	Not Project participant	4.8
24	508042	6236697	Not Project participant	1.5
25	516062	6248278	Not Project participant	4.6
26	512008	6250262	Not Project participant	3.6
27	508333	6240815	Not Project participant	1.8
28	508125	6244601	Not Project participant	2.1
29	*509340*	*6239277*	*Project participant*	*1.3*
30	507955	6245627	Not Project participant	3.1
31	*509990*	*6240459*	*Project participant*	*1.0*
32	507108	6238379	Not Project participant	2.4
33	516309	6234370	Not Project participant	5.5
35	507012	6242199	Not Project participant	2.3
36	510578	6253215	Not Project participant	6.7
50	514199	6251380	Not Project participant	5.3
53	504588	6237943	Not Project participant	4.9
54	504162	6244306	Not Project participant	5.3
55	506178	6244093	Not Project participant	3.3
57	517336	6248196	Not Project participant	5.6
58	518968	6246239	Not Project participant	5.6
59	519100	6242652	Not Project participant	4.3
60	517929	6241285	Not Project participant	3.3
61	517493	6239099	Not Project participant	4.3
62	513358	6234241	Not Project participant	3.8
63	514494	6237502	Not Project participant	2.4
68	503362	6237104	Not Project participant	6.1
69	503099	6235528	Not Project participant	6.6
71	507500	6233474	Not Project participant	4.1
72	515602	6251681	Not Project participant	6.3
73[3]	508394	6233003	Not Project participant	4.2
73[3]	510010	6235079	Not Project participant	2.1

Table 7 Dwellings within 5 km of the proposed Project boundary [3] (continued)

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Status	Distance to nearest turbine [km]
74	514190	6251387	Not Project participant	5.3
76	511505	6253366	Not Project participant	6.7
77	504184	6240872	Not Project participant	5.4
80	517992	6244911	Not Project participant	4.0
82	508310	6231888	Not Project participant	5.4
158	517992	6244911	Not Project participant	4.0
188	508310	6231888	Not Project participant	5.4

1. Project participants are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer 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.
3. Duplicate ID provided by Customer.

Table 8 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
9227741	10008317	11672856/1	-33.7916	117.5164	37	
9227742	10008317	11672856/1	-33.7916	117.5164	37	
3593378	9011357	1968902/2	-33.8058	116.7198	38	
3593379	9011357	1968902/2	-33.8058	116.7198	38	Electricity Networks Corporation Western Power GPO Box L921 Attn: Comms Operations & Maintenance PERTH WA 6842
1235606	9011356	1939588/1	-34.3000	117.5941	52	
1235609	9011356	1939588/1	-34.3000	117.5941	52	
9227765	9011356	11672862/1	-34.3000	117.5941	52	
9227766	9011356	11672862/1	-34.3000	117.5941	52	
7611195	603280	11195360/1	-33.7482	116.3377	74	
7611196	603280	11195360/1	-33.7482	116.3377	74	
1235504	28511	1924989/1	-33.8743	117.9677	74	
1235507	28511	1924989/1	-33.8743	117.9677	74	
9227749	10029177	11672858/1	-33.8740	117.9679	74	
9227750	10029177	11672858/1	-33.8740	117.9679	74	
819166	461487	1452259/1	-34.3694	117.0118	40	Quenby Viticultural Services Pty Ltd PO Box 383 MOUNT BARKER WA 6324
819173	461487	1452259/1	-34.3694	117.0118	40	
1250123	28330	1607438/1	-33.7922	117.5184	37	
1250124	28330	1607438/1	-33.7922	117.5184	37	
1251256	28330	1966624/1	-33.7922	117.5184	37	Water Corporation Water Corporation PO Box 100 LEEDERVILLE WA 6902
1251259	28330	1966624/1	-33.7922	117.5184	37	
10279404	28330	11969745/1	-33.7922	117.5184	37	
10279407	28330	11969745/1	-33.7922	117.5184	37	
1249532	9000382	1141545/1	-33.6985	117.5583	45	
1249535	9000382	1141545/1	-33.6985	117.5583	45	
1250733	9007255	1901014/1	-33.8419	116.3761	67	
1250736	9007255	1901014/1	-33.8419	116.3761	67	

Table 9 Details of other licences identified within 75 km of the proposed Project

Licence category	Licence type	Number of assignment IDs
1800 MHz Band	Spectrum	72
2 GHz Band	Spectrum	40
2.3 GHz Band	Spectrum	1558
2.5 GHz Band	Spectrum	44
3.4 GHz Band	Spectrum	222
700 MHz Band	Spectrum	396
800 MHz Band	Spectrum	226
850/900 MHz Band	Spectrum	124
AWL - Standard	Spectrum	36
Aeronautical Assigned System	Aeronautical	2
Amateur Repeater	Amateur	20
Ambulatory System	Land Mobile	2
CBRS Repeater	Land Mobile	6
Commercial Radio	Broadcasting	2
Commercial Television	Broadcasting	9
Earth Receive	Earth Receive	1
Fixed Receive	Fixed Receive	2
Land Mobile System - > 30MHz	Land Mobile	326
Land Mobile System 0-30MHz	Land Mobile	84
Narrowband Area Service station(s)	Broadcasting	1
Narrowcasting Service (Fixed Tax)	Broadcasting	1
Narrowcasting Service (LPON)	Broadcasting	13
National Broadcasting	Broadcasting	10
PMTS Class B	PTS	58
Paging System - Interior	Land Mobile	2
Retransmission (Out of Area)	Broadcasting	1

Table 10 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Department of Biodiversity Conservation and Attractions	Department of Biodiversity Conservation and Attractions Att: Coordinator, Telecommunications Systems Locked Bag 104 Office of Information Management BENTLEY DC WA 6983	42
Department of Fire and Emergency Services of Western Australia	Department of Fire and Emergency Services of Western Australia Attn Manager Radio Communications PO Box P1174 PERTH WA 6844	3
St John Ambulance Western Australia Ltd.	St John Ambulance Western Australia Ltd. PO Box 183 BELMONT WA 6104	6
St John Ambulance Western Australia Incorporated	St John Ambulance Western Australia Incorporated Technical Services 601-609 Blackburn Road NOTTING HILL VIC 3168	37
Western Australia Police	Western Australia Police Radio & Electronic Services Unit 21 Swanbank Road Att: Phillip Manna MAYLANDS WA 6051	6

Table 11 Bureau of Meteorology radar sites in the vicinity of the proposed Project

Site ID	Site name	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
140115	Bureau of Meteorology Met Office Albany Airport ALBANY	-34.9418	117.8164	120
10000625	Off Lake Grace-Newdegate Road NEWDEGATE	-33.0970	119.0087	195
138152	Bureau of Meteorlogy across the road from runway Lot 164 (286) Yangedi Rd HOPELAND	-32.3917	115.8670	205
44829	Walnut Rd BICKLEY	-32.0077	116.1349	230
601351	Bureau of Meteorology Office Northern Perimeter Road PERTH AIRPORT	-31.9274	115.9765	244
10000627	BOM Station Approximately 1.2km South of Fire Road SOUTH DOODLAKINE	-31.7770	117.9529	248
10000636	Off Edawa Road	-30.3600	116.2896	400
30184	Bureau of Met Radar Fairfields Street ESPERANCE	-33.8163	121.8842	437

Table 12 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]
Byenup	AGD66, AGD84, GDA94	-33.955	117.306	13
Dumbleyung 90	GDA94	-33.965	117.034	5
Kojonup 4	GDA94	-33.823	117.175	10
Kojonup 6	GDA94	-33.844	117.156	7
Mount Barker 25	AGD66, AGD84, GDA94	-34.150	117.043	16
NT 10	AGD66, AGD84, GDA94	-33.863	117.217	9
NT 10 T	AGD84, GDA94	-33.863	117.217	9
NT 11	AGD66, AGD84, GDA94	-33.966	117.124	Within project boundary
NT 12	AGD66, AGD84, GDA94	-33.909	116.980	11
NT 13	AGD66, AGD84, GDA94	-33.922	117.012	8
NT 13T	GDA94	-33.922	117.016	8
NT 9	AGD66, AGD84, GDA94	-33.862	117.075	7
Pemberton 2	AGD66, AGD84, GDA94	-34.105	116.954	16
R233T	GDA94	-33.742	117.230	20
Thornton	AGD66, AGD84, GDA94	-33.743	117.228	20

Table 13 Satellite vectors with potential to be intercepted by the proposed Project

Intercepted satellite	Services provided [55]	Affected dwellings[1]
NSS 9	Programs intended for Australian audiences	*18*

1. Project participants are indicated by *underlined italic text*.

Table 14 Dwellings with increased potential to experience EMI to DTV from television broadcast transmitters

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Located in potential interference zone		
			Kojonup	Southern Agricultural	Wagin
1	*514474*	*6243010*		*X*	
2	*514104*	*6241464*			
3	*509187*	*6247267*		*X*	
4	*509385*	*6247137*		*X*	
5	507510	6242858			
6	*508214*	*6238071*	*X*	*X*	*X*
7	515794	6239708	X		
8	*512059*	*6247860*		*X*	
9	*511465*	*6244182*	*X*	*X*	*X*
10	*512476*	*6239944*	*X*		*X*
11	516411	6242077			
12	516826	6242597			
14	*510096*	*6239305*	*X*	*X*	*X*
15	516903	6244382			
16	*508552*	*6242094*	*X*	*X*	
17	*508333*	*6242258*	*X*	*X*	
18	*509753*	*6240705*	*X*	*X*	*X*
19	*509758*	*6240878*	*X*	*X*	*X*
20	507264	6240722	X	X	
24	508042	6236697			
27	508333	6240815	X	X	X
28	508125	6244601		X	
29	*509340*	*6239277*	*X*	*X*	*X*
30	507955	6245627		X	
31	*509990*	*6240459*	*X*	*X*	*X*
32	507108	6238379	X		X
35	507012	6242199		X	
60	517929	6241285			
61	517493	6239099			
62	513358	6234241			
63	514494	6237502	X		X
71	507500	6233474	X		X
73[3]	508394	6233003	X		X
73[3]	510010	6235079	X		X

1. Project participants are indicated by *underlined italic text*.
2. Coordinate system: MGA zone 50, GDA94 datum. Coordinates were provided by the Customer 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.
3. Duplicate ID provided by Customer.

Table 15 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	Point-to-area (land mobile and CBRS repeater): 1020 m from nearest turbine	Shire of Kojonup 10559162-AUMEL-L-01-A	No response received to date
2	Fixed point-to-multipoint: 37 km from Project boundary	Western Power 10559162-AUMEL-L-02-A	Response received by email on 05 August 2025: *"…The proposed Kojonup Wind Farm turbines should not cause any EMI impact on any Western power's existing and currently proposed point to point Radio links. Also, the Point to multipoint DA remote radio service will have no EMI impact for the proposed turbine locations in Kojonup Wind farm area.* *Conclusion assumes (based on current data and analysis) that the proposed wind turbine locations for Kojonup Wind Farm could be constructed as proposed..."*
3	Fixed point-to-multipoint: 37 km from Project boundary	Water Corporation 10559162-AUMEL-L-03-A	No response received to date
4	Emergency services point-to-area: 42 km from Project boundary	Department of Biodiversity Conservation and Attractions 10559162-AUMEL-L-04-A	Response received by email on 19 September 2025 *"I would assume you will carry out the required engineering studies for the effects of EMI emissions that may affect any RF facility in the proximity and minimise the risks associated with interference as per ACMA requirements."* DNV response provided on 19 September 2025 *"Typically we will not model the EMI emissions, as the turbine manufacturers are better placed to undertake that sort of detailed assessment.* *In our EMI assessment we report that there is a Low likelihood of interference for DBCA licenses. In our report we justify the conclusion as follows…* *…If there is anything unclear in the above, please let us know."* No further response received to date.
5	Emergency services point-to-area: 1 km from nearest turbine	Department of Fire and Emergency Services of WA 10559162-AUMEL-L-05-A	Response received by email on 04 August 2025:

Table 15 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
			"..I have assessed this proposal and conclude this may have some effect on the Department of Fire and Emergency Services (DFES) VHF high-band communication in this region. *DFES do have a point-to-point link, however that is not within the line of site range of any of the proposed turbines. However, DFES do have a number of VHF services from several sites where this proposed wind farm falls inside the coverage radius of these services.* *One site that is a possible concern is the "10036639" Shire of Kojonup Radio Site Jingalup Road 15 km south of Kojonup. This is in very close proximity (1km) for the nearest towers @ -33.968532°,117.156703°. This site has two VHF mid-band services (ACMA needs updating) which my concern would be the EMI generated from turbines and whether this has any degradation on the VHF mid-band at this close proximity.* *I do not have enough information on the possible EMI emissions of turbines and if this is likely to cause degradation on any of our services (including the Shire of Kojonup site) to make an assessment, however I will flag these are current services do not experience any issues currently, and emphasis the terrain in this area adds to the difficulty of effective radio communications already, any degradation would be an impact to the local fire services..."* The following information was shared with DNV by the Customer on 19 September 2025. Response received by email on 19 September 2025: *"Thank you for following up on the EMI emissions. With these figures I'm happy that there is minimal chance of degradation on our services."*
6	Emergency services point-to-area: 6 km from Project boundary	St John Ambulance Western Australia Ltd 10559162-AUMEL-L-06-A	Response received by email on 28 July 2025: *"…I have reviewed the information you sent, and I don't see any impact on St John Services.* *The information also shows that the distance from St John Radio assets is adequate…"*
7	Emergency services point-to-area: 6 km from Project boundary	Western Australia Police 10559162-AUMEL-L-07-A	Response received by email on 18 September 2025: *"…WA Police has reviewed the proposal details* *Based on the information supplied, WA Police has "approved" as acknowledgment that the proposal would not interfere with operational outcomes based on the information supplied…"*

Table 15 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
8	Spectrum (wireless internet): 6 km from Project boundary	Optus 10559162-AUMEL-L-09-A	Response received by email on 29 July 2025: *"…Our technical team has reviewed this proposal and advised no interference issues with Optus equipment…."*
9	Spectrum (wireless internet): 6 km from Project boundary	Telstra 10559162-AUMEL-L-10-A	No response received to date
10	Spectrum (wireless internet): 6 km from Project boundary	Vodafone 10559162-AUMEL-L-11-A	Response received by email on 05 August 2025: *"…TPG-T/Vodafone has assessed this advice in two parts:* *A. Near Field Impact to existing and near future Public Mobile Telephone Coverage, and* *B. Impact to existing or near future microwave point to point links (which may impact connection services to our Public Mobile Telephone Coverage sites).* *Regarding Point A:* *The nearest TPG-T/Vodafone existing, or near future Public Mobile Telephone Coverage site, is over 88km from the proposed locations of the wind farm turbines. As such, there is no prohibitive or significant near field impact to our Public Mobile Telephone coverage.* *It is noted that Optus have sites located near the proposed windfarm boundary/turbines that are used by Vodafone customers as part of our Regional Sharing Agreement with Optus. It is expected that Optus will be consulted as part of the EMI assessment to determine whether their Mobile infrastructure assets are impacted.* *Regarding Point B:* *Purna, from our Transmission team has responded below and advised there is no impact to our existing transmission network…"*
11	Spectrum (wireless internet): 6 km from Project boundary	NBN 10559162-AUMEL-L-12-A	*Response received by email on 19 September 2025*

Table 15 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
			"I have reviewed the data provided based on the proposed wind farm location ; the wind farm has no overlapping areas with existing nbn wireless coverage boundaries. There are no nbn customers inside the wind farm boundary and the proposed wind tower locations pose no risk of introducing a physical obstruction along any customer RF profiles. [see images below]. *There is also no impact on any existing or planned nbn microwave links in this area.* *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].* *Potential Impacts of the Proposed Ambrosia Wind Farm on NBN Co Spectrum Communication Assets. Referring to your email dated 1st Sep 2025 regarding the application for the Ambrosia Wind Farm. We confirm that NBN Co Spectrum Pty Ltd (nbn Spectrum) has a number of spectrum licenses within 75 km of the proposed Ambrosia Wind Farm.* *nbn have strict obligations to provide internet services to the community, and this area has been determined as a FW service area where the footprint of this service is now in place. nbn will be forced to consider its position as part of the planning should there 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."*
12	DTV broadcasting: 6.5 km from Project boundary	BAI Communications 10559162-AUMEL-L-13-A	*Response received by email on 19 September 2025:*

Table 15 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
			"BAI Communications (BAI) has conducted a study on the proposed Kojonup Creek Wind Farm located near Kojonup, Western Australia. The impact on three digital television broadcast facilities was studied. Interference analysis predicts that DTV *services from Mt Barker [southern agricultural] will be affected by the proposed wind farm.* *BAI has modelled the proposed Kojonup Wind Farm to assess how they will affect DTV services in ATDI HTZ Communications. The DTV broadcast sites that have been identified to provide coverage around the area of the wind farm* *…* *There is no impact predicted from the wind farms to the digital TV reception from Kojonup.* *Figure 5 below shows the interference affected area to Mt Latham RT [Wagin] DTV coverage. Population analysis using ABS census data (2021) was conducted on the interference affected areas and it found that no people are predicted to be in the low-risk or high-risk areas. Upon closer inspection on Google Earth of the predicted interference, no households were observed to be contained within the interference areas.* *Figure 6 below shows the interference affected area to Mt Barker [Southern Agricultural] DTV coverage. Population analysis using ABS census data (2021) was conducted on the interference affected areas and it found that 2 people were in the low-risk area (orange) of having degraded digital television reception. Upon closer inspection on Google Earth of the predicted interference, no households were observed to be contained within the interference areas* *BAI has conducted field tests on existing wind farms in the past for the impact on FM services. The field test measurements concluded that FM radio had some minor reflections observed but these would not be expected to cause any noticeable effect on reception. Thus, it is not considered necessary to consider any impacts on FM broadcast services.* *The closest BAI AM Broadcast service is over 50 km away, so no assessment is deemed necessary.* *According to BAI records, there are no off-air links operating from/to BAI sites over the Kojonup Wind Farm area.*
13	Trigonometrical station: 219 m from nearest turbine	Geoscience Australia 10559162-AUMEL-L-14-A	Response received by email on 15 September 2025

Table 15 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
	GNSS station: 50 km from Project boundary		*"Thank you for consulting us with this information. Geoscience Australia does not foresee any interference to our GNSS infrastructure as a result of the proposed Kojonup Wind Farm."*
14	Spectrum (wireless internet): 34 km from Project boundary	Pivotel mobile Pty Ltd 10559162-AUMEL-L-15-A	No response received to date
15	Meteorological radar: 120 km from Project boundary	Bureau of Meteorology	<u>The following information was shared with DNV by the Customer on 15 September 2025</u> <u>Response received by email on 20 August 2025:</u> *"…Our assessment of the current Kojonup wind farm proposal has determined that, under normal atmospheric conditions, it poses a manageable risk to Bureau radar and radiocommunication assets.* *As a result, the Bureau has no objections to the proposed development proceeding, as detailed in the documentation provided for assessment.* *Modifications to the wind farms parameters, including layout designs, turbine locations, or heights, will require a new assessment…"*

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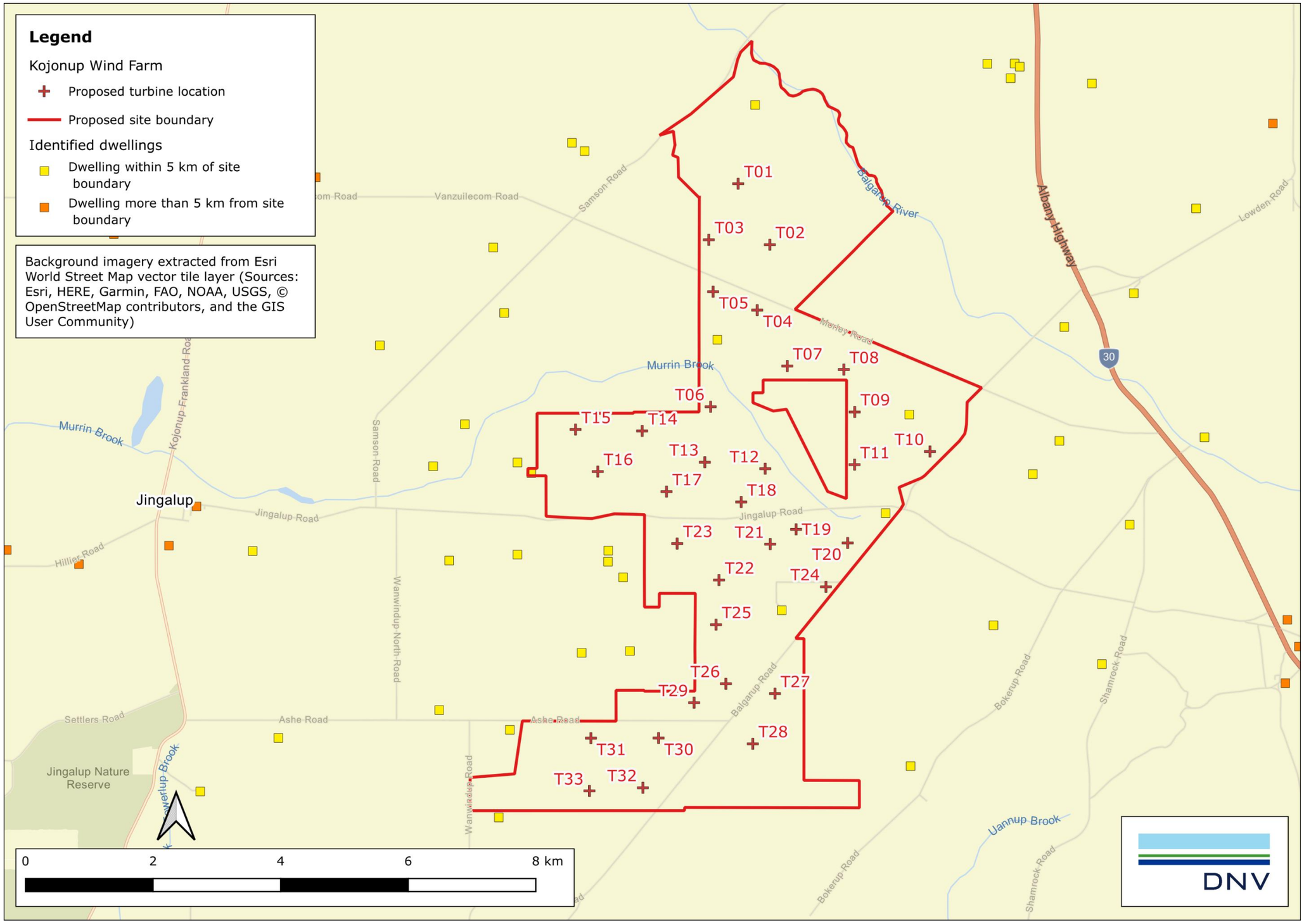

Figure 1 Map of the proposed Project, showing proposed boundary, turbine locations, and locations of nearby dwellings

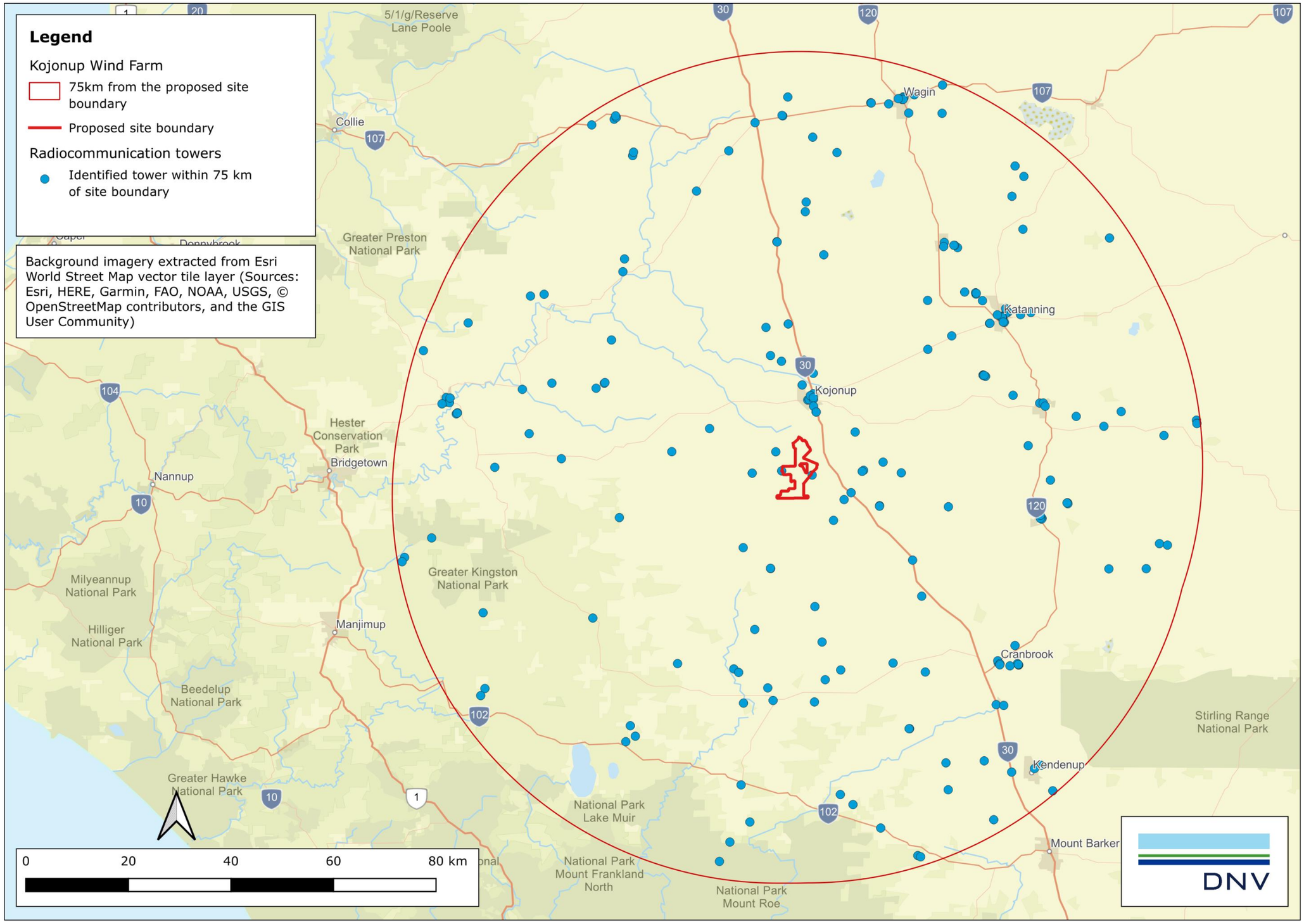

Figure 2 Location of the proposed Project and identified nearby radiocommunication sites

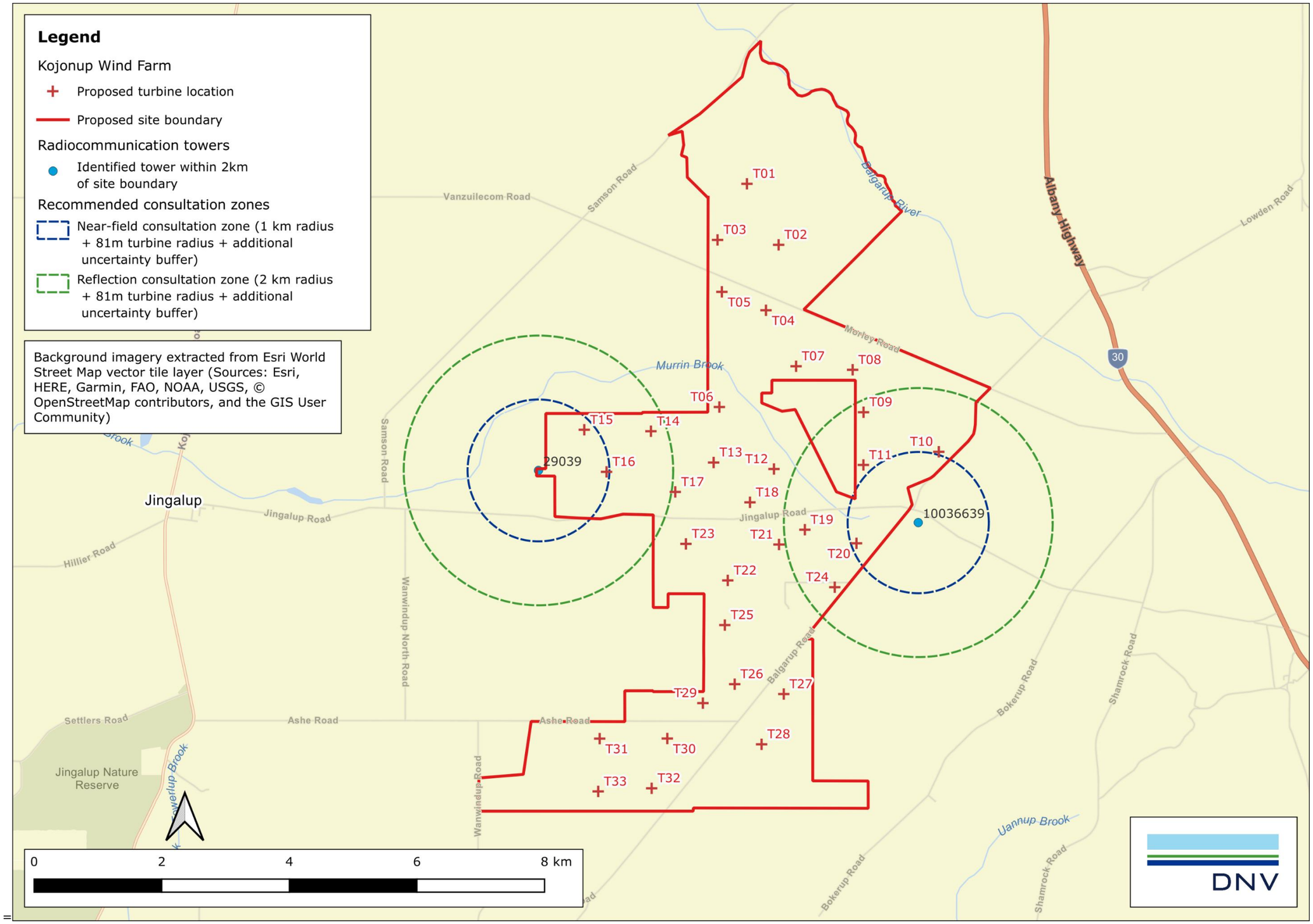

Figure 3 Identified radiocommunication sites within 2 km of the turbine locations for the proposed Project

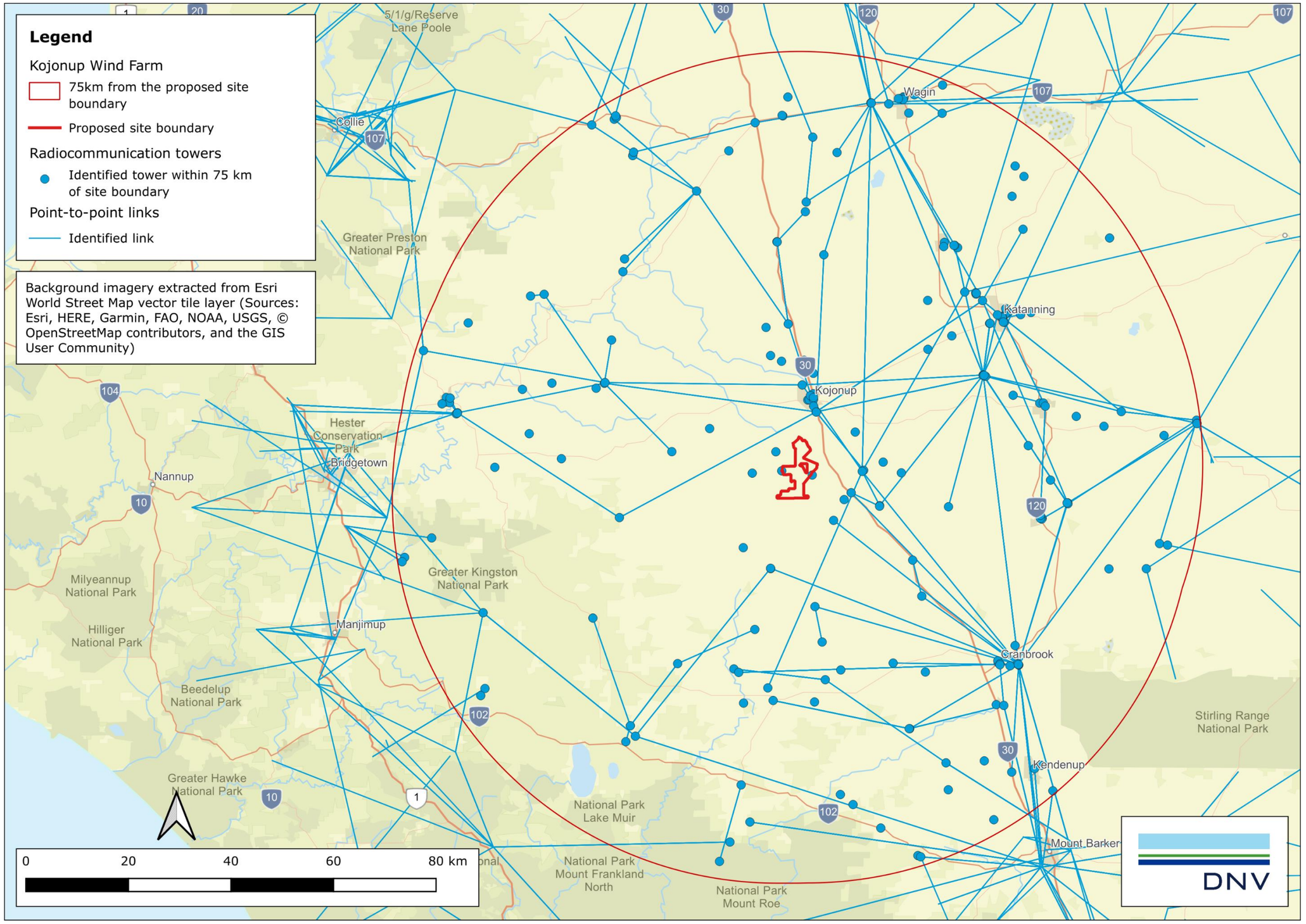

Figure 4 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

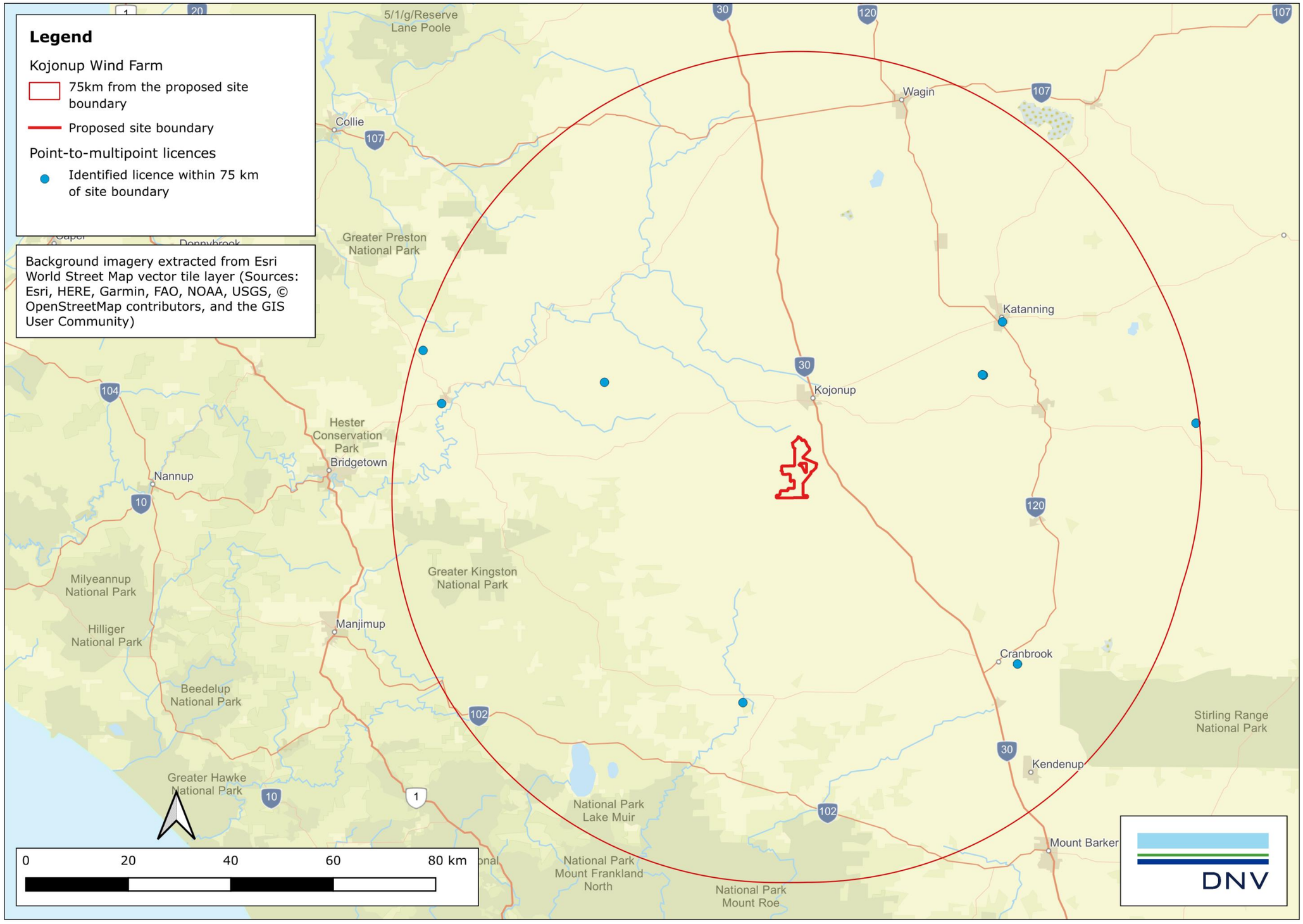

Figure 5 Location of point-to-multipoint licences in the vicinity of the proposed Project

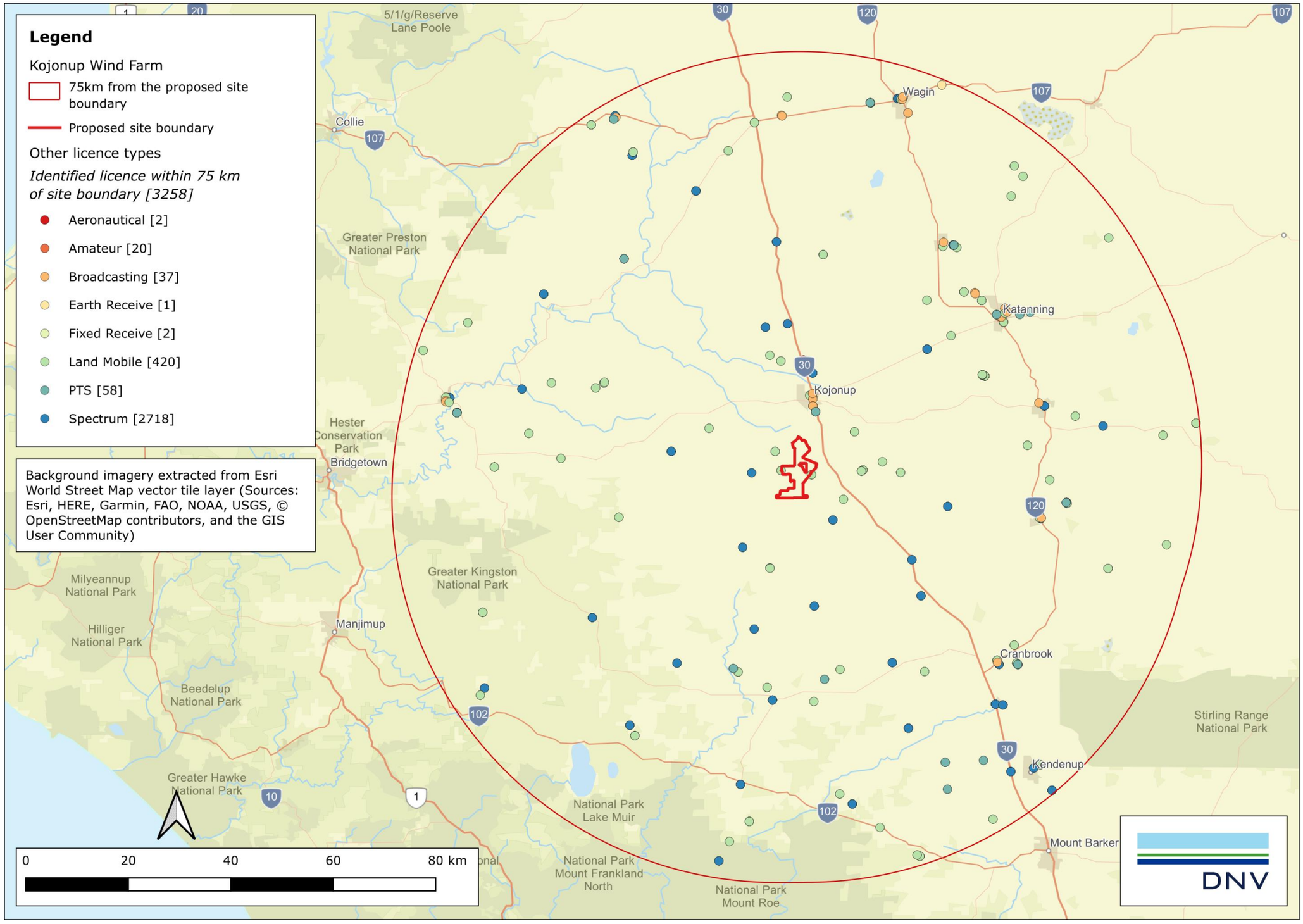

Figure 6 Location of other licence types within 75km of the proposed Project

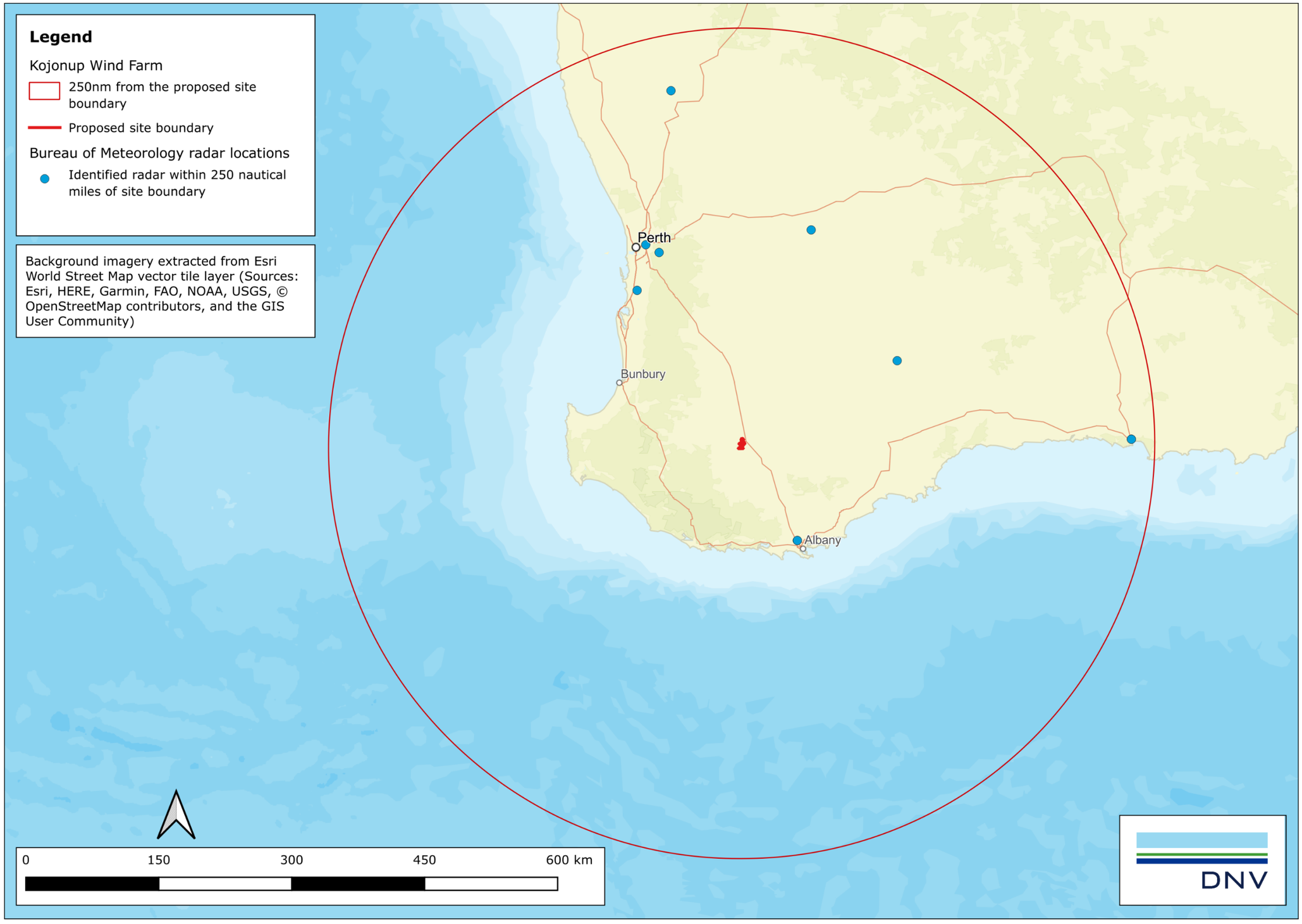

Figure 7 Location of meteorological radar sites within 250 nautical miles of the proposed Project

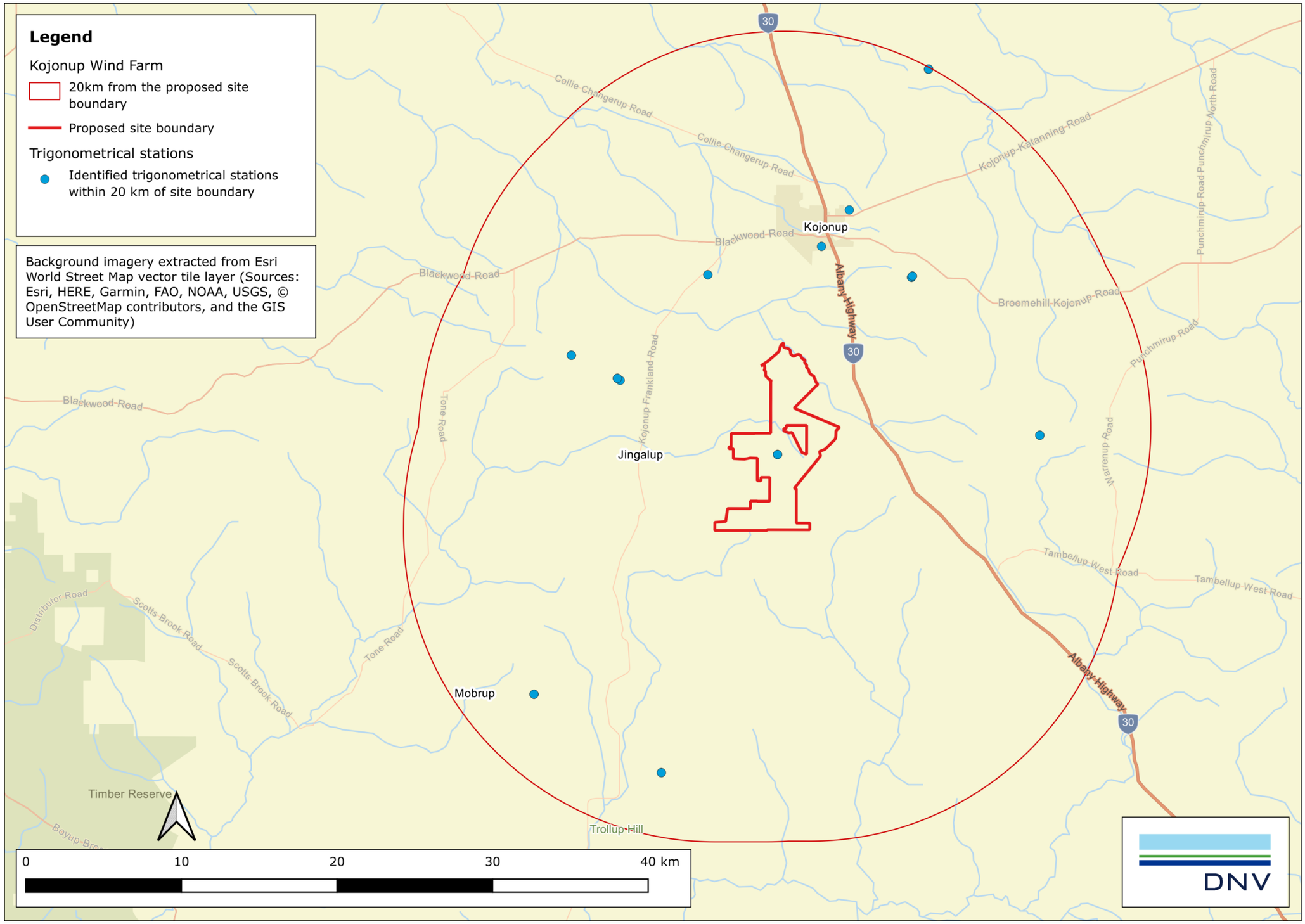

Figure 8 Location of trigonometrical stations within 20 km of the proposed Project

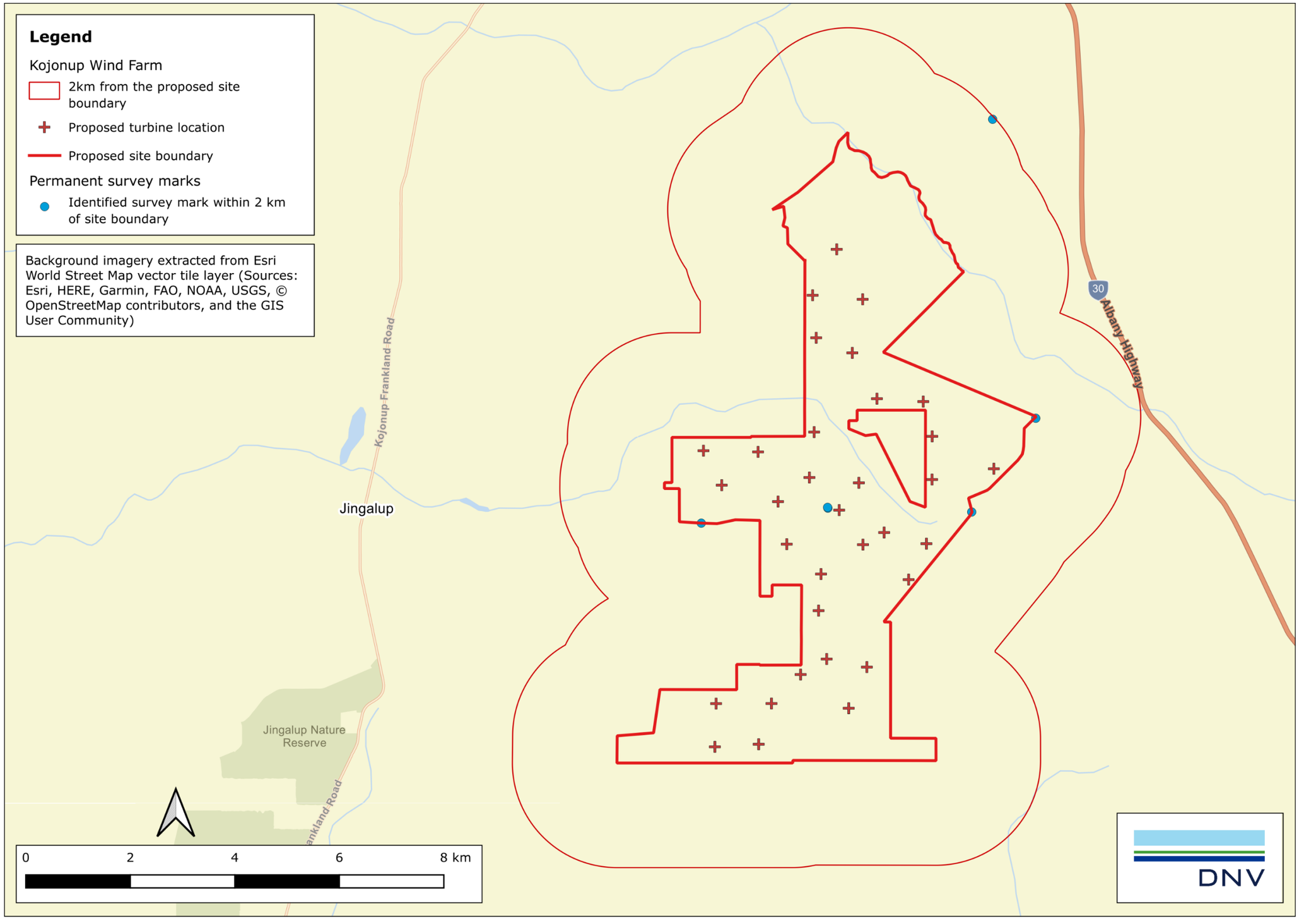

Figure 9 Location of permanent survey marks within 2 km of the proposed Project boundary

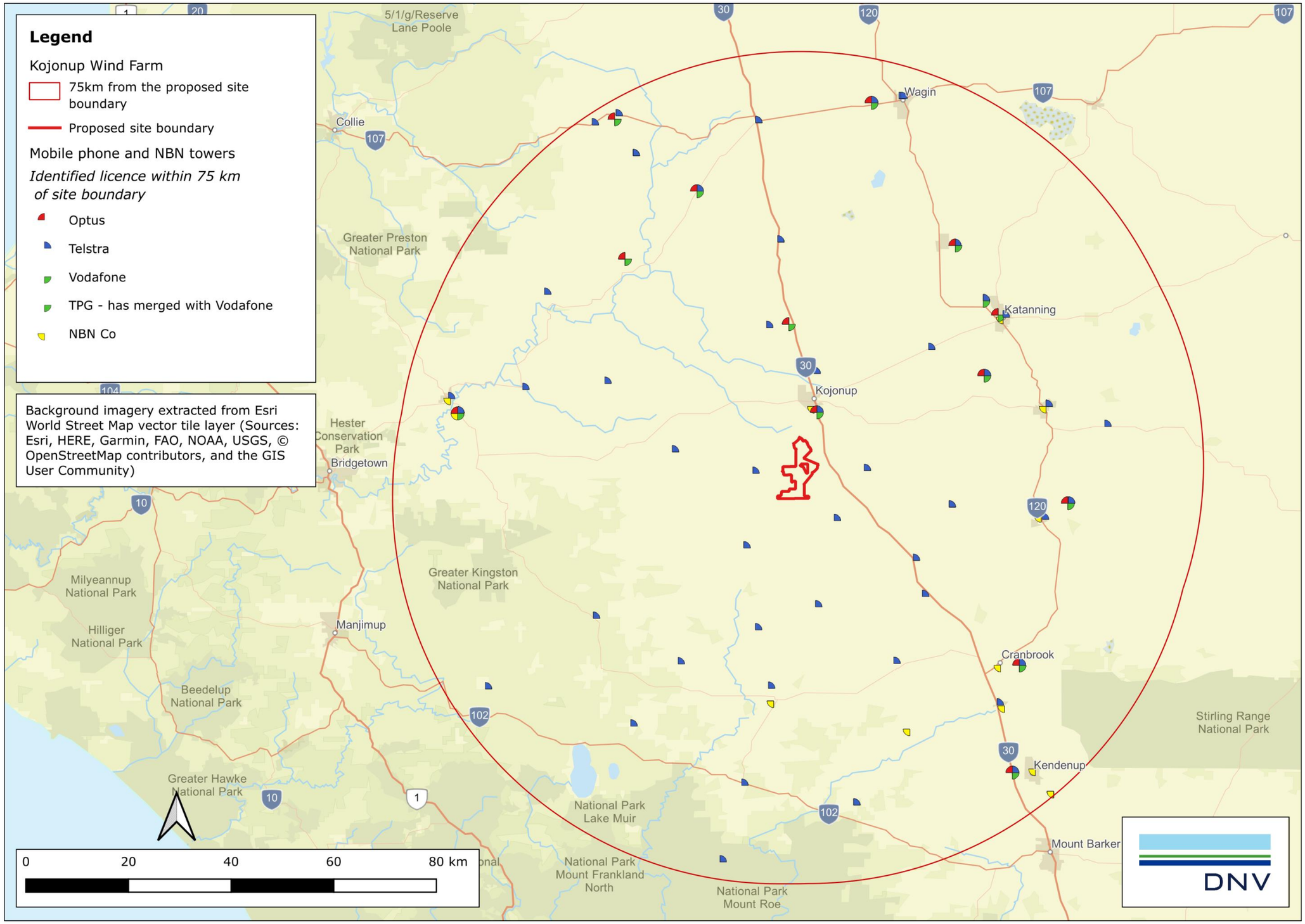

Figure 10 Location of mobile phone and NBN towers within 75 km of the proposed Project

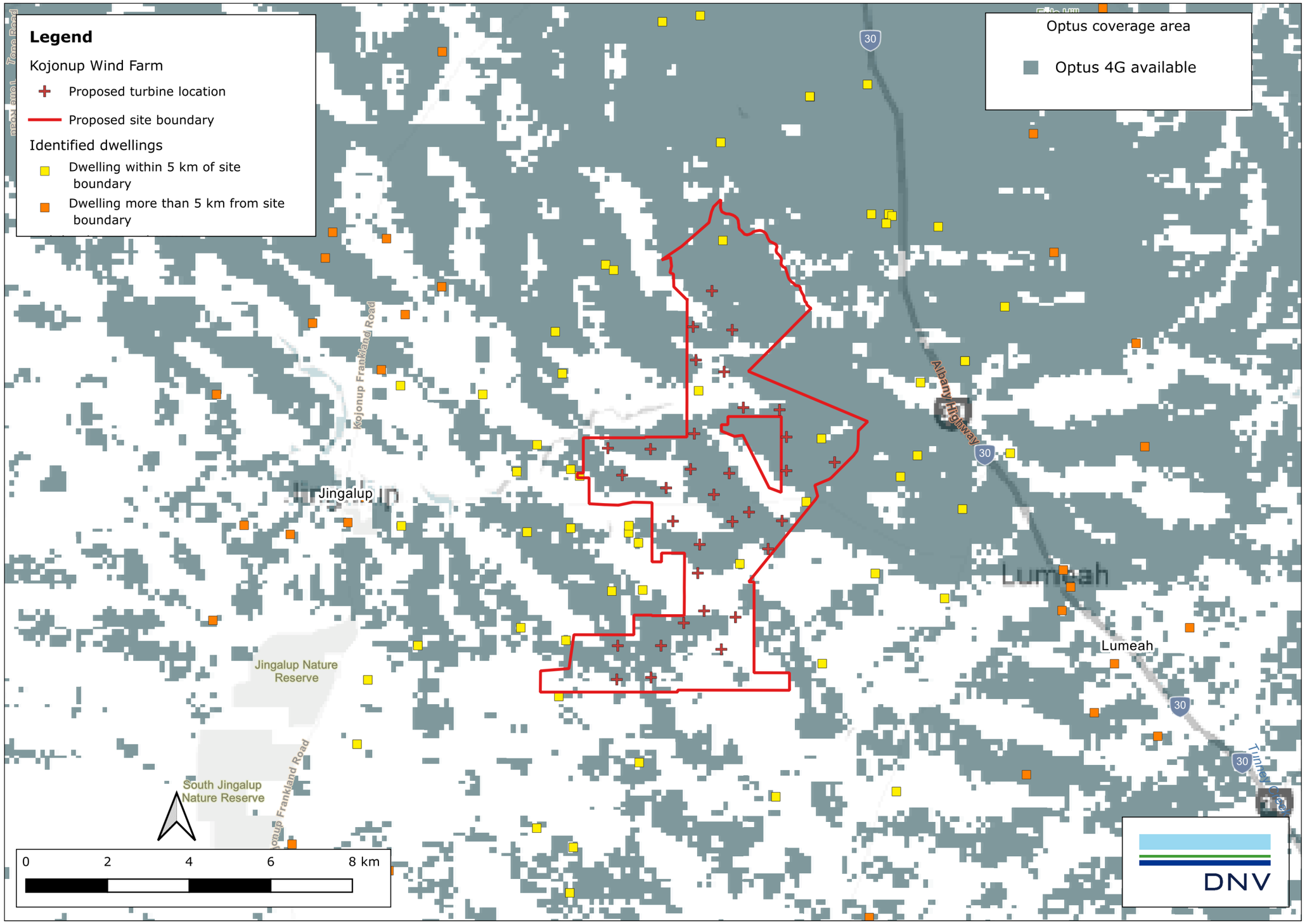

Figure 11 Optus Mobile 4G network coverage for the proposed Project

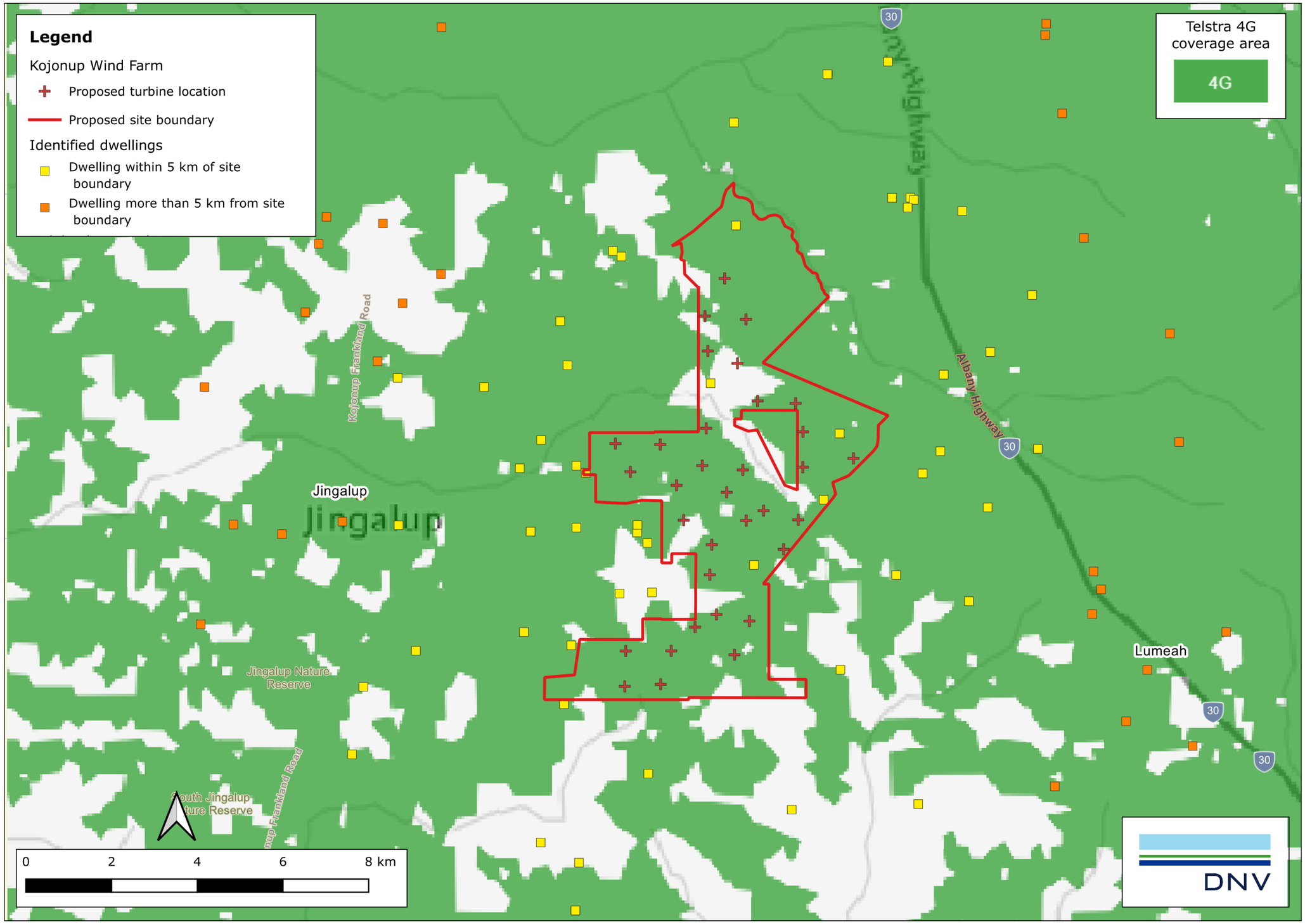

Figure 12 Telstra 4G network coverage for the proposed Project

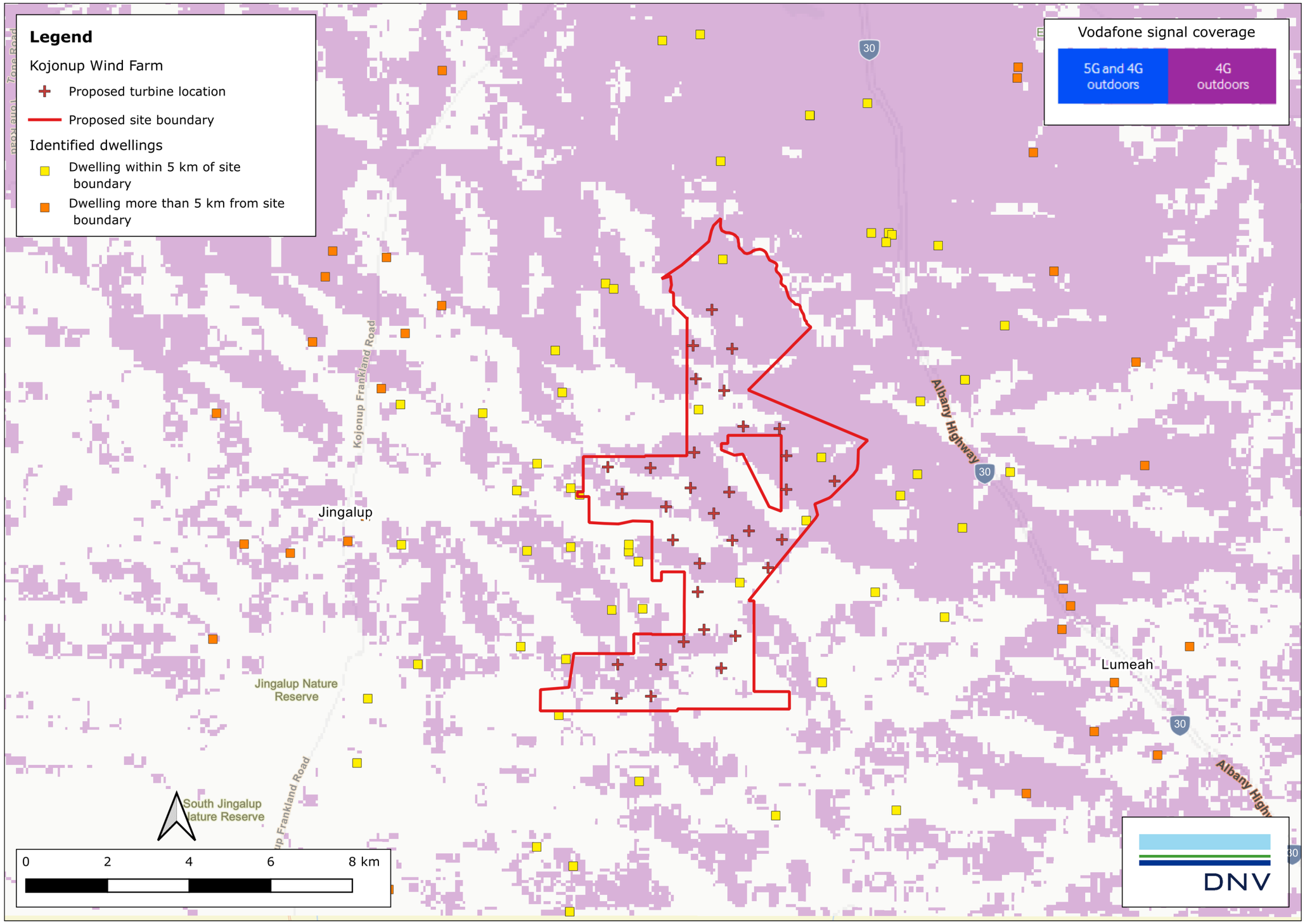

Figure 13 Vodafone/TPG network coverage (Apple iPhone 13 handset) for the proposed Project

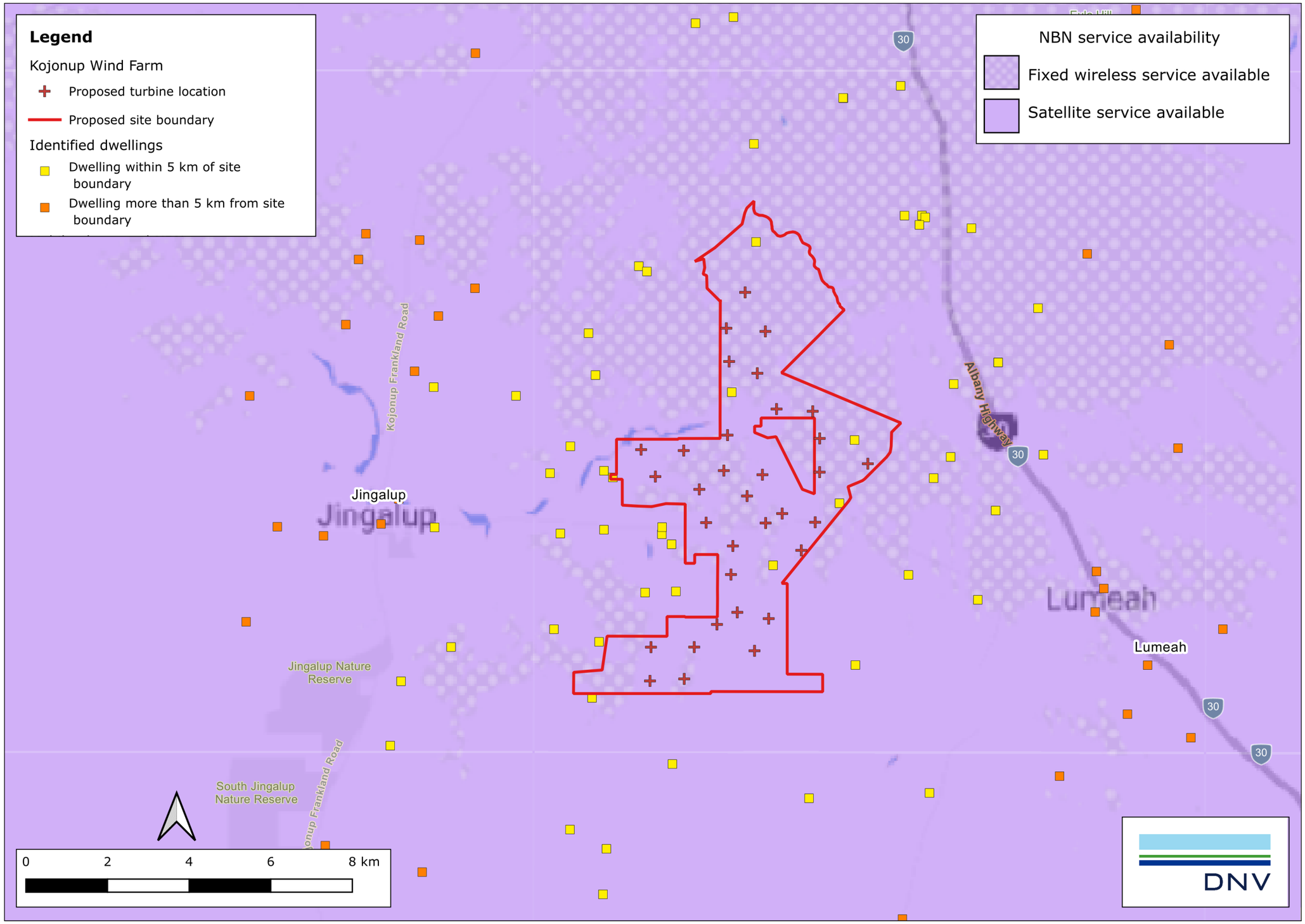

Figure 14 NBN internet coverage in the vicinity of the proposed Project

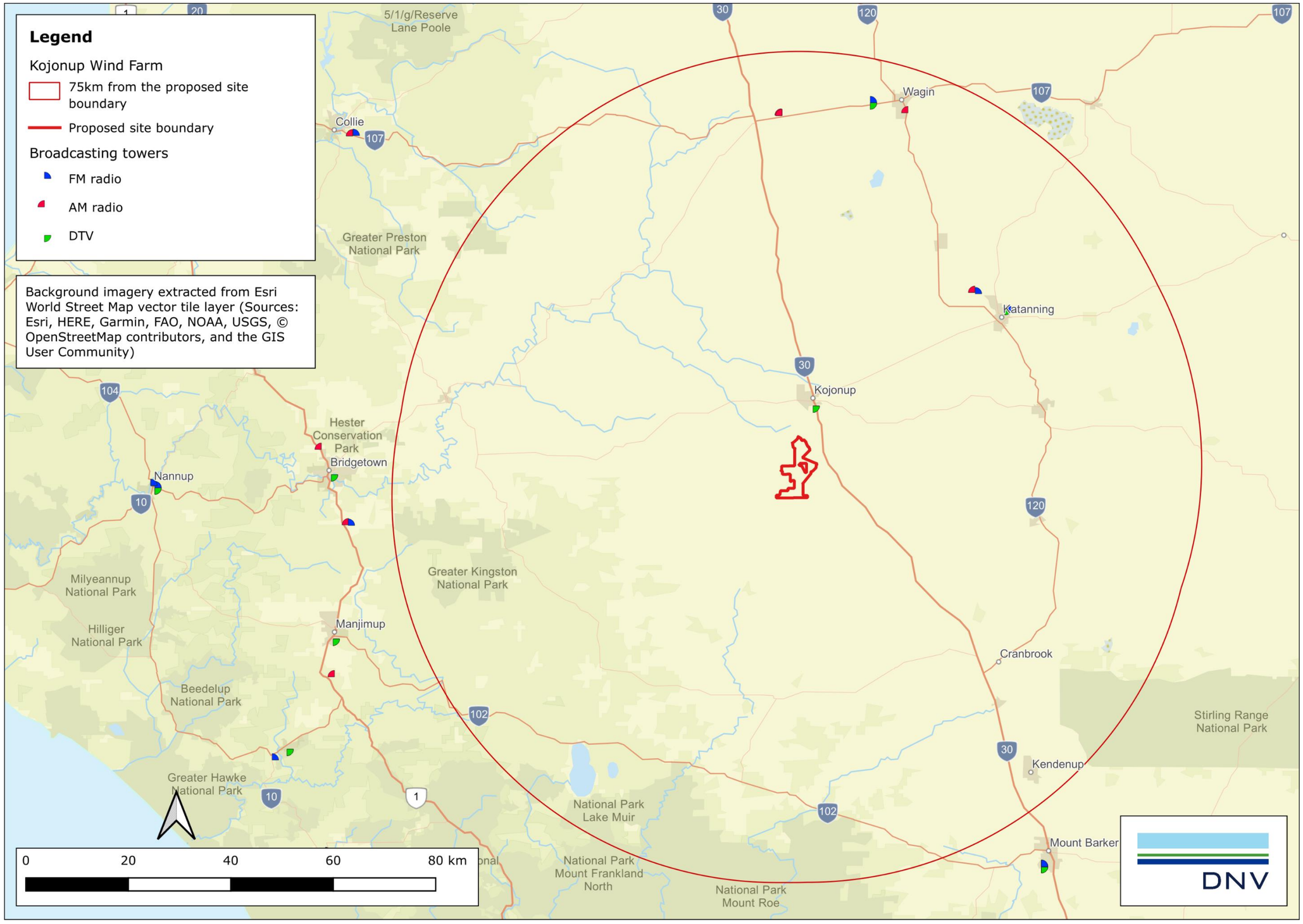

Figure 15 Location of broadcast transmitters in the vicinity of the proposed Project

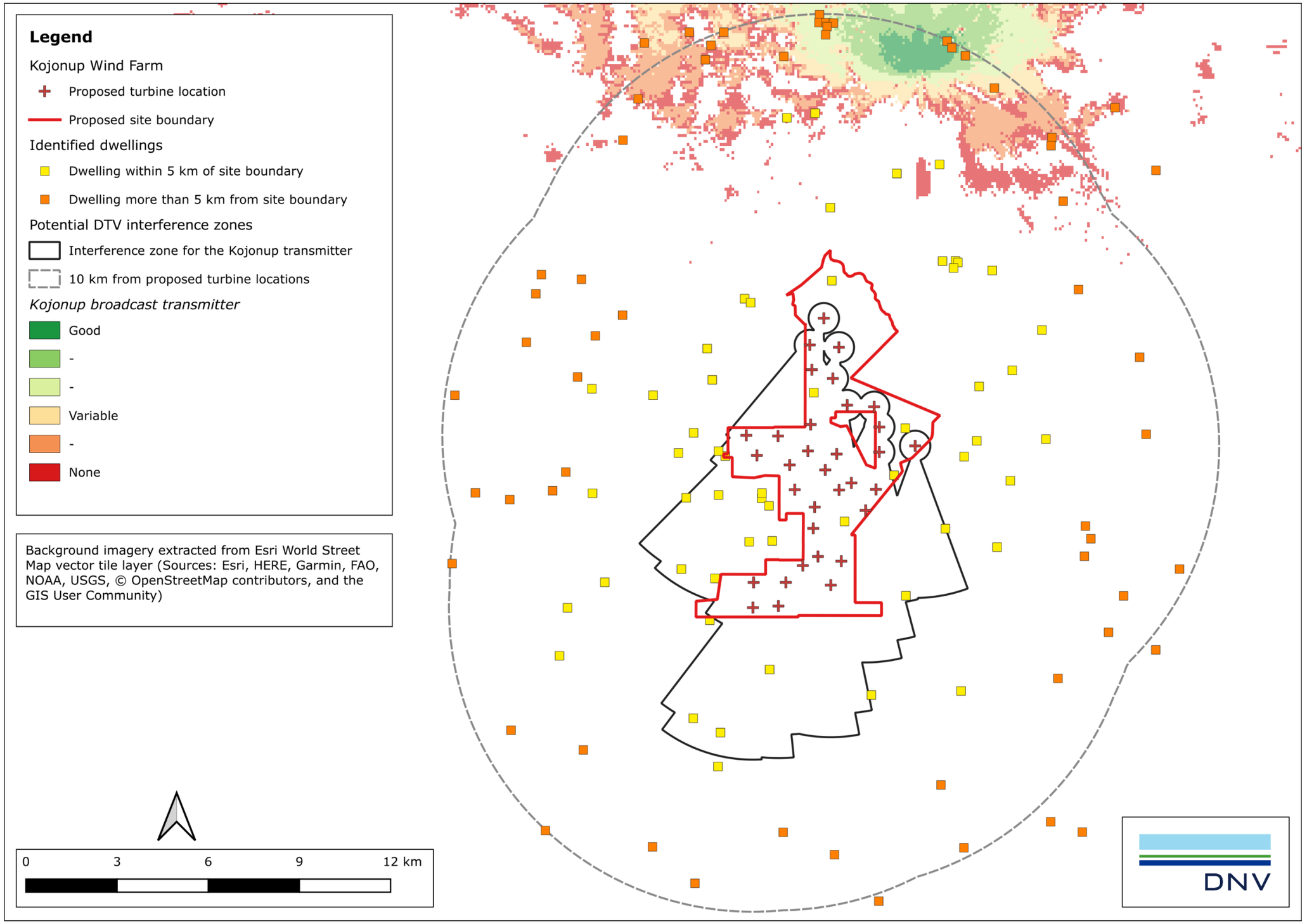

Figure 16 Potential television EMI zones for the Kojonup broadcast transmitter from the proposed Project

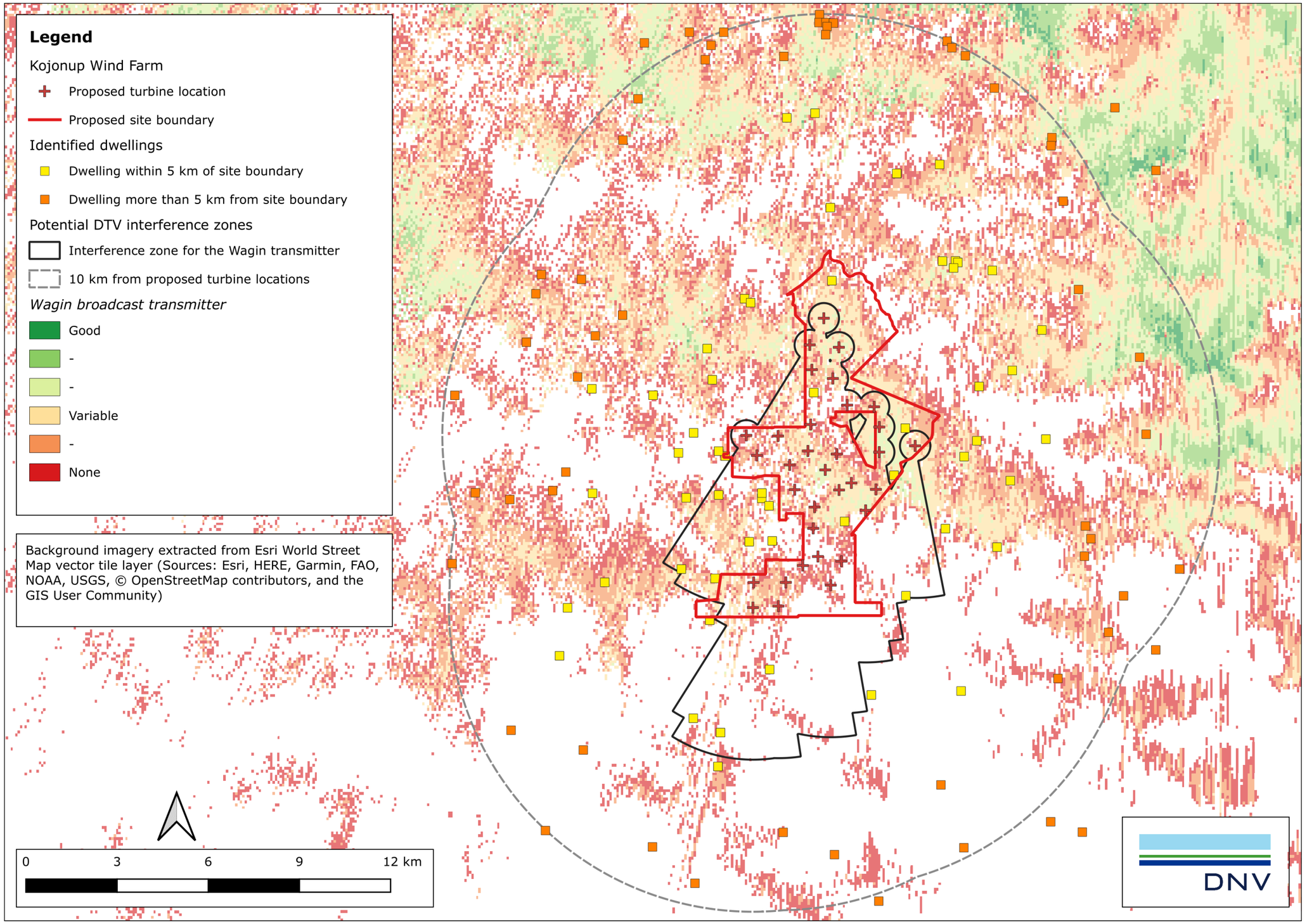

Figure 17 Potential television EMI zones for the Wagin broadcast transmitter from the proposed Project

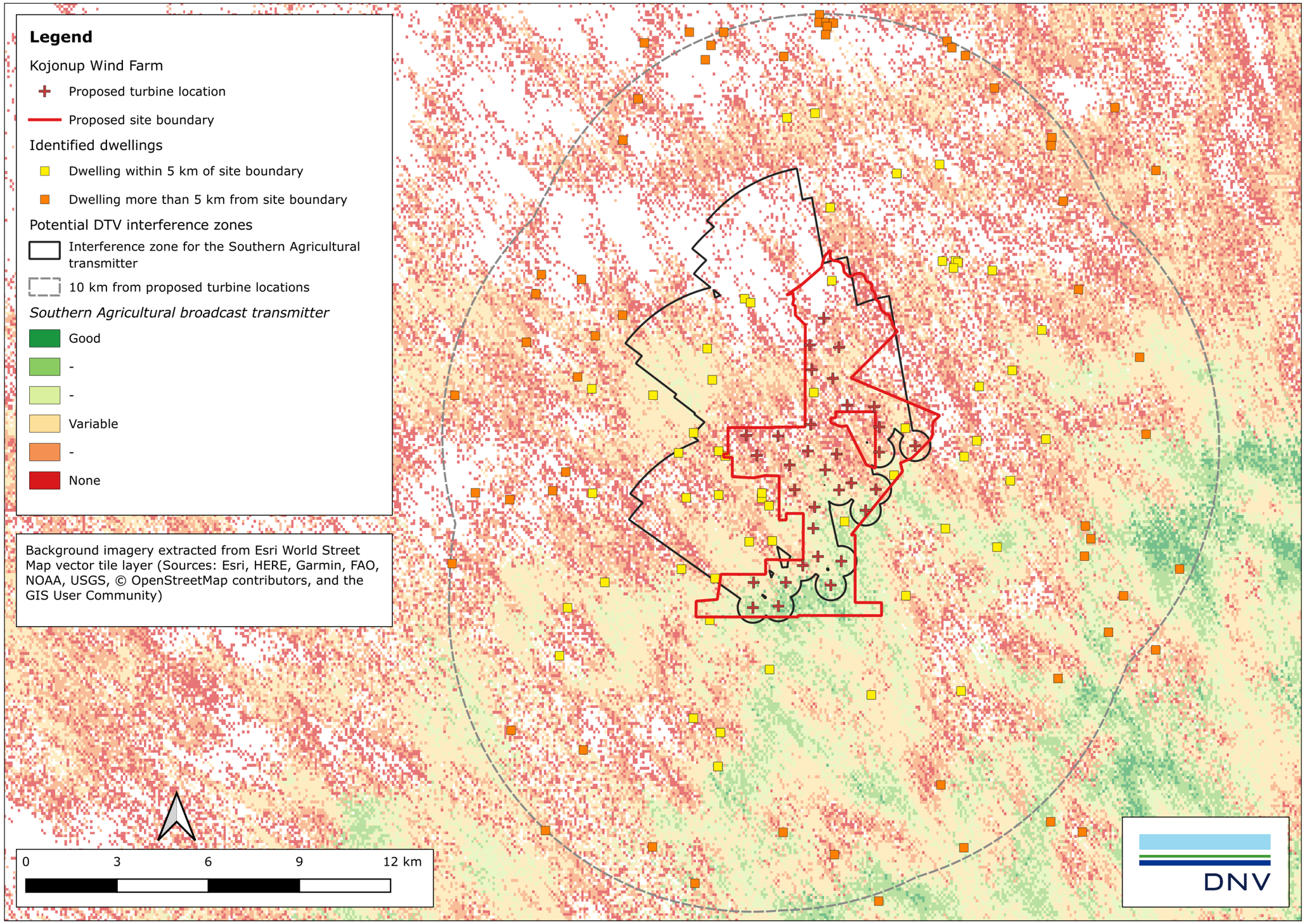

Figure 18 Potential television EMI zones for the Southern Agricultural broadcast transmitter from the proposed Project

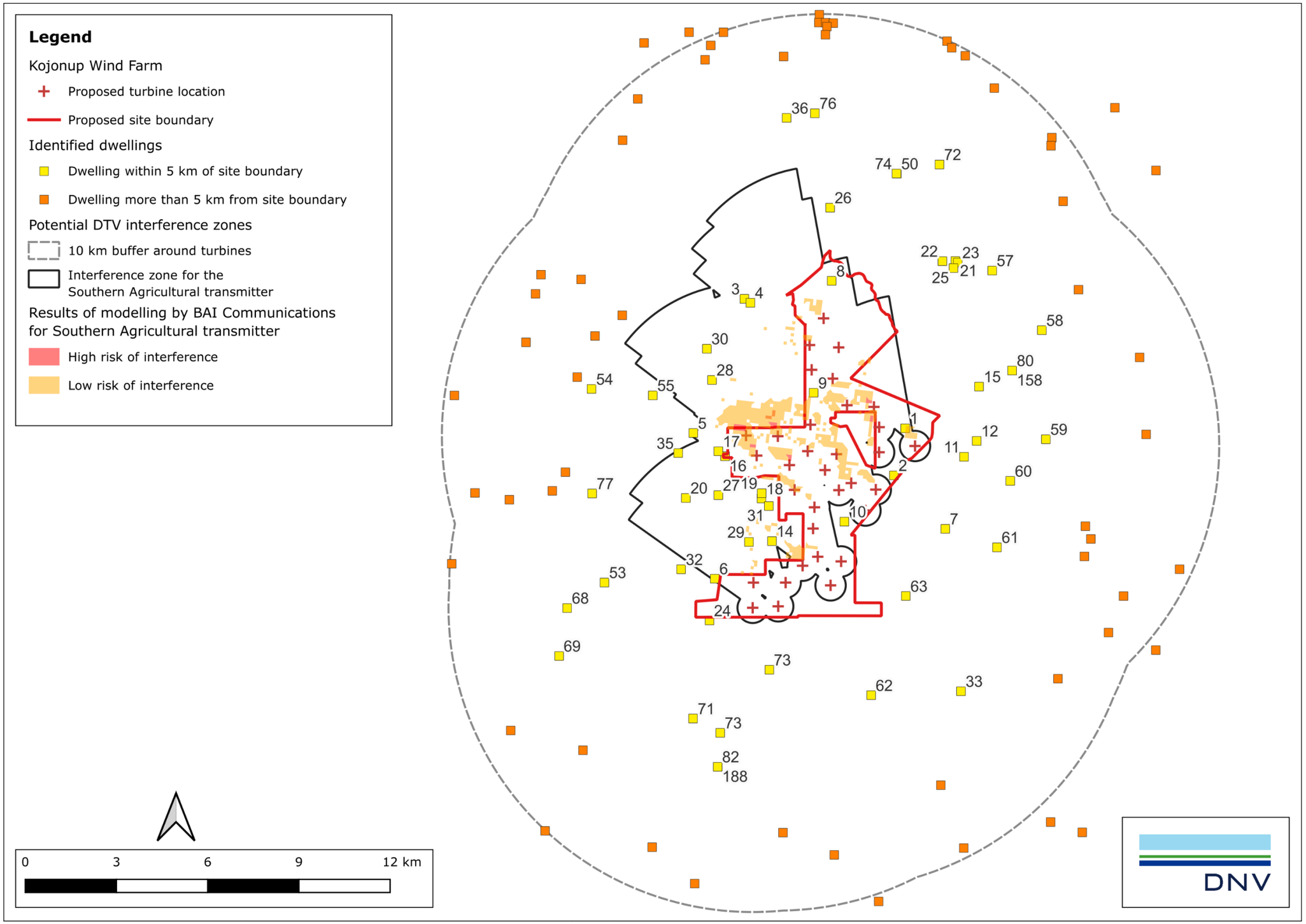

Figure 19 Potential television EMI zones, from the proposed Project, for the Southern Agricultural broadcast transmitter, as modelled by BAI Communications

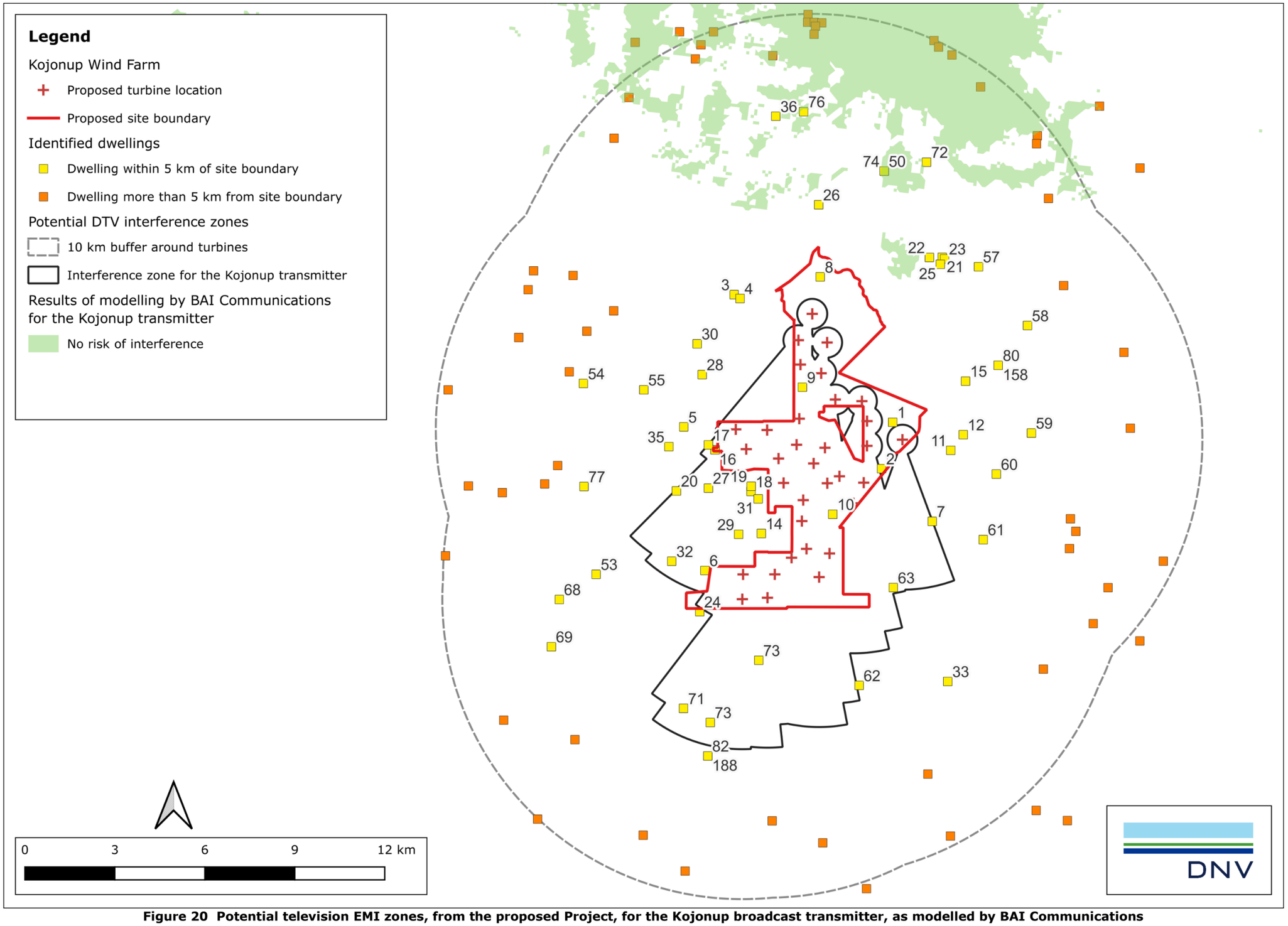

Figure 20 Potential television EMI zones, from the proposed Project, for the Kojonup broadcast transmitter, as modelled by BAI Communications

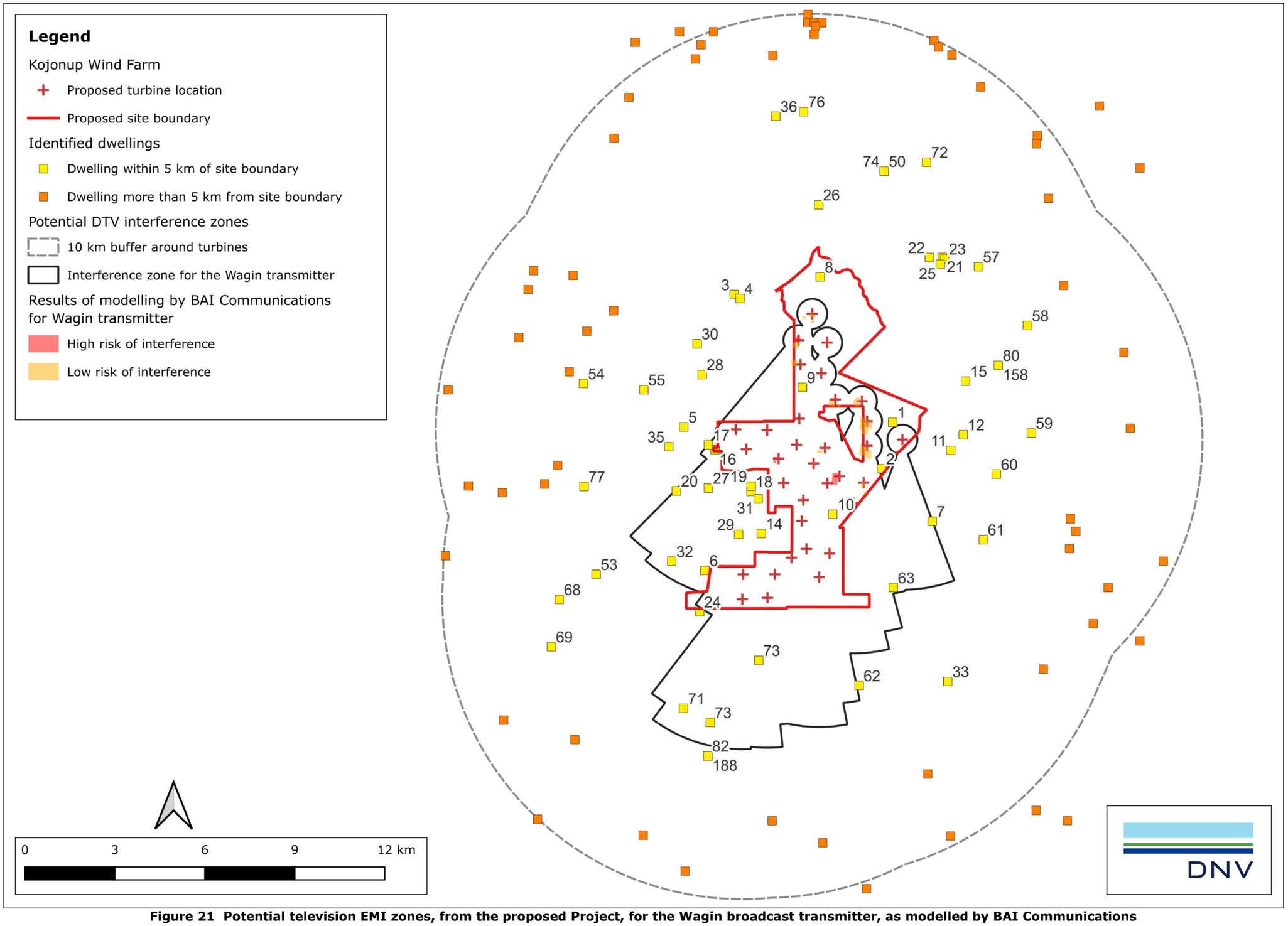

Figure 21 Potential television EMI zones, from the proposed Project, for the Wagin broadcast transmitter, as modelled by BAI Communications

About DNV

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

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