

BERRYBANK WIND FARM

EMI Assessment

Berrybank Development Pty Ltd

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EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd, now trading as DNV GL, has been commissioned by Berrybank Development Pty Ltd (the "Customer") to independently assess the potential electromagnetic interference (EMI) issues associated with the development and operation of the proposed Berrybank Wind Farm (the "Project").

This report summarises the results of an EMI assessment conducted for the site. Information relating to nearby telecommunication licences has been obtained from the Australian Communications and Media Authority (ACMA). In accordance with the planning guidelines relevant to the Project, this document assesses the potential risks regarding interference with radiocommunication services operating in the vicinity of the wind farm, and makes the findings and recommendations discussed below.

Wind turbines may cause interference to television broadcast signals. Historically, analogue television signals have been more likely to suffer from interference. However, digital television services have recently replaced analogue broadcasts and are generally more robust to interference from wind farms. Large scale interference to television signals can generally be avoided by placing the wind turbines distant from the broadcast tower. No television broadcast tower has been identified in close proximity to the Project site boundary, with the nearest broadcast tower approximately 24 km from the site, at Warrion Hill near Colac. The Australian Government MySwitch website indicates that the area around the Project receives digital television signals from the Ballarat broadcast tower at Tower Hill, with reasonably 'good' coverage across most of the site although some areas have 'variable coverage'. This report highlights the areas around the Project site where interference to terrestrial television broadcasts is most likely to occur. A total of 22 habitable dwellings were identified in the potential interference zone for the Ballarat tower, including six (6) dwellings belonging to participating landowners. If residents currently experience poor or marginal reception of the digital signals, they may be susceptible to interference from the wind farm. For such cases, there are a range of mitigation options available to rectify difficulties encountered with television reception, and dwellings in the area may be eligible for the government funded satellite television service.

Wind turbines can potentially cause interference to fixed point-to-point links through diffraction, scattering or near-field effects. However it is possible to design around this issue, as the path and interference zone of point-to-point signals is generally well known. It has been found that two fixed point-to-point links cross the proposed wind farm site, consisting of two fixed licences, operated by the Country Fire Authority and Powercor. An exclusion zone has been established around the Country Fire Authority link based on a standard industry methodology, while an exclusion zone has been derived for the Powercor link based on a clearance width requested by Powercor in addition to the turbine rotor radius. A total of two turbines have been identified within these exclusion zones, with one turbine located within the exclusion zone for each link. DNV GL has contacted both the Country Fire Authority and Powercor to seek feedback regarding the potential interference of the Project on their operations and services. Feedback has been received from both parties indicating that the links may be impacted by the proposed wind farm. Both parties have also highlighted additional turbines that are close to each of the exclusion zones, with five turbines near the Country Fire Authority link and two turbines near the Powercor link. The presence of turbines within the link exclusion zones mean the interference to the links is possible,



however it is noted that these links have been commissioned subsequent to the granting of the original planning permit for the Project.

Wind turbines can also cause interference with fixed point-to-multipoint links; however it is not possible to identify link paths for point-to-multipoint links as only the base-station is licensed and contained in the ACMA Radiocommunications Database. There is one point-to-multipoint base station listed in the ACMA database within 20km of the proposed Project site boundary, owned by Central Highlands Water. DNV GL has contacted Central Highlands Water as part of an extensive consultation process. No formal response has been received to date.

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, DNV GL has contacted the operators of these stations as part of the current consultation process to seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from a number of operators, and to date no concerns have been raised.

One telecommunication site operating a land mobile type licence has been identified within 2 km of the nearest turbine, belonging to VicTrack. Although land mobile type licences are generally not affected by the presence of wind turbines any more than by other forms of signal obstruction, DNV GL has contacted VicTrack to seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from VicTrack indicating that this site is now defunct, and that no impacts are expected.

In general, Very High Frequency (VHF) and Ultra High Frequency (UHF) frequency band radio signals, and digital voice based technologies such as mobile phones (e.g. 3G and 4G networks) are unaffected by wind farm development. Some interference is theoretically possible in areas where coverage is marginal and a wind turbine intercepts the signal. However, the signals are generally robust, and should interference from any source occur, the user can move to an area of better reception. DNV GL has contacted mobile phone network operators as part of the current consultation process to seek feedback regarding any potential impact that the wind farm could have on their services. To date, feedback has been received from Telstra and Optus, who have both indicated that the Project will have no impact on their services.

Emergency services operating radiocommunications assets in the vicinity of the Project have been identified. The majority of the licences identified can be broadly described as base to mobile station style communications. As per the above paragraph, these services are typically unaffected by wind farm development. Regardless, the operators of these stations have been contacted as part of the current consultation process to seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from a number of operators, and to date no concerns have been raised.

It is possible that wind turbines could cause interference to satellite television and internet services if a wind turbine intercepts the signal between a satellite and ground based receiver. DNV GL has identified that the signal from the Intelsat 22 satellite to two houses and the signal from the Eutelsat 70B satellite to three houses, all belonging to non-participating landowners, could be potentially intercepted by turbines. However, it is unlikely that residents in the vicinity of the Project will be receiving television signals from these satellites, as DNV GL understands that they do not transmit programming designed for Australian audiences.



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

Wind turbines have the potential to interfere with meteorological and aviation radars. Reflection of radar signals by wind turbine blades may give false readings or create a radar “shadow” behind the turbines. Due to the distance from radar assets, and the high probability that the turbines will lie below the radar line-of-sight, it is unlikely that the Project will cause interference to aviation radar, or any significant interference to meteorological radar. DNV GL has contacted the Bureau of Meteorology to seek feedback regarding the potential EMI impact of the Project on their meteorological radar operations. Feedback has been received from the Bureau of Meteorology indicating that they do not foresee any measurable impact to their current radars.

DNV GL has not considered impact to aircraft navigation systems or aviation radar, as it is assumed these will be considered as part of an aviation impact assessment.

There is a possibility that wind farms can interfere with trigonometrical stations (or trig points) used for surveying purposes. A review of trigonometrical stations in proximity to the wind farm has been conducted and a number of trigonometrical stations have been identified in the vicinity, including two (2) within the wind farm site boundary. In addition, the nearest Global Navigation Satellite Systems station is located approximately 9 km from the Project. To assess these potential impacts, Geoscience Australia and the Victorian Department of Environment, Land, Water and Planning Services (DELWP) have been notified of the development as part of the consultation process. Feedback has been received from both stakeholders, indicating that they do not foresee any impacts due to the Project.

DNV GL has considered the likely relative change in EMI impacts from the current proposed wind farm layout and geometry, compared to the previous layout and geometry assessed in 2009. The most significant change is anticipated to be a greater potential for interference to fixed point-to-point links, as a result of the presence of two links crossing the site which were not present at the time of the previous assessment. However, as noted above, these links were commissioned subsequent to the granting of the original planning permit for the Project. In addition, the increased turbine dimensions associated with the current layout may increase the potential for interference to terrestrial television broadcasts when compared with the previous layout.

Conclusions and recommendations from this analysis have been made in Section 4 of this report.

1 INTRODUCTION

Union Fenosa Wind Australia Pty Ltd on behalf of Berrybank Development Pty Ltd (the "Customer") is developing the proposed Berrybank Wind Farm (the "Project"), located in south-west Victoria, Australia. The Customer has instructed Garrad Hassan Pacific Pty Ltd, now trading as DNV GL ("DNV GL"), to carry out an independent analysis of potential electromagnetic interference (EMI) related impacts associated with the proposed Berrybank Wind Farm. The results of the work are reported here.

It is noted that DNV GL has previously conducted an EMI assessment for the Project [1], which was completed to assist with the original planning application for the Project. The current assessment seeks to assess the potential impact of a revised turbine layout and geometry.

This document has been prepared pursuant to the DNV GL proposal 170493-AUME-P-001-A, dated 15 September 2014, and is subject to the terms and conditions contained therein.

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

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

In order to conduct the EMI assessment, up to date information regarding radiocommunication licences in the vicinity of the wind farm have been obtained from the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database [2]. It should be noted that ACMA is currently in the process of transitioning data contained in the RRL from the existing database structure known as RADCOM to a new structure called SPECTRA. Both the RADCOM and SPECTRA datasets have been considered in this assessment in order to identify all potentially affected services in the vicinity of the Project; consequently, some licences may be duplicated in the results.

'Radiocommunications' is used as a broad term in this report to encompass all services that rely on electromagnetic or radio waves to transfer information. There are many methods of transmitting information via radiocommunication. Radiocommunication services operating in the vicinity of the Project, and their susceptibility to interference from the wind farm, are discussed in this document.

The prospective turbine dimensions and layout considered in this analysis have been provided by the Customer [3] and are detailed in Table 1 and Table 2.



DNV GL has carried out a consultation process with organisations operating services that may be impacted by the wind farm developments and operation. This has involved dissemination of basic information on the wind farm, and a request for the organisation to respond regarding whether they foresee any potential impacts. A number of responses have been received to date, and these are described throughout this report and summarised in Table 12.

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 General site description

The location of the Project is approximately 43 km southwest of Ballarat, Victoria, and is shown in Figure 1. The wind farm covers an area of around 5,000 hectares.

2.2 The Project

The Customer has provided a layout for the wind farm, which is composed of 79 wind turbine generators [3] and has been used for the purpose of the EMI study. DNV GL has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 130 m or less, and an upper tip height of 180 m or less.

Figure 2 shows a map of the site with the proposed turbine layout and locations of houses in the vicinity of the wind farm as provided by the Customer [4]. The proposed wind turbine layout and coordinates of existing dwellings are listed in Table 2 and Table 3 respectively. DNV GL has assumed that all existing dwellings are occupied, unless otherwise specified in Table 3.

2.3 Planning guidelines

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

The Policy and planning guidelines for development of wind energy facilities in Victoria (Victorian Guidelines), published by the Victorian Department of Environment, Land, Water and Planning in January 2016 [5] states that *"a wind energy facility can affect the amenity of the surrounding area due to ... electromagnetic interference."* and that *"[t]he potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting"*.

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

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

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

DNV GL considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the Victorian Guidelines, and it is noted that the Victorian Guidelines refer directly to the Draft National Guidelines.

3 METHODOLOGY, ANALYSIS AND RESULTS

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

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

Other services with the potential to experience interference from the project have also been identified, including meteorological and aviation radar and trigonometrical stations, and the potential for interference to those services discussed.

3.1 Telecommunication towers

An image of the ACMA database dated October 2015 was used for this assessment [2]. As mentioned in Section 1, records were taken from both the RADCOM and SPECTRA datasets and combined to identify all telecommunications assets in the vicinity.

From the database, there are a total of 931 telecommunication sites within a nominal 75 km of the wind farm. The locations of these telecommunication sites relative to the proposed wind farm are shown in Figure 1.

The Draft National Guidelines recommend that consultation is required if a turbine is within 2 km of a telecommunication site. One telecommunication site is located within 2 km of the nearest turbine, and is discussed in Section 3.4.

3.2 Fixed licences of point-to-point (microwave) type

3.2.1 Diffraction

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

The criteria used for avoiding interference due to diffraction point-to-point signals are normally based on an exclusion zone of circular cross-section around the direct path from the transmitter to the receiver (often called boresight) [6] [7] [8]. This exclusion zone is defined in terms of Fresnel zones. The n th Fresnel zone is comprised of all points for which, if the radio signal travelled in a



straight line from the transmitter to the point and then to the receiver, the additional length

compared to the straight transmitter-receiver path equals $\frac{n - \lambda}{2}$, where λ = wavelength.

To avoid interference to point-to-point signals, wind turbines, including the blades, should be kept outside the first or second Fresnel zone. The radius of the second Fresnel zone varies along the length of the signal, and is given by:

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

Where d_1 is the distance from the transmitter

d_2 is the distance from the receiver

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

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

Each individual link is given a unique identifier or "Assignment ID" so that it can be readily distinguished. For links in the RADCOM dataset, which contains data for broadcast licensing services and 900 MHz public telecommunication services licences [2], the Assignment ID is taken as the hyphenated combination of the Access ID and Device ID. For links in the SPECTRA dataset, which contains data for all other licences [2], the Assignment ID is 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 Equipment Frequency Link (EFL) ID (for apparatus licences, associated with the use of a particular device).

The paths resulting from the towers analysed are shown in Figure 3. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions.

A review of the ACMA database, as of October 2015, shows one point-to-point link passing over the proposed wind farm site, operated by the Country Fire Authority (CFA). This link is shown in greater detail in Figure 4.

References [6] [7] [8] state that turbines should be located outside of either the first or second Fresnel zone in order to avoid interference to that link. For the link identified crossing the site, an exclusion zone has been established based on the link operating frequency, the second Fresnel zone plus the blade length for turbines with a 130 m rotor diameter. The potential exclusion zone is also shown in Figure 4.

It is common practice to have multiple assignment ID's for the same physical link to cover practicalities such as licensing for sending and/or receiving signals. Accordingly, the Fresnel zone setback is calculated on the Assignment ID with the lowest frequency. In this case, all the Assignment ID's for the CFA link use the same frequency, which has been used to determine the setback. Details of the link are provided in Table 4.



In addition to the requirement for consultation for turbines within 2 km of telecommunication sites, the Draft National Guidelines also recommend that consultation is required if a turbine is located within the second Fresnel zone of a point-to-point link. As can be seen from Figure 4, there is one turbine (turbine 1) located within the exclusion zone for the point-to-point link crossing the site. Two turbines (turbines 2 and 6) are located within approximately 200 m of the exclusion zone.

DNV GL has contacted the CFA to determine if there is any potential for the Project to cause interference to their operations and services. Feedback has been received from the CFA, indicating that the above point-to-point link may be impacted by the Project. In addition, the CFA has noted that turbines 2, 3, 6, 9, and 34 are close to the point-to-point link, but do not obstruct the link path, based on the current turbine layout provided by the Customer. However it is noted that this link did not exist at the time the previous EMI assessment for the Project was conducted [1] or when the planning permit for the Project was granted.

As part of the consultation process, DNV GL has also contacted Powercor, which operates a number of fixed point-to-point licences in the vicinity of the Project. Feedback received from Powercor has identified a point-to-point licence that was not listed in the ACMA database as of October 2015. The point-to-point link associated with this licence passes over the proposed wind farm site, and is presented in Figure 5. Details of the link are also presented in Table 4. It should be noted that this new Powercor link does not appear in Figure 3, as this Figure only presents point-to-point licences identified in the ACMA database as of October 2015.

DNV GL has derived an exclusion zone for the Powercor link crossing the wind farm boundary based on a 200 m clearance as requested by Powercor, as well as the turbine rotor radius of 75 m, to assist with determining whether a turbine rotor will encroach on the required clearance zone. One turbine (turbine 51) has been identified within this exclusion zone, as shown in the inset in Figure 5.

Through the consultation process, Powercor has requested that turbine 51 be moved from the above clearance zone (incorporating both the 200 m clearance as well as the 75 m rotor radius). Powercor has also noted that turbines 44 and 45 are “marginally clear” of the clearance zone. However it is noted that this link did not exist at the time the previous EMI assessment for the Project was conducted [1] or when the planning permit for the Project was granted.

It is recommended that the Customer undertakes further engagement with both the CFA and Powercor prior to the construction of the wind farm, to establish an understanding of how any potential interference to these links may be mitigated should interference be encountered following construction of the wind farm.

A preliminary assessment was also carried out to determine if both links pass over the Project at a height that is well above the highest point of the turbines (hub height + blade length = 180 m). This was achieved by examining the elevation and tower heights at each end of the links, as well as the approximate elevation of the areas within the wind farm boundaries over which the links cross. It was determined that both links cross the site at a height which has the potential to intersect with turbine blades.

3.2.2 Near field effects and scattering

The Draft National Guidelines [6] mention the possibility of interference to point-to-point links from two additional mechanisms, near field effects and scattering.



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

No telecommunication towers operating point-to-point licences have been identified within 2 km of the Project turbines, and therefore it is not expected that any point-to-point links will experience interference due to near field effects or scattering.

3.3 Fixed licences of point-to-multipoint type

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

Administratively, for a fixed licence of the point-to-multipoint type, the ACMA database details the location of the static station only. Hence, the location of the transmission vectors is not readily identifiable. A review of fixed licences of point-to-multipoint types was undertaken, and 266 Assignment ID's were identified within approximately 75 km of the proposed site boundary. These licences are shown in Figure 6. The details of the licence holders as per the ACMA database are provided in Table 5.

There is one point-to-multipoint base station listed in the ACMA database within 20 km of the Project boundary, owned by Central Highlands Region Water Corporation ("Central Highlands Water") (Site ID 45665). It is not possible to determine if there are any potential impacts without knowing the locations of each station in the multipoint network; however DNV GL has contacted Central Highlands Water as part of an extensive consultation process to seek feedback on whether their services are likely to be affected by the Project. No formal response has been received to date.

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the Project. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the Project, DNV GL has contacted operators of the stations within 60 km from the centre of the Project to seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from a number of operators, and to date no concerns have been raised.

3.4 Other licence types

A review of the ACMA database for other licences was conducted. These licences are shown in Table 6 and Figure 7.

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



be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

The Draft National Guidelines recommend that consultation is required if a turbine is located within 2 km of a telecommunication site. One telecommunication site operating a land mobile type licence has been identified approximately 1.2 km from the nearest turbine (Berrybank Railway Station, site ID 43649), operated by Victorian Rail Track (VicTrack). DNV GL has contacted VicTrack to seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from VicTrack indicating that this site is now defunct, and that no impacts are expected.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services, and are broadly covered in Sections 3.14 and 3.15.

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

3.5 Emergency services

A review of the ACMA database was conducted to identify emergency services with licences for radiocommunications assets operating in the vicinity of the wind farm. The groups identified are listed in Table 7 along with their contact details. While no direct interference to services has been identified, DNV GL has contacted operators of all stations within 60km from the centre of the wind farm about the proposed development to seek feedback of any potential impact that the wind farm could have on their services. Feedback has been received from a number of operators, and to date no concerns have been raised. The responses received can be seen in Table 12.

3.6 Aircraft navigation systems

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

3.7 Aviation radar

Primary surveillance radar (PSR) is used for air traffic control and requires line-of-sight to the target object for successful detection. PSR transmits a pulse of energy that is reflected back to the radar receiver by the target object. Some combinations of turbine orientation and blade angle can cause significant Doppler returns to the illuminating radar, thereby creating false targets on the radar screen. The sporadic nature of these false positives makes them difficult to filter with current radar software. Further, turbines may create a radar obstruction or “shadow” where aircraft are not detected. In Australia, PSR installations are located at major airports and typically have a range of approximately 50 nautical miles (93 km).

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



aircraft at high altitude. However, at or near ground level, the range of SSR is expected to be less due to terrain obstructions and curvature of the earth.

The Draft National Guidelines recommend that radar operators be notified of the development of wind farms within 250 nautical miles (463 km) of aviation radar operators [6]. Radar installations are typically located at major airports. As shown in Table 8 and Figure 8, the Project is located approximately 116 km from Melbourne International Airport. There are three secondary airports within 80 km to 134 km of the site which also serve Melbourne.

Due to the significant distance from major airports, and the high probability that the turbines will lie below the radar line-of-sight, it is unlikely that the Project will cause interference with aviation radar. However, DNV GL assumes that an aviation impact study will be undertaken to assess the impact of the Project to aviation related radar systems.

3.8 Meteorological radar

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

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

Wind profile measurements are used to ensure the safe and economical operation of aircraft and provide an important source of data for the Bureau’s general weather forecasting system.

“Weather watch” radars monitor weather situations and are able to indicate the possibility of severe storms out to as distance of 250 km or more. Hence, whilst the uninhibited operation of meteorological radars may not be as critical as aviation radar, there are implications for public safety if severe weather is not predicted or if its approach is masked due to EMI.

Wind farms located at distances greater than 5 km from a BoM field station are unlikely to affect wind finding operations [6]. Generally, the optimal coverage area for “weather watch” radar extends approximately 200 km from the radar installation at a height of approximately 3000 m [9] [10], and approximately 100 km at a height of 1000 m [10]. Theoretically, wind farms can impact upon weather watch radar when located within several hundred kilometres of a radar station, however, due to the curvature of the earth, and intervening terrain, the range at or near ground level is generally less.

According to the Draft National Wind Farm Development Guidelines, consultations with operators of weather stations within 250 nautical miles (463 km) of the proposed wind farm should be undertaken [6]. It has been identified that the BoM operates six (6) weather stations within that range with the closest station “Melbourne” located approximately 105 km east of the Project site. The locations of these stations are shown in Figure 8 and the details of each station can be found in Table 9.



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

The Draft National Guidelines recommend that the BoM be contacted regarding the potential for interference from the Project. DNV GL has contacted the BoM regarding the Project to seek feedback on whether interference to their services is possible. Feedback has been received from the BoM indicating that they do not foresee any measurable impact to their current radars.

3.9 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes. Some trig points may host surveying equipment such as GPS antennas and Electronic Distance Measuring (EDM) devices. EDM devices measure the distance from the trig point to the target object by means of a beam of known velocity which is reflected back to the unit from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed. The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 to 5 km while microwave systems can measure distances up to 150 km. However, such systems are not limited by the line of sight or affected by visibility [11].

DNV GL has undertaken a review of the Primary Geodetic Network of Australia [12] and it has been observed that the Project is located within the first-order triangulation region. First-order triangulation depends on trigonometrical stations of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation will then be used for second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

According to the database from Geoscience Australia [13], there are 36 trigonometrical stations within 40 km of the Project site boundary. The locations of some of the stations are expressed using multiple datums, resulting in a total of 57 points. The details of all trigonometrical stations are provided in Table 10 and illustrated in Figure 9. Two trigonometrical stations (Berrybank and Berrybank RM1) are located within the Project site boundary, as shown in Figure 10 (note that due to the proximity of the stations to each other, they appear as one point in the Figure).

The Global Navigation Satellite Systems (GNSS) Network is comprised of permanent stations which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. The GNSS network also provides information to the International GNSS Service. Eight stations from the GNSS database in Australia form the Australian Fiducial Network (AFN) [14] [15]. The AFN stations are equipped with EDM devices and GPS receivers and transmit data to GeoScience Australia via phone lines, internet and/or satellite [15]. In addition to the national network, the Victorian Department of Environment, Land, Water and Planning (DELWP) operates a network of GNSS Continuously Operating Reference Stations (CORS), known as GPSnet, across the state [16].

The closest GNSS station is located approximately 9 km southeast of the Project, at Cressy (CORS ID: CRSY).

DNV GL has contacted Geoscience Australia and the DELWP to inform them of the Project development, and to seek feedback regarding whether interference to their systems is possible,



both in regards to trig points and GNSS stations. Feedback has been received from both Geoscience Australia and the DELWP, indicating that they do not foresee any impact on either trig points or GNSS stations.

3.10 Citizens Band radio

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

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

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

The UHF CB radio service is unique in Australia and uses the FM transmission mode. It provides clear communication over 5-20 km and is less susceptible to power line noise. However, the UHF CB radio service requires "line-of-sight" and is easily hindered by hilly terrain and forested areas. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. Repeater stations are set up on hilltops by community groups and commercial organisations to transmit signals from one channel to another.

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

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

3.11 Mobile phones

Mobile phone networks typically operate at frequencies of either between 700 and 900 MHz, or between 1800 and 2600 MHz; however, some new services may operate at up to 3500 MHz. At such frequencies, signals are likely to be affected by physical obstructions such as buildings and wind turbines. However, mobile phone networks are designed to operate in such conditions and in most cases, if there is sufficient mobile network coverage and signal strength, the presence of wind turbines is unlikely to cause any interference.

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is



theoretically possible that wind turbines could cause some interference to the signal, although there is little evidence of this in the literature.

A review of mobile phone towers in the vicinity of the proposed wind farm has been carried out. The nearest mobile phone tower is located approximately 4 km to the north of the proposed turbine locations.

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

Figure 12 shows the Optus network coverage for the wind farm area [17]. The map shows outdoor 3G coverage in the vicinity of the wind farm, as well as areas of outdoor 4G coverage.

Figure 13 shows the Telstra network coverage for the wind farm area [18]. The map shows areas of 3G coverage and 4G coverage in the vicinity of the wind farm.

Figure 14 shows the Vodafone network coverage for the wind farm area [19]. The map shows 3G coverage in the vicinity of the wind farm, with isolated patches of marginal 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.

DNV GL has contacted Optus, Telstra, and Vodafone to inform them of the Project development as part of the current consultation process and to seek feedback on any potential impact that the wind farm could have on their services. To date, DNV GL has received feedback from both Telstra and Optus indicating that they do not foresee any impacts on their services as a result of the Project. No formal response has been received from Vodafone to date.

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

3.12 Wireless internet

Aussie Broadband Pty Ltd holds a number of point-to-multipoint licences in the vicinity of the wind farm, with the nearest station located approximately 34 km from the site (Site ID 9009153). As the locations of Aussie Broadband customers are not known, it is not possible to determine whether there is the potential for interference to Aussie Broadband's service, however it is unlikely that a station at this distance will be servicing customers in the vicinity of the proposed wind farm. DNV GL has contacted Aussie Broadband to seek feedback regarding the potential for interference to their services. Aussie Broadband has responded indicating that they do not have any concerns regarding interference as a result of the wind farm.

Additionally, residents in the vicinity of the wind farm are likely to utilise Telstra wireless broadband services. Telstra's wireless broadband service utilises the same network as Telstra's mobile phone service, and therefore the comments made in Section 3.11 are applicable here. Specifically, the presence of wind turbines is unlikely to cause any interference if the existing coverage is good; however interference may be possible in areas where coverage is marginal. Should interference occur, the simple mitigation options given in Section 3.11 may be applicable.

The NBN (National Broadband Network) website [20] indicates that the NBN service is currently available in areas surrounding the wind farm (including Lismore and Rokewood). Therefore residents in the vicinity of the wind farm also have the opportunity to access wireless internet via the NBN. DNV GL has contacted NBN Co to inform them of the Project development and to seek feedback on whether there is the potential for interference to their services. No formal response has been received to date.

3.13 Satellite television and internet

In some rural or remote areas, television and internet access can be provided through satellite only. Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. The satellite transmits television signals to the user's antenna at two frequency bands; the C band at between 4 GHz and 8 GHz, and the Ku band at between 12 GHz and 18 GHz. Signals in the C band are susceptible to interference due to radio relay links, radar systems, and other devices operating at a similar frequency, while signals in the Ku band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. DNV GL understands that there are currently 20 satellites that provide television to the east coast of Australia [21].

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



2 way connection to the Internet via Satellite [22]

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

A number of satellites transmit television signals that can be received in Australia. DNV GL has analysed the line-of-sight for satellites which provide any television services to eastern Australia. Although only a small number of satellites are likely to be providing television services intended for Australia (e.g., Optus C1, D1, and D2), all viewable satellites have been considered.

The analysis indicates that signals from the Intelsat 22 satellite may be intercepted by turbines for two habitable house locations (dwellings 9 and 73) while signals from the Eutelsat 70B satellite may be intercepted by turbines for three habitable house locations (dwellings 9, 73, and 103), all of which belong to non-participating landowners. It is DNV GL's understanding, however, that these satellites do not transmit programming designed for Australian audiences [23] [24], and as



such DNV GL considers it unlikely that residents in the vicinity of the Project will be receiving television signals from either of these satellites.

The main satellites for providing satellite internet in Australia are the IPSTAR 1 and Optus D2 satellites. From the Project site, the IPSTAR 1 and Optus D2 satellites have elevations of approximately 39.4° and 45.1° respectively [25]. Therefore it is unlikely that the Project will impact upon the line-of-sight from these satellites to any house.

3.14 Radio broadcasting

DNV GL has assumed that broadcast radio includes both Amplitude Modulation (AM) and Frequency Modulation (FM) radio used to broadcast audio signals. In Australia, AM radio operates in the Medium Wave (MW) band at frequencies of between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency band (VHF) between 87.5 MHz and 108 MHz. The locations of the AM and FM broadcast transmitters in the vicinity of the Project are shown in Figure 15.

3.14.1 AM radio

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

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

As AM radio signals are able to propagate around obstructions such as turbines, it is expected that a wind farm would not cause significant interference for a receiver. Additionally, due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [26]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna and/or amplifier.

3.14.2 FM radio

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

FM radio signals are susceptible to interference from buildings and other structures, although they are less vulnerable than higher frequency signals. Reflection or scattering of radio waves by physical structures can reduce signal strength at a receiver, or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can



cause hissing or distortion to be heard by a listener. However, generally any interference will only be likely in the immediate vicinity of the wind turbine [26], and should be easily rectified through the installation of a high quality antenna and/or amplifier.

3.14.3 Digital radio

Digital radio services have been introduced in metropolitan licence areas from July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne and Sydney [27]. According to the digital radio coverage map available on the ABC website [28], digital radio is not yet available in the Project region.

3.15 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 Victoria are now digital broadcasts [29]. 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 in areas of good coverage. DNV GL has experience in situations where houses were able to receive adequate digital television reception in an area of adequate signal strength where the digital television signal is passing through a wind farm.

However, the UK telecommunications regulator Ofcom [30], states the following with regard to interference to digital television reception.

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

DNV GL has drawn two conclusions from this report:

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

The Broadcast Transmitter Database [29] was examined to identify broadcaster towers nearby to the proposed wind farm, with those found shown in Figure 15. The television transmitter used by residents in the vicinity of the wind farm is likely to be the Ballarat transmitter at Lookout Hill.

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

- proximity of wind turbines to television broadcast tower;
- proximity of wind turbines to receivers (houses);
- location of wind turbines in relation to houses and television broadcast towers;

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

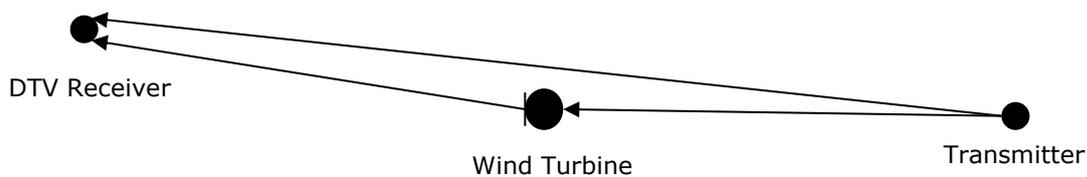
3.15.1 Large scale interference

For broadcast signals large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay television transmitters are more commonly found in rural areas. Primary television transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay television transmitters, while a clearance of at least 6 km is recommended for primary television transmitters [7]. The closest digital television transmitter to the Project is the Colac transmitter at Warrion Hill, which is approximately 24 km away; therefore the wind farm is not expected to cause large scale interference.

3.15.2 Forward and back scatter

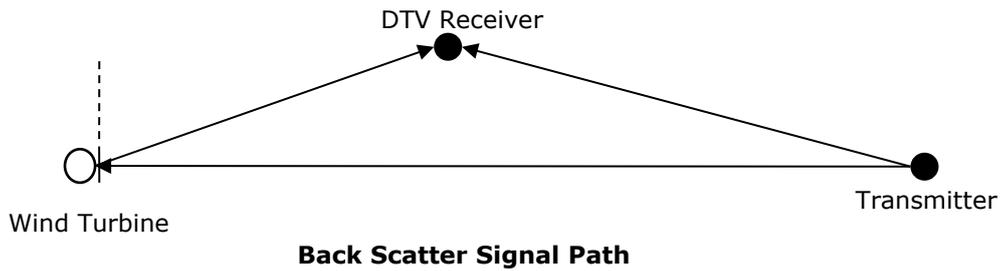
Wind turbines cause interference to television signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A wind turbine has the potential to scatter electromagnetic waves carrying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

Forward scatter can occur when the transmitter, one or more wind turbines, and receiver are almost aligned as shown below. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [31]. Both of these effects can potentially degrade the DTV signal quality.



Forward Scatter Signal Path

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

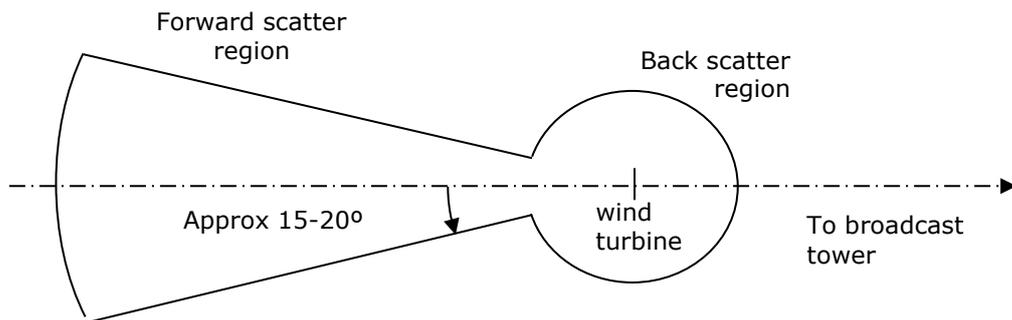


Interference of DTV signals from wind turbine developments can potentially occur in both the forward and backward scatter region. The effect of a wind turbine on a DTV signal can be different depending on the scattering region where the receiver is located [31].

According to Ofcom [32], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [7] [33] [30]. Interference may extend beyond 5 km if the houses are screened from the broadcast tower, but do have line-of-sight to the wind turbines [30]. 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 $\pm 15^\circ$ to $\pm 20^\circ$, 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 house delayed relative to the source signal from the broadcast tower. The back scatter region generally does not extend further than 500 m [7] [34], assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio, or an omni-directional antenna is used, this region is likely to be larger.

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



Potential television interference zones around a wind turbine

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

In Australia, digital television signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [35] 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 ($\pm 60^\circ$ 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 [36] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more wind turbines, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [36].

With regards to back scattering, ITU states:

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

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

3.15.3 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 [37]. This comparison with empirical data found:

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

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

As an alternative, it is common practice to identify those dwellings or areas that are most likely to experience potential television interference based on likely forward and back scatter regions. As introduced above, this is often referred to as the 'keyhole' approach, and is an established technique for predicting where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [32]. The union of these areas forms a region where there is an increased likelihood of interference to television signals occurring.

3.15.4 Potentially affected dwellings

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

The results of the analysis can be seen in Figure 16 and Figure 17, and Table 11. The dwellings that are most likely to be susceptible to interference include those within the possible interference zone. A total of 29 houses were identified in the potential interference zone for the Ballarat broadcast tower at Lookout Hill. However, DNV GL understands that seven of these houses are uninhabitable, as specified in Table 3. Therefore, a total of 22 habitable dwellings have been identified in the potential interference zone for the Ballarat broadcast tower, including six (6) dwellings belonging to participating landowners. It should be noted that if the signal received at a dwelling from the transmitter is sufficiently weak, or an antenna with insufficient directional discrimination is installed (i.e., a low gain or omni-directional antenna), interference may still occur outside of the identified interference zones.

According to the Australian Government MySwitch website [39], the area around the Project receives digital television signals from the Ballarat broadcast tower. The coverage map (reproduced in Figure 17) suggests that the majority of the area surrounding the wind farm receives reasonably good coverage with some areas of 'variable' coverage.

Thus, although digital television signals are generally unlikely to be susceptible to interference from wind turbines in areas of adequate signal strength, interference could be encountered in areas where reception is marginal and antennas at dwellings may receive a reflected signal from a turbine that is of sufficient power to interfere with the signal received directly from the transmitter. Based on the coverage map for the area around the Project, it is possible that some areas could be deemed to have marginal reception, and interference could be encountered. If reception difficulties are encountered, there are a number of mitigation options available, and these are discussed in further detail in Section 3.15.5.

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

3.15.5 Mitigation options

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

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



In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue, however, as noted in [35] DVB-T reception quality may not be substantially affected in the forward scatter region.

ITU [34] identified that the receiver height can also affect interference. In areas that are relatively flat and free of vegetation, reflections can enhance or decrease the received signal strength relative to the free path signal strength. ITU found that the received signal strength may not increase monotonically with receiver height. In other words, lowering the receiver height can improve reception in some cases.

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription based broadcasts. Residents in areas which are unable to receive digital TV 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 [40].

3.16 Anticipated change

The relative change anticipated in EMI impact since the previous assessment, which was carried out in 2009 [1], is considered here.

The key differences between the current and previous proposed wind farm layout and turbine geometry are as follows:

- The number of turbines has decreased from 100 turbines, to the endorsed 95 turbines to the current 79 turbines;
- The maximum rotor diameter has increased from 101 m to 130 m; and
- The maximum blade tip height has increased from 131 m to 180 m.

The current layout has two fixed point-to-point links crossing the Project boundary, both of which were not present when the previous assessment was carried out. These links cross the site at a height which has the potential to intersect with turbine blades, with a total of two turbines in the link exclusion zones (one turbine in the exclusion zone for each link). However it is noted that these links have been commissioned subsequent to the granting of the original planning permit for the Project.

The distance from the Project to the nearest identified point-to-multipoint base station for the previous and current assessment is approximately 35 km and 19 km, respectively. For the current layout, the potential impact on the licence within 20 km is currently being assessed through consultation with the service operator.

For both fixed point-to-point and point-to-multipoint licences, the anticipated change is due to changes in radiocommunications licences since the previous assessment was carried out.



The current wind farm layout is approximately 24 km from the nearest television broadcast tower, compared to 25 km for the previous layout, and therefore no change is expected regarding the potential for large scale interference to television signals.

The number of houses in the potential interference zone for the Ballarat (Lookout Hill) television broadcast tower has decreased from 33 for the previous layout to 29 for the current layout. It should be noted that the 33 houses identified in the previous assessment and the 29 dwellings identified in the current assessment both include seven uninhabitable dwellings. Therefore the current layout decreases the number of inhabited houses in the potential interference zone by a total of four.

The potential for interference to television signals caused by a wind turbine is likely to be proportional to the radar cross section of the turbine, which is typically proportional to the turbine dimensions [41]. Therefore, the increased turbine dimensions associated with the current configuration of the Project may increase the potential for interference when compared with the previous configuration. However, given the number of mitigation options available (as discussed in 3.15.5), it is likely that any potential interference could be rectified.

For other services considered in this assessment, either impacts are considered to be minor, or impacts are being assessed through consultation with the service operators.

Additionally, it is assumed that any changes to the impact of the Project on aviation radar and navigation systems arising from the revised wind farm layout will be identified as part of an aviation impact study.

4 CONCLUSIONS

Broadcast towers and transmission paths around the Project were investigated to see if EMI would be experienced as a result of the development of the Project. The proposed wind farm would involve the installation of 79 wind turbine generators. DNV GL has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 130 m or less, and an upper tip height of 180 m or less.

4.1 Fixed point-to-point microwave links

A total of two point-to-point microwave links (involving two licences) were identified with paths crossing the site boundary. The potential interference zones around the links have been identified and it has been found that two turbines from the Project have the potential to cause interference to these links. DNV GL has contacted the owners of the links, namely the Country Fire Authority and Powercor, to determine if there is any potential for the Project to cause interference to their operations and services. Feedback has been received from both parties indicating that the links may be impacted by the proposed wind farm. Both parties have also highlighted additional turbines that are close to each of the potential interference zones, with five turbines near the Country Fire Authority link and two turbines near the Powercor link. However it is noted that these links have been commissioned subsequent to the granting of the original planning permit for the Project.

It is recommended that the Customer undertakes further engagement with both the CFA and Powercor prior to the construction of the wind farm, to establish an understanding of how any potential interference to these links may be mitigated should interference be encountered following construction of the wind farm.

4.2 Point-to-multipoint microwave links

There is one point-to-multipoint base station listed in the ACMA database within 20 km of the Project boundary, owned by Central Highlands Water. It is not possible to determine if there are any potential impacts without knowing the locations of each station in the multipoint network, however DNV GL has contacted Central Highlands Water to seek feedback regarding any potential EMI impacts that may arise from the development and operation of the Project. No formal response has been received to date.

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Again, it is not possible to determine if there are any potential impacts without knowing the locations of each station in the multipoint network. However, it is unlikely that stations at this distance will be servicing customers in the vicinity of the site. DNV GL has contacted the operators of these stations to inform them of the proposed development and seek feedback on any potential impact that the wind farm could have on their services. Feedback has been received from a number of operators, and to date no concerns have been raised.

4.3 Other licence types

A review of other licences within 75 km of the Project site was conducted. Many of the licences identified can broadly be described as base to mobile station style communication, and include radio broadcasting, commercial and private mobile telephony. These licence types are generally



not affected by the presence of wind turbines any more than other effects such as terrain, vegetation and other forms of signal obstruction. For most services, should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

One telecommunication site operating a land mobile type licence has been identified within 2 km from the nearest turbine. DNV GL has contacted the operator of this licence, namely Victorian Rail Track, to seek feedback on any potential impact that the Project could have on their services. Feedback has been received from VicTrack indicating that this site is now defunct, and that no impacts are expected.

A number of aeronautical and radiodetermination licenses have been identified. DNV GL assumes that potential impacts to these services will be considered as part of an aviation impact study.

4.4 Emergency services

Emergency services with radiocommunications assets in the vicinity of the site have been identified and contacted to seek feedback on the potential for adverse impacts to their services. Feedback has been received from a number of operators, and to date no concerns have been raised.

4.5 Aircraft navigation systems

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

4.6 Aviation radar

The Project is located approximately 116 km from Melbourne Airport. Due to the significant distance of the major airports from the wind farm and the high probability that the turbines will lie below the aviation radar line-of-sight, it is unlikely that the Project will have an impact on aviation radar. However, it is recommended that organisations operating aviation radar assets are consulted as part of a detailed aviation study.

4.7 Meteorological radar

DNV GL has also undertaken an assessment of the Bureau of Meteorology (BoM) radar stations operating in the vicinity of the proposed wind farm, and the closest station is located at approximately 105 km east of the site. Due to the distance between the station and the site, and the intervening terrain, it is unlikely that the wind farm would have an impact on meteorological radar operations. However, in accordance with the Draft National Wind Farm Development Guidelines, DNV GL has contacted the BoM to inform them of the Project and to seek feedback on the potential for interference. Feedback has been received from the BoM indicating that they do not foresee any measurable impact to their current radars.

4.8 Trigonometrical stations

A total of 36 trigonometrical stations have been identified within 40 km of the Project, including two within the wind farm site boundary. In addition, the closest Global Navigation Satellite Systems (GNSS) station is located approximately 9 km southeast of the Project. Geoscience Australia and the Victorian Department of Environment, Land, Water and Planning (DELWP) have



been contacted to inform them of the Project development and seek feedback regarding whether there is potential for interference to their systems. Feedback has been received from both stakeholders, indicating that they do not foresee any impacts due to the Project.

4.9 Citizens Band radio

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

4.10 Mobile phones

In general, mobile phone signals are not susceptible to interference from wind turbines. The nearest mobile phone base station is located approximately 4 km north of the proposed turbine locations.

Published mobile network coverage has been reviewed for the area around the proposed wind farm. It has been found that there is generally good network coverage in most areas around the proposed wind farm, and mobile signals are unlikely to be affected. However there are some areas where coverage may be marginal and therefore mobile signals may be susceptible to interference from the wind farm.

Optus, Telstra, and Vodafone have been contacted to seek feedback on any potential impact that the Project could have on their services. To date, DNV GL has received feedback from both Telstra and Optus indicating that they do not foresee any impacts on their services as a result of the Project, while no formal response has been received from Vodafone. DNV GL notes that if interference is encountered, mitigation options are available, such as installation of an external antenna or moving a short distance until the signal improves.

4.11 Wireless internet

Aussie Broadband operates point-to-multipoint licences in the vicinity of the Project; however it is not possible to identify customers who are using the Aussie Broadband service. Although DNV GL believes that it is unlikely that any of these licences are servicing customers in the vicinity of the proposed wind farm, Aussie Broadband has been contacted as part of an extensive consultation process. Feedback has been received from Aussie Broadband indicating that they do not have any concerns regarding interference as a result of the wind farm.

A review of the NBN availability map indicates that the NBN service is currently available in areas surrounding the proposed wind farm. NBNco has been contacted to seek feedback on whether there is the potential for interference to their services. No formal response has been received to date.

DNV GL's comments on Telstra's mobile coverage in the above section are also applicable to Telstra's wireless broadband services.

4.12 Satellite television and internet

Residents in the vicinity of the wind farm may also have access to satellite television and internet. DNV GL has reviewed the line-of-sight of commonly used TV and internet satellites, and has identified that the signal from the Intelsat 22 satellite to two houses and the signal from the Eutelsat 70B satellite to three houses, all belonging to non-participating landowners, could be potentially intercepted by turbines. However, DNV GL believes that it is unlikely that residents in the vicinity of the Project will be receiving television signals from these satellites, as they do not transmit programming designed for Australian audiences.

4.13 Radio broadcasting

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

4.14 Television broadcasting

Broadcast towers in the vicinity of the proposed wind farm were investigated to identify whether television interference is possible as a result of the Project. Television interference mechanisms are complex to calculate and can have limited predictive accuracy. Television interference around wind turbines is generally limited to less than 5 km and is a function of the visibility of the wind turbines and the transmitter from the receptor. Digital terrestrial broadcasts have recently replaced analogue broadcasts in Victoria and are generally much less susceptible to interference from wind farms. However, interference is possible in some areas of low signal strength.

DNV GL has highlighted the areas around the Project site where interference to terrestrial television broadcasts is likely to occur. According to the Australian Government Digital Ready MySwitch website, residents in the vicinity of the Project receive television signals from the Ballarat (Lookout Hill) broadcast tower. A total of 22 habitable dwellings were identified in the potential interference zone for the Ballarat broadcast tower, including six (6) dwellings belonging to participating landowners.

According to the MySwitch website, the majority of the area surrounding the Project site receives reasonably good coverage with some areas of 'variable' coverage, and therefore interference could be encountered.

In areas where digital reception is marginal, residents in the vicinity of the Project may be eligible to receive access to the Government-funded satellite television service to view free-to-air television.

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

1. Realigning the householders TV antenna more directly towards their existing transmitter;
2. Adjusting the height of the TV antenna;
3. Tuning the householders antenna into alternative sources of the same or suitable TV signal;

- 
4. The installation of a more directional and/or higher gain antenna at the affected building;
 5. Relocating the antenna to a less affected position;
 6. The installation of a cable or satellite TV receiver at the affected house;
 7. Installation of a TV relay station.

4.15 Anticipated change

DNV GL has considered the relative change anticipated in EMI impacts from the current proposed wind farm layout and geometry, compared to the previous layout and geometry assessed in 2009.

It is anticipated that the current layout will have a greater potential for interference to fixed point-to-point links, as a result of the presence of two links crossing the site which were not present at the time of the previous assessment. However it is noted that these links have been commissioned subsequent to the granting of the original planning permit for the Project.

The current layout will introduce the potential for satellite signals to be intercepted by turbines at three house locations; however, it is understood that these satellites do not provide television services designed for Australian audiences.

For terrestrial television broadcasts, the current layout decreases the total number of inhabited houses in the potential interference zone for the Ballarat broadcast tower by four. However, the increased turbine dimensions associated with the current layout may increase the potential for interference when compared with the previous layout.

While it is not possible to determine the anticipated change to the potential EMI impacts on point-to-multipoint links without obtaining further information from the service operators, the consultation process being undertaken by DNV GL will help to determine the potential for the Project to cause interference, and hence assess the likely change in impact caused by the current layout compared to the previous layout.

Potential EMI impacts on other services considered in this assessment are either considered to be minor or are being assessed through consultation with the service operators.

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No of Turbines	79
Rotor diameter (m)	130 or less
Upper Tip Height (m)	180 or less

Table 1 - Turbine assumptions for the EMI assessment

NAME	Easting ¹	Northing ¹	NAME	Easting ¹	Northing ¹
1	718723	5802176	51	725119	5798064
2	719252	5802580	52	722922	5798109
3	719751	5802721	54	722535	5797663
4	720031	5797730	55	720424	5790132
6	719967	5802221	57	720523	5797897
7	719492	5801285	58	720518	5795662
9	719747	5801765	59	720985	5795834
12	718962	5801349	60	721985	5797957
13	720348	5801559	61	721349	5798047
14	720545	5801081	62	717031	5792379
15	721921	5797435	63	720391	5790792
17	721258	5799760	64	723429	5798169
18	720733	5799429	65	719954	5797147
19	721859	5800552	66	720611	5796396
20	722364	5800847	67	719453	5797154
21	721322	5800299	69	721076	5797527
22	722296	5800211	72	719092	5795312
23	722817	5799718	73	719710	5795545
24	722780	5800575	74	717068	5792757
25	719710	5798063	75	719076	5794661
26	721169	5799204	76	719538	5794878
27	721740	5799891	77	720541	5794620
28	722189	5799582	78	720275	5795050
31	720387	5791255	79	720845	5795231
32	721000	5794218	80	722289	5794039
33	717508	5792561	82	719929	5794535
34	719266	5801952	84	721290	5793778
36	720062	5798490	85	721955	5795028
37	720583	5798464	86	722325	5793119
38	721057	5798686	88	720489	5794103
39	723772	5798717	89	721109	5794788
40	722821	5792881	90	721503	5794377
42	721414	5792516	93	722543	5794720
43	722465	5792519	94	722034	5794531
44	725612	5797947	96	721796	5793893
45	724851	5798766	97	721893	5792827
46	724683	5797804	98	721681	5793316
47	724291	5798236	99	722975	5792402
48	717298	5793181	100	721359	5795356
49	723942	5797816			

Note: 1. Coordinate system used is Zone 54H, GDA94 datum

Table 2 - Proposed turbine layout for the Project

Dwelling ID	Easting¹ [m]	Northing¹ [m]	Landholder and Dwelling Status	Nearest Turbine	Distance from nearest turbine [km]
9	724123	5799807	Non-participant	39	1.1
10	718587	5797888	Non-participant, uninhabitable	25	1.1
18	719391	5803724	Non-participant	3	1.1
19	719185	5805026	Non-participant	3	2.4
20	718656	5804668	Non-participant	2	2.2
21	717547	5803608	Non-participant	1	1.9
22	715098	5801127	Non-participant	1	3.8
23	714589	5801057	Non-participant	1	4.3
24	713788	5795489	Non-participant	48	4.2
25	714049	5795420	Non-participant	48	3.9
26	714511	5795536	Non-participant	48	3.6
27	716501	5793929	Non-participant	48	1.1
28	715923	5793021	Non-participant	74	1.2
29	716065	5791501	Non-participant	62	1.3
30	715431	5790719	Non-participant	62	2.3
37	716656	5798944	Non-participant	25	3.2
38	720714	5788267	Non-participant	55	1.9
39	722143	5787638	Non-participant	55	3.0
41	725172	5789858	Non-participant	99	3.4
42	725866	5790427	Non-participant	99	3.5
43	725385	5792233	Non-participant	99	2.4
45	726590	5794934	Non-participant	44	3.2
47	727033	5797127	Non-participant	44	1.6
48	727061	5797842	Non-participant	44	1.4
53	720577	5803778	Non-participant	3	1.3
54 (s)	720176	5800321	Participant, uninhabitable	14	0.8
55 (s)	719613	5799970	Participant	18	1.2
56	719602	5799532	Non-participant, uninhabitable	18	1.1
57	719459	5799651	Non-participant	18	1.3
58	717818	5801367	Non-participant	12	1.1
60	717667	5797118	Non-participant	67	1.8
61 (s)	719390	5796269	Participant	73	0.8
62 (s)	721670	5796577	Participant	15	0.9
63	722798	5796160	Non-participant	85	1.4
64	724012	5796148	Non-participant	49	1.7
65 (s)	723797	5798337	Participant, uninhabitable	39	0.4
66 (s)	722414	5798736	Participant	52	0.8
67 (s)	718431	5793106	Participant	33	1.1

Note 1: Coordinate system used is Zone 54 H, GDA 94 datum

Table 3 - Existing dwellings in the vicinity of the Project Wind Farm

Dwelling ID	Easting¹ [m]	Northing¹ [m]	Landholder and Dwelling Status	Nearest Turbine	Distance from nearest turbine [km]
68 (s)	718429	5793061	Participant, uninhabitable	33	1.0
69	718535	5793693	Non-participant	75	1.1
70	718346	5793752	Non-participant	75	1.2
71 (s)	718590	5793405	Participant	48	1.3
72	718520	5793406	Non-participant	48	1.2
73	718619	5792068	Non-participant	33	1.2
74	718006	5791092	Non-participant	33	1.6
75	717955	5789787	Non-participant	55	2.5
76 (s)	722702	5792294	Participant, uninhabitable	99	0.3
78 (s)	720663	5793064	Participant	42	0.9
79	719983	5793140	Non-participant, destroyed by fire	88	1.1
80	719684	5793375	Non-participant	88	1.1
81 (s)	719130	5793548	Participant, uninhabitable	75	1.1
82	716793	5795383	Non-participant	48	2.3
83	721502	5791385	Non-participant	31	1.1
84	723128	5790975	Non-participant	99	1.4
85	724101	5791516	Non-participant	99	1.4
86	724815	5788076	Non-participant	99	4.7
101	726673	5796189	Non-participant	44	2.1
102	725109	5796692	Non-participant	46	1.2
103	723431	5793860	Non-participant	80	1.2
104	718137	5804335	Non-participant	2	2.1
105	717630	5797179	Non-participant	67	1.8
106	716455	5804551	Non-participant, uninhabitable	1	3.3
107	715247	5802080	Non-participant, uninhabitable	1	3.5
108	718494	5793339	Non-participant, non-residential	48	1.2
109	718502	5793373	Non-participant, non-residential	48	1.2
112 (s)	720055	5800295	Participant	14	0.9

Note 1: Coordinate system used is Zone 54 H, GDA 94 datum

Table 3 - Existing dwellings in the vicinity of the Project Wind Farm (concluded)

Link No.	Assignment ID ¹	Licence Number ¹	Frequency (MHz)	Licensee & Address
1	987984	1979584/1	5745.0	Country Fire Authority PO Box 701 MOUNT WAVERLEY VIC 3149
	987985	1979584/1	5745.0	
	987986	1979584/1	5745.0	
	987987	1979584/1	5745.0	
2 ²	1382016	9877662/1	1507.0	Powercor Australia Ltd c/- Commander Enterprise Service Pty Ltd PO Box 58 CASTLEMAINE VIC 3450
	1382017	9877662/1	1507.0	
	1382018	9877662/1	1446.5	
	1382019	9877662/1	1446.5	

Notes

1: Based on SPECTRA database

2: Not present in ACMA database originally accessed October 2015. Identified through subsequent consultation with Powercor.

Table 4 - Details of point-to-point links crossing the Project site boundary

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
792127	48774	1325174/1	-38.38622	144.18308	71	Alcoa of Australia Limited PO Box 252 APPLECROSS WA 6953
792130	48774	1325174/1	-38.38622	144.18308	71	
1245674	48074	1910333/1	-38.16001	144.20322	60	Ausnet Gas Services Pty Ltd Locked Bag 1405 Licensing-ICT Business Office MELBOURNE CITY MAIL CENTRE VIC 8001
1245677	48074	1910333/1	-38.16001	144.20322	60	
1245678	11724	1910334/1	-37.57667	143.95834	53	
1245681	11724	1910334/1	-37.57667	143.95834	53	
1173040	9000478	1142109/1	-38.30508	142.73830	72	Aussie Broadband Pty Ltd PO Box 3351 GIPPSLAND MC VIC 3841
1173043	9000478	1142109/1	-38.30508	142.73830	72	
1173044	9000479	1142110/1	-38.05588	142.81192	58	
1173047	9000479	1142110/1	-38.05588	142.81192	58	
1173076	9000479	1142836/1	-38.05588	142.81192	58	
1173079	9000479	1142836/1	-38.05588	142.81192	58	
1173080	9000479	1142837/1	-38.05588	142.81192	58	
1173083	9000479	1142837/1	-38.05588	142.81192	58	
1173084	9000479	1142838/1	-38.05588	142.81192	58	
1173087	9000479	1142838/1	-38.05588	142.81192	58	
1173088	9000478	1142839/1	-38.30508	142.73830	72	
1173091	9000478	1142839/1	-38.30508	142.73830	72	
1173092	9000478	1142840/1	-38.30508	142.73830	72	
1173095	9000478	1142840/1	-38.30508	142.73830	72	
1173096	9000478	1142841/1	-38.30508	142.73830	72	
1173099	9000478	1142841/1	-38.30508	142.73830	72	
1173112	37916	1142845/1	-38.23537	143.11630	41	
1173115	37916	1142845/1	-38.23537	143.11630	41	
1173116	37916	1142846/1	-38.23537	143.11630	41	
1173119	37916	1142846/1	-38.23537	143.11630	41	
1173120	37916	1142885/1	-38.23537	143.11630	41	
1173123	37916	1142885/1	-38.23537	143.11630	41	
1173276	9000478	1182332/1	-38.30508	142.73830	72	
1173279	9000478	1182332/1	-38.30508	142.73830	72	
1173280	9000478	1182333/1	-38.30508	142.73830	72	
1173283	9000478	1182333/1	-38.30508	142.73830	72	
1174763	37916	1920098/1	-38.23537	143.11630	41	
1174766	37916	1920098/1	-38.23537	143.11630	41	
1174783	9009153	1920111/1	-37.58722	143.44928	34	
1174786	9009153	1920111/1	-37.58722	143.44928	34	
1174787	9009152	1920113/1	-37.78473	142.98879	45	
1174790	9009152	1920113/1	-37.78473	142.98879	45	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
1174791	9000479	1920116/1	-38.05588	142.81192	58	Aussie Broadband Pty Ltd PO Box 3351 GIPPSLAND MC VIC 3841
1174794	9000479	1920116/1	-38.05588	142.81192	58	
1174799	11727	1920118/1	-37.57670	143.95738	52	
1174802	11727	1920118/1	-37.57670	143.95738	52	
1174803	9000478	1920119/1	-38.30508	142.73830	72	
1174806	9000478	1920119/1	-38.30508	142.73830	72	
789056	303867	1321193/1	-37.54144	143.82240	48	Ballarat City Council CITY OF BALLARAT PO Box 655 BALLARAT VIC 3353
789059	303867	1321193/1	-37.54144	143.82240	48	
830748	136985	1564237/1	-37.54416	143.80304	47	Ballarat Golf Club Inc PO Box 66W BALLARAT WEST VIC 3350
830751	136985	1564237/1	-37.54416	143.80304	47	
1205355	9001426	1960388/1	-37.59072	143.85833	46	Balmaine Gold Pty Ltd PO Box 98 MT CLEAR VIC 3350
1205358	9001426	1960388/1	-37.59072	143.85833	46	
785908	44003	1309727/1	-38.55078	143.97991	72	Barwon Region Water Corporation PO Box 659 (Matthew Grills) GEELONG VIC 3220
785911	44003	1309727/1	-38.55078	143.97991	72	
857419	42557	1804445/1	-38.06589	144.32853	68	
857422	42557	1804445/1	-38.06589	144.32853	68	
857427	47360	1804446/1	-38.41531	144.17433	72	
857430	47360	1804446/1	-38.41531	144.17433	72	
857443	11681	1804448/1	-38.15717	144.31392	69	
857446	11681	1804448/1	-38.15717	144.31392	69	
857483	54070	1804453/1	-38.45843	144.08929	70	
857486	54070	1804453/1	-38.45843	144.08929	70	
857491	137678	1804454/1	-38.35377	144.19056	69	
857494	137678	1804454/1	-38.35377	144.19056	69	
857495	136893	1804455/1	-38.44732	143.73065	52	
857498	136893	1804455/1	-38.44732	143.73065	52	
857503	41974	1804457/1	-38.39133	143.59459	43	
857506	41974	1804457/1	-38.39133	143.59459	43	
857507	11692	1804458/1	-37.88565	144.26838	61	
857510	11692	1804458/1	-37.88565	144.26838	61	
857515	9012920	1804459/1	-38.17463	144.29815	69	
857518	9012920	1804459/1	-38.17463	144.29815	69	
857524	11692	1804460/1	-37.88565	144.26838	61	
857525	11692	1804460/1	-37.88565	144.26838	61	
866390	42097	1904315/1	-38.54760	143.85966	67	
866395	42097	1904315/1	-38.54760	143.85966	67	
890895	44003	1922531/1	-38.55078	143.97991	72	
890896	44003	1922531/1	-38.55078	143.97991	72	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
897501	9012007	1926008/1	-38.53166	143.71976	61	Barwon Region Water Corporation PO Box 659 (Matthew Grills) GEELONG VIC 3220
897504	9012007	1926008/1	-38.53166	143.71976	61	
897509	9012008	1926009/1	-38.53132	143.72361	61	
897512	9012008	1926009/1	-38.53132	143.72361	61	
917754	9011083	1940704/1	-38.54120	143.96822	71	
917755	9011083	1940704/1	-38.54120	143.96822	71	
923124	11681	1944362/1	-38.15717	144.31392	69	
923127	11681	1944362/1	-38.15717	144.31392	69	
947497	42571	1959246/1	-38.28167	144.05361	55	
947500	42571	1959246/1	-38.28167	144.05361	55	
947505	41974	1959247/1	-38.39133	143.59459	43	
947508	41974	1959247/1	-38.39133	143.59459	43	
947513	42097	1959249/1	-38.54760	143.85966	67	
947516	42097	1959249/1	-38.54760	143.85966	67	
947521	54070	1959250/1	-38.45843	144.08929	70	
947524	54070	1959250/1	-38.45843	144.08929	70	
954339	302655	1962700/1	-38.10493	144.35356	71	
954342	302655	1962700/1	-38.10493	144.35356	71	
976244	42571	1973579/1	-38.28167	144.05361	55	
976245	42571	1973579/1	-38.28167	144.05361	55	
976248	301265	1973580/1	-38.51781	143.97710	69	
976249	301265	1973580/1	-38.51781	143.97710	69	
981455	136893	1976141/1	-38.44732	143.73065	52	
981456	136893	1976141/1	-38.44732	143.73065	52	
981463	44003	1976143/1	-38.55078	143.97991	72	
981464	44003	1976143/1	-38.55078	143.97991	72	
992642	9022112	1981667/1	-38.04281	144.16997	54	
992645	9022112	1981667/1	-38.04281	144.16997	54	
1003686	9023387	1986668/1	-37.89407	144.13157	49	
1003687	9023387	1986668/1	-37.89407	144.13157	49	
1006330	9023699	1988013/1	-38.53941	143.53967	59	
1006333	9023699	1988013/1	-38.53941	143.53967	59	
1012136	9024339	1990731/1	-38.03049	144.13767	51	
1012137	9024339	1990731/1	-38.03049	144.13767	51	
1306702-1305288	44003	1309727	-38.55078	143.97992	72	
1306703-1305288	44003	1309727	-38.55078	143.97992	72	
1819011-2235334	42097	1904315	-38.54760	143.85967	67	
1819012-2235334	42097	1904315	-38.54760	143.85967	67	
8258535-8282864	44003	1922531	-38.55078	143.97992	72	
8258536-8282865	44003	1922531	-38.55078	143.97992	72	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
8267532-8293986	9012007	1926008	-38.53166	143.71977	61	Barwon Region Water Corporation PO Box 659 (Matthew Grills) GEELONG VIC 3220
8267533-8293987	9012008	1926009	-38.53132	143.72362	61	
8267534-8293988	9012007	1926008	-38.53166	143.71977	61	
8267535-8293989	9012008	1926009	-38.53132	143.72362	61	
8311754-8347678	9011083	1940704	-38.54120	143.96824	71	
8311755-8347679	9011083	1940704	-38.54120	143.96824	71	
8321350-8359182	11681	1944362	-38.15717	144.31393	69	
8321351-8359183	11681	1944362	-38.15717	144.31393	69	
8370725-8418564	42571	1959246	-38.28167	144.05362	55	
8370726-8418565	41974	1959247	-38.39133	143.59460	43	
8370727-8418566	42571	1959246	-38.28167	144.05362	55	
8370728-8418567	41974	1959247	-38.39133	143.59460	43	
8370731-8418570	42097	1959249	-38.54760	143.85967	67	
8370732-8418571	42097	1959249	-38.54760	143.85967	67	
8370733-8418572	54070	1959250	-38.45843	144.08930	70	
8370734-8418573	54070	1959250	-38.45843	144.08930	70	
8378778-8428840	302655	1962700	-38.10493	144.35358	71	
8378779-8428841	302655	1962700	-38.10493	144.35358	71	
8401884-8459825	42571	1973579	-38.28167	144.05362	55	
8401885-8459826	42571	1973579	-38.28167	144.05362	55	
8401886-8459827	301265	1973580	-38.51781	143.97711	69	
8401887-8459828	301265	1973580	-38.51781	143.97711	69	
8406483-8466732	136893	1976141	-38.44732	143.73066	52	
8406484-8466733	136893	1976141	-38.44732	143.73066	52	
8406524-8466809	44003	1976143	-38.55078	143.97992	72	
8406525-8466810	44003	1976143	-38.55078	143.97992	72	
8417834-8482206	9022112	1981667	-38.04281	144.16998	54	
8417835-8482207	9022112	1981667	-38.04281	144.16998	54	
8431335-8500648	9023387	1986668	-37.89407	144.13158	49	
8431336-8500649	9023387	1986668	-37.89407	144.13158	49	
8434863-8505270	9023699	1988013	-38.53941	143.53968	59	
8434864-8505271	9023699	1988013	-38.53941	143.53968	59	
910617	9013603	1936474/1	-38.17415	144.35540	73	Barwon Valley Golf Club Inc PO Box 367 BELMONT VIC 3216
910620	9013603	1936474/1	-38.17415	144.35540	73	
715994	44050	213607/1	-37.53773	143.81932	48	Central Highlands Region Water Corporation PO Box 152 BALLARAT VIC 3353
715997	44050	213607/1	-37.53773	143.81932	48	
716002	11727	213608/1	-37.57670	143.95738	52	
716005	11727	213608/1	-37.57670	143.95738	52	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
745884	305907	1145189/1	-37.44011	143.81536	57	Central Highlands Region Water Corporation PO Box 152 BALLARAT VIC 3353
745887	305907	1145189/1	-37.44011	143.81536	57	
745892	301006	1145190/1	-37.62641	143.90226	45	
745895	301006	1145190/1	-37.62641	143.90226	45	
745900	305311	1145191/1	-37.53318	143.88444	52	
745903	305311	1145191/1	-37.53318	143.88444	52	
750913	9001493	1149774/1	-37.62981	144.10237	58	
750916	9001493	1149774/1	-37.62981	144.10237	58	
750917	9001492	1149775/1	-37.42453	143.38131	53	
750920	9001492	1149775/1	-37.42453	143.38131	53	
759676	305311	1189792/1	-37.53318	143.88444	52	
759679	305311	1189792/1	-37.53318	143.88444	52	
762792	45665	1192847/1	-37.85602	143.75663	19	
762795	45665	1192847/1	-37.85602	143.75663	19	
785540	301006	1307545/1	-37.62641	143.90226	45	
785543	301006	1307545/1	-37.62641	143.90226	45	
832756	9004355	1565856/1	-37.63935	143.70479	33	
832759	9004355	1565856/1	-37.63935	143.70479	33	
832764	9004356	1565857/1	-37.26051	143.53363	70	
832767	9004356	1565857/1	-37.26051	143.53363	70	
832968	9004396	1566084/1	-37.67325	143.35439	27	
832971	9004396	1566084/1	-37.67325	143.35439	27	
833016	204824	1566090/1	-37.68937	143.52372	23	
833019	204824	1566090/1	-37.68937	143.52372	23	
930103	9015837	1949039/1	-37.57046	144.23051	71	
930106	9015837	1949039/1	-37.57046	144.23051	71	
930117	9015847	1949064/1	-37.32658	143.78508	68	
930120	9015847	1949064/1	-37.32658	143.78508	68	
945463	9004355	1958169/1	-37.63935	143.70479	33	
945466	9004355	1958169/1	-37.63935	143.70479	33	
945475	305907	1958170/1	-37.44011	143.81536	57	
945478	305907	1958170/1	-37.44011	143.81536	57	
1005182	9023545	1987399/1	-37.58338	144.08163	60	
1005185	9023545	1987399/1	-37.58338	144.08163	60	
1007066	305907	1988415/1	-37.44011	143.81536	57	
1007069	305907	1988415/1	-37.44011	143.81536	57	
8271267-8298020	305907	1926638	-37.44011	143.81537	57	
8271268-8298021	305907	1926638	-37.44011	143.81537	57	
1207849	301164	1308885/1	-37.57682	143.83121	45	
1207852	301164	1308885/1	-37.57682	143.83121	45	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
788447	303241	1318832/1	-38.14625	143.12867	34	John Lewis Jones Page House Holdings 684 Darlington Road BOOKAAR VIC 3260
788450	303241	1318832/1	-38.14625	143.12867	34	
714804	55528	182133/1	-37.56452	143.85548	48	Ken Belsar Consultancy Pty Ltd PO Box 354 BALLARAT VIC 3353
714807	55528	182133/1	-37.56452	143.85548	48	
785592	55528	1307808/1	-37.56452	143.85548	48	
785595	55528	1307808/1	-37.56452	143.85548	48	
785680	55528	1308322/1	-37.56452	143.85548	48	
785683	55528	1308322/1	-37.56452	143.85548	48	
795672	55528	1329002/1	-37.56452	143.85548	48	
795675	55528	1329002/1	-37.56452	143.85548	48	
949782	55528	1960472/1	-37.56452	143.85548	48	
949785	55528	1960472/1	-37.56452	143.85548	48	
976699	55528	1973819/1	-37.56452	143.85548	48	
976702	55528	1973819/1	-37.56452	143.85548	48	
982359	55528	1976628/1	-37.56452	143.85548	48	
982362	55528	1976628/1	-37.56452	143.85548	48	
1311220-1308905	55528	1313634	-37.56452	143.85549	48	
1311221-1308905	55528	1313634	-37.56452	143.85549	48	
172348-27225	55528	529003	-37.56452	143.85549	48	
387945-27225	55528	529003	-37.56452	143.85549	48	
722697	305790	354784/1	-38.05596	142.81161	58	Powercor Australia Ltd C/- Commander Enterprise Service Pty Ltd PO Box 58 (C/- P Dessens) CASTLEMAINE VIC 3450
722700	305790	354784/1	-38.05596	142.81161	58	
795056	305790	1327796/1	-38.05596	142.81161	58	
795059	305790	1327796/1	-38.05596	142.81161	58	
923787	305790	1945114/1	-38.05596	142.81161	58	
923790	305790	1945114/1	-38.05596	142.81161	58	
935895	305522	1951662/1	-37.49212	143.97561	61	
935898	305522	1951662/1	-37.49212	143.97561	61	
943368	304700	1956930/1	-37.39352	143.11273	65	
943371	304700	1956930/1	-37.39352	143.11273	65	
943376	9017014	1956931/1	-37.83081	143.88747	30	
943379	9017014	1956931/1	-37.83081	143.88747	30	
943432	305522	1956938/1	-37.49212	143.97561	61	
943435	305522	1956938/1	-37.49212	143.97561	61	
1002001	9023261	1986117/1	-38.16108	144.34332	72	Sensus UK Systems Limited 3 Lindenwood Crockford Lane Chineham Business Park RG24 8QY United Kingdom
1002002	9023261	1986117/1	-38.16108	144.34332	72	
1002009	9023261	1986118/1	-38.16108	144.34332	72	
1002010	9023261	1986118/1	-38.16108	144.34332	72	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (continued)

Assignment ID	Site ID	Licence number	Latitude [GDA94]	Longitude [GDA94]	Distance to wind farm [km]	Licensee [Address]
1002013	9023261	1986119/1	-38.16108	144.34332	72	Sensus UK Systems Limited 3 Lindenwood Crockford Lane Chineham Business Park RG24 8QY United Kingdom
1002014	9023261	1986119/1	-38.16108	144.34332	72	
1002017	9023261	1986120/1	-38.16108	144.34332	72	
1002018	9023261	1986120/1	-38.16108	144.34332	72	
1002021	9023261	1986121/1	-38.16108	144.34332	72	
1002022	9023261	1986121/1	-38.16108	144.34332	72	
1002049	9023261	1986126/1	-38.16108	144.34332	72	
1002050	9023261	1986126/1	-38.16108	144.34332	72	
785981	11693	1310561/1	-37.88688	144.26936	61	Telstra Corporation Limited Attn: Barry McDonald Lv 2, Bld M5 30 Henderson Rd CLAYTON VIC 3168
785984	11693	1310561/1	-37.88688	144.26936	61	
786251	11726	1311720/1	-37.57662	143.95851	53	
786254	11726	1311720/1	-37.57662	143.95851	53	
802036	150365	1415313/1	-37.57536	143.96016	53	Veolia Water Services (ANZ) Pty Ltd United Water PO Box 272 BROWN HILL VIC 3350
802039	150365	1415313/1	-37.57536	143.96016	53	
972359	150365	1971491/1	-37.57536	143.96016	53	
972362	150365	1971491/1	-37.57536	143.96016	53	
1279135	11719	1327185/1	-37.65293	143.92646	44	Victorian Rail Track VicTrack GPO Box 1681 (C/- R Douglas) MELBOURNE VIC 3001
1279138	11719	1327185/1	-37.65293	143.92646	44	
793622	46455	1326835/1	-38.49253	142.98049	70	Wannon Region Water Corporation PO Box 1158 WARRNAMBOOL VIC 3280
793625	46455	1326835/1	-38.49253	142.98049	70	
793630	42618	1326836/1	-38.23779	143.12197	40	
793633	42618	1326836/1	-38.23779	143.12197	40	
793650	300876	1326839/1	-38.06420	142.80851	58	
793653	300876	1326839/1	-38.06420	142.80851	58	
804029	42618	1418709/1	-38.23779	143.12197	40	
804032	42618	1418709/1	-38.23779	143.12197	40	
1325567-1320536	46455	1326835	-38.49253	142.98050	70	
1325568-1320536	46455	1326835	-38.49253	142.98050	70	
1325569-1320537	42618	1326836	-38.23779	143.12198	40	
1325570-1320537	42618	1326836	-38.23779	143.12198	40	
1325575-1320540	300876	1326839	-38.06421	142.80852	58	
1325576-1320540	300876	1326839	-38.06421	142.80852	58	
1416380-1413030	42618	1418709	-38.23779	143.12198	40	
1416381-1413030	42618	1418709	-38.23779	143.12198	40	

Table 5 - Details of point-to-multipoint licences within 75 km of the Project (concluded)

Licence Type	Licence Category	Number of Licences
ACA	ACA Assigned	3
Aeronautical	Aeronautical Assigned System	25
Amateur	Amateur Beacon	4
Amateur	Amateur Repeater	93
Broadcasting	Broadcast Service	93
Broadcasting	Narrowband Area Service station(s)	2
Broadcasting	Narrowcasting Service	30
Fixed	Point to Multipoint	196
Fixed	Sound Outside Broadcast	3
Land Mobile	Ambulatory - Initial	4
Land Mobile	Ambulatory System	40
Land Mobile	CBRS Repeater	6
Land Mobile	Land Mobile System - > 30MHz	1724
Land Mobile	Land Mobile System 0-30MHz	188
Land Mobile	Paging System - Exterior	34
Land Mobile	Paging System - Interior	16
PTS	PMTS Class B	884
Radiodetermination	Radiodetermination	2
Scientific	Scientific Assigned	18
Spectrum	1800 MHz Band	334
Spectrum	2 GHz Band	1201
Spectrum	2.3 GHz Band	18
Spectrum	2.5 GHz Band	218
Spectrum	2.5 GHz Mid Band Gap	52
Spectrum	3.4 GHz Band	8
Spectrum	700 MHz Band	504
Spectrum	800 MHz Band	680
Total		6380

Table 6 - Details of other licences identified within 75 km of the Project

Emergency Service	Contact Details	Distance of closest site from site boundary [km]
Ambulance Victoria	Ambulance Victoria Attn: Tim McCallum 303 Gillies Street North WENDOUREE VIC 3355	44
Country Fire Authority	Country Fire Authority PO Box 701 MOUNT WAVERLEY VIC 3149	2
St John Ambulance Australia (Victoria) Incorporated	St John Ambulance Australia (Victoria) Incorporated PO Box 573 MT WAVERLEY VIC 3149	34
State of Victoria – Department of Justice	Corrections Victoria Security and Emergency Services Group Radiocommunications Coordinator Locked Bag 7 LARA VIC 3212	54
	Emergency Services Telecommunications Authority c/- 10 Wesley Court – Motorola MMR project Tally Ho Business Park EAST BURWOOD VIC 31551	34
	Regional Mobile Radio c/- Level 2 Bld M5 30 Henderson Rd CLAYTON VIC 3168	23
	Visionstream Australia Grd Floor 333 Collins St Attn: Rosario Holden MELBOURNE VIC 3000	23
Victoria Police	Victoria Police Attn Natalie Leao Level 7, Tower 2, 637 Flinders Street MELBOURNE VIC 3005	44
Victoria State Emergency Service	Victoria State Emergency Service Authority 168 Sturt St SOUTHBANK VIC 3006	11

Table 7 - Emergency services with radiocommunication assets in the vicinity of the Project



Airport	Latitude [degrees]¹	Longitude [degrees]¹	Approximate Distance from the Project [km]
Avalon	-38.04	144.47	80
Melbourne	-37.67	144.85	116
Essendon	-37.73	144.9	119
Moorabbin	-37.98	145.1	134

Note: 1. Coordinate system used is Lat/Long WGS84 datum

Table 8 - Airports in the vicinity of the Project

BoM Radar site	Latitude [degrees]¹	Longitude [degrees]¹	Approximate Distance from the Project [km]
Melbourne	-37.86	144.76	105
Mt Gambier	-37.75	140.77	238
Yarrawonga	-36.03	146.03	304
Bairnsdale	-35.33	138.50	350
NW Tasmania	-41.18	145.58	394
Mildura	-34.23	142.08	427

Note: 1. Coordinate system used is Lat/Long WGS84 datum

Table 9 - BoM radar sites in the vicinity of the Project

Station Name	Datum	Latitude	Longitude	Distance to site boundary [km]
Bald Hill	AGD66	S38°4' 58.95"	E143°24' 26.47"	11
Barunah	AGD66	S38°4' 26.80"	E143°54' 40.20"	33
Berrybank	AGD66	S37°58' 52.44"	E143°29' 54.40"	0 ¹
Berrybank RM1	AGD66	S37°58' 52.28"	E143°29' 54.37"	0 ¹
Black Hill	AGD66	S38°10' 47.99"	E143°41' 51.34"	24
Bute	AGD66	S37°41' 30.47"	E143°31' 21.98"	22
Cherry Tree Hill	AGD66	S37°40' 30.50"	E143°35' 50.94"	26
Colac	GDA94	S38°20' 32.55"	E143°35' 6.50"	37
Colac Quarry	AGD66	S38°19' 50.15"	E143°37' 46.37"	37
Corrangamite 1	AGD66	S38°21' 4.76"	E143°28' 37.24"	38
Culraven	AGD66	S38°2' 2.76"	E143°31' 40.84"	3
Culraven ECCE A	AGD66	S38°2' 8.26"	E143°31' 41.71"	3
Culraven ECCE B	AGD66	S38°2' 8.38"	E143°31' 37.66"	3
Cundare	AGD66	S38°7' 19.00"	E143°32' 31.33"	12
Cundare ECCE G	AGD66	S38°7' 19.04"	E143°32' 31.42"	12
Elephant	AGD66	S37°57' 42.83"	E143°11' 37.96"	24
	AGD84	S37°57' 42.84"	E143°11' 37.87"	24
	GDA94	S37°57' 37.46"	E143°11' 42.76"	24
Emu	AGD66	S37°35' 20.74"	E143°26' 51.13"	34
	AGD84	S37°35' 20.75"	E143°26' 51.05"	34
	GDA94	S37°35' 15.36"	E143°26' 55.90"	34
Enfield	AGD66	S37°44' 23.97"	E143°45' 13.28"	27
Gellibrand	AGD66	S38°14' 5.85"	E143°47' 27.76"	34
	AGD84	S38°14' 5.87"	E143°47' 27.67"	34
	GDA94	S38°14' 0.47"	E143°47' 32.55"	34
Gellibrand ECCE B	AGD66	S38°14' 5.84"	E143°47' 27.76"	34
Gnarpurt	AGD66	S38°2' 19.11"	E143°25' 3.12"	6
Gows Hill	AGD66	S38°0' 50.80"	E143°52' 6.38"	27
	AGD84	S38°0' 50.81"	E143°52' 6.29"	27
	GDA94	S38°0' 45.41"	E143°52' 11.15"	27
Hesse	AGD66	S38°9' 38.35"	E143°49' 58.87"	31
Jolly Hill	AGD66	S37°36' 31.21"	E143°46' 21.66"	40
Kinross	AGD66	S37°51' 38.87"	E143°28' 38.77"	4
	AGD84	S37°51' 38.87"	E143°28' 38.68"	4
	GDA94	S37°51' 33.48"	E143°28' 43.55"	4

Note: 1. Located within site boundary

Table 10 - Trigonometrical stations in the vicinity of the Project

Station Name	Datum	Latitude	Longitude	Distance to site boundary [km]
Leura	AGD66	S38°14' 45.54"	E143°9' 22.99"	39
	AGD66	S38°14' 45.58"	E143°9' 22.94"	39
	AGD84	S38°14' 45.55"	E143°9' 22.90"	39
	AGD84	S38°14' 45.60"	E143°9' 22.85"	39
	GDA94	S38°14' 40.18"	E143°9' 27.81"	39
	GDA94	S38°14' 40.23"	E143°9' 27.76"	39
Mercer	AGD66	S37°49' 16.22"	E143°51' 45.19"	29
	AGD84	S37°49' 16.23"	E143°51' 45.10"	29
	GDA94	S37°49' 10.82"	E143°51' 49.95"	29
Porndon	AGD66	S38°18' 55.47"	E143°17' 10.74"	39
	AGD84	S38°18' 55.49"	E143°17' 10.65"	39
	GDA94	S38°18' 50.12"	E143°17' 15.56"	39
Rebecca	AGD66	S38°2' 11.48"	E143°42' 38.20"	15
Rebecca ECCE A	AGD66	S38°2' 11.61"	E143°42' 38.38"	15
Robertsons Hill	AGD66	S38°19' 12.18"	E143°30' 42.96"	34
Shelford	AGD66	S38°1' 39.77"	E143°57' 57.49"	36
Taralea	AGD66	S37°58' 2.30"	E143°45' 50.32"	17
Warrion	AGD66	S38°13' 32.04"	E143°31' 43.36"	24
	AGD84	S38°13' 32.05"	E143°31' 43.28"	24
	GDA94	S38°13' 26.67"	E143°31' 48.17"	24
Watch Hill	AGD66	S38°7' 48.64"	E143°37' 37.10"	16
Widderin	AGD66	S37°44' 40.72"	E143°21' 21.67"	21

Table 10 - Trigonometrical stations in the vicinity of the Project (concluded)

House ID	Landholder and Dwelling Status	Easting ¹ [m]	Northing ¹ [m]
10	Non-participant, uninhabitable	718587	5797888
38	Non-participant	720714	5788267
39	Non-participant	722143	5787638
45	Non-participant	726590	5794934
54 (s)	Participant, uninhabitable	720176	5800321
55 (s)	Participant	719613	5799970
56	Non-participant, uninhabitable	719602	5799532
57	Non-participant	719459	5799651
61 (s)	Participant	719390	5796269
62 (s)	Participant	721670	5796577
63	Non-participant	722798	5796160
64	Non-participant	724012	5796148
65 (s)	Participant, uninhabitable	723797	5798337
66 (s)	Participant	722414	5798736
74	Non-participant	718006	5791092
75	Non-participant	717955	5789787
76 (s)	Participant, uninhabitable	722702	5792294
78 (s)	Participant	720663	5793064
79	Non-participant, destroyed by fire	719983	5793140
80	Non-participant	719684	5793375
81 (s)	Participant, uninhabitable	719130	5793548
83	Non-participant	721502	5791385
84	Non-participant	723128	5790975
85	Non-participant	724101	5791516
86	Non-participant	724815	5788076
101	Non-participant	726673	5796189
102	Non-participant	725109	5796692
103	Non-participant	723431	5793860
112 (s)	Participant	720055	5800295

Note 1: Coordinate system used is Zone 54 H, GDA 94 datum
2: 'S' denotes participating landholders (i.e. 'stakeholders')

Table 11 - Houses with potential to experience EMI to digital television broadcast

	Licence type	Closest distance to Wind Farm [km]	Operator	DNV GL Reference	Response received
1	Fixed point-to-point; land mobile system	1 turbine (Turbine 1) in 2nd Fresnel exclusion zone set by DNV GL	Country Fire Authority	170493-AUME-L-01-A	<u>Responses received on 08-03-2016 and 06-04-2016:</u> There is a CFA point-to-point radio link that runs through the Berrybank Wind Farm zone boundary. [...] Our analysis indicates that the Turbine 1 of Berrybank wind farm will obstruct this microwave link. Turbines 2,3,6,9 and 34 are close to the radio link path but the link path is not obstructed at the exact proposed locations.
2	Fixed point-to-point; fixed point-to- multipoint	1 turbine (Turbine 51) in 200m exclusion zone requested by Powercor	Powercor Australia Ltd	170493-AUME-L-08-A	<u>Response received on 04-04-2016:</u> Turbine 51 needs to be removed from the line of sight clearance zones (200mts either side of line of sight and have the blade radius clear of the edge of the clearance zone) [...] Turbines 44 & 45 are marginally clear of the clearance zones.
3	Fixed point-to-multipoint	53	Ausnet Gas Services Pty Ltd	170493-AUME-L-02-A	<u>Response received on 01-04-2016:</u> This is not an issue for us [...] our radio links are clear from the Berrybank wind farm
4	Fixed point-to- multipoint; wireless internet	34	Aussie Broadband Pty Ltd	170493-AUME-L-03-A	<u>Response received on 04-03-2016:</u> We don't have any concerns with this wind farm proposal.
5	Fixed point-to-multipoint	43	Barwon Region Water Corporation	170493-AUME-L-05-A	<u>Response received on 07-03-2016:</u> I can't foresee any Issues with EMR and the Barwon Water Telemetry Systems.
6	Fixed point-to- multipoint; land mobile system	2 (land mobile)	VicTrack	170493-AUME-L-11-A	<u>Response received on 07-03-2016:</u> Berrybank [identified land mobile asset] doesn't exist anymore and I don't believe it should be a problem with Mt Buningyong [identified point-to-multipoint asset].
7	Land mobile system	44	Ambulance Victoria	170493-AUME-L-13-A	<u>Response received on 23-03-2016:</u> I do not anticipate there will be any adverse impact on the communications services.

Table 12 - Summary of responses received to date to consultation undertaken by DNV GL

	Licence type	Closest distance to Wind Farm [km]	Operator	DNV GL Reference	Response received
8	Land mobile system	61	Victoria Police	170493-AUME-L-15-A	<u>Response received on 08-03-2016:</u> Based on the provided data, we expect nil impact to police radio communications and therefore support the proposed Berrybank wind farm.
9	Land mobile system	11	Victoria State Emergency Service	170493-AUME-L-16-A	<u>Response received on 24-03-2016:</u> Our assessment shows that there will be minimal impact to our telecommunications network.
10	Meteorological radar	105	Bureau of Meteorology	170493-AUME-L-17-A	<u>Response received on 08-03-2016:</u> The Bureau radars currently in place will not be measurably affected by the proposed Berrybank wind farm.
11	Trigonometrical stations, Global Navigational Satellite System (GNSS) stations	2 Trigonometrical stations within site boundary	Geoscience Australia	170493-AUME-L-18-A	<u>Response received on 29-03-2016:</u> Geoscience Australia does not see foresee any impact to our trigonometrical stations, Global Navigational Satellite System stations, equipment, facilities or services associated with the proposed Berrybank Wind Farm.
12	Trigonometrical stations, GNSS stations	2 Trigonometrical stations within site boundary	Victorian Department of Environment, Land, Water, and Planning (DELWP)	170493-AUME-L-19-A	<u>Response received on 24-03-2016:</u> This won't be a problem for our GNSS & ITC infrastructure.
13	Public Telecommunications Service (PTS); spectrum; fixed point-to-multipoint	4	Telstra	170493-AUME-L-09-A	<u>Response received on 24-03-2016:</u> There are no Telstra's [sic] point to point and point to multipoint links in the area proposed for the Berrybank Wind Farm. Telstra radio links will not be affected by your Wind Farm proposal.
14	PTS; spectrum	4	Optus	170493-AUME-L-20-A	<u>Response received on 17-03-2016:</u> The mobile network team has reviewed this information and has no concerns regarding impact to our mobile access network. <u>Response received on 18-03-2016:</u> The proposed Berrybank Wind farm has no impact on the existing or planned microwave radio transmission links at present in Optus Network in the area.

Table 12 - Summary of responses received to date to consultation undertaken by DNV GL (concluded)

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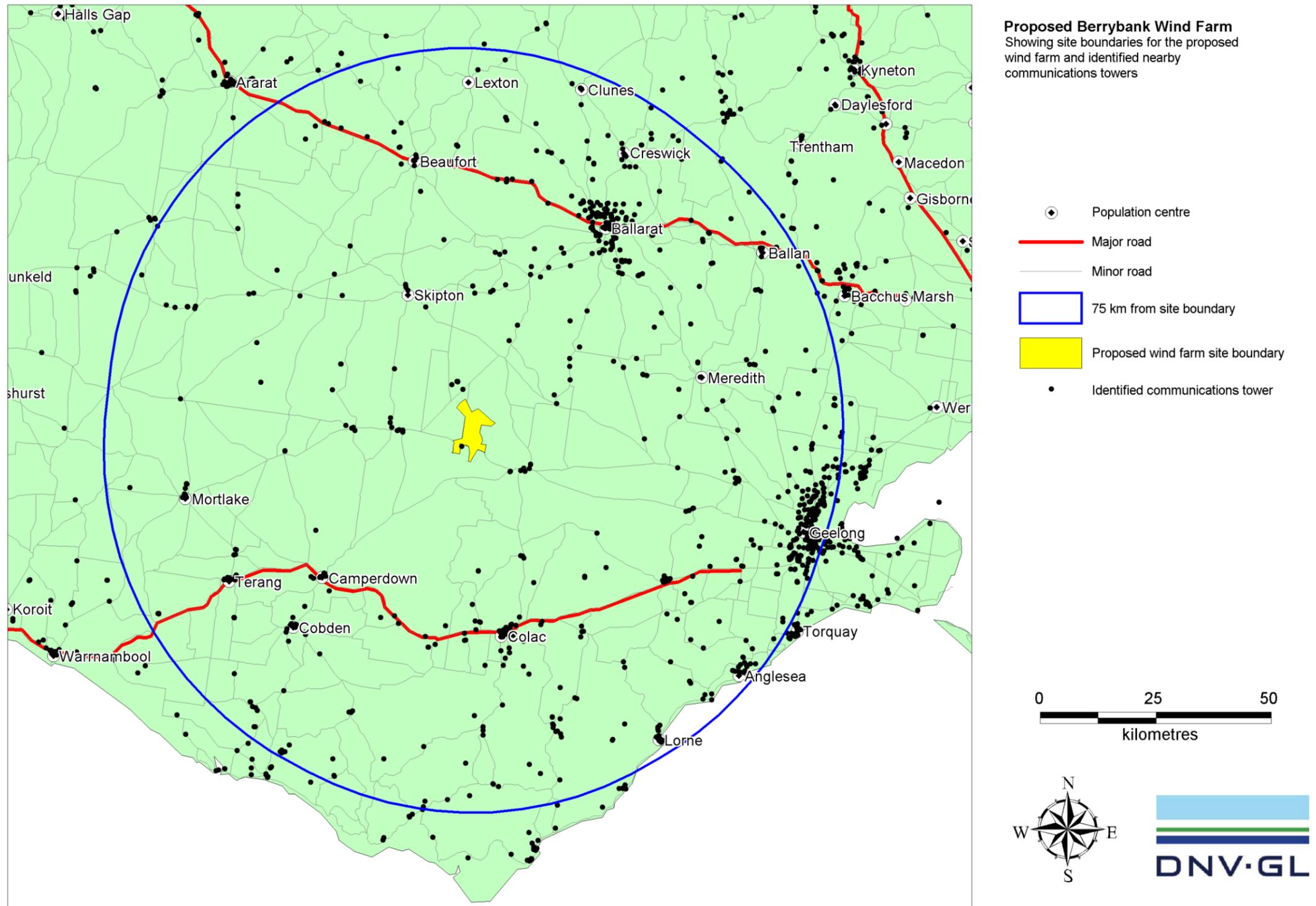
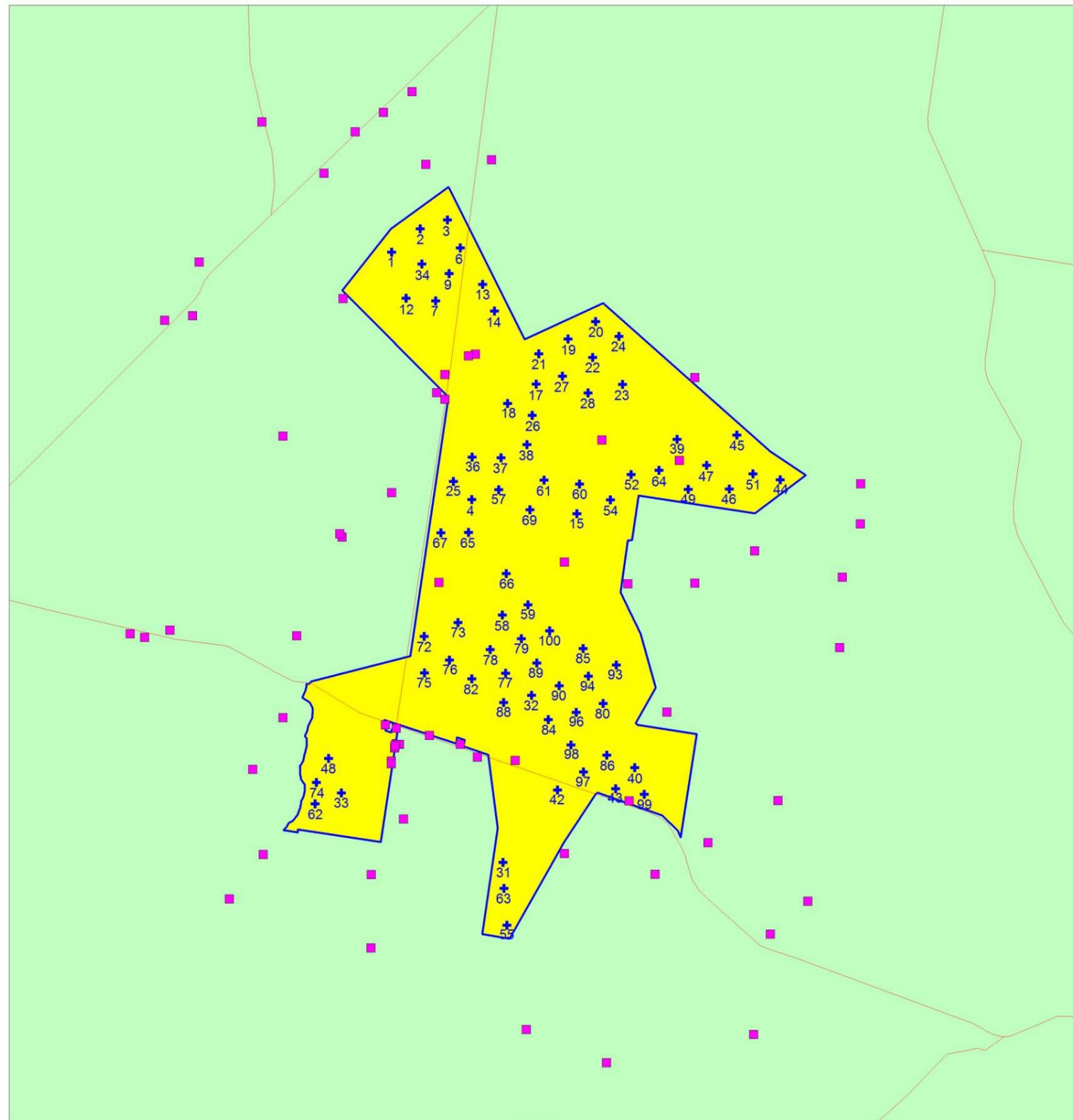


Figure 1 - Location of the Project and identified radiocommunications sites in the vicinity



Proposed Berrybank Wind Farm

Showing proposed turbine layout and locations of existing dwellings

- + Proposed turbine location
- Existing dwelling
- Proposed wind farm site boundary
- Road

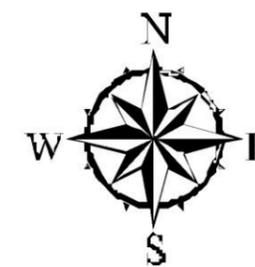


Figure 2 - Map of the Project

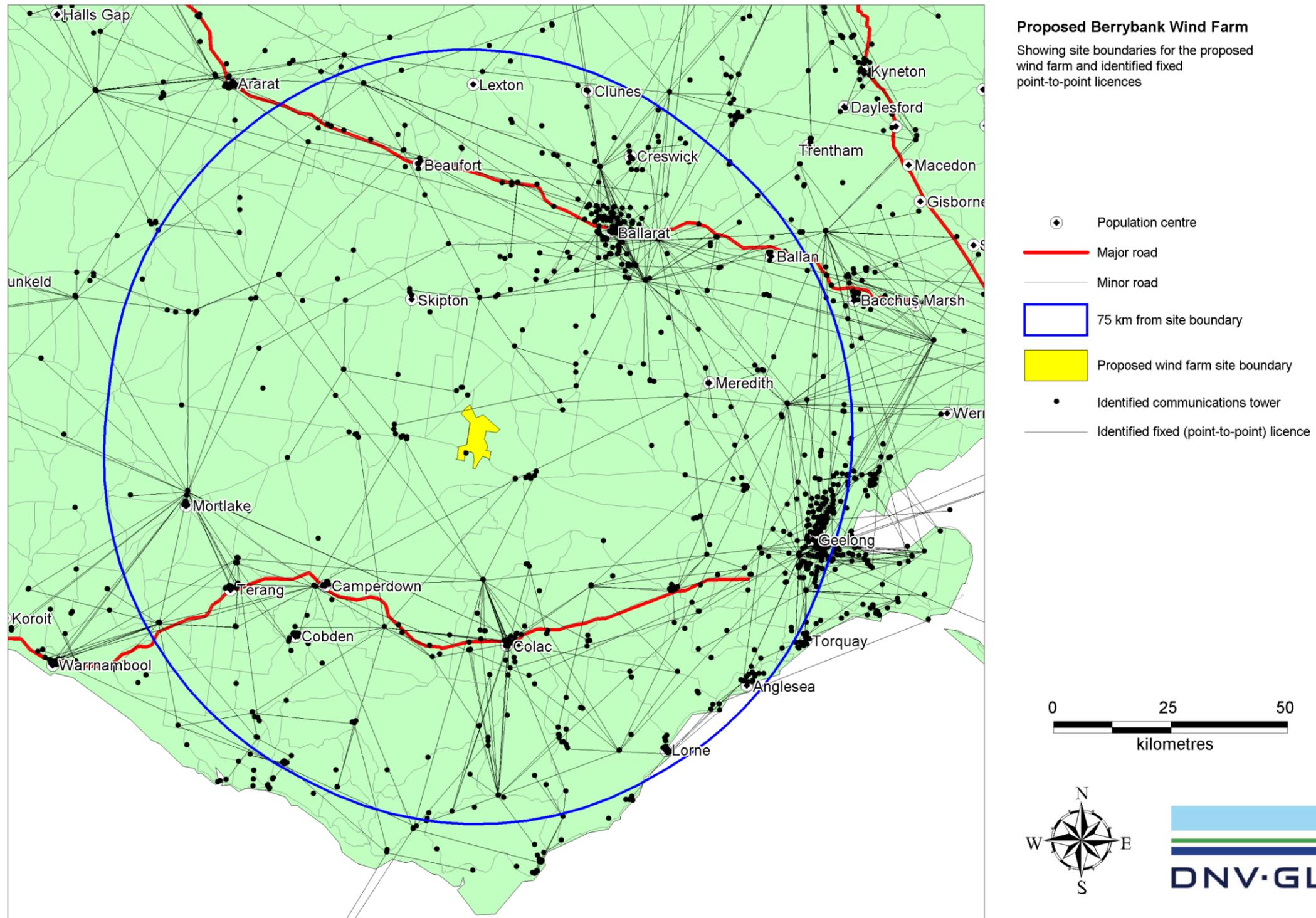
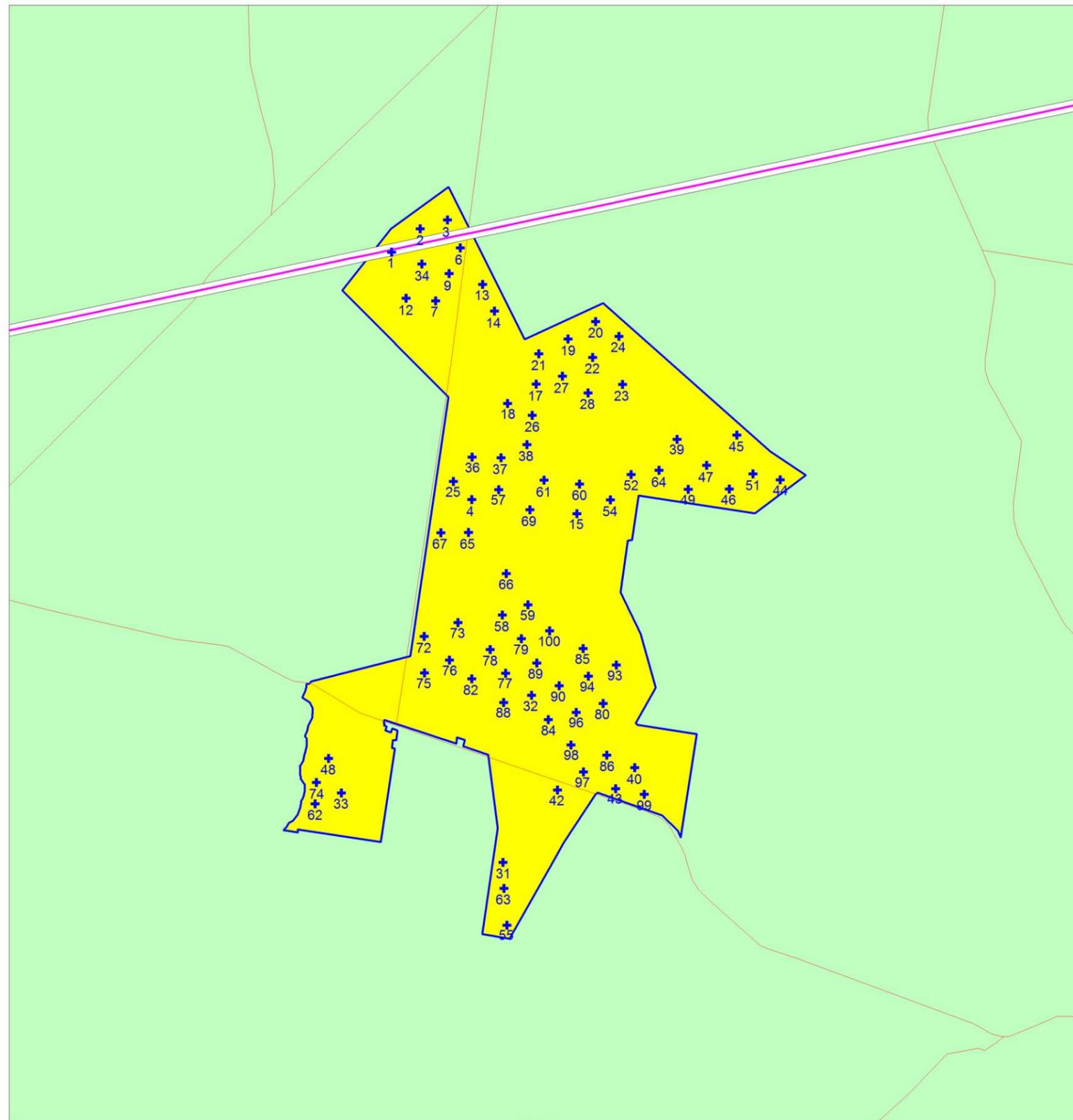


Figure 3 - Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the Project



Proposed Berrybank Wind Farm

Showing identified point-to-point licence crossing site boundary and 2nd Fresnel zone

- + Proposed turbine location
- Proposed wind farm site boundary
- Road
- Point-to-point link
- Point-to-point link exclusion zone (2nd Fresnel zone of lowest frequency link + 75 m rotor radius)

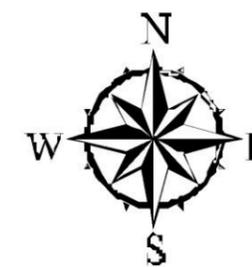
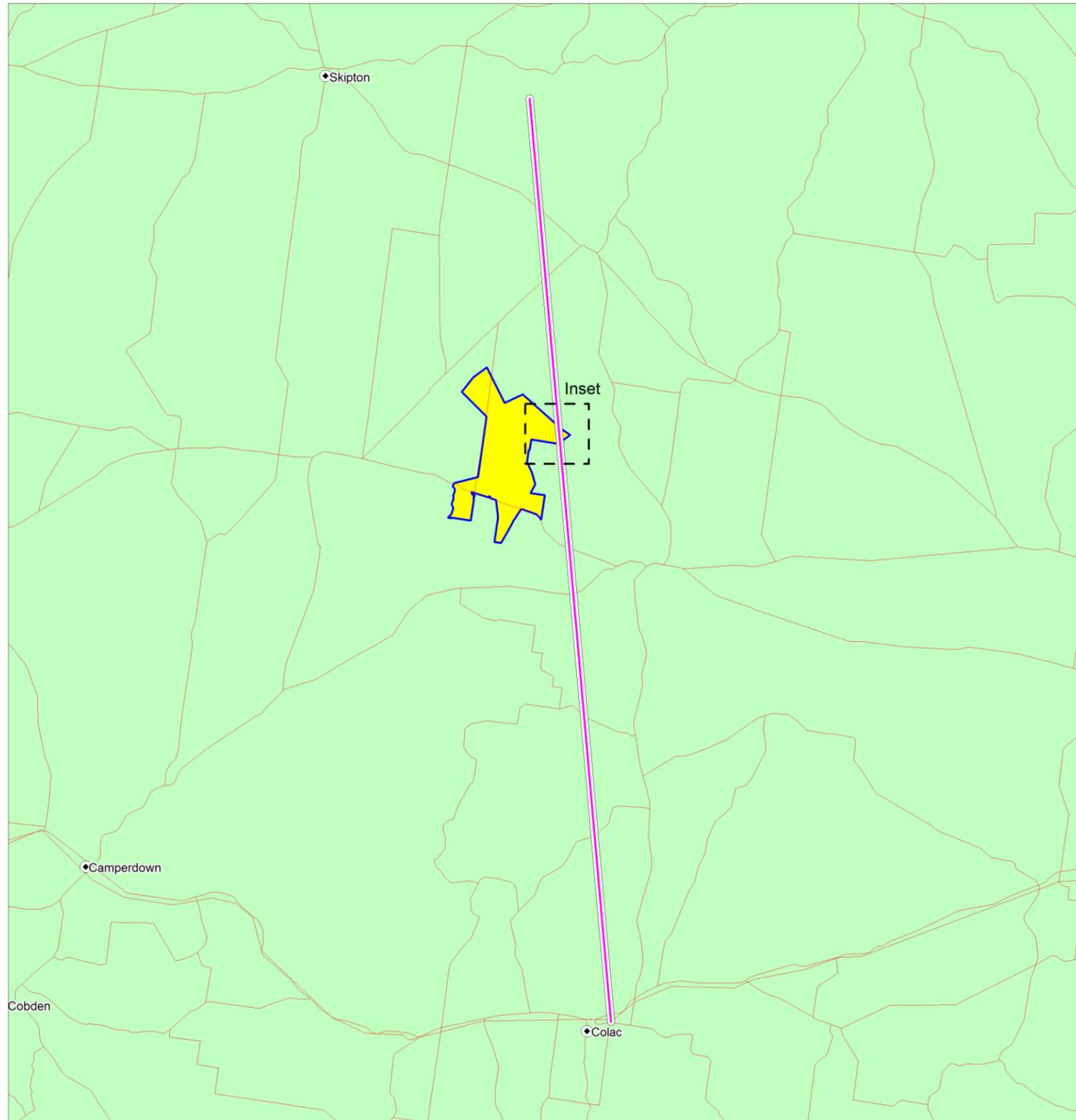


Figure 4 - Point-to-point link crossing the Project site (identified from the ACMA database) and associated exclusion zone



Proposed Berrybank Wind Farm

Showing Powercor point-to-point licence crossing site boundary and requested exclusion zone

- + Proposed turbine location
- Proposed wind farm site boundary
- Road
- Point-to-point link
- Point-to-point link exclusion zone (200m clearance either side of direct line of site + 75 m rotor radius)
- Population centre

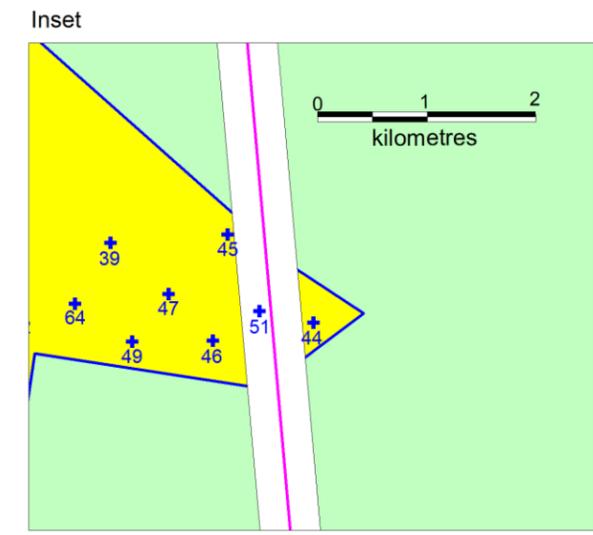


Figure 5 – New point-to-point link crossing the Project site (based on consultation feedback) and requested exclusion zone

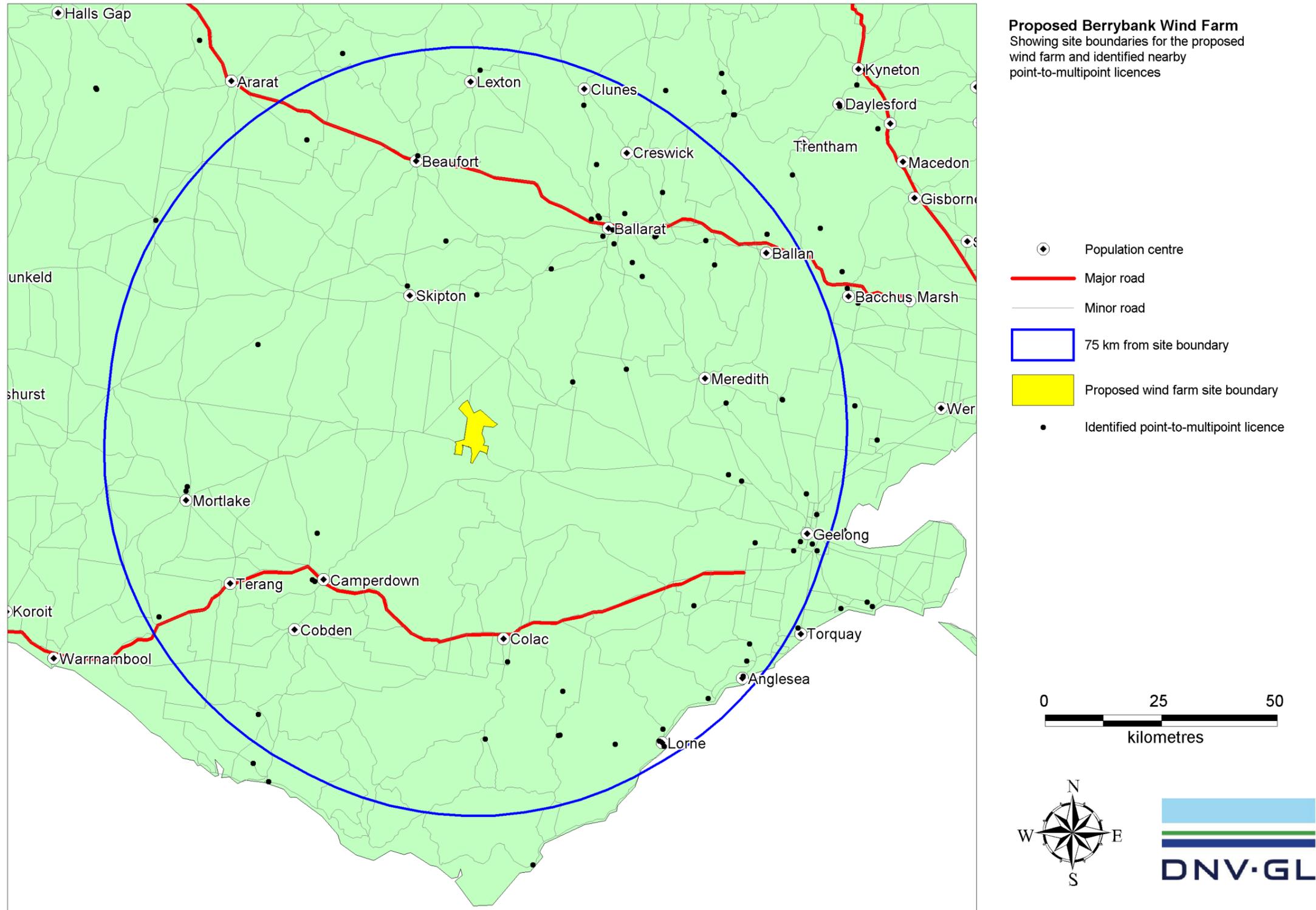


Figure 6 - Location of point-to-multipoint stations in the vicinity of the Project

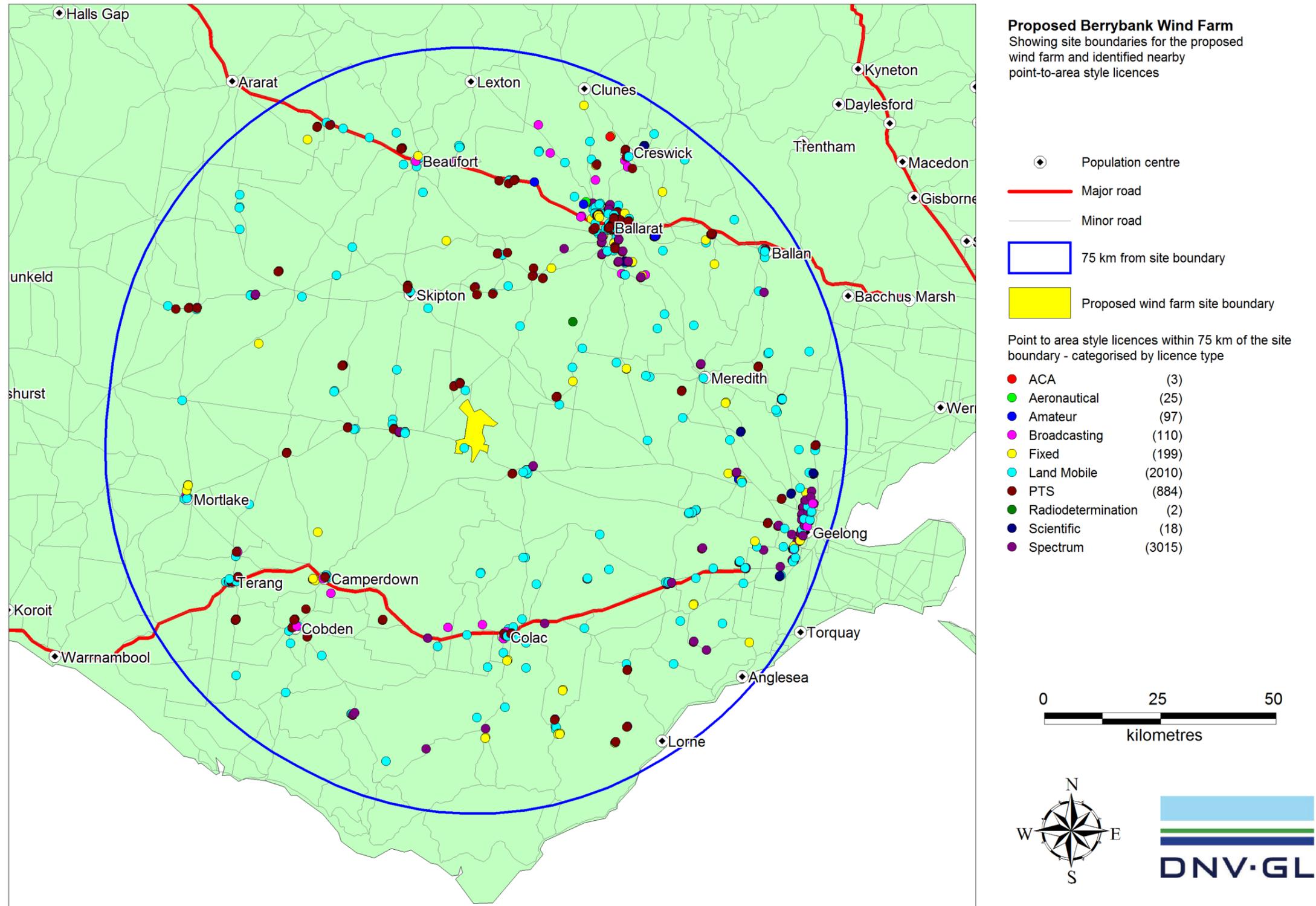


Figure 7 - Location of general point to area style licences within 75km of the Project

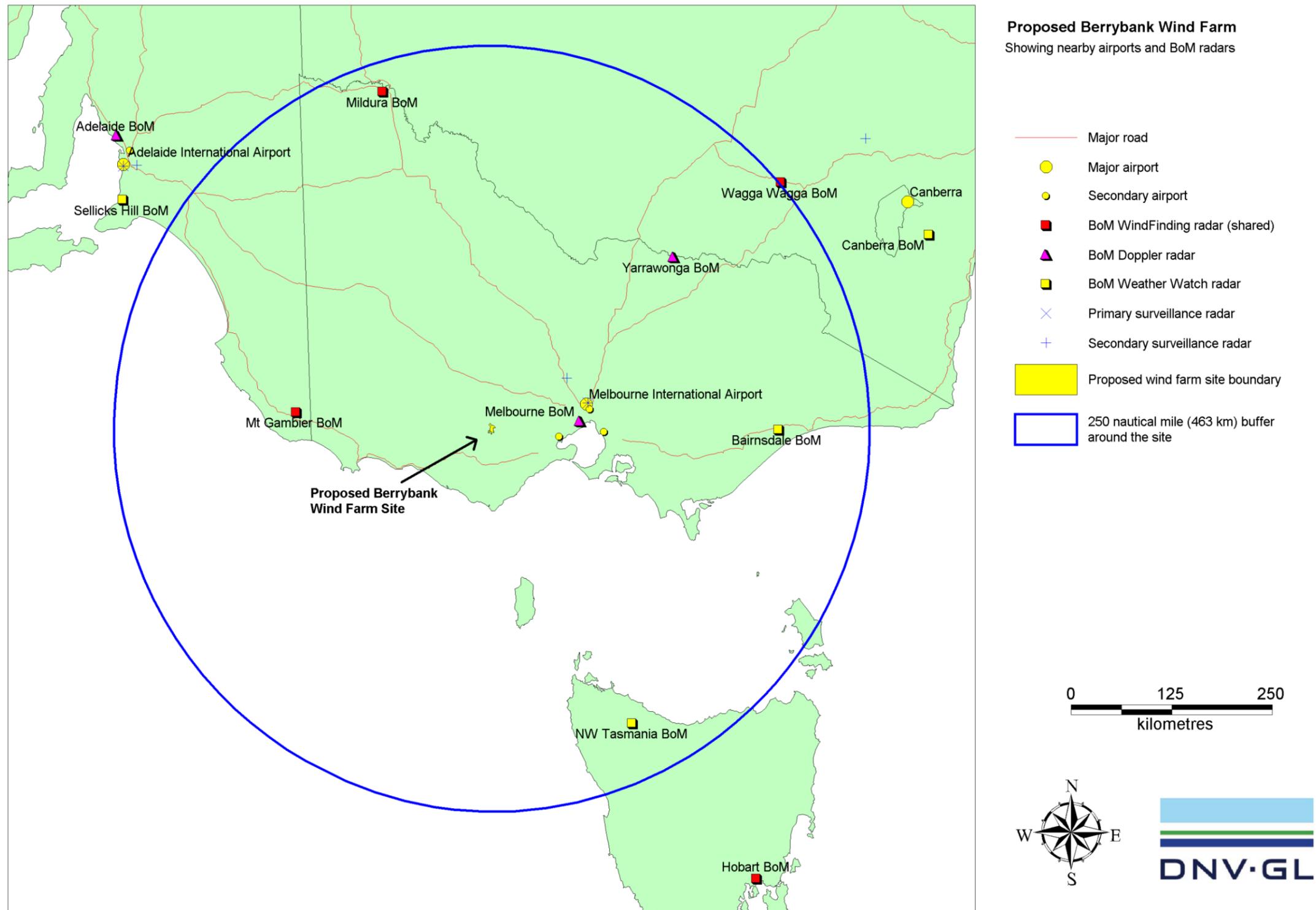
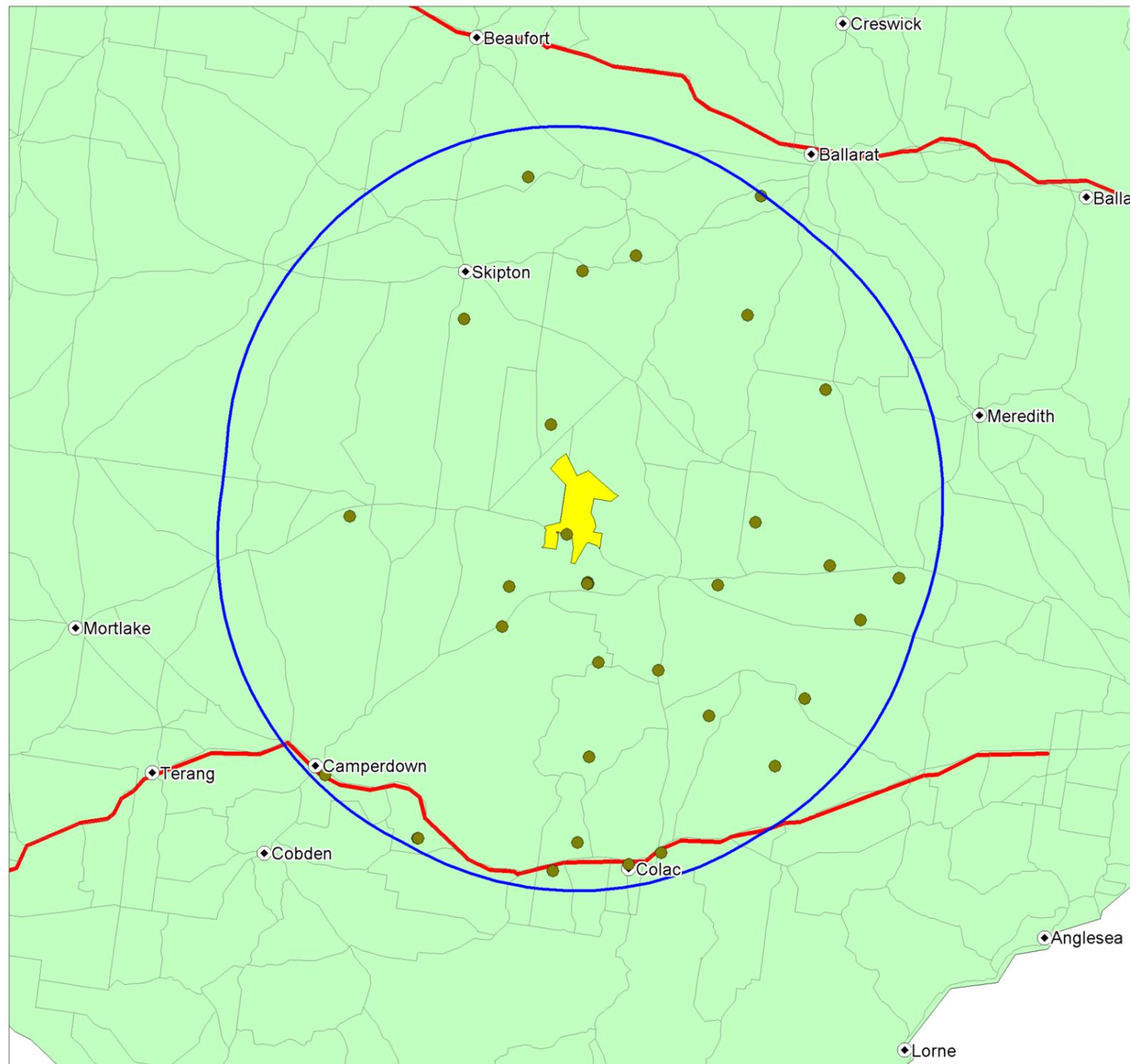


Figure 8 - Location of major airports and Bureau of Meteorology radar sites within 250 nautical miles of the Project

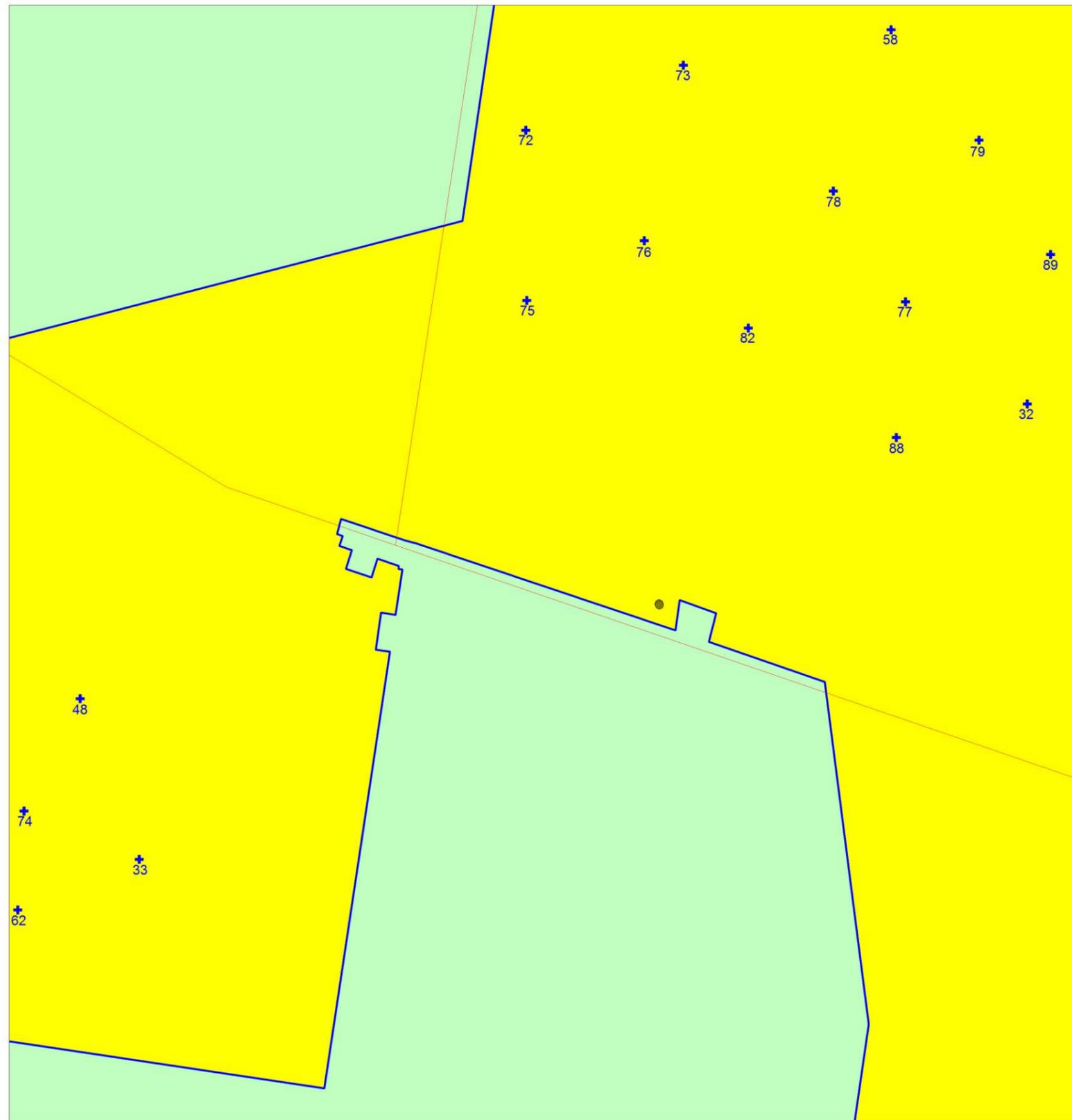


Proposed Berrybank Wind Farm
 Showing site boundaries for the proposed wind farm and identified nearby trig stations

- ◊ Population centre
- Major road
- Minor road
- 40 km from site boundary
- Proposed wind farm site boundary
- Trig station



Figure 9 - Location of trigonometrical stations within 40 km of the Project



Proposed Berrybank Wind Farm
 Showing location of identified trig stations within proposed wind farm boundary relative to wind turbine locations

- + Proposed turbine location
- Proposed wind farm site boundary
- Road
- Trig station

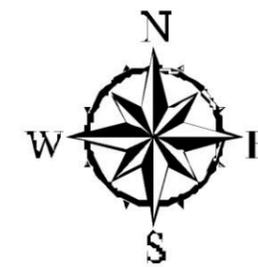


Figure 10 - Location of trigonometrical stations within Project site boundary

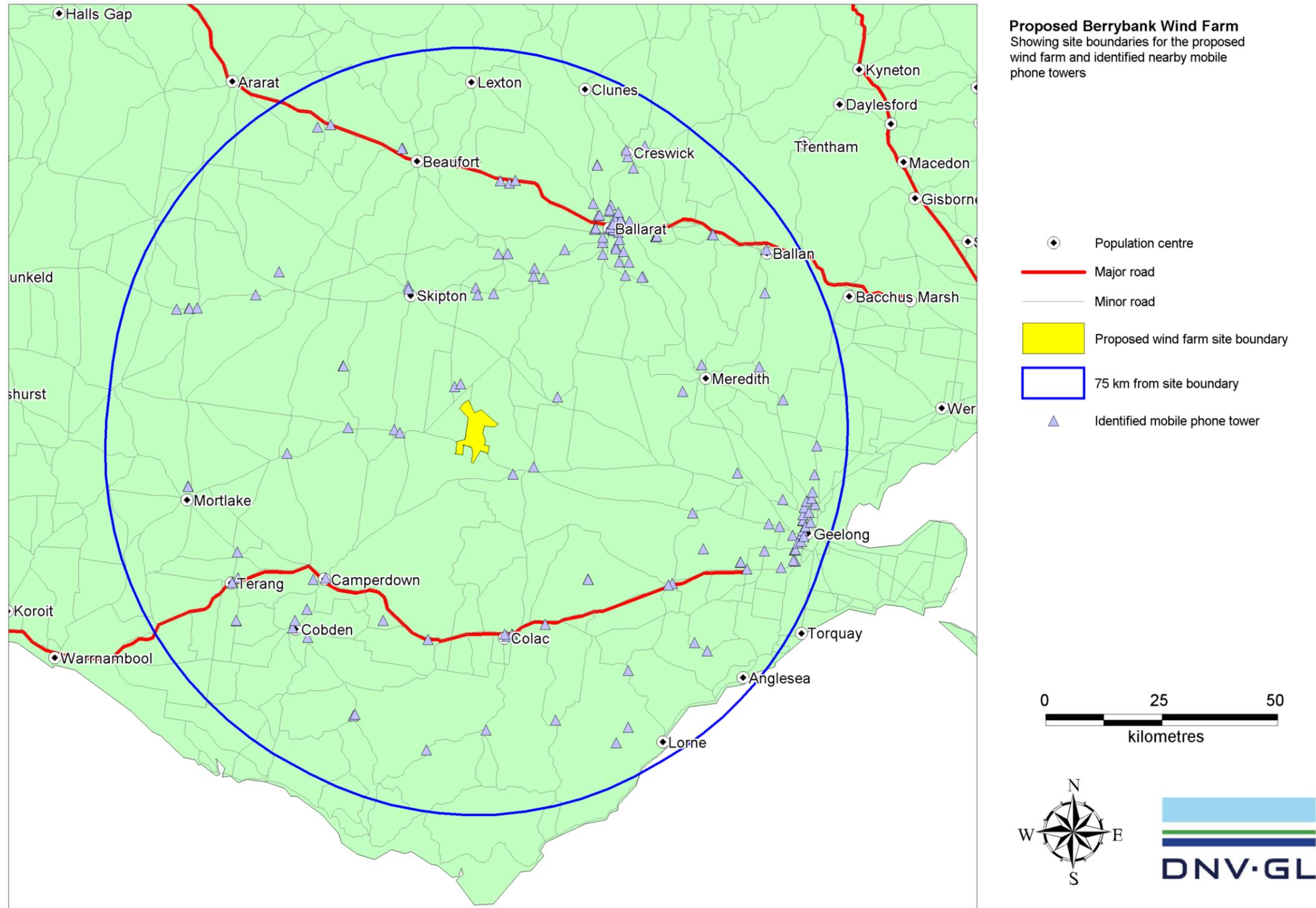
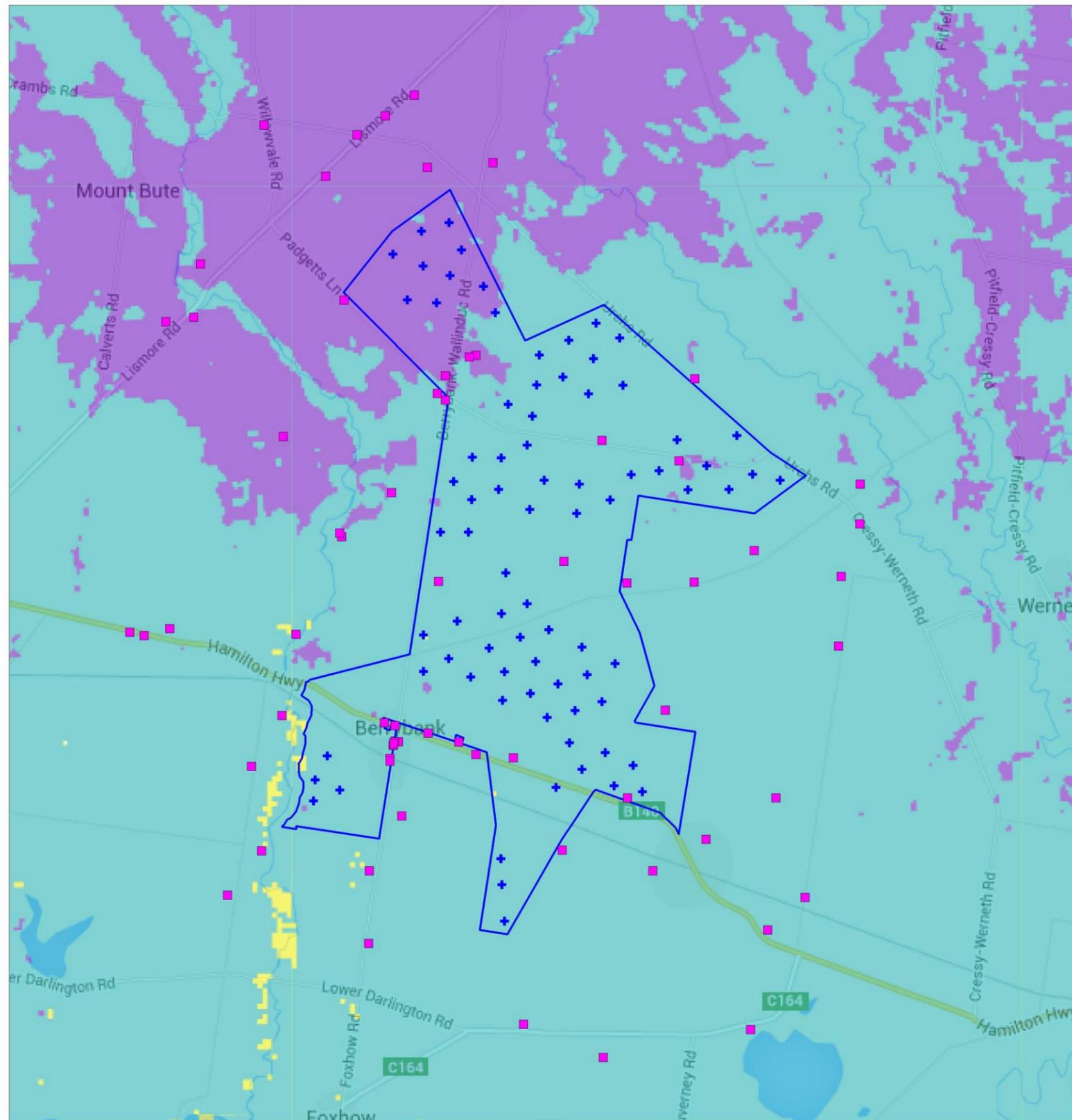


Figure 11 - Location of mobile phone towers in the vicinity of the Project



Proposed Berrybank Wind Farm

Showing Optus mobile network coverage in the vicinity of the proposed wind farm site

- + Proposed turbine location
- Proposed wind farm site boundary

	4G PLUS - OUTDOOR
	3G - OUTDOOR
	3G - WITH ANTENNA

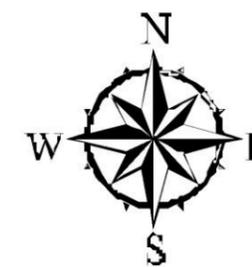
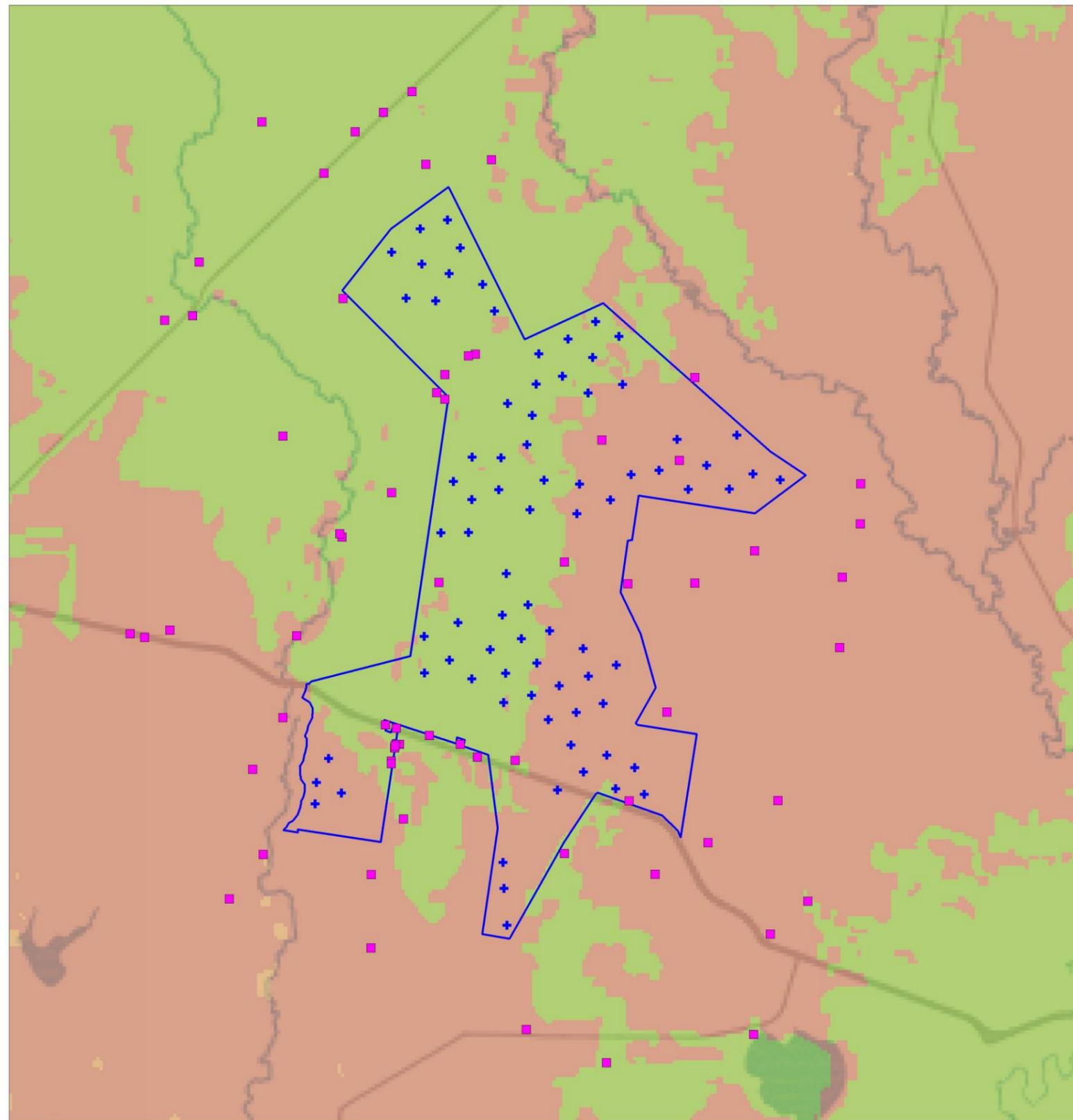


Figure 12 - Optus mobile network coverage in the vicinity of the Project (based on iPhone 6 handset)



Proposed Berrybank Wind Farm
 Showing Telstra mobile network coverage
 in the vicinity of the proposed wind farm site

- + Proposed turbine location
- Proposed wind farm site boundary
- 4GX device only typical download speed 2 to 75Mbps
- 3G device only
- 3G external antenna

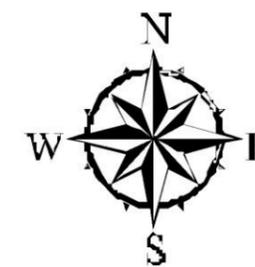
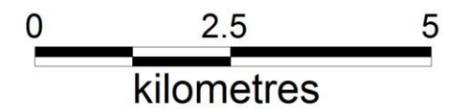
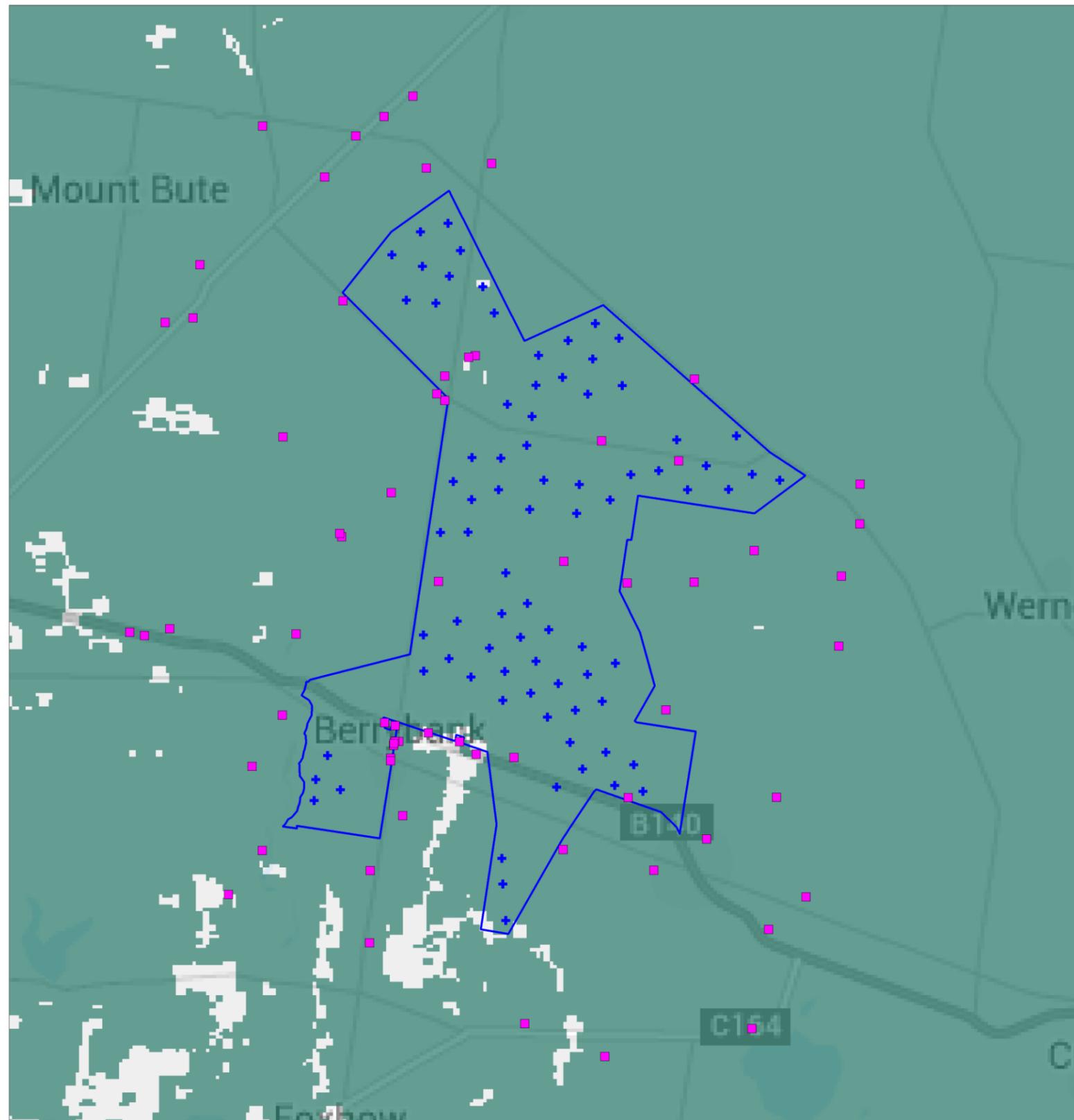


Figure 13 - Telstra mobile network coverage in the vicinity of the Project



Proposed Berrybank Wind Farm

Showing Vodafone mobile network coverage in the vicinity of the proposed wind farm site

- + Proposed turbine location
- Proposed wind farm site boundary

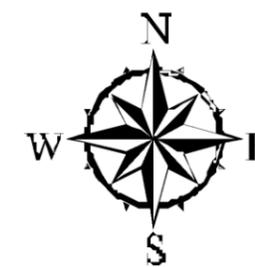
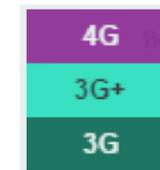


Figure 14 - Vodafone mobile network coverage in the vicinity of the Project

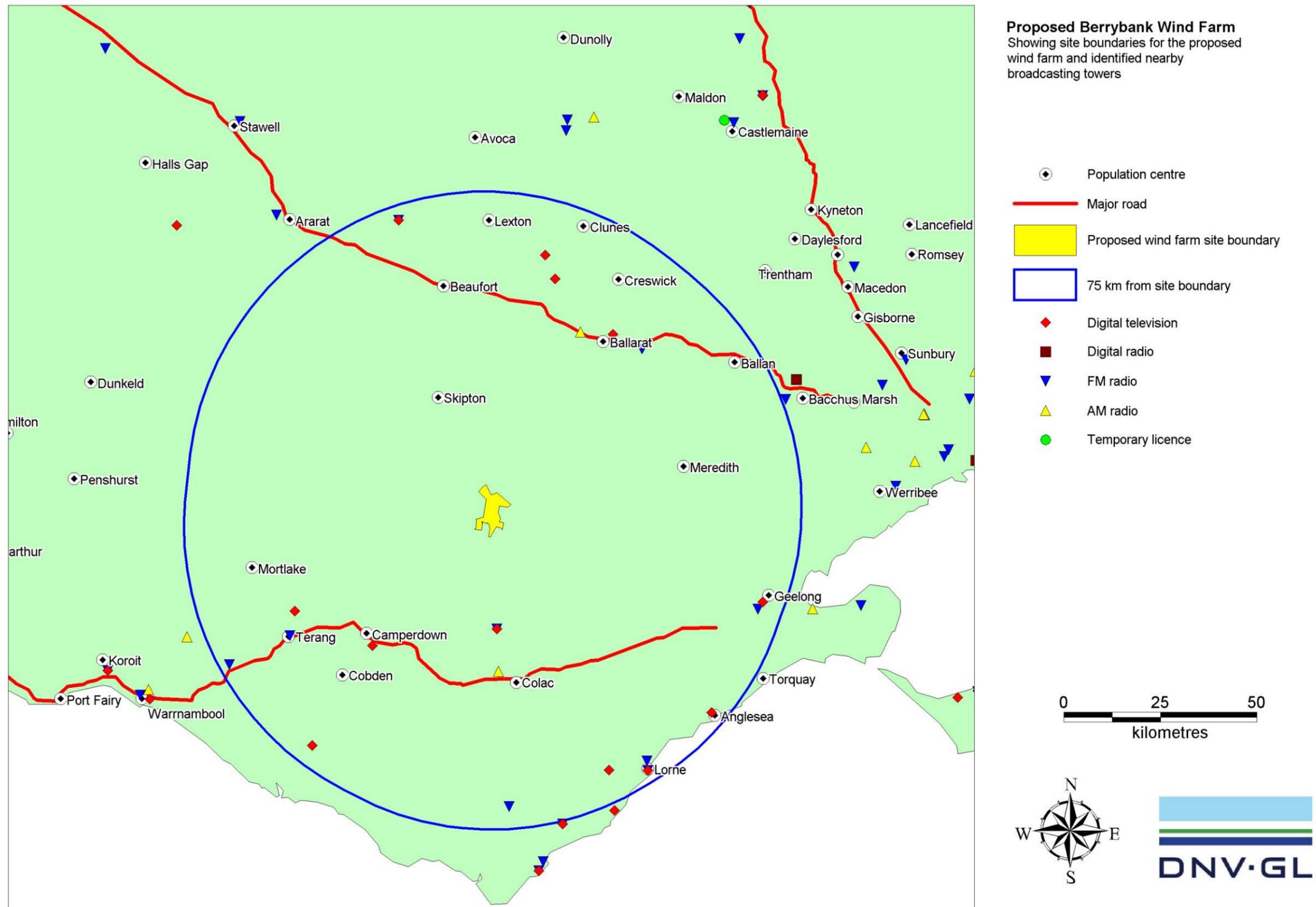
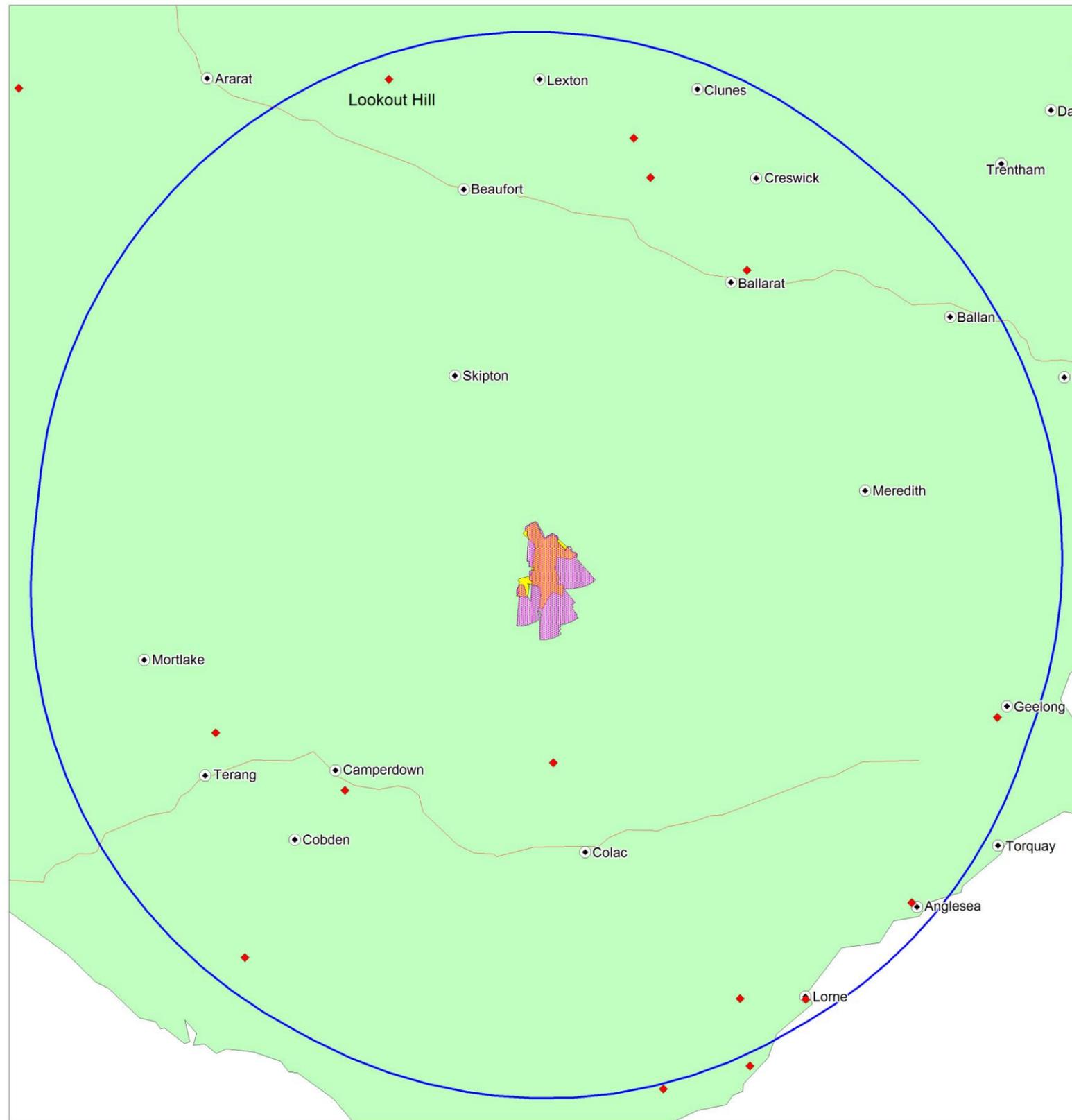


Figure 15 - Location of broadcasting transmitters in the vicinity of the Project



Proposed Berrybank Wind Farm

Showing site boundaries for the proposed wind farm, nearby digital television broadcasting towers, and the potential television interference zone

- Population centre
- Major road
- Proposed wind farm site boundary
- 75 km from site boundary
- ◆ Digital television broadcast tower
- ▨ Potential TV interference zone from Lookout Hill broadcast tower

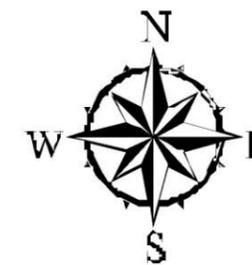
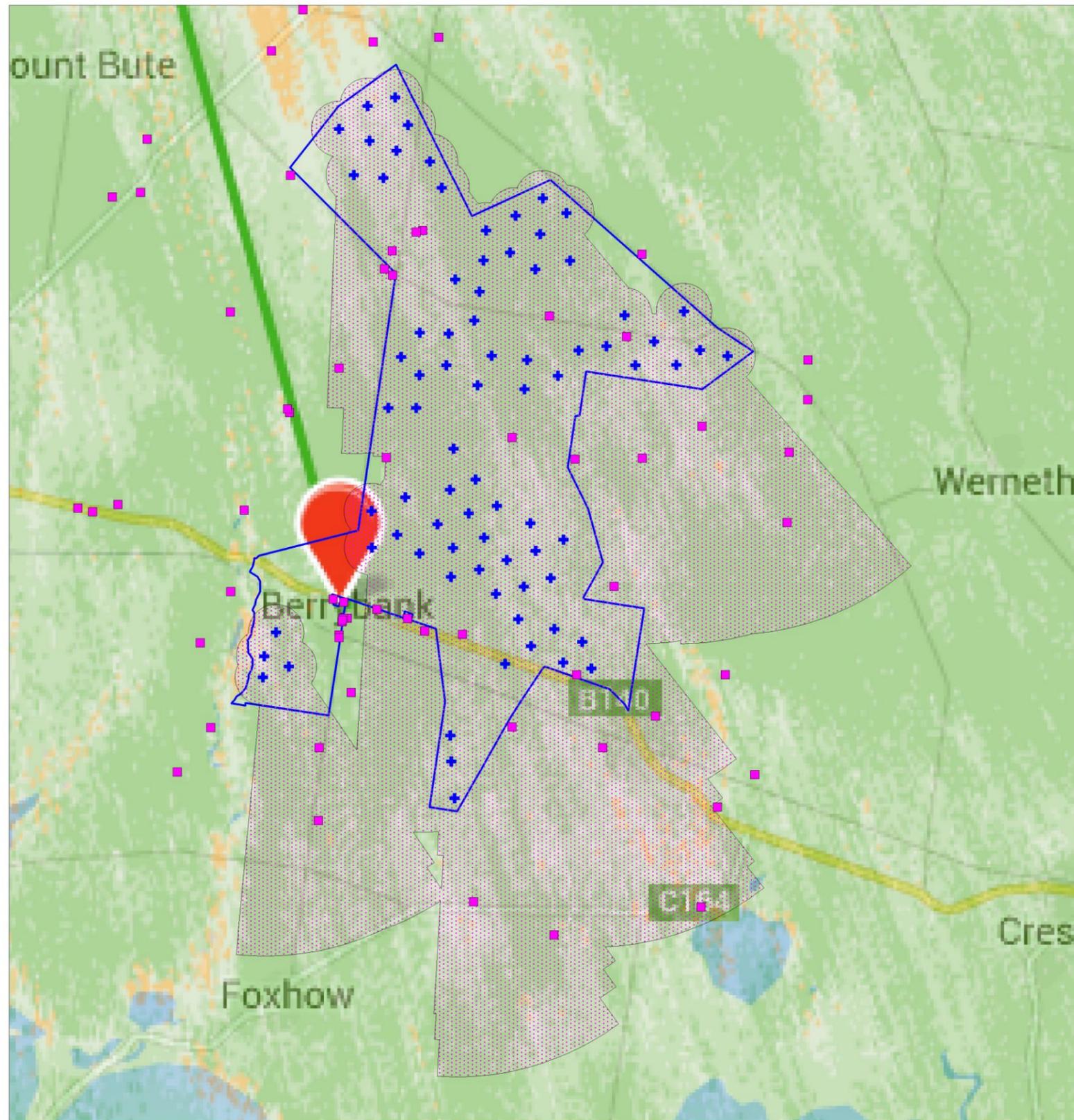


Figure 16 - Location of television broadcast towers in the vicinity of the Project



Proposed Berrybank Wind Farm

Showing potential television interference zones in the vicinity of the proposed wind farm site

- + Proposed turbine location
- Existing dwelling
- Proposed wind farm site boundary
- Potential TV interference zone from Lookout Hill broadcast tower

TV coverage legend

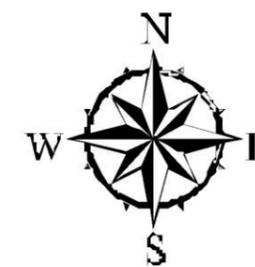


Figure 17 - Potential television EMI zones from the Lookout Hill broadcast tower



ABOUT DNV GL

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