



Study Corridor Identification Report

Central-West Orana Renewable Energy Zone Transmission

March 2021

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Term	Definition
AEMO	Australian Energy Market Operator – manages the National Electricity Market.
AER	Australian Energy Regulator – part of the Australian Competition and Consumer Commission and enforces the rules established by the Australian Energy Market Commission.
Easement	An area surrounding and including the transmission lines, which allows for ongoing access and maintenance of the lines. Each easement is a legal ‘right of way’ and will be acquired from landowners. The easement widths would be either 60 or 80 metres wide depending on the voltage of the transmission lines.
ISP	Integrated System Plan, a nationally coordinated, long-term electricity grid investment plan, which recommends immediate, short and long term infrastructure investment for the system of generating, transporting and consumption of electricity in the NEM. The most recently published version of the ISP is July 2020. AEMO is obliged to publish a new version of the ISP every two years.
NEM	National Electricity Market, covers the five eastern and southern States (QLD, NSW, VIC, SA, TAS) and the Australian Capital Territory and allows electricity to flow and be traded across regions.
REZ	Renewable Energy Zone, a geographical area identified as suitable for a combination of renewable energy generation (such as wind and solar), storage (such as batteries and pumped hydro) and high-voltage transmission to deliver electricity to the homes, businesses and industries that need it. This report focuses on the Central-West Orana REZ.
Strategic Alternatives	Strategic Alternatives were the early high level concept ideas that were developed to begin the process of identifying potential technical options for new electricity transmission infrastructure that would meet the objectives for the 3,000MW Central-West Orana REZ.
Study Area	A broad area that defines the boundary limits within which the Transmission Project and the strategic alternatives being investigated should reasonably occur, whilst also providing reasonable flexibility to consider a range of potential feasible strategic alternatives.
Study Corridor	An indicative area where the transmission lines and infrastructure could be located. For the Transmission Project, the study corridor runs north-west from the existing transmission network near Merriwa, passing south of Dunedoo before connecting to the existing transmission network east of Wellington. The corridor also includes an option to extend further south near Lake Burrendong. This optional section is called the ‘Burrendong Extension’. The study corridor is generally between 3km – 6km wide and is approximately 180km in length. Through consultation with landowners and the community, design and environmental investigations, the study corridor would be refined and progressively narrowed to final easements.
Transmission Project	The Transmission Project includes: <ul style="list-style-type: none"> Proposed transmission lines that will run north-west from the existing network near Merriwa, passing south of Dunedoo before connecting to the existing network east of Wellington An option to extend to the south of the existing network with one or two transmission lines to another point on the existing network near Lake Burrendong New substations and switching stations Upgrades at Transgrid’s existing substation at Wollar. <p>The locations of the sub/switching stations have not been determined. Potential locations will be identified as the study corridor is narrowed. The final locations will be determined after considering the outcomes of further engineering and environmental studies and the NSW Government’s market process for generation and storage projects that is anticipated to be conducted in mid-2021.</p>

1. Executive Summary

Transgrid is working with the NSW Government to plan new transmission infrastructure for the Central-West Orana Renewable Energy Zone (REZ).

Investment in new transmission infrastructure will allow renewable energy generators (such as solar and wind) and storage projects (such as batteries and pumped hydro) in the Central-West Orana region to connect to the grid and provide affordable, reliable and clean energy for NSW customers.

The purpose of this report is to provide a summary of the process that has been undertaken to identify the initial study corridor for developing the Central-West Orana REZ Transmission (the Transmission Project). The study corridor is the area within which the new transmission infrastructure could be located. The study corridor is not a final location for the new transmission infrastructure.

The process to identify the study corridor is multi-step and considers many factors. The main steps in identifying the study corridor are:

- Identification of a broad study area
- Identification and analysis of feasible technical options
- Selection of a preferred network infrastructure solution
- Identification of a study corridor

At every step in the development of the new transmission infrastructure, Transgrid seeks to avoid and minimise impacts to the environment and community.

A detailed feasibility study was undertaken to (i) consider the range of different Strategic Alternatives that could achieve the objectives for the 3,000MW Central-West Orana REZ and identify feasible technical options and (ii) consider environmental and community constraints including:

- Ecology
- Cultural heritage, including Aboriginal cultural heritage
- Land tenure and use including important agricultural land
- Bushfire prone land
- Existing and approved infrastructure, including mines, airports and renewable projects
- Locations of dwellings and proximity to townships and other sensitive receptors

The identification and analysis of technical options for the new transmission infrastructure for the REZ was undertaken by Transgrid working with a technical working group formed by the NSW Government, acting through the Department of Planning, Industry and Environment. The analysis considered the abovementioned social, environmental, technical, and economic factors and the results of the Registration of Interest process for generation and storage projects conducted by the NSW Government in mid-2020. Based on the analysis and input from the Australian Energy Market Operator, a preferred network infrastructure solution which would best support the objectives for the 3,000MW Central-West Orana REZ whilst minimising impacts was selected.

The preferred network infrastructure solution was then used to develop an initial study corridor, to commence consultation and field studies. The study corridor for the Transmission Project runs north-west from the existing 500kV transmission network near Merriwa, passing south of Dunedoo before connecting to the existing transmission network east of Wellington. The corridor also includes an option to extend further south near Lake Burrendong. The study corridor is generally between 3km – 6km wide and is approximately 180km in length.

The identification of the study corridor is one of the early steps in the process of planning the new transmission infrastructure. Through consultation with landowners and the community, design and environmental investigations, the location of the study corridor will be finalised and the corridor will be refined and progressively narrowed to easement alignments that minimise impacts to local communities and the environment.

2. Background

2.1 Strategic context

The NSW Electricity Strategy (2019) is the NSW Government’s plan for a reliable, affordable and sustainable electricity future that supports a growing economy. There are numerous challenges to achieving this future. Some arise from the fact that the State’s existing fleet of power stations are reaching the end of their technical lives, which is increasing reliability risks to the system. Within 15 years, three quarters of NSW’s electricity supply is expected to reach the end of its technical life. Replacing these energy sources and building the infrastructure needed to connect them to our homes and businesses will take years.

Others arise from congestion in the transmission system which is dampening investment in the new generation required to reduce electricity prices, improve reliability and protect the environment. As more projects connect to the grid, congestion on the network impacts generator revenue and results in an

inefficient market and ultimately higher wholesale energy prices. When the network is congested, generators are less likely to have all of their available energy dispatched into the market.

The Strategy states that while NSW benefits from world-class energy resources, many of the areas with the strongest renewable resource potential are located far away from the existing network, which was primarily designed to connect coal-fired generators and the Snowy Hydro Scheme. The Strategy identifies the need to connect the scale of new generation required to meet NSW’s future energy needs, making it critical to efficiently develop transmission to these new locations. The NSW shared transmission network is shown in the map below.

Subsequent to the selection of the Study Corridor for the Transmission Project, the NSW Government released the Electricity Investment Roadmap and introduced legislation to implement elements of the Strategy, including powers to formally establish and deliver Renewable Energy Zones (REZs).

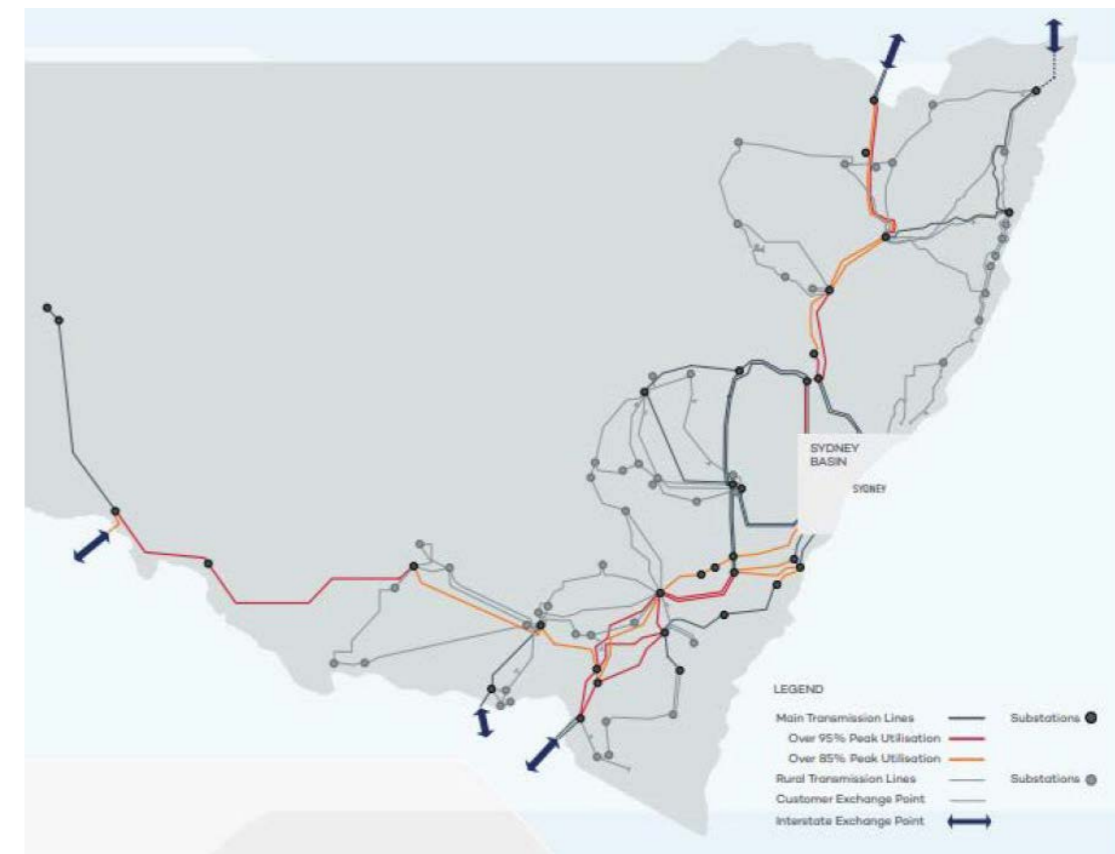


Figure 1: Capacity of the NSW shared transmission network

Source: Transgrid June 2019. Note: The existing shared transmission capacity between southern NSW (including the Snowy Mountains) and major load centres of Sydney, Newcastle and Wollongong is heavily utilised at times of peak demand. The peak utilisation has ranged between 90 per cent and 110 per cent over the last three years, and transmission constraints are expected to become more frequent as new renewable generation connects in southern NSW.

2.2 Central-West Orana REZ Transmission Project

The NSW Government is leading the coordination and delivery of Australia's first Renewable Energy Zone (REZ), in the State's Central-West Orana region. In late 2020 the Government re-established a dedicated body, the Energy Corporation of NSW, to coordinate the development of transmission, new generation (such as solar and wind) and storage projects (such as batteries and pumped hydro) within the REZ.

Transgrid operates the high-voltage transmission network across NSW and the ACT. Transgrid is working with the NSW Government to plan the new transmission infrastructure for the REZ. A key objective of the Transmission Project is to provide at least 3,000MW of new transmission transfer capacity to facilitate new renewable energy projects located in the Central-West Orana REZ by enabling connection of the REZ to the existing transmission network. Development of the new transmission infrastructure will enable electricity generation and storage projects participating in the Central-West Orana REZ to connect to the transmission network and export their electricity.

The Transmission Project builds on the NSW Transmission Infrastructure Strategy, delivers a key element of the NSW Electricity Strategy and the NSW Electricity Infrastructure Roadmap. This supports the implementation of the Australian Energy Market Operator's 2020 Integrated System Plan (ISP), in which 3,000MW of Central-West Orana REZ Transmission was designated as an 'actionable project' (refer to Figure 2 below). These actionable projects are critical to address cost, security and reliability issues, and have been carefully selected from a large range of possible options to achieve power system needs through a complex, energy sector transition.

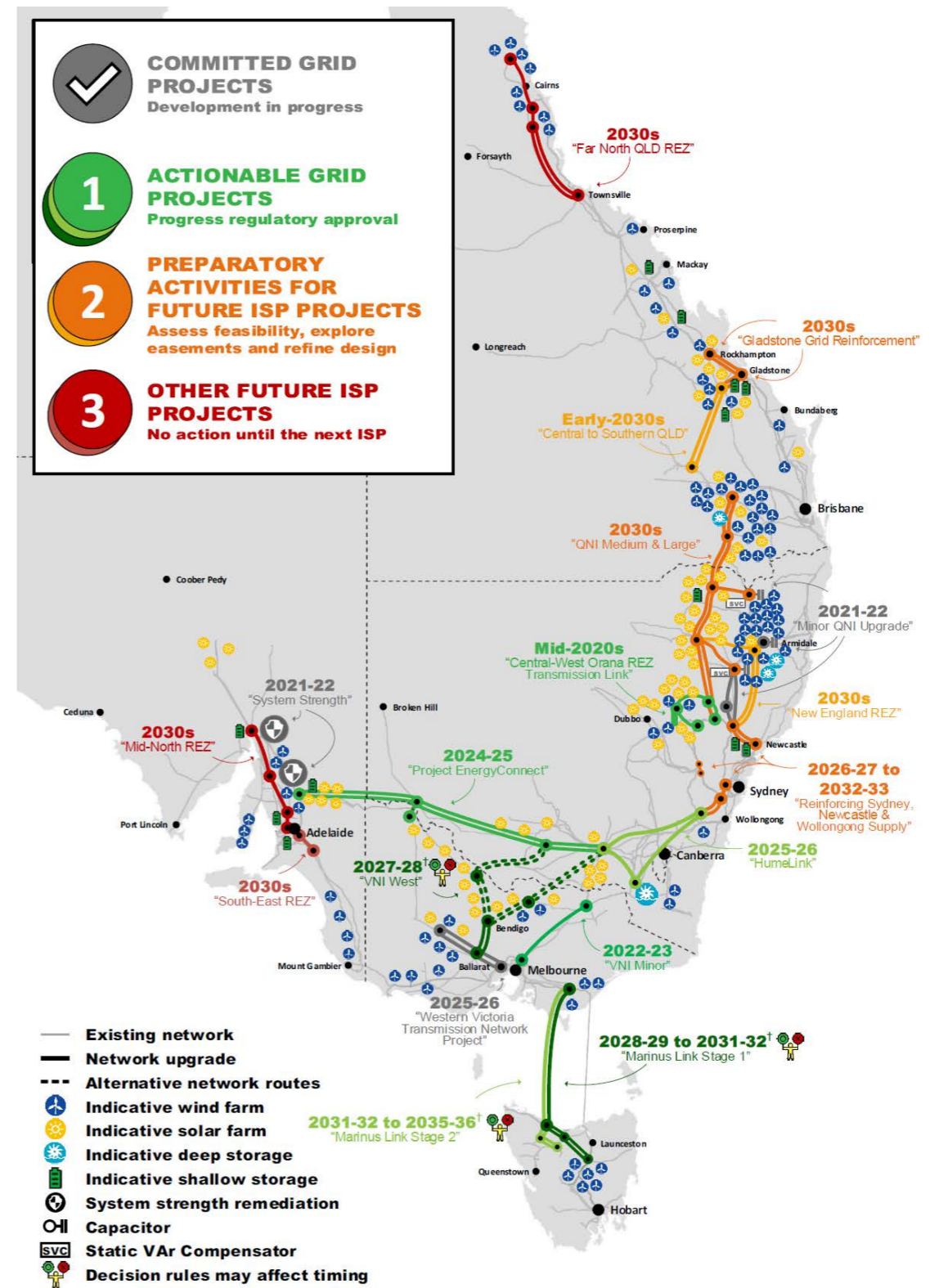


Figure 2: AEMO's Integrated System Plan shows the optimal development path for the NEM (July 2020)

† The timing of these actionable projects is dependent on decision rules.

All dates are indicative, and on a financial year basis. For example, 2023-24 represents the financial year ending June 2024.

3. Purpose of this Report

The purpose of this report is to:

- Describe the objectives and guiding principles for identifying the location of new transmission infrastructure
- Describe the process that has been undertaken to identify the study corridor; where the study corridor is an indicative area where the transmission lines and infrastructure could be located
- Outline the next steps for the Transmission Project.

3.1 Acknowledgement

As the NSW electricity transmission planner and operator, Transgrid is incurring the costs of the Transmission Project to date, including the feasibility and scoping study activities.

Transgrid acknowledges that the Transmission Project is receiving funding from the Australian Renewable Energy Agency (ARENA), as part of ARENA's Advancing Renewables Program, to help assess the technical and commercial options for the development of new high-voltage transmission lines to enable the Central-West Orana REZ and demonstrate a pathway for future REZs across the National Electricity Market.

4. Objectives and Guiding Principles

The key objectives in developing the Transmission Project are to identify a socially acceptable solution which:

- Delivers a key element of the NSW Electricity Strategy and Electricity Infrastructure Roadmap
- Minimises property impacts and land access complexity
- Minimises environmental impacts and approval complexity
- Provides appropriate opportunity for community consultation
- Is technically feasible
- Meets transmission network planning requirements and risk considerations
- Provides at least 3,000MW of transmission transfer capacity enabling connection of a mix of new renewable energy generation and storage projects
- Provides best value for money for consumers.

At every phase of the development of the Transmission Project, Transgrid seeks to:

- Provide opportunities for stakeholder and community input
- Demonstrate a continual strategy of seeking to reasonably avoid and minimise impacts to the environment and the community.

The process described in this report for the identification of a study corridor aligns with Transgrid's policies and practices for identifying the location of new transmission infrastructure.

5. Overview of the Process to Identify the Study Corridor

The identification of the study corridor was a multi-step process that considered many factors. Figure 3 below outlines the main steps in the process from the development of the broad Study Area, identification and analysis of broad Strategic Alternatives and feasible technical options, selection of a preferred network infrastructure solution, through to the identification of the study corridor.

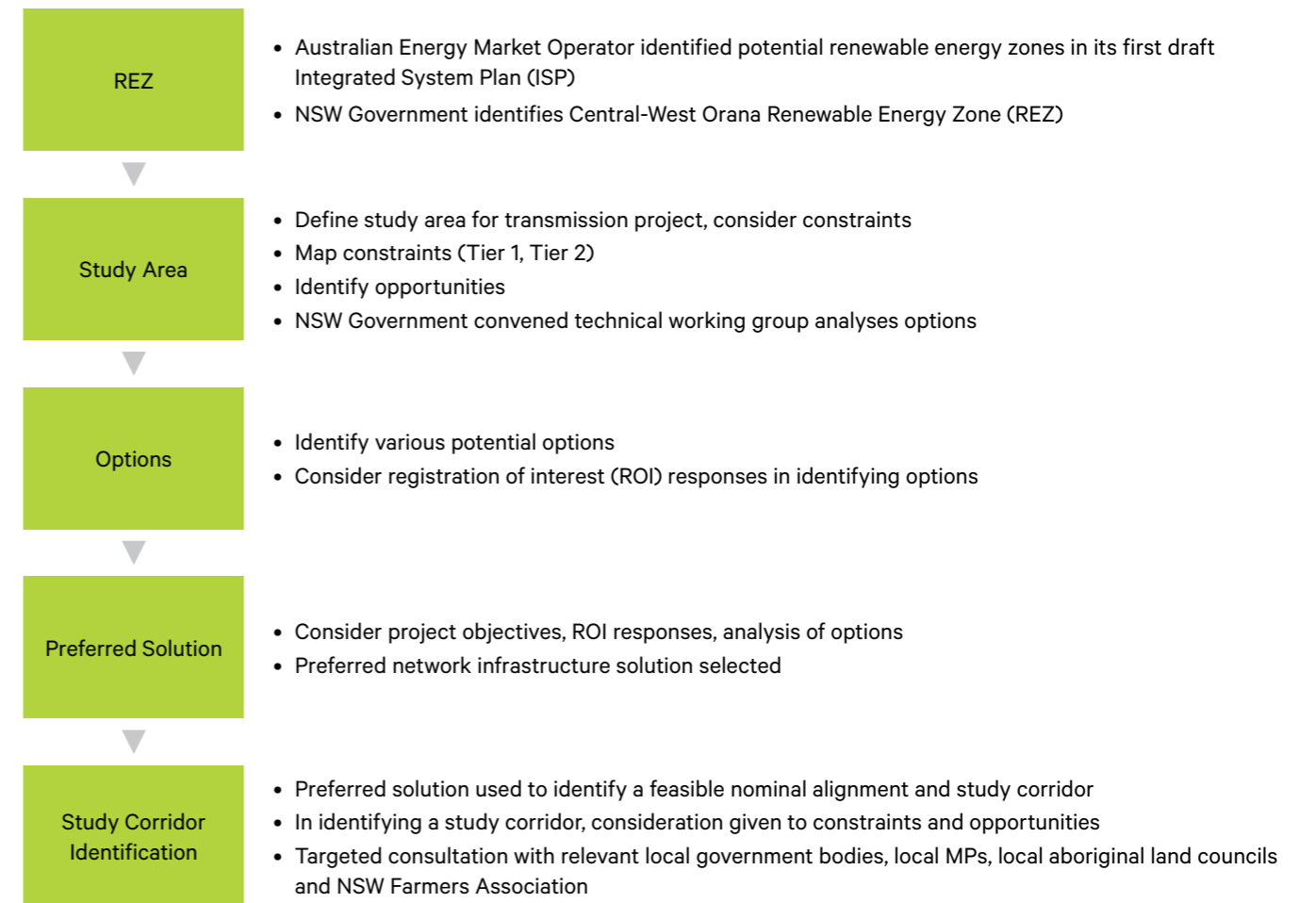


Figure 3: Overview of Process to Identify a Study Corridor

Section 6 of this document describes each of the steps in the flow chart in more detail.

The identification of a study corridor is one of the early steps in the development of the Transmission Project and Section 7 provides an overview of the steps that follow the identification of a study corridor. These steps include consultation with landowners and the community, design and environmental investigations which will all contribute to refining and progressively narrowing the corridor to final easement alignments.

6. Key Steps in Identifying the Study Corridor

6.1 NSW Government Announces Central-West Orana REZ

The NSW Government first identified the potential of the Central-West Orana region for the development of renewable energy projects in its March 2018 submission to AEMO's first draft Integrated System Plan (ISP). This was then reflected in the NSW Transmission Infrastructure Strategy (2018) before the NSW Electricity Strategy (2019) announced that the NSW Government will support the development of new transmission to connect low-cost generation to the electricity system by supporting transmission upgrades for a pilot 3,000MW Renewable Energy Zone (REZ) in the Central-West of NSW.

The Central-West Orana region was chosen for the pilot because it benefits from relatively low transmission build costs due to its proximity to the existing backbone transmission network, a strong mix of energy resources and significant investor interest (NSW Government, 2020).

An indicative location of the REZ that was identified by the NSW Government is shown in Figure 4.

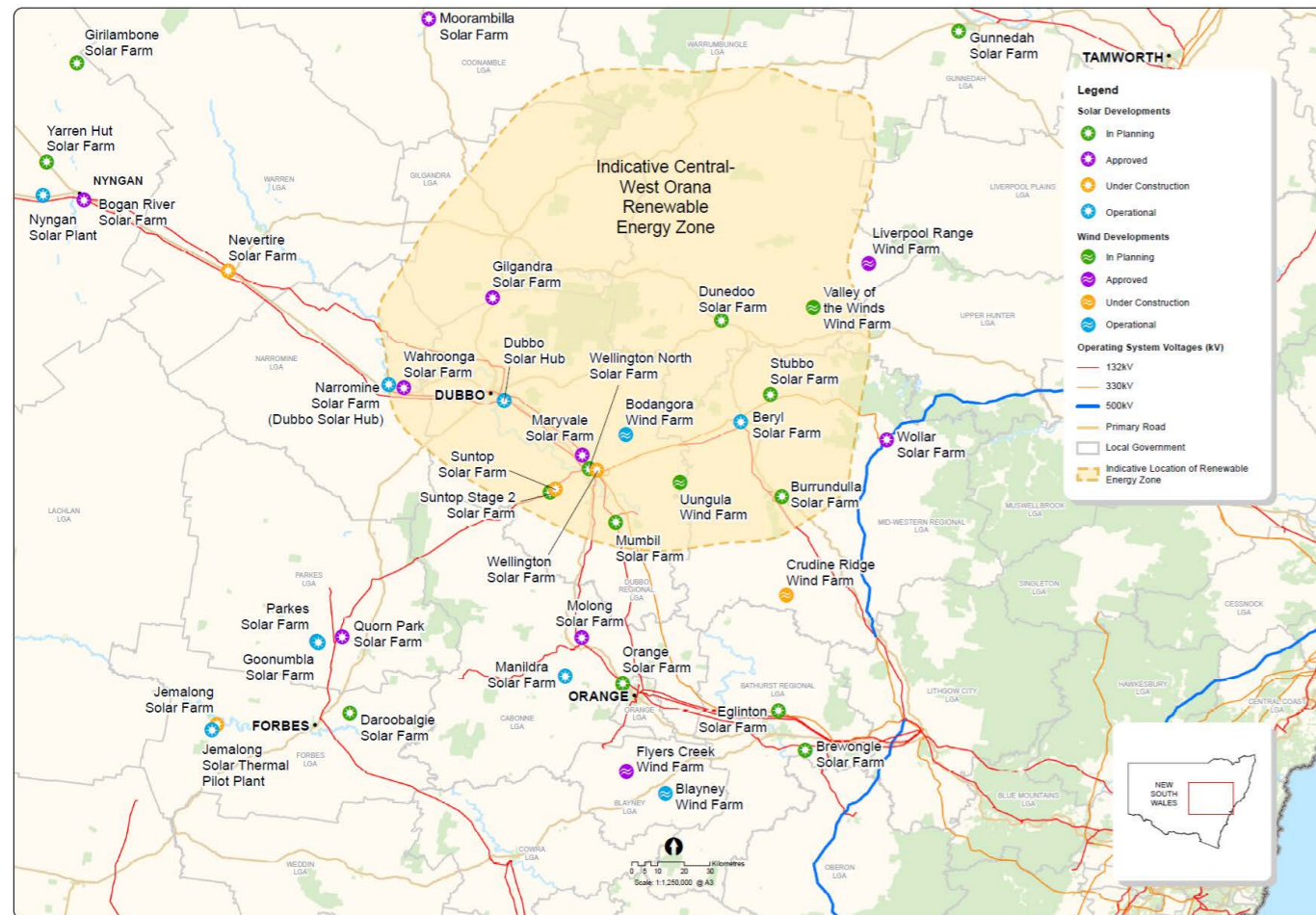


Figure 4: Indicative Location of the Central-West Orana Renewable Energy Zone (NSW Government, 2020)

6.2 Study Area Identification

The key objective of the Transmission Project is to help facilitate at least 3,000MW of new renewable energy generation in the Central-West Orana REZ by enabling connection to the existing transmission network.

Using the broad indicative area of the Central-West Orana REZ identified by the NSW Government and preliminary potential technical options as a starting point, an initial study area for the Transmission Project was identified.

Defining a study area boundary established an area in which technical options can be identified while also defining reasonable limits on the length of transmission lines. This approach was informed by key stakeholders and ensured that the identified options would allow sufficient opportunity to avoid environmental, community and property constraints where possible, be feasible from an engineering point of view and provide reasonable value for money.

This study area (see Figure 5):

- Took into consideration the location of potential future renewable energy generation projects in the public domain or as advised by NSW Government
- Considered broad landscape-scale constraints such as areas of substantial tree coverage and steep terrain across the region
- Considered the location of the existing transmission network and potential connection points, noting that 3,000MW of transmission transfer capacity would likely require at least two points of connection with the existing high-voltage network for system reliability and security
- Covered a broad area to allow for consideration of a range of potential feasible options that would be able to connect back to the existing transmission network.

The boundaries of the study area and relevant aspects of the rationale are outlined in Table 1.

Table 1 Study Area boundaries

Boundary	Reasoning
Northern boundary	Defined broadly based on environmental sensitivities, to avoid impacts to Coolah Tops National Park, as well as practical and cost-benefit considerations of transmission lines going too far north from the existing transmission network.
Western boundary	Defined by Cobbora Road from Wellington to north west of Coolah. This road provided a useful western extent to avoid technical challenges and additional costs of extending a new transmission infrastructure too far west. From Wellington southwards the boundary is generally along the Mitchell Highway. This allowed for sufficient space to the west of Transgrid's existing transmission line network in this area.
Eastern boundary	Defined by the desire to avoid environmental sensitivities within Manobalai Nature Reserve and considering the additional distance if transmission infrastructure were to originate from this area. The eastern boundary also aligns southwards along an existing transmission line. This line would be the point of connection to the existing network for some options, and it is also preferable to avoid crossing this line as crossing would result in unnecessary technical challenges and additional costs.
Southern boundary	Includes areas of proposed generation near existing transmission lines south of Wellington in the vicinity of Lake Burrendong and potential pumped hydro energy storage projects utilising water resources of the lake.

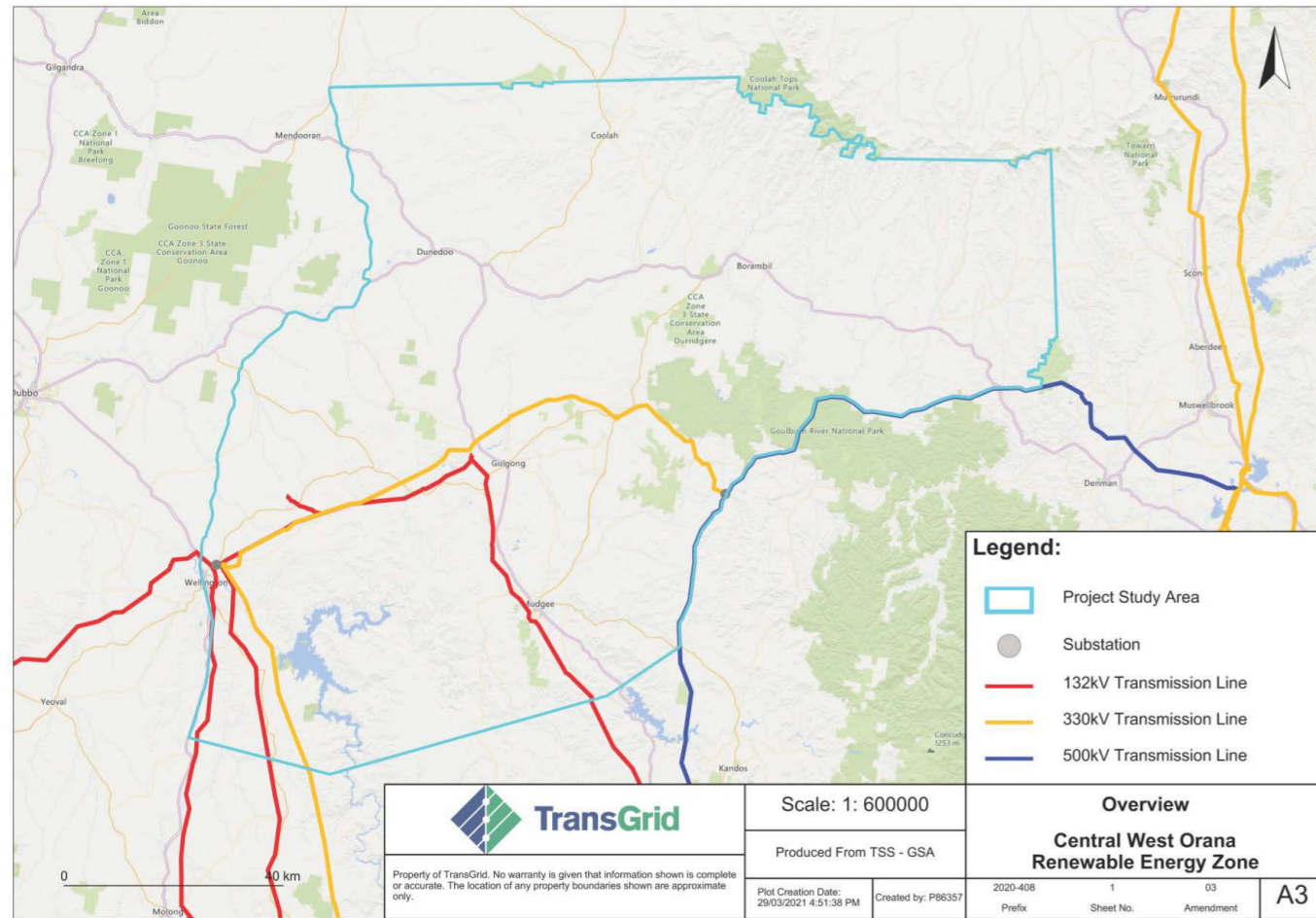


Figure 5: Central-West Orana REZ Transmission Project Study Area

6.3 Constraints and Opportunities

Within the identified study area, constraints at a landscape scale were identified. The aim was to avoid significant constraints and sensitivities at a very early phase in the development of the project.

A hierarchy of landscape level constraints was identified, as shown tables 2 and 3. These constraints are also mapped in Figure 6-1 and Figure 6-2, not including bushfire prone land. The sources of the datasets used for each constraint are outlined in Appendix A.

Tier 1 or no-go constraints are the highest level in the hierarchy and these constraints present significant environmental or indigenous heritage sensitivity, safety or security concerns, which can be expected to cause the project to fail. These include areas of World Heritage, townships and large open cut mines.

Table 2 Tier 1 Constraints – No-go zones Constraint Reason Environmental, social and land use

Constraint	Reason
Environmental, social and land use	
Areas of national environmental significance – Commonwealth and World Heritage areas, declared wilderness areas	These constraints present significant environmental or indigenous heritage sensitivity, safety or security concerns, and therefore environmental approval and land access is considered unachievable.
Defence land	
Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	
Proximity to airports and licensed airstrips	
Large open-cut mining sites	
Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act	

Tier 2 constraints are the next level down in hierarchy and these constraints should be avoided if possible and if avoidance is not possible then the project should aim to minimise impacts to these constraints.

Table 3 Tier 2 Constraints – Avoid if possible or minimise impacts

Constraint	Reason
Environmental, social and land use	
Ecological conservation areas including National Parks, National Park Estate and reserves	These constraints present a level of environmental/ heritage sensitivity, safety risk, indigenous sensitivity that environmental approvals and/ or land access would be considered complex and have approval timeframe implications.
State Non-Aboriginal heritage items or conservation areas	
Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites)	
Commonwealth land ¹	
Large scale agricultural/irrigated land and horticultural uses, including important agricultural land, biophysical strategic agricultural land and intensive horticulture Engineering/design	

¹ Note, there is no Commonwealth land located within the study corridor.

Constraint	Reason
Engineering/design	
Active mining area	These constraints are to be avoided where possible as they would present difficulties for the design and could present cost/risk implications.
< 80 m width available to accommodate an easement	
Areas with undulating terrain, valleys / rivers requiring large spans	In bushfire risk areas, there is a network operational requirement to separate single-circuit 500kV lines. ²
Crossings with existing transmission lines (132kV and above)	
Adequate set back from wind farm turbines	
Network operational risks including high bushfire risk and lightning risk (i.e. separate 500kV circuits by 5 km in high bushfire risk areas)	
Major infrastructure crossings (waterways / railway)	

² The study corridor identification process has sought to mitigate bushfire risk to the circuits in areas of high bushfire risk mapped as Category 1 vegetation by NSW Rural Fire Service. Other measures to reduce network operational risks will continue to be investigated during project development (e.g. consideration to land-use, engineering solutions, and maintenance regimes).

Opportunities that could improve or benefit the project outcomes have also been identified so these can be targeted. Opportunities identified included:

- Minimising overall corridor length (to reduce impacts, construction time and costs)
- Paralleling existing transmission lines (potential to overlap with existing cleared easements to minimise environmental and property impacts, and utilise existing access tracks)
- Where two circuits are needed, running two circuits in parallel where network risks allow (with potential to further consider use of double-circuit structures and reduce easement requirements)
- Targeting areas of existing disturbance, such as cleared land or land with poorer habitat, existing roads, tracks, property boundaries and other utility services (to reduce environmental and property impacts).

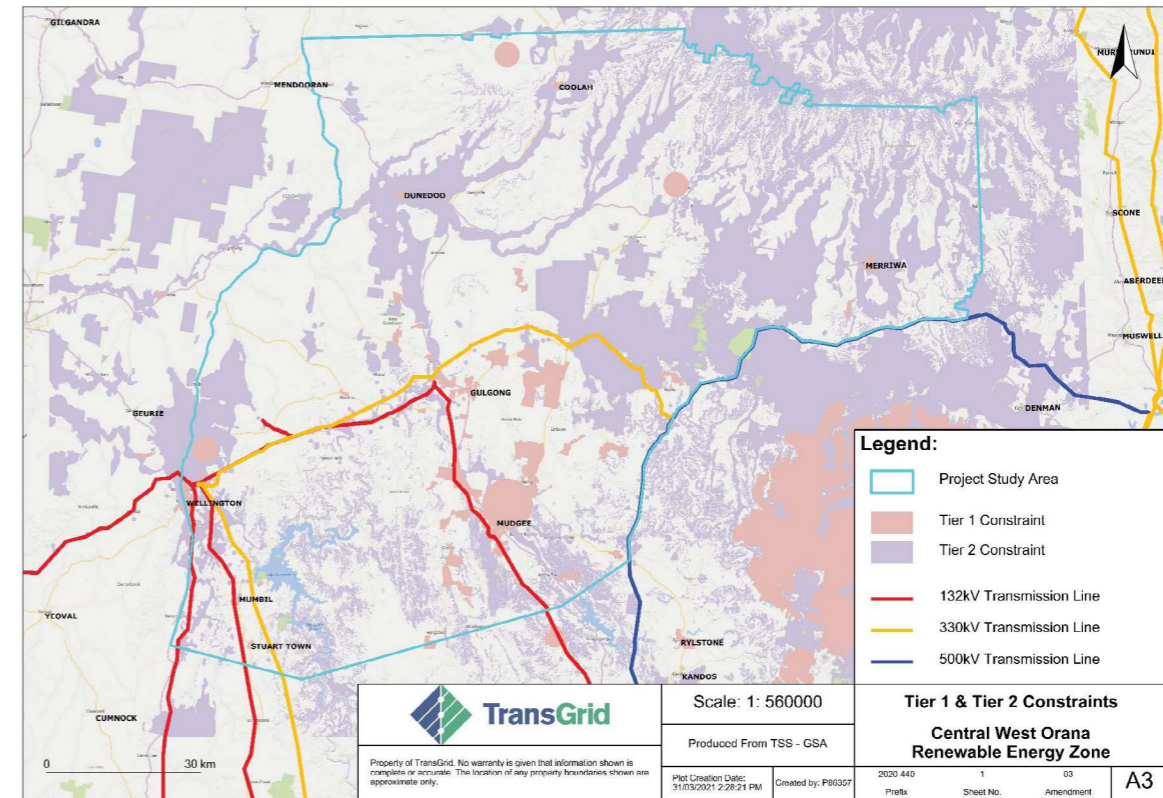


Figure 6-1: Tier 1 and Tier 2 Constraints in the Study Area (dwelling and buildings not shown)

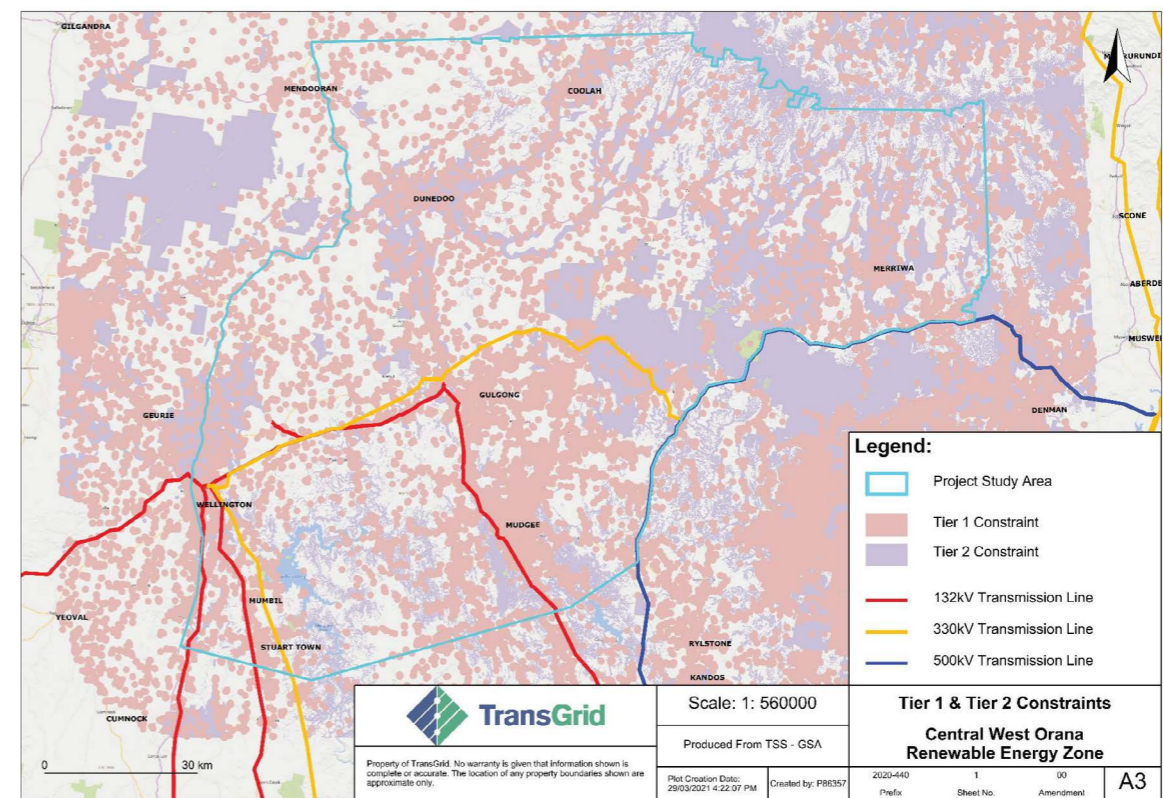


Figure 6-2: Tier 1 and Tier 2 Constraints in the Study Area (buffered dwellings and buildings shown)

6.3.1 Undergrounding opportunities and constraints

Underground solutions have also been considered. Due to their limited transfer capacity and significantly higher cost, they are normally only resorted to in heavily built-up cityscapes where there is no opportunity for an overhead solution.

Undergrounding requires a significantly higher direct land impact during construction than that of overhead construction. Lines are typically buried within an excavated trench the length of the alignment, at least 2-3m deep and approximately 1.5m wide. In the case of high voltage lines, multiple lines may be required to manage the power flow, potentially requiring multiple parallel (but separated) trenches.

The result is that the land cleared could be up to approximately 40-60m width for the entire underground route length during construction.

Further, cable jointing and inspection bays are required approximately every 800 – 1000m, and at any overhead–underground transition points an additional termination station is required.

Some of the difficulties that undergrounding high-voltage electricity transmission lines creates are:

- Permanent requirement for no deep-rooted vegetation within the easement
- During bushfires, cables are susceptible to significant heat damage
- Any damage or faults along the cable cannot be identified from inspection, and may require excavation of a significant length of cable
- The presence of rock geology along the transmission route would significantly increase the construction costs further above that of the overhead solution.

Utilising an underground solution for the Transmission Project has not been considered further at this time, because it does not present significant benefits to the project and due to the impact on the environment.

6.3.2 National Park Opportunities and Constraints

Assessment of these constraints across all potential options led to the decision to prefer the current study corridor over alternative options, including the options through the National Park.

The objective of the feasibility studies and corridor selection process is to select a location which achieves the best, lowest impact balance across a wide range of considerations, including potential land-use conflicts.

The main advantage of building through the National Park is that fewer landowners would be impacted. However, in the case of the Goulburn River National Park, the potentially significant ecological and Aboriginal cultural heritage impacts, bush fire risk and constructability/accessibility constraints outweigh this benefit, as well as making it more difficult to obtain necessary agreements and approvals.

The constraints identified throughout the feasibility study process relevant to proposed routes through the National Park included:

Potentially significant ecological and Aboriginal cultural heritage impacts

Ecological impacts

The National Park is a sanctuary for kangaroos, wombats, emus, goannas, platypus and a wide variety of birds. It lies within the Mudgee-Wollar Important Bird Area, as identified by BirdLife International because of its importance for the endangered regent honeyeater. The significant vegetation removal necessary to establish cleared paths for the transmission lines would require biodiversity offsets, adding extra time to the program and potentially significant cost to the project.

If EPBC species (e.g. koalas, regent honeyeater, grassy box woodland) are identified or suspected, more likely in National Parks than elsewhere, additional ecological studies would be required. There would be a high likelihood of requiring approval under the EPBC Act, due to significant impacts to listed threatened species and communities within the National Park.

Native Title and Aboriginal heritage

The National Park includes areas subject to Native Title and areas of significant Aboriginal heritage and high archaeological significance. With more than 300 known sites, located mostly along the river, the area is very important to local Aboriginal people. The river valley that runs through Goulburn River National Park was an important trading route between the Aboriginal people who resided on the coast and those who lived on the western plains. The area was traditionally occupied by the people of the Wiradjuri, Gamilaraay and Wonnarua Clans.

Bushfire risks

The Goulburn River National Park is Level 1 bush fire prone land. Bushfire prone land and bushfire risk represent significant operational and reliability risks to the wider transmission network, and in particular to transmission of electricity generated from the CWOREZ.

Unfavourable terrain

Many areas of the National Park, including those in the line between Wollar and the Liverpool Ranges, have steep and highly erodible terrain, as well as valleys and rivers requiring large spans. In addition to the impacts on the land such as vegetation clearing, this terrain increases risks and costs for safety of employees, construction and ongoing network reliability, accessibility and maintenance.

Legislative and policy constraints

The Goulburn River National Park is classed as a ‘Protected area of NSW’, which is reserved under the National Parks and Wildlife Act 1974. The options that are within the boundaries of the Goulburn River National Park have to take into account two legislative mechanisms:

- Prohibition arising from the Environmental Planning and Assessment Act 1979 (as prohibited development under applicable environmental planning instruments); and
- Restrictions under the National Parks and Wildlife Act 1974 applied to development within a National Park, and the need for consistency with the objects of the Act and the Goulburn River National Park and Munghorn Gap Nature Reserve Plan of Management (National Parks and Wildlife Service, 2003).

While neither of these are absolute prohibitions given the project’s status as Critical State Significant Infrastructure, Transgrid’s understanding of the policy intent, coupled with previous and current experience in relation to National Park land, is that they may represent “effective prohibitions” where other options are available. As a result, a route through National Park would be difficult to achieve, particularly compared with options that do not raise these issues, to meet the objectives of the CWOREZ project in the required timeframe.

6.4 Investigation of Strategic Alternatives

Considering the constraints and opportunities identified within the study area, a number of high level concept ideas (Strategic Alternatives) for technical options for the new transmission infrastructure were identified.

Several options were investigated, which are described below:

- **Strategic Alternative 1** – two new single circuit 500kV transmission lines connecting to the Uarbry area from the existing network either near Merriwa or at the Wollar Substation. This option included three different concepts for new lines, from Wollar substation along the existing 330kV transmission line corridor or through the National Park or from the existing 500kV transmission line near Merriwa, and a new substation.
- **Strategic Alternative 2** – a new transmission line loop that connects at both ends to the existing network, one connection point would be Wollar Substation and the other connection point would be near Merriwa. These strategic alternatives involve a combination of 500kV and 330kV transmission lines and up to two new substations and/or switching stations.

- **Strategic Alternative 3** – new 500kV and 330kV transmission lines that connect into the existing network near Merriwa, pass south of Dunedoo and terminate as far west as Goolma. This option could also include up to two new substations and/or switching stations.
- **Strategic Alternative 4** – new 500kV and 330kV transmission lines starting from the existing network near Merriwa, pass south of Dunedoo and connect into the existing network at either the existing Wellington Substation or the existing transmission line near Goolma. This option could also include up to two new substations and/or switching stations.
- **Strategic Alternative 5** – new 500kV and 330kV transmission lines that connect into the existing network near Merriwa, pass south of Dunedoo and continue west before connecting to the existing network north east of Wellington near the proposed Ungula wind farm. From here, there is an option for a transmission line extending south near Lake Burrendong. This option also includes two to three new substations and/or switching stations.

Figures 7 to 11 below show the approximate localities of the Strategic Alternatives that were investigated during the feasibility stage.

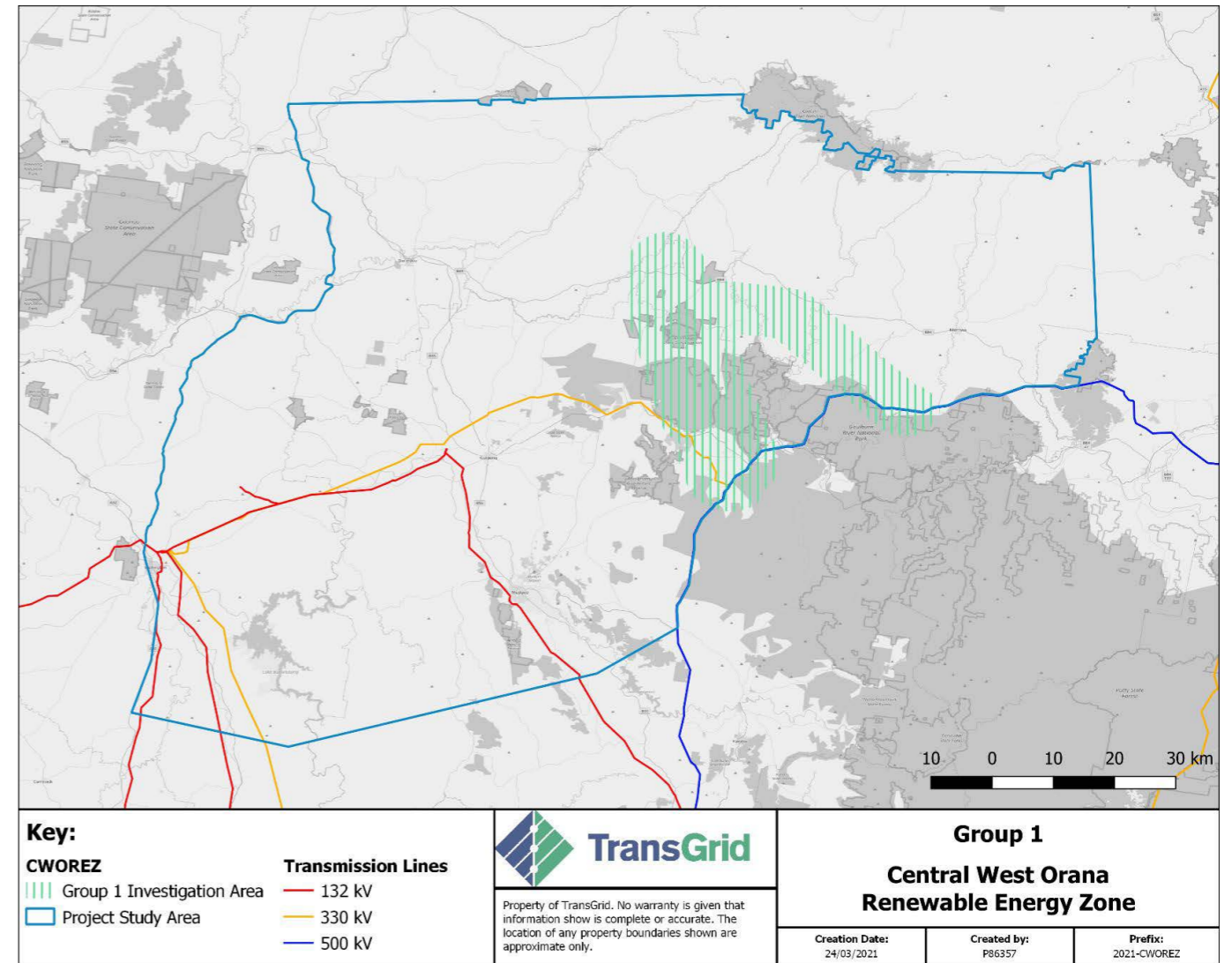


Figure 7: Strategic Alternative 1 investigation area (potential linear configurations from either Wollar substation or near Merriwa shown in green hashing)

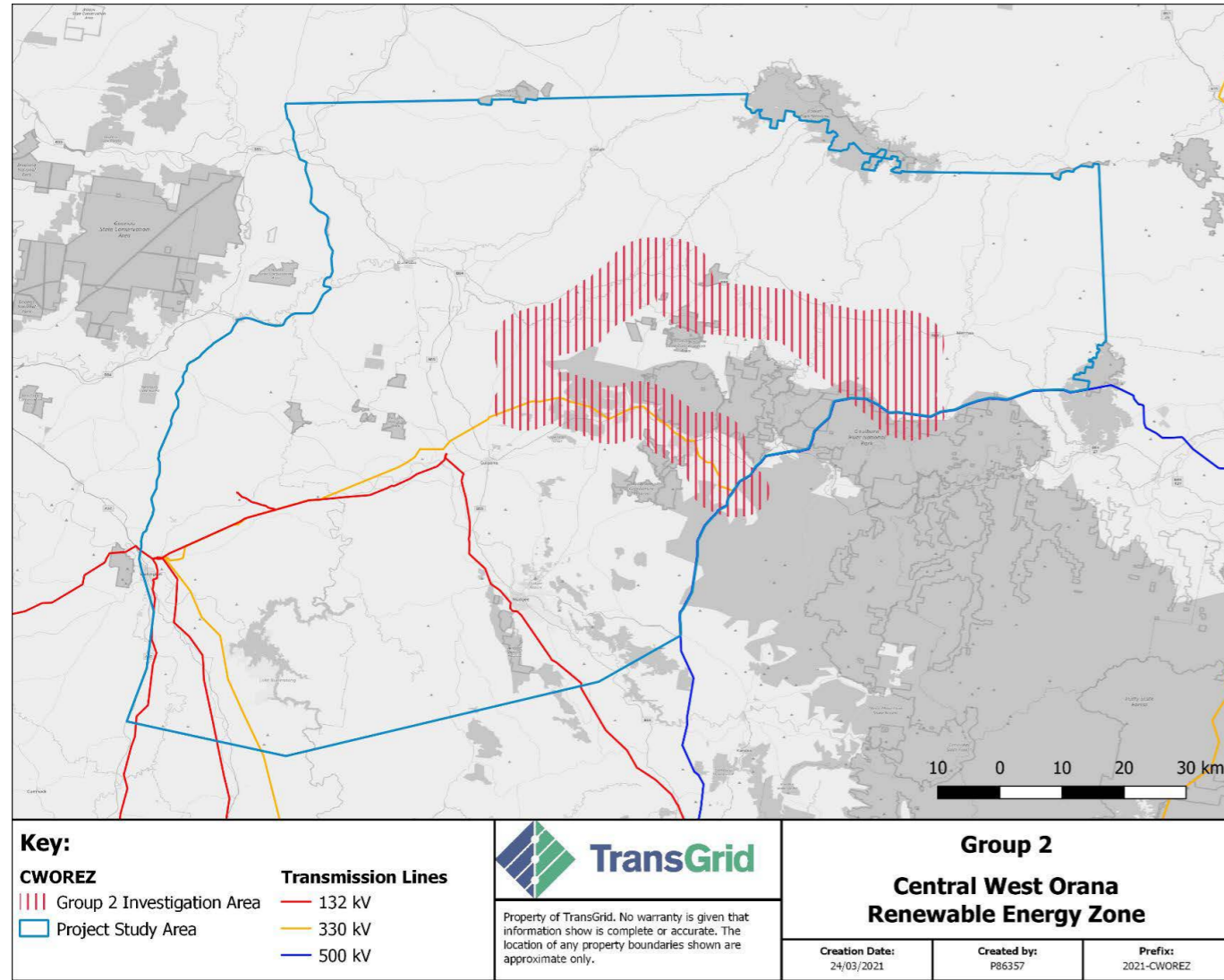


Figure 8: Strategic Alternative 2 investigation area (potential loop configurations shown in red hashing)

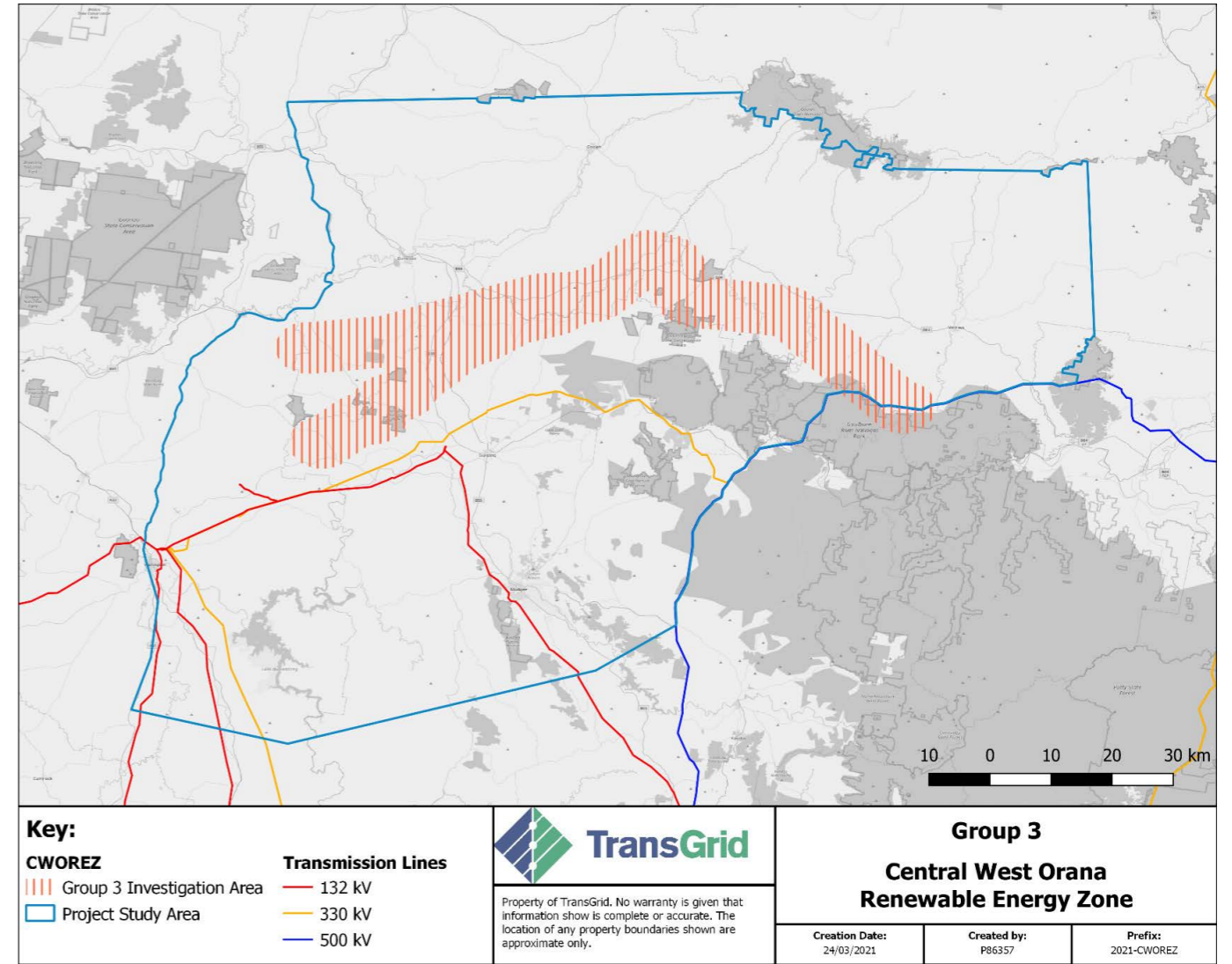


Figure 9: Strategic Alternative 3 investigation area (shown in orange hashing)

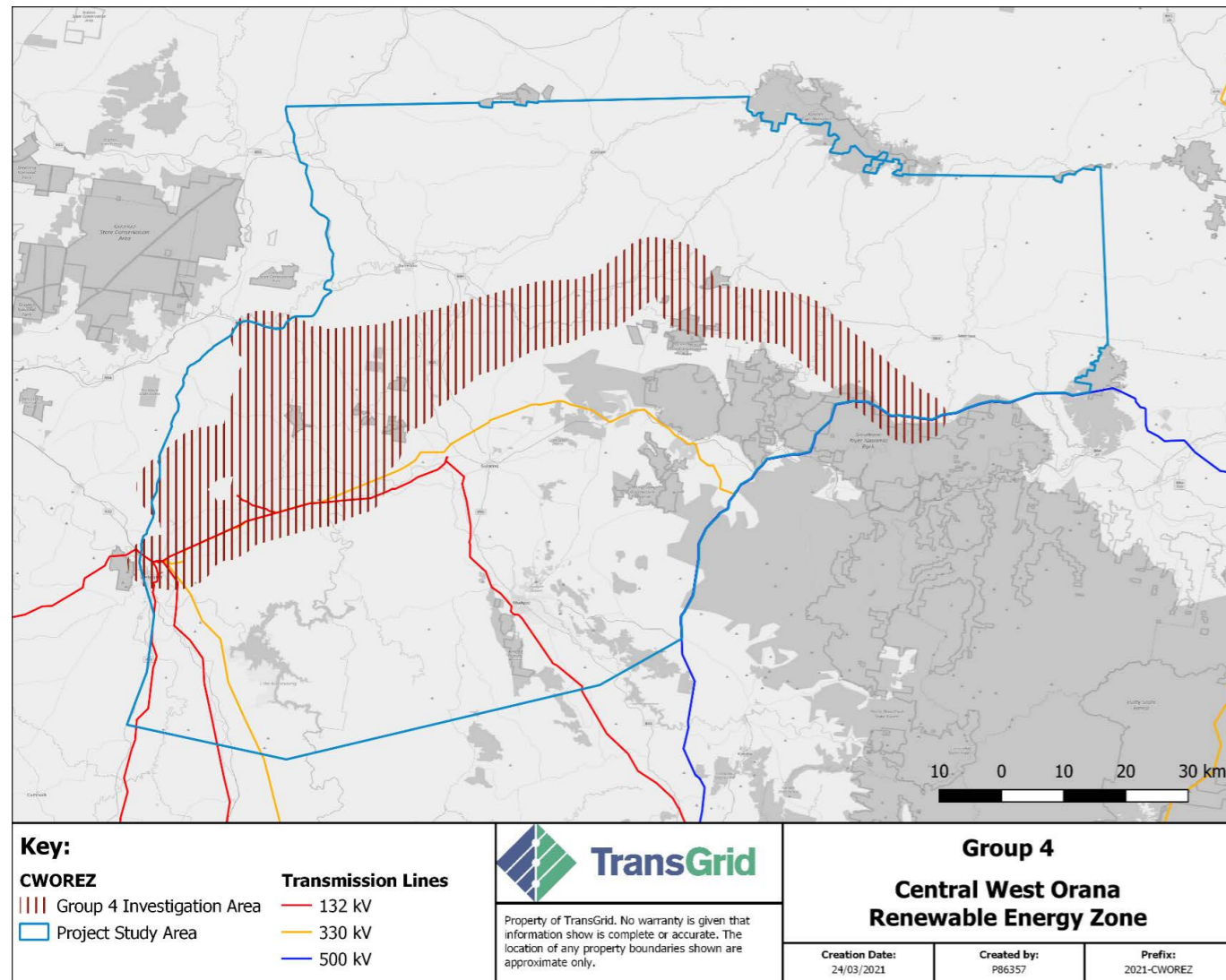


Figure 10: Strategic Alternative 4 investigation area (shown in burgundy hashing)

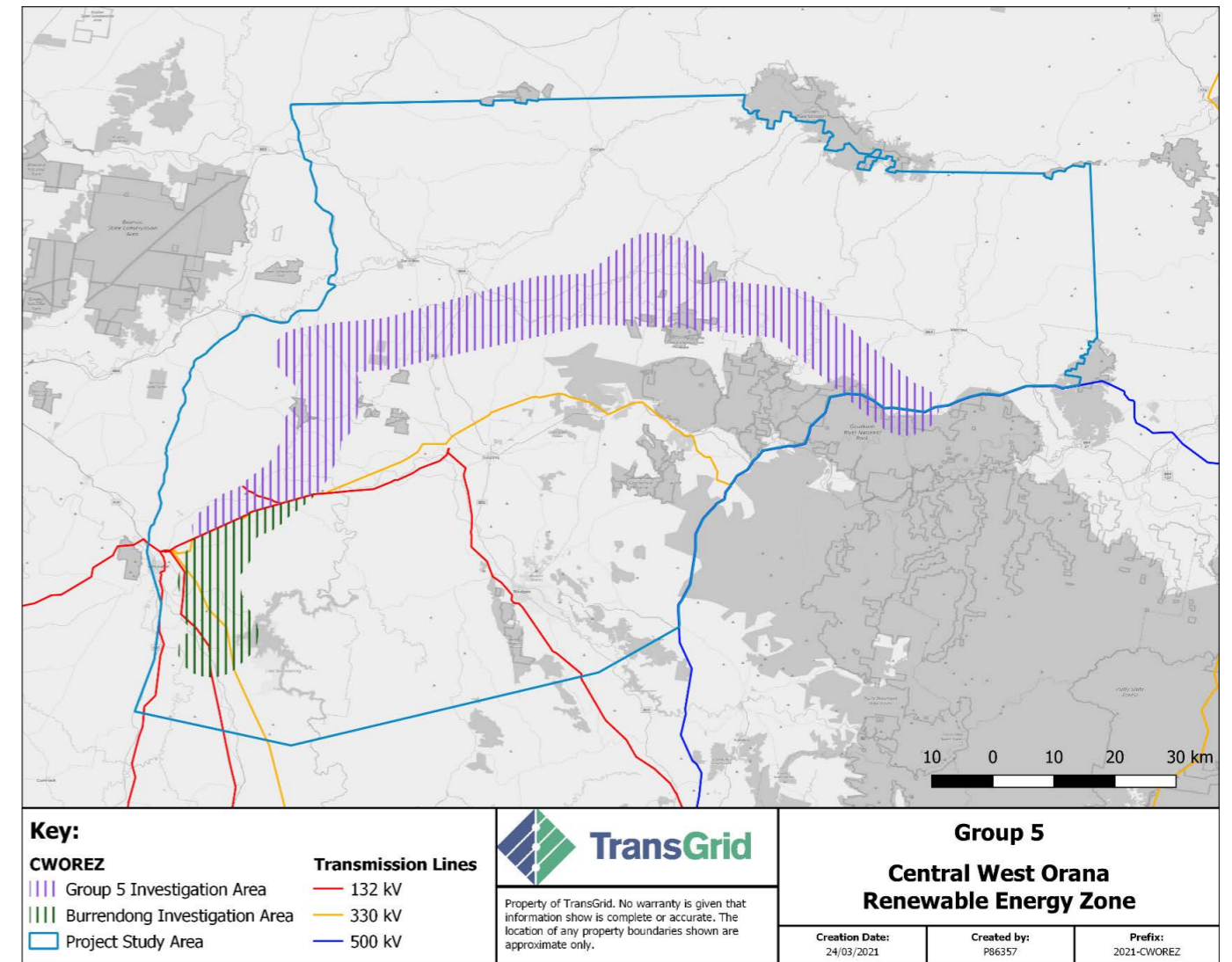


Figure 11: Strategic Alternative 5 investigation area (shown in purple and dark green hashing)

Transgrid has identified and evaluated technical options for the Transmission Project. Initial technical options built on previous work reflected in the 2018 NSW Transmission Infrastructure Strategy and the potential Contingent Project Application referenced in Transgrid's current revenue determination. In early 2020, the NSW Government formed a technical working group to identify and consider potential technical options for the Transmission Project. A detailed desktop feasibility study was undertaken to investigate these options and develop other options for investigation. The feasibility study considered environmental and community constraints including:

- Ecology
- Cultural heritage
- Land tenure and use including important agricultural land
- Bushfire prone land
- Existing and proposed infrastructure, such as mines, airports and proposed renewable projects
- Locations of dwellings and proximity to townships and other sensitive receptors

The findings of the feasibility study informed the technical working group's assessment of options against numerous social, environmental, technical and economic factors. Feedback from the technical working group members has been incorporated into the process of investigating the options.

In June 2020 the Department of Planning Industry and Environment (DPIE) conducted a registration of interest (ROI) process to gather information from developers of renewable energy generation and energy storage projects interested in connecting to the new transmission infrastructure. The responses to the process helped to identify the size and location of potential energy generation and storage projects that are interested in connecting to the Transmission Project.

The technical options identified were a good fit with the location of potential generation projects which could fully utilise the 3,000 MW of transfer capacity the NSW Government has specified for the initial REZ. In particular, many of the technical options would provide connection opportunities for the known wind resources in the REZ, including in the north of the Study Area and in the area north-east of Wellington. This is an important aspect which is expected to enable a good mix of wind and solar generation projects, as envisaged when the NSW Government made the decision to prioritise the Central-West Orana as the first REZ to be delivered in NSW.

The Strategic Alternatives were further investigated to identify and compare potential impacts and performance against the project objectives (as outlined in section 4). Tables 4 – 8 below summarise the findings for the five strategic alternate options, which highlights the Tier 1 and Tier 2 constraints, along with identified opportunities.



Table 4: Strategic Alternative 1 constraints and opportunities

Description	Constraints	Consideration of constraints
Two new single circuit 500kV transmission lines connecting to the Uarbry area from the existing network either at Merriwa or the Wollar Substation. This option also includes a new substation.	Tier 1 Constraints: Environmental, Social and Land Use – No Go Zones	
	Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Maximum Estimated Group Area (ha) = 122085 Maximum Estimated Length = 60km Maximum Estimated Dwellings = 44 Maximum Estimated Other Buildings = 151
Some options considered intersect the centre of Goulburn River National Park and will likely require approvals under the EPBC Act and potentially a Deed of Easement to be negotiated with National Parks and Wildlife Services.	Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	No Granted Native Title Claims. Native Title Application along full alignment.
	Large open-cut mining sites	Adjacent to Wilpinjong Mine Boundary
Tier 2 Constraints: Environmental, Social and Land Use – Avoid if possible, or minimise impacts		
Ecological conservation areas including National Parks, National Park Estate and reserves	Intersects the centre of the Goulburn River National Park. A Deed of Easement may need to be negotiated with National Parks and Wildlife Services which will result in additional costs and time. Buffer Zone clips the Durrigere State Conservation Area.	
State Non-Aboriginal heritage items or conservation areas	Four identified.	
Large scale agricultural/irrigated land and horticultural uses (Maximum estimated land impacted)	Maximum Estimated Important Agricultural Land (ha) = 2800	
Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites) – medium significance	>50	
Tier 2 Constraints: Engineering /Design		
< 80 m width available to accommodate an easement	Sufficient space available to accommodate 80m easement.	
Adequate set back from wind farm turbine	No interactions with wind farms.	
Areas with undulating terrain, valleys / rivers requiring large spans	Crosses valleys associated with Goulburn River National Park.	
Active mining area	No identified mines.	
Crossings with existing transmission lines (132kV and above)	None identified.	
Network operational risks including bushfire risk (required to separate 500kV circuits by 5 km in high bushfire risk areas)	Passes through significant areas Category 1 vegetation (line must be split apart by 5km).	
Major infrastructure crossings (waterways / railway)	Multiple watercourses and one railway corridor.	
Opportunities		
Potential connectivity to renewable energy generation projects	Least connectivity potential.	
Existing or approved large solar or wind farm projects	Intersects Transmission Line for Liverpool Ranges Wind Farm and buffer intersects Wollar Solar Farm.	
Parallels existing transmission lines	No existing infrastructure to utilise.	
Targets areas of existing disturbance	This option goes through Goulburn Valley National Park and does not avoid native vegetation.	

Table 5: Strategic Alternative 2 constraints and opportunities

Description	Constraints	Consideration of constraints
A new transmission line loop that connects at both ends to the existing network, one connection point would be Wollar Substation and the other connection point would be near Merriwa. These options involve a combination of 500kV and 330kV transmission lines and up to two new substations and/or switching stations.	Tier 1 Constraints: Environmental, Social and Land Use - No Go Zones	
	Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Maximum Estimated Group Area (ha) = 162801 Maximum Estimated Length = 150km Maximum Estimated Dwellings = 65 Maximum Estimated Other Buildings = 314 Intersects the buffer for Ulan Public School (could likely be refined to avoid).
	Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	No Granted Native Title Claims. Native Title Application along full alignment.
	Large open-cut mining sites	Buffer intersects Moolarben and Wilpinjong Mine boundaries.
	Tier 2 Constraints: Environmental, Social and Land Use - Avoid if possible, or minimise impacts	
	Ecological conservation areas including National Parks, National Park Estate and reserves	Buffer clips the Durridgere State Conservation Area and the edge of Goulburn River National Park.
	State Non-Aboriginal heritage items or conservation areas	Four identified.
	Large scale agricultural/irrigated land and horticultural uses (Maximum estimated land impacted)	Maximum Estimated Important Agricultural Land (ha) = 4400
	Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites) – medium significance	> 100
	Tier 2 Constraints: Engineering /Design	
	< 80 m width available to accommodate an easement	Potential 80m easement width issue at Ulan.
	Adequate set back from wind farm turbine	No interactions with wind farms.
	Areas with undulating terrain, valleys / rivers requiring large spans	Passes through Uarbry Valley / some undulating terrain.
	Active mining area	Intersects a Mine Subsidence District - 'Mudgee'
	Crossings with existing transmission lines (132kV and above)	Crosses existing 330kV.
Network operational risks including bushfire risk (required to separate 500kV circuits by 5 km in high bushfire risk areas)	Passes through some Category 1 vegetation (line must be split apart by 5km).	
Major infrastructure crossings (waterways / railway)	Multiple watercourses and one railway corridor.	
Opportunities		
Potential connectivity to renewable energy generation projects	High connectivity potential.	
Existing or approved large solar or wind farm projects	Buffer intersects Wollar Solar Farm.	
Parallels existing transmission lines	Utilises existing Ulan Mine easement.	
Targets areas of existing disturbance	Predominantly passes through cleared areas.	

Table 6: Strategic Alternative 3 constraints and opportunities

Description	Constraints	Consideration of constraints
A new 500kV and 330kV transmission lines that connect into the existing network near Merriwa, pass south of Dunedoo and terminate as far west as Goolma. This option could also include up to two new substations and/or switching stations.	Tier 1 Constraints: Environmental, Social and Land Use - No Go Zones	
	Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Maximum Estimated Group Area (ha) = 161738 Maximum Estimated Length = 130km Maximum Estimated Dwellings = 53 Maximum Estimated Other Buildings = 237
	Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	No Granted Native Title Claims. Native Title Application along majority of alignment.
	Large open-cut mining sites	No large open-cut mining sites nearby.
	Tier 2 Constraints: Environmental, Social and Land Use - Avoid if possible, or minimise impacts	
	Ecological conservation areas including National Parks, National Park Estate and reserves	Buffer clips the Durridgere State Conservation Area and Yurrobil National Park.
	State Non-Aboriginal heritage items or conservation areas	Three identified.
	Large scale agricultural/irrigated land and horticultural uses (Maximum estimated land impacted)	Maximum Estimated Important Agricultural Land (ha) = 5000
	Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites) – medium significance	> 50
	Tier 2 Constraints: Engineering /Design	
	< 80 m width available to accommodate an easement	Sufficient space available to accommodate 80m easement.
	Adequate set back from wind farm turbine	No interactions with wind farms.
	Areas with undulating terrain, valleys / rivers requiring large spans	Reasonably flat along alignment - passes through some valleys.
	Active mining area	No identified mines.
	Crossings with existing transmission lines (132kV and above)	None identified.
Network operational risks including bushfire risk (required to separate 500kV circuits by 5 km in high bushfire risk areas)	Passes through some Category 1 vegetation (no need to split 330kV).	
Major infrastructure crossings (waterways / railway)	Multiple watercourses and one railway corridor.	
Opportunities		
Potential connectivity to renewable energy generation projects	High connectivity potential.	
Existing or approved large solar or wind farm projects	Intersects TL area for Liverpool Ranges Wind Farm.	
Parallels existing transmission lines	No existing infrastructure to utilise.	
Targets areas of existing disturbance	Predominantly passes through cleared areas.	

Table 7: Strategic Alternative 4 constraints and opportunities

Description	Constraints	Consideration of constraints
A new 500kV and 330kV transmission lines that connect into the existing network near Merriwa, pass south of Dunedoo and terminate as far west as Goolma. This option could also include up to two new substations and/or switching stations.	Tier 1 Constraints: Environmental, Social and Land Use - No Go Zones	
	Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Maximum Estimated Group Area (ha) = 266084 Maximum Estimated Length = 190km Maximum Estimated Dwellings = 79 Maximum Estimated Other Buildings = 352
	Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	No Granted Native Title Claims. Native Title Application along majority of alignment along with the southern arm of the corridor leading towards Transmission Line 79.
	Large open-cut mining sites	No large open-cut mining sites nearby.
	Tier 2 Constraints: Environmental, Social and Land Use - Avoid if possible, or minimise impacts	
	Ecological conservation areas including National Parks, National Park Estate and reserves	Buffer clips the Durridgere State Conservation Area and Yurrobil National Park.
	State Non-Aboriginal heritage items or conservation areas	Three identified.
	Large scale agricultural/irrigated land and horticultural uses (Maximum estimated land impacted)	Maximum Estimated Important Agricultural Land (ha) = 9500
	Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites) – medium significance	> 50
	Tier 2 Constraints: Engineering /Design	
< 80 m width available to accommodate an easement	Sufficient space available to accommodate 80m easement.	
Adequate set back from wind farm turbine	Buffer intersects Bodangora Wind Farm boundary. Intersects TL area for Uungula Wind Farm planning approval footprint.	
Areas with undulating terrain, valleys / rivers requiring large spans	Reasonably flat along alignment - passes through some valleys.	
Active mining area	No identified mines.	
Crossings with existing transmission lines (132kV and above)	None identified.	
Network operational risks including bushfire risk (required to separate 500kV circuits by 5 km in high bushfire risk areas)	Runs adjacent to existing Transmission Line 79 (330kV), and intersects Transmission Line 79, and Transmission Line 4934 (132kV).	
Major infrastructure crossings (waterways / railway)	Multiple watercourses, and two railway corridors (one non-operational).	
Opportunities		
Potential connectivity to renewable energy generation projects	High connectivity potential.	
Existing or approved large solar or wind farm projects	Intersects Transmission Line area for Liverpool Ranges Wind Farm. Buffer intersects Bodangora Wind Farm.	
Parallels existing transmission lines	Briefly utilises existing easement as it approaches Wellington and Uungula Wind Farm.	
Targets areas of existing disturbance	Predominantly passes through cleared areas.	

Table 8: Strategic Alternative 5 constraints and opportunities

Description	Constraints	Consideration of constraints
A new 500kV and 330kV transmission lines that connect into the existing network near Merriwa, pass south of Dunedoo and continue west before connecting to the existing network north east of Wellington near the proposed Uungula wind farm. From here, there is an option for a transmission line extending south near Lake Burrendong. This option also includes two to three new substations and/or switching stations.	Tier 1 Constraints; Environmental, Social and Land Use - No Go Zones	
	Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Maximum Estimated Group Area (ha) = 198709 Maximum Estimated Length = 220km Maximum Estimated Dwellings = 74 Maximum Estimated Other Buildings = 322
	Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	No Granted Native Title Claims. Native Title Application along eastern arm of alignment (approximately half of the alignment).
	Large open-cut mining sites	No large open-cut mining sites nearby.
	Tier 2 Constraints; Environmental, Social and Land Use - Avoid if possible, or minimise impacts	
	Ecological conservation areas including National Parks, National Park Estate and reserves	Buffer clips the Durridgere State Conservation Area.
	State Non-Aboriginal heritage items or conservation areas	Two identified.
	Large scale agricultural/irrigated land and horticultural uses (Maximum estimated land impacted)	Maximum Estimated Important Agricultural Land (ha) = 9800
	Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites) – medium significance	> 50
	Tier 2 Constraints: Engineering /Design	
< 80 m width available to accommodate an easement	Sufficient space available to accommodate 80m easement.	
Adequate set back from wind farm turbine	Buffer intersects Bodangora Wind Farm boundary. Intersects TL area for Uungula Wind Farm planning approval footprint.	
Areas with undulating terrain, valleys / rivers requiring large spans	Reasonably flat along alignment - passes through some valleys.	
Active mining area	No identified mines.	
Crossings with existing transmission lines (132kV and above)	Runs adjacent to Transmission Line 79 (330kV).	
Network operational risks including bushfire risk (required to separate 500kV circuits by 5 km in high bushfire risk areas)	Passes through some Category 1 vegetation (no need to split 330kV).	
Major infrastructure crossings (waterways / railway)	Multiple watercourses, and two railway corridors (one non-operational).	
Opportunities		
Potential connectivity to renewable energy generation projects	High connectivity potential.	
Existing or approved large solar or wind farm projects	Intersects Transmission Line area for Liverpool Ranges Wind Farm.	
Parallels existing transmission lines	Briefly utilises existing easement as it approaches Wellington and Burrendong.	
Targets areas of existing disturbance	Predominantly passes through cleared areas.	



6.5 Selection of Preferred Network Infrastructure Solution

The technical working group formed by DPIE and including representatives from Transgrid, AEMO and ARENA considered each of the strategic alternatives and various options identified in each against numerous social, environmental, technical and economic factors.

The preferred network infrastructure solution eventually selected was Strategic Alternative 5. The preferred network infrastructure solution includes:

- Proposed transmission lines that will run north-west from the existing network near Merriwa, passing south of Dunedoo before connecting to the existing network east of Wellington
- An option to extend the new transmission lines further south to the existing network near Lake Burrendong
- New substations and switching stations
- Upgrades at Transgrid's existing substation at Wollar.

The preferred network infrastructure solution was selected as it:

- Meets the strategic objectives of the Central-West Orana REZ to provide at least 3,000MW of new electricity transmission transfer capacity and be operational by the mid-2020s
- Has the potential to serve a good mix of identified renewable energy generation and storage projects located in the REZ with technical elements which should provide a strong and efficient network for a reasonable cost
- Avoids impacts to Tier 1 constraints such as areas of national environmental significance, open cut mines, townships and defence land

6.6 Study Corridor Identification

The preferred network infrastructure solution was then used as the basis for defining an initial study corridor. A workshop was held involving in-house technical leads across a range of disciplines, and consideration was given again to a range of mapped constraints and sensitivities, and also consideration of having a study corridor that would support Transgrid objectives around stakeholder and community consultation and participation.

The width and location of the study corridor took into consideration:

- Avoiding Tier 1 constraints and minimising impacts to Tier 2 constraints
- Avoiding towns/clusters of dwellings
- Number of affected property owners and residences
- Avoiding impacts to high value agricultural land
- Community sentiment risks
- Overall length of transmission lines and costs
- Operational risk management
- Opportunities to improve project outcomes
- The strategic objectives for the REZ
- The need for flexibility to allow for changes following consideration of future consultation with the community and the outcomes of the DPIE generator market process

The initial study corridor is shown in Figure 12-1 and Figure 12-2. These figures do not show the Tier 2 constraint of bushfire prone land.

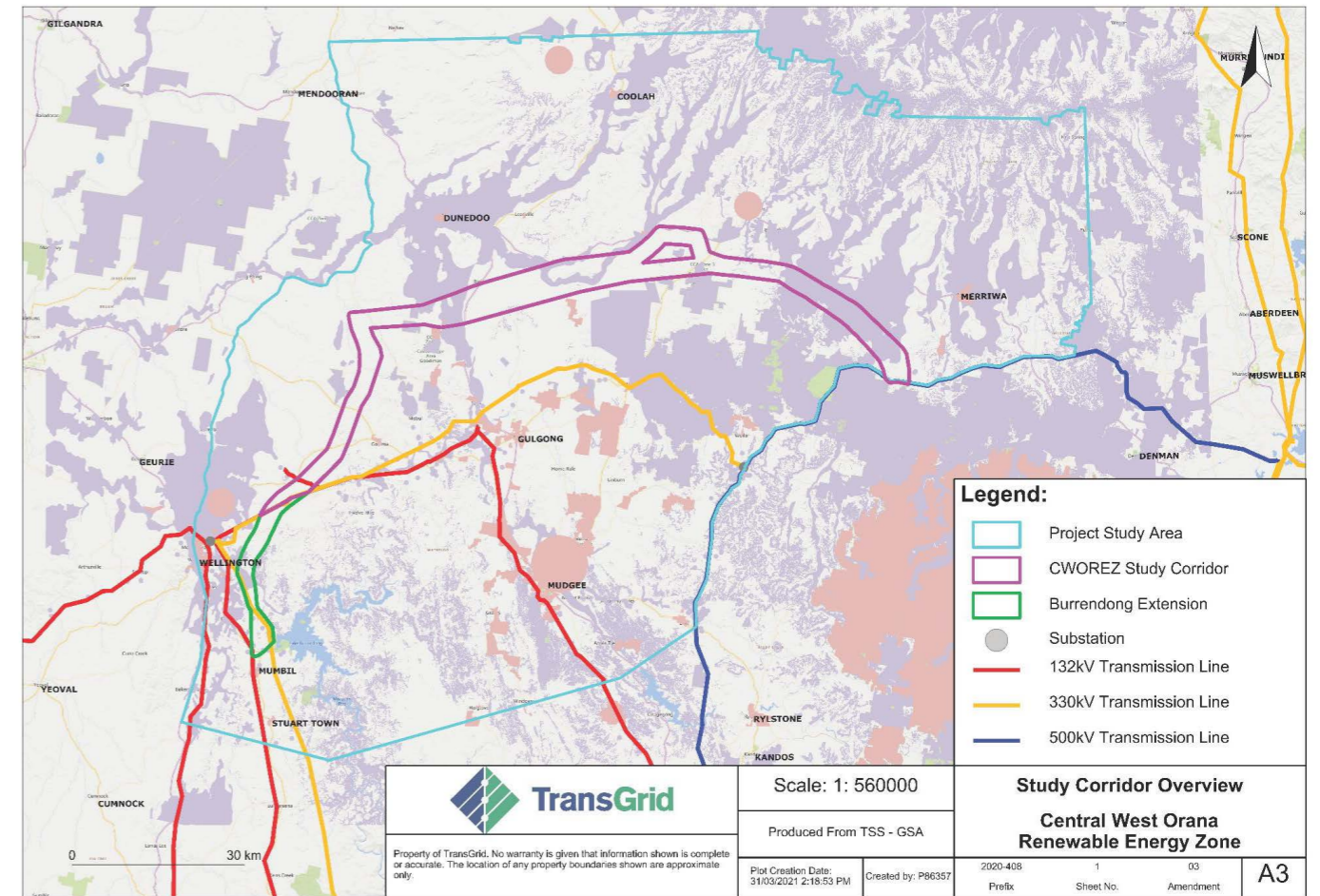


Figure 12-1: Study Corridor (dwellings and buildings not shown)

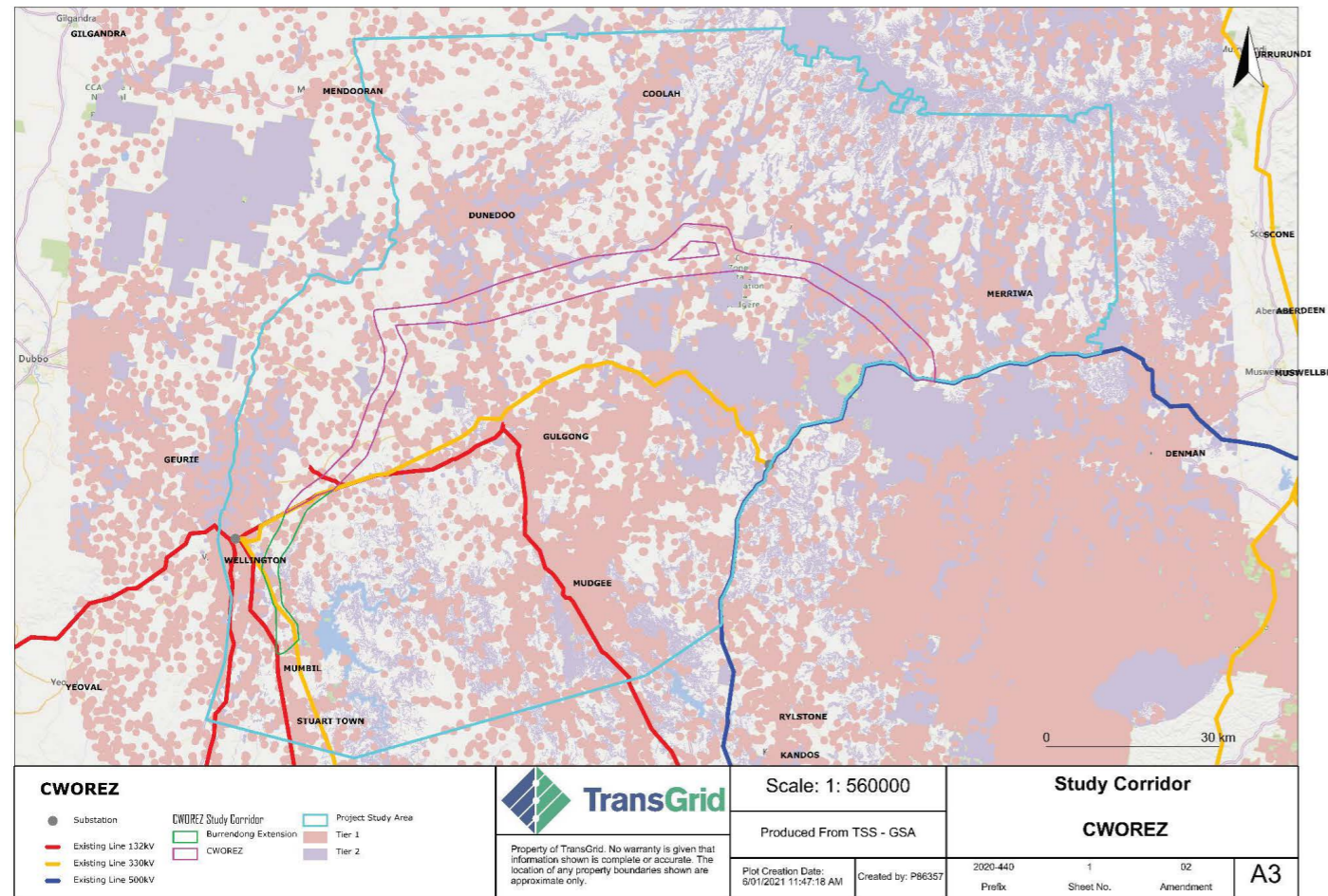


Figure 12-2: Study Corridor (buffered dwellings and buildings shown)

The study corridor is generally between 3km to 6km wide and is approximately 180km in length. The final transmission line easements will be either 60m (for 330 kV transmission lines) or 80m wide (for 500 kV transmission lines).

A width of approximately 3 – 6km was identified as suitable as this:

- Provides a level of flexibility for future stages of the corridor refinement process and for selecting a final route within the study corridor
- Is wide enough to provide flexibility for the selection of the route for the transmission lines and the design of the Transmission Project, but not too wide that it encompasses constrained areas

In areas where there is more uncertainty about the design of the Transmission Project or there are additional constraint complexities, a wider corridor has been identified. This is relevant in areas where substation locations have not yet been selected, which results in greater uncertainty of transmission connection locations. It also includes areas where route diversity may need to be maintained i.e. where two single circuit 500kV lines might be required due to high bushfire risk.

The identified study corridor provides an indicative area where the transmission lines and infrastructure could be located and an area within which further investigation can take place. Further investigation would include field studies and consultation with landowners and other stakeholders.



7. Next Steps

The identification of the study corridor is one of the early steps in the process of developing the Transmission Project. Further refinement of the corridor will take place over the following months.

Community consultation is vital to the success of the Transmission Project and Transgrid will consult with local communities at each stage of the project. In early 2021, Transgrid commenced the process of consulting landowners and local communities.

Landowner and community feedback will help to refine and narrow the study corridor and develop a route for the transmission lines that minimises impacts to local communities and the environment.

People will have many opportunities to get involved and have their say including:

- COVID-safe meetings with landowners and community groups
- Contribution of information to the project's online interactive map
- Attending community information sessions which will be advertised in local papers and our website)
- Visiting Transgrid's website www.Transgrid.com.au/centralwestorana for regular project updates and fact sheets
- Calling the project hotline 1800 313 212 (toll free number) or sending us an email to cwo@Transgrid.com.au

An environmental assessment process will also begin in 2021 following an initial early phase of consultation on the study corridor. Community consultation will continue throughout the route identification and environmental assessment processes.

8. References

AECOM, 2020, Central-West Orana REZ Feasibility Study.

AECOM, 2020, Central-West Orana REZ Feasibility Study – Addendum Report.

Australian Energy Market Operator (AEMO), 2020. Integrated System Plan.

National Grid, 2015, Undergrounding high voltage electricity transmission lines.

Department of Planning, Industry and Environment (DPIE), 2019. NSW Electricity Strategy.

Department of Planning, Industry and Environment (DPIE), 2018. NSW Transmission Infrastructure Strategy.

Appendix A: Datasets and Sources

Table A.1 Tier 1 Constraints – No-Go Zones

Constraint	Dataset	Source
Environmental, social and land use		
Areas of national environmental significance – Commonwealth and World Heritage areas, declared wilderness areas	Commonwealth Heritage List	Department of Environment & Energy (Australian Government)
	National Heritage List	
	World Heritage List	Department of Planning, Industry & Environment
	Declared Wilderness Areas	
Defence land	Defence Land (Land Use)	Department of Planning, Industry & Environment
Township, homesteads, residential areas and sensitive community locations (churches/ schools etc)	Built Up Areas - derived from Zoning & Land Use	Department of Planning, Industry & Environment
	Building Footprint	Geoscape
	Dwellings	Spatial Services NSW
Proximity to airports and licensed airstrips	Airports	Spatial Services NSW
Large open-cut mining sites	Mining (Land Use)	Resources & Geoscience NSW
	Mining Licenses	
Areas subject to Native Title and land granted under NSW Aboriginal Land Rights Act – high archaeological significance	Native Title Register	National Native Title Tribunal

Table A.2 Tier 2 Constraints – Avoid if possible or minimise impacts

Constraint	Dataset	Source
Environmental, social and land use		
ecological conservation areas including National Parks, National Park Estate and reserves	NSW National Parks & Wildlife Service (NPWS) Estate	Spatial Services NSW
	NSW National Parks & Wildlife Service (NPWS) Other Land	NSW National Parks & Wildlife Service
State Non-Aboriginal heritage items or conservation areas	State Heritage Register	Department of Premier and Cabinet
Known or registered Aboriginal heritage sites and places (managed by DPIE e.g. AHIMS sites)	Aboriginal Heritage Information Management System (AHIMS)	Department of Planning, Industry & Environment
Commonwealth land	Commonwealth Land (Land Use)	Department of Planning, Industry & Environment
Large scale agricultural/irrigated land and horticultural uses	Important Agricultural Land	Department of Planning, Industry & Environment
	Biophysical Strategic Agricultural Land Intensive Horticulture (Land Use)	
Engineering/design		
Active mining area	Mining (Land Use)	Resources & Geoscience NSW
< 80 m width available to accommodate an easement	Based on other constraints	Based on other relevant data sets
Areas with undulating terrain, valleys / rivers requiring large spans (30% slope over 500 metres)	Vulnerable Land: Steep, Highly Erodible Land	Department of Planning, Industry & Environment
Crossings with existing transmission lines (130 kV and above)	Distributor Lines	Spatial Services NSW
	Transgrid Transmission Lines	Transgrid
Adequate set back from wind farm turbine	Derived from available location data for renewable energy projects	Various - publicly available information and confidential data sources
Network operational risks including high bushfire risk and lightning risk (i.e. separate 500kV circuits by 5 km in high bushfire risk areas)	Bushfire Prone Land	Rural Fire Service
Major infrastructure crossings (waterways / railway)	Rivers	Spatial Services NSW
	Railways	



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