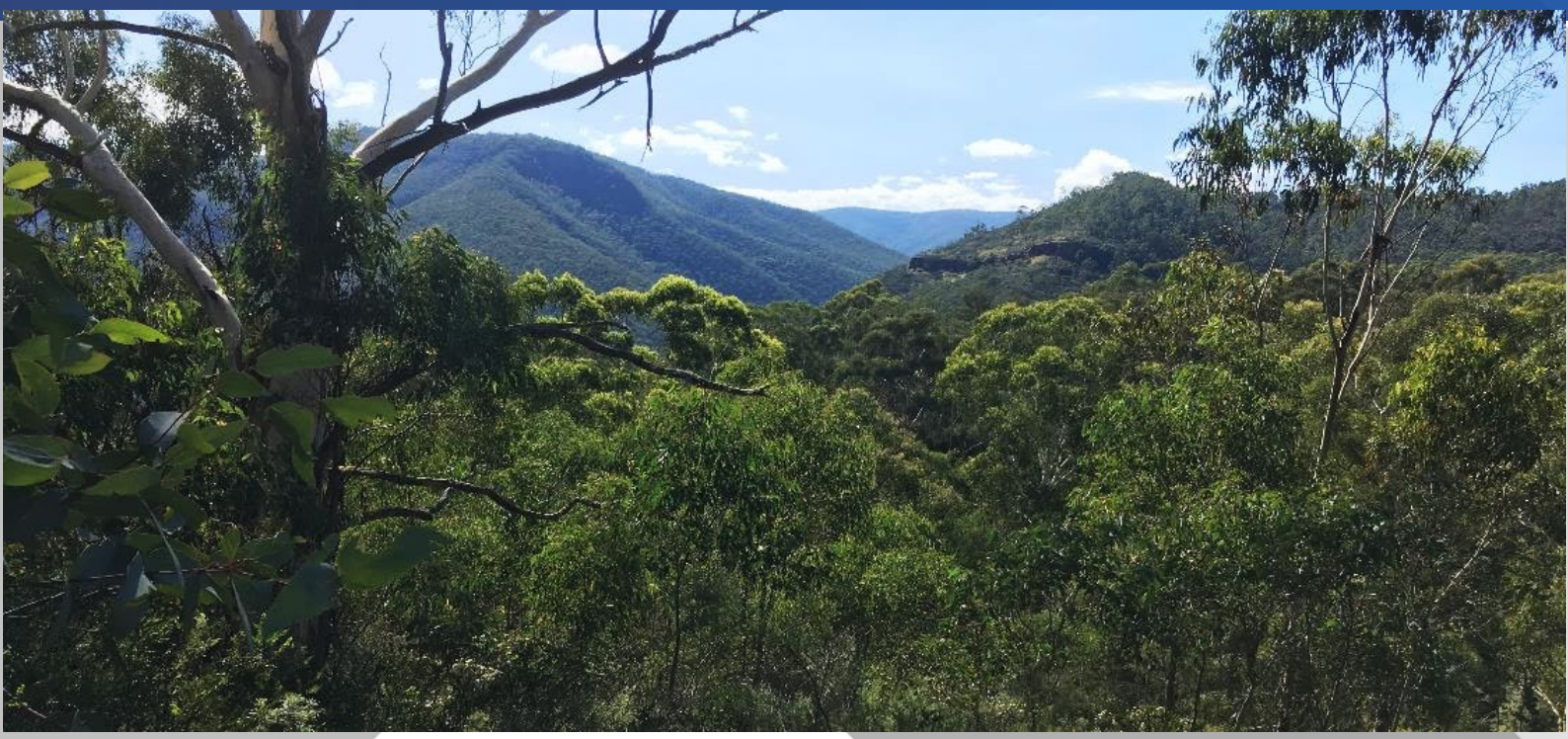
Appendix J Noise and vibration assessment

Snowy 2.0 Transmission Connection Project

Environmental Impact Assessment

(February 2021)



Snowy 2.0 Transmission Connection Project

Noise and Vibration assessment

Rev 5

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TransGrid Limited

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Executive Summary

Background

TransGrid is seeking approval under Part 5 Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a transmission line connection and substation to enable the grid connection of the Snowy 2.0 pumped hydro generation project. As part of the Environmental Impact Statement (EIS) being prepared for the project, an assessment was completed in accordance with the "Interim Construction Noise Guideline" (ICNG) (Department of Environment and Climate Change [DECC], 2009), the "Noise Policy for Industry" (NPI) (NSW Environment Protection Authority, 2017), Assessing Vibration: a technical guideline (NSW Department of Environment and Conservation [DEC], 2006) and other relevant State, National and International policies and guidelines to identify and evaluate the potential for noise and vibration-related impacts during the construction and operation of the project.

Key features of the existing environment

A review of available information was completed to characterise key features of the existing environment. Aerial imagery was reviewed to identify sensitive receivers around the project. Nearby heritage structures that can be more sensitive to vibration were identified by reviewing the *Snowy 2.0 Transmission Connection Project Non-Aboriginal Heritage Assessment* (Jacobs, 2020) prepared for the project. Noting that certain meteorological conditions can enhance the propagation of noise, information presented in Appendix R: *Noise and Vibration Impact Assessment Snowy 2.0 Main Works'*, (EMM, 2019) were reviewed which identified that noise-enhancing meteorological effects required consideration as part of the assessment. Background noise levels established in Appendix R: *Noise and Vibration Impact Assessment Snowy 2.0 Main Works'*, (EMM, 2019) were also reviewed to confirm the suitability of adopting the minimum rating background levels (RBLs) from the NPI.

Estimation of emissions

Construction staging and operational noise emissions information provided by TransGrid were used to develop emissions inventories. Reference sound power levels (SWLs) from various standards and guidelines were used to estimate overall noise emissions from different phases of construction. These inventories were cross-referenced against recommended safe setback guidance for avoiding vibration-related building cosmetic structural and human health impacts to identify vibration-generating plant/equipment to be used. Potential airblast overpressure and vibration levels from blasting activities were estimated using guidance presented in *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives*. Cumulative construction noise impacts were evaluated by considering worst-case predictions from the project and Snowy 2.0 as presented in Appendix R: *Noise and Vibration Impact Assessment Snowy 2.0 Main Works'*, (EMM, 2019).

Assessment of impacts

Potential noise, vibration and airblast overpressure levels at identified surrounding receiver locations were quantitatively assessed using various predictive methods. Results were evaluated by comparing the predictions against limits established based on guidance from relevant NSW, National and international standards and guidelines.

Using this approach, the following potential for impacts were determined:

- Predicted worst-case noise levels during construction were predicted to remain below project noise management levels (NMLs) at the identified receiver locations. Levels up to 59 dB(A) were predicted at receiver A16 (Snowy 2.0 works accommodation) although this is not considered to be a sensitive receiver given its association with Snowy 2.0. It is expected that the Snowy 2.0 accommodation facility would meet relevant requirements to provide adequate levels of amenity.
- Sleep disturbance impacts were not predicted during construction or operation
- Additional traffic movements from project construction activities are not expected to result in unacceptable changes in traffic noise levels at sensitive receivers along the intended haulage routes

- Building cosmetic damage and human comfort impacts from vibration generated from the use of hydraulic rock breakers and vibratory rollers at identified receiver locations would be unlikely. Care would need to be taken if this equipment is required within 50 m of heritage items R45 and R49
- Airblast overpressure and vibration impacts from blasting activities were not anticipated at the identified sensitive receiver locations. Care would be required to avoid damage to R45 and R49 if blasting is required around these locations
- Operational noise from the substation and transmission lines would not result in unacceptable impacts at the identified sensitive receivers
- The potential for cumulative noise impacts during the construction of the project and Snowy 2.0 was also determined to be negligible with cumulative levels remaining below NMLs at the identified sensitive receiver locations.

Conclusion and recommendations

Considering these outcomes, it was determined that the potential for noise and vibration impacts during the project would be limited. Measures to minimise construction noise and vibration from the project in line with best practice were recommended as required, with specific measures recommended regarding vibration. No noise impacts were determined during operation and therefore no measures have been recommended.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to assess potential noise and vibration impacts associated with the Snowy 2.0 Transmission Connection Project (the project) in accordance with the scope of services set out in the contract between Jacobs and TransGrid. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by TransGrid and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from TransGrid (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of TransGrid, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and TransGrid. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Overview

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT).

TransGrid is seeking approval under Part 5 Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of an overhead transmission connection and substation to enable the grid connection of the Snowy 2.0 pumped hydro generation project (Snowy 2.0).

The Snowy 2.0 Transmission Connection Project (the project) has been declared critical State Significant Infrastructure (SSI) under the *State Environmental Planning Policy (State and Regional Development) 2011* and is subject to assessment and determination by the Minister for Planning and Public Spaces. This noise and vibration assessment has been developed in support of the Environmental Impact Statement (EIS) for the project.

1.2 Purpose of this report

This noise and vibration assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the project on 1 November 2019 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE).

The SEARs relating to noise and vibration impacts are outlined in **Table 1-1**, along with a reference to where these requirements are addressed in this report.

Table 1-1: Secretary's environmental assessment requirements – Noise and vibration

Requirement	Where addressed
Amenity – an assessment of the construction, operational and road noise impacts of the project.	**Section 6**

In meeting these requirements, the objectives of this assessment were to:

- Describe the project setting, details and potential noise and vibration-related risks (**Section 2**)
- Outline key features of the existing environment including surrounding receivers, meteorology and background noise levels (**Section 3**)
- Establish suitable assessment criteria (**Section 4**)
- Estimate noise and vibration-related emissions associated with the construction and operational phases of the Project (**Section 5**)
- Predict the potential for noise and vibration-related impacts (including the potential for cumulative impacts) (**Section 6**)
- Recommend mitigation and management measures (**Section 7**).

2. Project description

2.1 Project components

The project involves the construction and operation of an overhead transmission connection and substation to connect Snowy 2.0 to the National Electricity Market.

The key elements of the project would include:

- A new 500/330 kilovolt (kV) substation located within Bago State Forest and adjacent to TransGrid's existing Line 64, which forms a 330 kV connection between Upper Tumut and Lower Tumut switching stations. The substation would occupy a footprint of approximately 300 metres (m) wide by 600 m long inclusive of an approximate 25 to 45 m wide cleared asset protection zone (APZ) surrounding the switchyard. Key noise-generating equipment at the new substation include three 500 kV transformers, two 500 kV reactors, three auxiliary transformers and two voltage transformers
- Upgrade and widening of an existing access road off Elliott Way to the new substation including the construction of a new driveway into the 330 kV and 500 kV switchyards
- Two new 330 kV overhead double-circuit transmission lines from the Snowy 2.0 cable yard to the new substation:
  - Total length of each line is approximately nine kilometres (km)
  - Located in a corridor ranging in width from approximately 120 m to 200 m
  - Each line would comprise approximately 21 steel lattice structures up to 75 m in height
- Short overhead 330 kV transmission line connection (approximately 300 metres in length) comprising both steel lattice structures and pole structures as required between the substation and Structure 43 on Line 64
- Construction of approximately 10 km of new access tracks (Option A) or 8 km (Option B) to the transmission structures and upgrade to existing access tracks where required. Option A minimises disturbance within a mapped high risk naturally occurring asbestos (NOA) zone. The access tracks would remain following the completion of construction to service ongoing maintenance activities along the transmission lines
- Establishment of a helipad (approximately 30 m wide by 30 m long) to support the transmission line construction activities carried out at higher elevations and steep terrain
- Ancillary activities, including the establishment of tensioning and pulling sites for conductor and earth wire stringing, crane pads, site compounds, and equipment laydown areas.

The project location and key components of the project are shown **Figure 2-1** and in **Figure 2-2** respectively.

A complete project description which includes a consolidated summary and discussion of the construction and operation of the project is provided in Chapter 5 of the EIS.

2.2 Project location

The eastern extent of the project is defined by the location of Snowy 2.0 cable yard at Lobs Hole in Kosciuszko National Park (KNP). The cable yard serves as the transition point between the underground cables carrying electricity generated by Snowy 2.0 to the overhead transmission connection. The cable yard forms part of Snowy 2.0.

From the cable yard, the transmission connection extends west through KNP and up Sheep Station Ridge which is characterised by steep, mountainous terrain before traversing Talbingo Reservoir. The transmission connection then continues west, passing over Elliott Way at three locations before entering Bago State Forest to the proposed substation site. The location of the project is shown in **Figure 2-1**.

The nearest large town to the project is Tumut, which is located approximately 55 km to the north west Other townships near the project include Talbingo, Tumbarumba, Cabramurra and Adaminaby. Talbingo and Cabramurra were built to provide accommodation for the original Snowy Scheme workers and their families.

2.3 Project area

For the purposes of predicting environmental impacts of the project, a **disturbance area** has been defined. The disturbance area encompasses the extent of physical disturbance likely to be required to accommodate construction activities and infrastructure needed to build the overhead transmission line, the permanent substation and access roads and vegetation clearing along the transmission corridor.

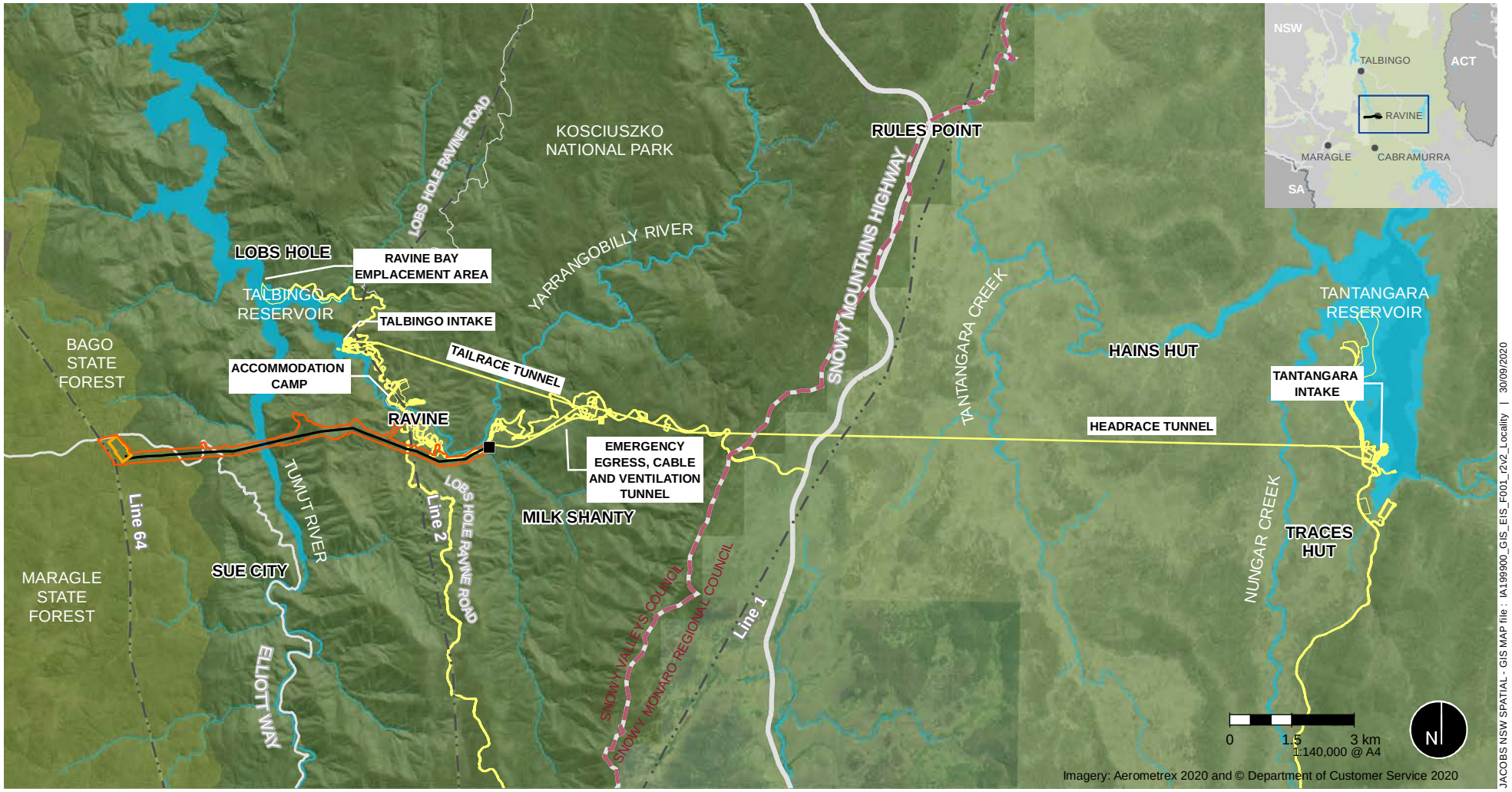
A broader project area has also been defined. The **project area** represents the limits of where disturbance may occur during construction to allow for flexibility for the final siting of project infrastructure. Final siting of the infrastructure (i.e. the disturbance area) can move within the assessed project area subject to recommended environmental management measures and provided it does not exceed the limits defined by the project area.

The project traverses Talbingo Reservoir, which naturally splits the project area into two. When defining the area of works, the terms 'project area east' and 'project area west' have been used where required for the purpose of the EIS. These are defined as follows:

- **Project area east:** includes the project area and existing surrounding access roads in the area east of Talbingo Reservoir
- **Project area west**: includes the project area and existing surrounding access roads in the area west of Talbingo Reservoir.

The existing landscape character of much of the project area consists of undisturbed and mountainous terrain, forested valleys, and is the only true alpine environment in NSW (NPWS 2003). This landscape contains limited human disturbance, however existing transmission line easements, minor access tracks, and infrastructure associated with the Talbingo Reservoir occur within and in the vicinity of the project area.

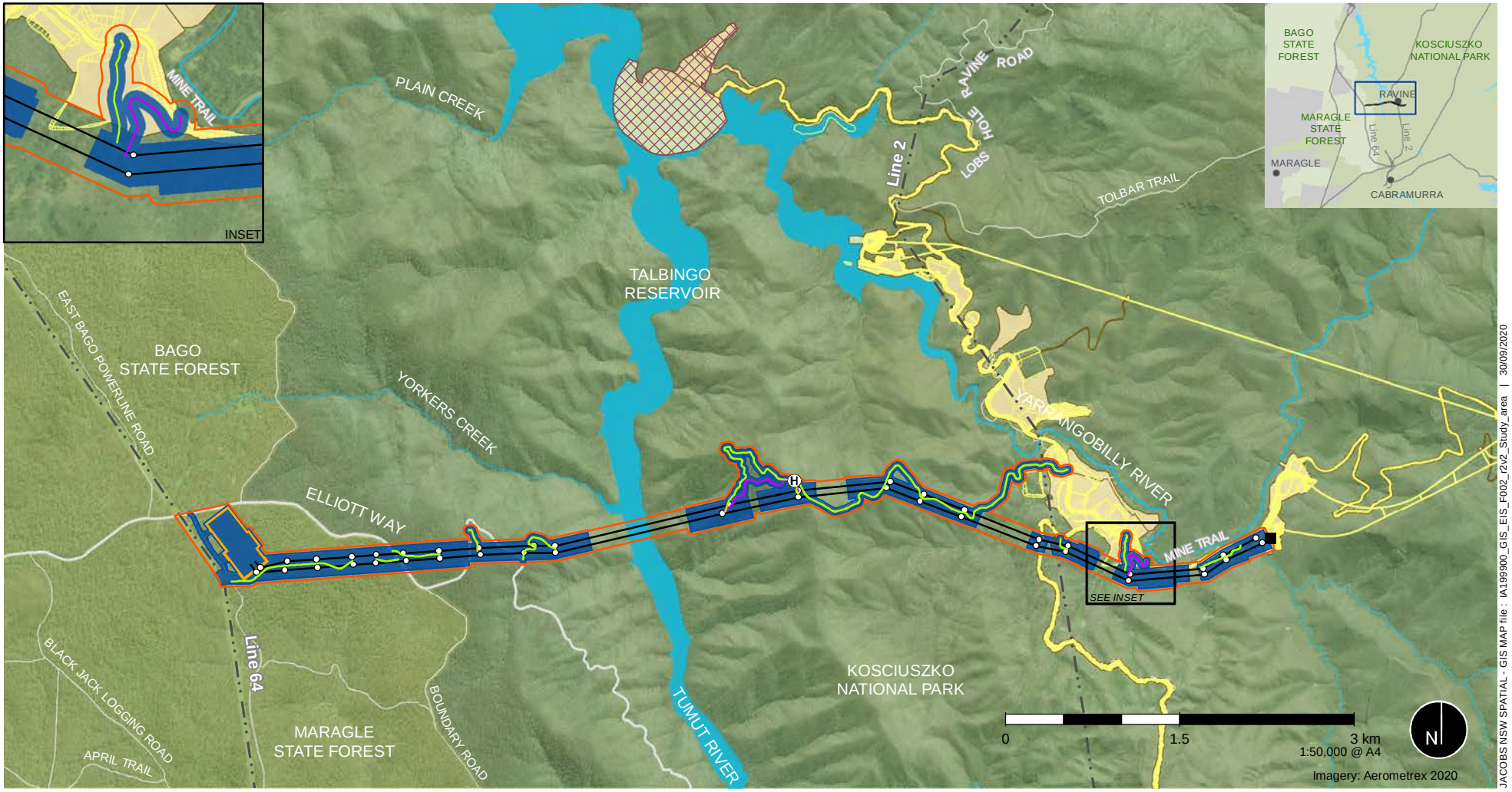
The project area and disturbance area shown in **Figure 2-1**.



Project area
Proposed transmission line
Proposed 500kV substation
Snowy 2.0 cable yard
Snowy 2.0 element
Electricity transmission line
Local Government boundary
Waterway
Water body
State forest
NPWS estate

Figure 2-1 | Project location

Data source:
Jacobs 2020, TransGrid, EMM 2020



- Project area
- Disturbance area
- Proposed 500kV substation
- Potential helipad location
- Proposed structure
- Proposed transmission line
- Proposed access track - Option A
- Proposed access track - Option B
- Snowy 2.0 cable yard
- Snowy 2.0 element
- Ravine Bay Emplacement Area
- Snowy 2.0 Disturbance footprint
- Electricity transmission line
- Waterway
- Water body
- State forest
- NPWS estate

Figure 2-2 | Project overview

Data source:
Jacobs 2020, TransGrid, EMM 2020,

2.4 Construction activities

The construction works would commence with the construction of the access tracks to the substation and transmission structure locations. Construction of the helipad is also expected to commence in the initial stages. Once suitable access has been established, construction of the substation and transmission line would commence and occur concurrently. **Table 2-1** below summarises the key construction activities associated with each of the of the project elements above.

Table 2-1: Project construction overview

Construction activity	Description
Pre-construction, site establishment	▪ Site mobilisation once relevant approvals have been granted, property acquisitions have been finalised with Forestry Corporation of NSW (FCNSW) and National Parks and Wildlife Service (NPWS) and agreements with construction contractors has been achieved ▪ Surveying and marking out the approved disturbance area and any environmental avoidance areas ▪ Installation of appropriate stormwater and diversion drainage and erosion and sedimentation control works prior to ground disturbance and vegetation clearing ▪ Inform recreational users of KNP, Bago State Forest and Talbingo Reservoir of the construction activities, the extent of work areas and the locations of environmental exclusion areas with project notifications, including warning signs of construction activities and notifications of access restrictions ▪ Establishment of the construction compound and equipment laydown areas at the substation site and at Lobs Hole*.
Access tracks	▪ Vegetation clearing within the approved corridor. This is expected to be carried out both manually in the areas of steeper slopes and machine clearing where access can be safely achieved ▪ Grubbing and bulk earthworks (cut and fill) using an excavator ▪ Installation of suitable drainage structures and sediment retention basins where required ▪ Laying and compaction of a suitable rock aggregate/road base ▪ Grading and/or reshaping of existing tracks where required, within the existing access track width (no road widening) ▪ Minor excavations followed by laying and compaction of crushed rock or gravel, to improve the existing track surface and drainage.
Substation	▪ Vegetation clearing across the substation site and surrounding APZ. This would involve the stripping and stockpiling of topsoil for later use. Vegetation clearing is expected to be carried out utilising a bulldozer equipment with a tree pusher, however would be confirmed in consultation with FCNSW ▪ Establishment of a site compound and laydown area within the cleared APZ. The site compound would be in placed throughout the construction period and is expected to contain a demountable office, meal room, and toilet/shower facilities, equipment laydown areas, vehicle and equipment storage, maintenance sheds, chemical/fuel stores and stockpile areas ▪ Minor earthworks to establish the site amenities; which would include cut and fill to establish a level area for the site facilities and temporary storage areas and establishment of the permanent site access road

Construction activity	Description
	▪ Earthworks: - Excavation works to remove excess material, provide a level surface, and create the required trenches for drainage, earthing, and electrical conduits. Some spoil from the excavation may be reused on site for filling and compaction (including benching areas of the site where required). Excavation works would be carried out using equipment such as excavators, dozers and crushing plant. Furthermore, depending on the underlying geology, blasting may be required to facilitate the break-up of rock, should it be present - Bulk earthworks to establish the level surface for the substation bench - Approximately 11,300 cubic metres of excess spoil would be generated from the levelling of the substation site and construction of the access road. Any soil which cannot be reused onsite as fill material, landscaping or other means would be disposed of off-site at a suitably licenced facility and/or at a location(s) as agreed with FCNSW - Where excavated spoil is not appropriate for reuse on site, additional spoil would be imported to site ▪ Civil and building works: - Civil works involving the establishment of concrete footings for the high voltage equipment and buildings, construction of stormwater drainage and oil containment infrastructure and cable trenches and subsurface cables - Construction of onsite buildings (e.g. control room) and services installed including general lighting, power and ventilation.
Transmission corridor	▪ Vegetation clearing within the approved transmission corridor where the overhead conductors would not meet safe clearance heights above the underlying vegetation ▪ Grading and/or reshaping of existing access tracks where required ▪ Vegetation clearing and bulk earthworks to establish the level helipad ▪ Establishment of the transmission structure work sites involving: - Clearing of an approximate 40 m by 60 m area around each transmission structure location to allow for the laydown of materials and equipment and facilitate access for vehicles, plant and machinery during structure construction - Bulk earthworks (cut and fill) to establish level construction benches within the worksite to allow for the safe operation of plant and equipment (namely elevated works platforms and cranes) during structure construction - Geotechnical investigation works using a mobile drill rig at each structure location to determine the most appropriate footing design - Bulk earthworks and excavations to establish the structure footings involving the installation of steel framework and backfilling with concrete or pile type footings involving boring four boreholes at each structure leg location and backfilling with concrete - Steel lattice structures would be transported to each structure location via heavy vehicle in parts and assembled on site using mobile cranes ▪ Stringing of conductor and overhead earth wire which would involve: - Establishment of level tensioning and pulling sites within the approximate 40 m by 60 m structure worksite or at suitable locations within the transmission corridor

Construction activity	Description
	- Attachment of sheaves (or pulleys) to the top of the structures in readiness for stringing work using an elevated work platform - Pulling out a light weight draw wire across the section of line being strung using a drone or vehicle/machine (such as dozer), followed by the placement of the draw wire through the sheaves - Attachment of the draw wire to the earth wire or conductor drum (depending on which is being strung) and pulling it through the sheaves under tension using specialised tensioning and pulling equipment - Termination of the conductor/earth wire at each end clipping it into position followed by the removal of the sheaves.
Commissioning	▪ Testing of all high voltage equipment at the substation and ensuring all protection, control and metering equipment is operating correctly ▪ Completion of all necessary cut-in works to Line 64 and relevant testing undertaken ▪ Placement of the new transmission lines and substation into standby in readiness for Snowy 2.0 to be completed ▪ Once Snowy 2.0 becomes operational, energisation of the high voltage equipment and the project placed into service
Rehabilitation and demobilisation	▪ Removal of all non-permanent infrastructure and equipment from the work sites and site compounds ▪ Decommissioning and dismantling of the site compounds at the substation and Lobs Hole ▪ Site stabilisation and landscaping involving: - Stabilisation of exposed areas and slopes - Installation and maintenance of erosion and sediment controls at the work sites to manage impacts post-construction - Seeding soil slopes to assist stabilisation - Planting vegetation on any higher risk slopes - Mulching of stabilised and revegetated areas where required.

*The site compound at Lobs Hole would be located within the approved disturbance footprint of Snowy 2.0.

2.4.1 Construction staging and timing

These works are anticipated to commence in early 2022 and take approximately 39 months to complete. An indicative is program is presented below in **Figure 2-3**. Further details on the estimated timing and staging of the main project activities is described in Section 5.3 of the EIS.

Construction works	2022				2023				2024				2025
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Access tracks, roads and helipad													
330 kV Switchyard													
500 kV Substation													
Transmission connection													

Figure 2-3: Indicative timing for the construction of key project components

2.4.2 Construction working hours

Given the isolated location and the construction of Snowy 2.0 occurring in parallel, construction works are expected to be carried out 12 hours per day, seven days per week between the hours of 6 am and 6 pm.

2.4.3 Construction traffic movements

Construction vehicle movements have the potential to generate temporary adverse noise impacts along access routes which use public roads as vehicles deliver materials to and from the project site. Construction vehicle movements would comprise vehicles transporting equipment, waste, materials and spoil, as well as vehicles driven by the construction workforce accessing the work locations. Estimated light and heavy vehicle movements on a typical day and during the peak construction period is outlined in **Table 2-3**.

Table 2-3: Estimated project-related vehicle movements during construction

Vehicles	Movement type	Estimated movements / day
Substation		
Light vehicles	Indicative daily movements (typical day)	50
	Maximum daily movements (critical/peak construction period)	80
Heavy vehicles	Indicative daily movements (typical day)	30
	Maximum daily movements (critical/peak construction period)	75
Transmission line		
Light vehicles	Indicative daily movements (typical day)	30
	Maximum daily movements (critical/peak construction period)	60
Heavy vehicles	Indicative daily movements (typical day)	50
	Maximum daily movements (critical/peak construction period)	75

* Indicative daily movements are based on current program of work and may change as a result of detailed construction planning with one vehicle movement referring to one inbound and outbound trip.

It is anticipated that the maximum predicted daily heavy vehicle movements would occur during:

- Bulk earthworks and civil works during the substation construction
- Bulk earthworks and civil works during access track construction and establishment of the transmission structure footings
- Transmission connection corridor vegetation clearing works.

The high volume of heavy vehicle movements during the above activities is attributed to heavy vehicles transporting large volumes of spoil, vegetative matter and debris from the project area.

Light personnel vehicle movements would be generally attributed to the construction workforce accessing the substation site for work each day and accessing the work locations along the transmission connection corridor.

2.4.3.1 Primary construction transport routes

The values in **Table 2-3** above are based on current program of works. The anticipated haulage routes for heavy vehicles carrying materials and equipment to and from the project area are outlined below.

- **Project area west**: It is expected that majority of materials and equipment would travel along Hume Highway, Snowy Mountains Highway, Batlow Road, Tooma Road and Elliott Way.

- **Project area east**: It is expected that the majority of materials and equipment would travel along Snowy Mountains Highway (from both Tumut and Cooma), Link Road and Lobs Hole Ravine Road.

It is expected that all heavy transport would occur between 5am and 7pm and be limited to daylight hours to avoid sleeping hours.

2.5 Operation and maintenance

The substation and transmission connection would be inspected by field staff on a regular basis. Key activities undertaken during operation would include:

- Regular inspection and maintenance of electrical equipment at the substation including structural integrity of all footings and support structures
- General inspection and maintenance of other components within the substation including the stormwater management system, fire detection system, onsite buildings and drainage infrastructure
- Regular inspection and maintenance of the transmission structures, footings, fittings, conductors and overhead earth wires
- Vegetation removal and trimming along the transmission easement and APZ surrounding the substation to maintain appropriate clearances between ground vegetation and the overhead transmission lines and around the substation to manage bushfire risk
- Removal of trees which have the potential to strike the overhead conductors if they were to fall (referred to as hazard trees) as required.

It is expected that only light vehicles and small to medium plant would need to access the substation site and the transmission corridor for these activities. The substation would not accommodate full-time staff or contractors, and the regular collection of waste would not be required. Any waste generated during operation of the substation would be minimal and disposed of on an 'as need' basis.

Given that only 40 traffic movements per year are estimated to be generated during operations, the potential for noise impacts from additional traffic generated by the operation of the project is not expected and has not been considered further in the assessment.

2.6 Primary noise and vibration-related risks

Noise and vibration-related impacts can arise when levels from an industry or construction activities result in unacceptable levels at surrounding sensitive receivers. Noise and vibration have the potential to be generated during the construction and operational phases of the project. The key activities with the potential to generate noise and vibration during the project include:

- Site establishment; construction of new access tracks, substation and transmission lines; commissioning and demobilisation/rehabilitation, including associated traffic movements
- Noise from the substation and transmission lines during operation.

Additionally, the other key noise and vibration-related risk would be cumulative impacts at surrounding sensitive receivers.

3. Existing environment

3.1 Surrounding sensitive receivers

Surrounding receivers in relation to the project are shown on **Figure 3-1**. As displayed, there are two passive recreation areas within the vicinity of the project: Coonara Point Campground and Rest Area and O'Hares Campground. There are also a number of private residential properties along Bradleys Drive, Nurenmerenmong. The Snowy Hydro's accommodation camp at Lobs Hole (Snowy 2.0 works accommodation) is also located nearby. Although this location would be sensitive to noise from project activities, it was not considered to be a sensitive receiver location in 'Appendix R: *Noise and Vibration Impact Assessment Snowy 2.0 Main Works'*, (EMM, 2019) owing to its affiliation with the project. It is expected that the contractor responsible for the Snowy 2.0 works accommodation would design these facilities to meet relevant requirements to provide adequate levels of amenity.

Details of the receiver locations identified in **Figure 3-1** are listed in **Table 3-1**.

Table 3-1: Nearby noise sensitive receivers

Receiver ID	Receiver details	Receiver type	Approximate co-ordinates (UTM MGA Zone	
			Easting (m) E	Northing (m) S
A3	Coonara Point Campground and Rest Area	Passive recreation area	622202	6039251
A5	O'Hares Campground	Passive recreation area	623443	6035053
R20	Private properties at Nurenmerenmong and McPherson Plains caravan park	Residential	615307	6040979
A16	Snowy 2.0 works accommodation	n/a*	625947	6039216

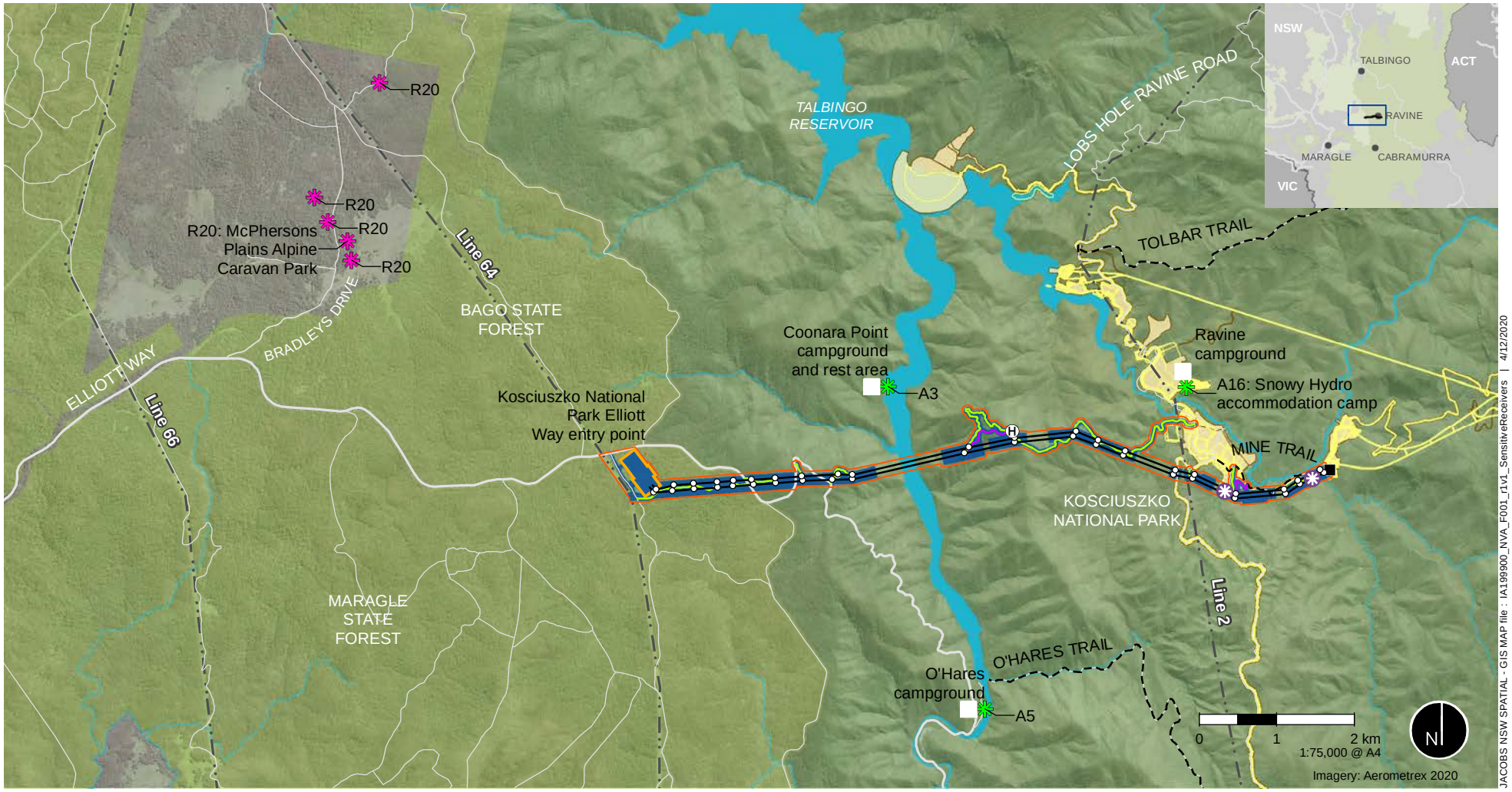
* Not applicable, the Snowy 2.0 works accommodation forms part of the overall Snowy 2.0 construction works

There would also be sensitive receivers along routes and towns (such as Cooma, Batlow, Tumbarumba and Tumut) affected by haulage and daily construction traffic (ie traffic between accommodation locations and the construction sites).

The *Snowy 2.0 Transmission Connection Project Non-Aboriginal Heritage Assessment* (Jacobs, 2020) (Jacobs, 2020) identified two heritage structures within the disturbance area. These are listed in **Table 3-2** and shown in **Figure 3-1**.

Table 3-2: Non-Aboriginal heritage items identified within the project area

Identifier	Name	Location
R45	Lobs hole Copper mine water race	150 m south west of the first set of structures in project area east
R49	Circular stone wall	145 m west of the fourth set of structures in project area east



- Project area
- Disturbance area
- Proposed 500kV substation
- Potential helipad location
- Proposed structure
- Proposed transmission line
- Proposed access track - Option A
- Proposed access track - Option B
- Sensitive receiver - accommodation
- Sensitive receiver - private residence
- Historic heritage - significant item (NSW Archaeology 2019)
- Snowy 2.0 cable yard
- Snowy 2.0 element
- Snowy 2.0 Disturbance footprint
- Kosciuszko National Park Elliott Way entry point
- Campground
- Electricity transmission line
- Track
- Major road
- Waterway
- Water body
- State forest
- NPWS estate

Figure 3-1 | Sensitive receivers

3.2 Meteorology

Certain meteorological conditions can enhance the propagation of noise and their influence is required to be accounted for where they are found to be a feature of the locality. In the EIS completed for the Snowy 2.0 Main Works a review of whether noise-enhancing meteorological conditions were a 'significant' feature of the local environment was undertaken. This included a review of prevailing winds and temperature inversions consistent with the methods detailed in Fact Sheet D of the NSW Environment Protection Authority's (EPA's) "*Noise Policy for Industry*" (NPI) (2017). This review found that wind noise-enhancing effects were not a feature of the local setting, although the occurrence of temperature inversion conditions was significant' with 'F' and 'G' atmospheric stability class conditions occurring more than 30% of night time periods in winter (EMM, 2019). As such, it was concluded that noise-enhancing meteorological conditions were a feature of the local environment. This conclusion was considered to be relevant for the purpose of this assessment.

3.3 Background noise levels

An understanding of background noise levels is necessary to determine a locality's sensitivity to changes in the acoustic environment. Background noise monitoring was undertaken as part of the noise and vibration assessment undertaken for the Snowy 2.0 Main Works EIS. Although none of the five Snowy 2.0 EIS background noise sampling locations were located near the project works being assessed, they provide an indication of background noise conditions around the wider project setting. These results are reproduced in **Table 3-3**.

Table 3-3: EIS background noise monitoring results summary (EMM, 2019)

ID	Location	Period	Measured and (adopted) rating background level, RBL dB(A)	Measured equivalent noise level, $L_{AEQ\ period}$ dB(A)
EIS L1	Brownlie Court, Talbingo	Day	28 (35)	48
		Evening	29 (30)	47
		Night	23 (30)	35
EIS L2	Yarrangobilly Village Campground, Snowy Mountains Highway	Day	31 (35)	53
		Evening	31 (30)	45
		Night	32 (30)	41
EIS L3	Sawyers Hut, Snowy Mountains Highway	Day	26 (35)	54
		Evening	25 (30)	49
		Night	24 (30)	46
EIS L4	Tooma Road, Tooma	Day	25 (35)	57
		Evening	24 (30)	51
		Night	23 (30)	53
EIS L5	Rock Forest, Adaminaby	Day	34 (35)	41
		Evening	<30 (30)	-
		Night	<30 (30)	-
EIS L6	Snowy Mountains Highway, Adaminaby	Day	26 (35)	58
		Evening	21 (30)	53
		Night	21 (30)	47

The term rating background level (RBL) above in **Table 3-3** refers to the median value of monitored background noise levels measured over each period and is used for the purpose of establishing background noise levels. Additionally, the term 'L_{Aeq}' refers to the equivalent continuous sound level or energy-time average for the relevant period of monitoring. As listed, measured daytime RBLs ranged between 25 and 34 dB(A), evening values between 21 and 31 dB(A), and levels at night ranged from 21 and 32 dB(A). In the absence of monitored background noise levels, the NPI provides the minimum RBLs listed in **Table 3-4:**for the purpose of the noise assessment.

Table 3-4: Adopted background noise levels dB(A)

Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
35	30	30

These minimum recommended RBLs are consistent with those measured at receivers around Snowy 2.0 and are typical for the remote project setting where there would be limited anthropogenic noise sources contributing to background noise levels. As such, these minimum recommended RBLs were applied in the assessment.

4. Policy setting and criteria

4.1 Construction noise

4.1.1 Noise management levels

The "*Interim Construction Noise Guideline*" (ICNG) (Department of Environment and Climate Change [DECC], 2009) provides guidance for assessing noise from construction activities in NSW. It establishes noise management levels (NMLs) according to the hours in which construction may take place. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the noise management levels. **Table 4-1** lists ICNG guidance for establishing construction NMLs at residential receivers.

Table 4-1: ICNG guidance for establishing construction NMLs at residential receivers

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH) - All other times including public holidays	Noise affected RBL + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Considering the adopted RBLs presented in **Table 3-4:** and the guidance above from the ICNG, the following NMLs listed in **Table 4-2** were established to assess potential construction noise impacts at the identified surrounding residential receiver location (receiver R20).

Table 4-2: ICNG NMLs for residential receivers

Receiver type	Day (during standard hours)		Day (outside standard hours)		Evening		Night	
	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)	L_{90} (RBL) dB (A)	NML $L_{eq\ 15\ min}$ dB(A)
Residential	35	45	35	40	30	35	30	35

The ICNG also provides construction NMLs for non-residential land uses. This guidance has been reproduced below in **Table 4-3**, which was applied at receivers A3 and A5.

Table 4-3: ICNG NMLs for non-residential receivers

Non-residential receiver type	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Passive recreation areas	External noise level – 60 dB(A)

4.1.2 Construction traffic noise impacts

Section 9 of the "Construction Noise and Vibration Guideline" (CNVG), (NSW Roads and Maritime, 2016) provides guidance for the assessment of noise associated with additional traffic generated during construction. This guidance was adopted for this assessment and has been reproduced below:

> *'For RMS projects an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2dB(A) due to construction traffic or a temporary reroute due to a road closure. Where increases are 2dBA or less no further assessment is required.*
>
> *Where noise levels increase by more than 2dB(A) [i.e. 2.1 dBA] further assessment is required using Roads and Maritimes Criteria Guideline. This documents RMS' approach to implementing the Road Noise Policy. Consideration should be given under the Noise Criteria Guideline as to whether construction traffic or temporary reroute triggers new road criteria due to changes in road category'.*

This guidance was considered for the purpose of reviewing potential noise associated with additional traffic generated as a result of the project.

4.1.3 Sleep disturbance during construction

The ICNG does not provide a specific method for assessment of potential sleep disturbance noise impacts and guidance on the acceptability of these events is taken from the NSW Road Noise Policy (RNP), (DECCW, 2011).

The RNP provides two criteria:

- Sleep disturbance screening criterion – used to identify situations where there is the potential for sleep disturbance
- Sleep disturbance awakening criterion – levels below which awakening is unlikely to occur.

The sleep disturbance screening criterion recommends that where the $L_{A1\ (1\ minute)}$ does not exceed the $L_{A90\ (15\ minute)}$ by 15 dB(A) or more, sleep disturbance impacts are likely to be maintained at an acceptable level. The $L_{A1,\ (1\ minute)}$ descriptor is meant to represent a maximum noise level when measured using a 'fast' time response.

The sleep disturbance awakening criterion is the threshold at which an awakening reaction is likely to occur. Research discussed in the RNP identified this threshold to be an internal bedroom noise level of around 50 to 55

dB(A). Windows often allow the greatest amount of sound transmission from outside to inside across a building façade. Noting guidance presented in *AS2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites*, where bedrooms are ventilated by an opened window, a sleep disturbance awakening criterion measured outside the bedroom window of 60 to 65 dB(A) would generally apply.

4.2 Operational noise

4.2.1 Overview

Operational noise criteria for the project was determined in accordance with the NSW EPA's NPI which seeks to regulate noise impact from 'industrial activity' pertaining to noise from fixed industry and mechanical plant (including substations and transmission lines) rather than from road, rail or construction sources. To achieve this, the NPI applies two separate noise levels: one aimed at limiting the intrusiveness of the project's noise against the prevailing level of background noise, and the other focused on achieving suitable acoustic amenity for the surrounding land uses from industry. The more stringent of these is used to define the operational noise criteria for a project.

4.2.2 Intrusiveness noise level

A noise source will be deemed to be non-intrusive if the monitored $L_{Aeq\ (period)}$ noise level of the development does not exceed the RBL by more than 5 dB(A). Based on the RBLs adopted in **Table 4-4**, the following criteria noise intrusiveness criteria would apply:

Table 4-4: NPI intrusiveness noise levels

Receiver type	Time of Day	L_{90} (RBL) dB (A)	Allowance	Noise intrusiveness criteria dB(A)
Residential receivers	Day (7 am to 6 pm)	35	+5 dB(A)	40
	Evening (6 pm to 10 pm)	30		35
	Night (10 pm to 7 am)	30		35

4.2.3 Amenity noise level

The recommended amenity noise levels represent the objective for total operational noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single development at a receiver location. To ensure that operational noise levels remain within the recommended amenity noise levels for an area, the project amenity noise levels below in **Table 4-5** would apply:

Table 4-5: NPI amenity noise criteria, residential receivers

Receiver type	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{Aeq\ 15\ minute}$ Noise Level dB(A)
Residential receivers	Day (7 am to 6 pm)	50	48
	Evening (6 pm to 10 pm)	45	43
	Night (10 pm to 7 am)	40	38

The NPI also presents amenity noise levels for non-residential receivers. These have been reproduced below in **Table 4-6**.

Table 4-6: NPI amenity noise criteria, other receivers

Receiver type	Time of day	Recommended amenity $L_{Aeq\ 15\ minute}$ Noise Level dB(A)
Passive recreational area	When in use	48

4.2.4 Project operational noise criteria

Considering the intrusive and amenity criteria developed above, the NPI recommends that the more stringent values be applied for each period of assessment. Considering this, the criteria listed in **Table 4-7** were adopted for the purpose of assessing the potential for operational noise impacts from the project.

Table 4-7: Project operational noise criteria

Receiver type	Time of day	Recommended L_{Aeq} Noise Level dB(A)
Residential receivers	Day (7 am to 6 pm)	40
	Evening (6 pm to 10 pm)	35
	Night (10 pm to 7 am)	35
Passive recreational area	When in use	48

4.2.5 Sleep disturbance during operations

For premises where night operations occur, the potential for noise levels to lead to sleep disturbance should be considered. Where noise levels from an operational premises at a residential receptor at night exceeds the following, the NPI recommends that a maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40dB(A) or the RBL + 5dB(A), whichever is greater, and/or;
- L_{AFMax} 52 dB(A) or the RBL +15 dB(A), whichever is greater.

Based on this guidance, an operational sleep disturbance screening criterion of $L_{Aeq,15min}$ 40 dB(A) was applied.

4.3 Vibration

4.3.1 Overview

Vibration arising from construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two outcomes have different criteria levels, with the effects of vibration on human comfort having a lower threshold.

4.3.2 Human comfort

With respect to human comfort, vibration arising from construction activities must comply with criteria presented in "Assessing Vibration: a technical guideline", (DECC, February 2006) and *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* [BS 6472-1: 2008]. DECC, 2006 identifies three different forms of vibration associated with construction activities:

- Continuous: uninterrupted vibration occurring over a defined period
- Impulsive: short-term (typically less than two seconds) bursts of vibration which occurs up to three times over an assessment period
- Intermittent: interrupted periods of continuous or repeated impulsive vibration, or continuous vibration that varies significantly in magnitude

Continuous vibration may result from steady road traffic or steady use of construction equipment (e.g. generator). Impulsive vibration may arise during the loading or unloading of heavy equipment or materials or infrequent use of hammering equipment. Intermittent vibration may arise from the varied use of construction equipment (i.e. a dump truck moving around a site, idling while being loaded with materials, and then dumping the materials) or repeated high-noise activities such as hammering, piling or cutting.

Preferred and maximum values of human exposure for continuous and impulsive vibrations are listed (DECC, February 2006) in **Table 4-8** below.

Table 4-8: Preferred and maximum weighted root mean squared (rms) values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x and y axis	z-axis	x and y axis
Continuous vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night	0.020	0.014	0.040	0.028
Impulsive vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night	0.64	0.46	1.28	0.92
Workshops	Day or night	0.64	0.46	1.28	0.92

[1] Daytime is 7am to 10pm. Night-time is 10pm to 7am

[2] includes hospital operating theatres or precision laboratories.

Intermittent vibration is assessed differently using vibration dose values (VDV). Preferred and maximum VDVs for different types of receivers have been reproduced in **Table 4-9** below.

Table 4-9: Preferred and maximum VDVs for intermittent vibration ($ms^{-1.75}$), (DECC, 2006)

Location	Day time (7 am to 10 pm)		Night time (10 pm to 7 am)	
	Preferred VDV	Maximum VDV	Preferred VDV	Maximum VDV
Critical areas[1]	0.10	0.20	0.10	0.2
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

[1] Includes operating theatres, precision laboratories and other areas where vibration-sensitive activities may occur.

4.3.3 Buildings and structures

Appendix J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundbourne vibration* [BS7385-2:1993] and are shown below in **Table 4-10**.

Table 4-10: Transient vibration guideline values for cosmetic damage

Type of building	**Peak particle velocity (ppv) mm/s**		
	4 to 15 Hz	**15 to 40 Hz**	**40 Hz and above**
Reinforced or framed structures Industrial and heavy commercial buildings	50		
Un-reinforced or light-framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

Guidance for more sensitive structures is presented in the German standard, *DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures* (DIN 4150-3: 2016). Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard.

4.3.4 Construction Noise and Vibration Guideline

Section 7 of the CNVG provides useful guidance for safe working distances to achieve human comfort (*Assessing Vibration: a technical guideline*, (DECC, February 2006) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These have been reproduced below.

Table 4-11: Recommended safe setback distances

Plant	**Rating / description**	**Safe working distance (meters)**	
		Cosmetic damage (BS7385-2: 1993)	**Human response (DECC, 2006)**
Vibratory Roller	<50 kN (typically 1-2 tonne) <100 kN (typically 2-4 tonne) <200 kN (typically 4-6 tonne) <300 kN (typically 7-13 tonne) >300 kN (typically 13-18 tonne) >300 kN (> 18 tonne)	5 m 6 m 12 m 15 m 20 m 25 m	15 to 20 m 20 m 40 m 100 m 100 m 100 m
Small hydraulic hammer	300 kg – 5 to 12 tonne excavator	2 m	7 m
Medium hydraulic hammer	900 kg – 12 to 18 tonne excavator	7 m	23 m
Large hydraulic hammer	1600 kg – 18 to 34 tonne excavator	22 m	73 m
Vibratory pile driver	Sheet piles	2 to 20 m	20 m
Pile boring	≤800 mm	2 m(nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

4.4 Blasting

Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZEC, 1990) provides guidance for establishing goals for assessing blast air-blast overpressure and ground vibration. These are listed below in **Table 4-12** and **Table 4-13**.

Table 4-12: Airblast overpressure criteria

Airblast overpressure (dB(Lin Peak))	Allowable exceedance
115	5% of total number of blasts over a 12 month period
120	0%

Table 4-13: Peak particle velocity criteria

Peak particle velocity (mms^{-1})	Allowable exceedance
5	5% of total number of blasts over a 12 month period
10	0%

These criteria would be applicable at the residential receivers at Nurenmerenmong (R20). The air-blast overpressure limit applies within 3.5 m of these receivers. The peak particle velocity ground vibration levels apply within distances equivalent to the longest dimension of the foundations of a building or structure away from buildings and structures associated with R20.

4.5 Other policy considerations

The *Kosciuszko National Park Plan of Management* (Department of Environment and Conservation, 2006) (KNP POM) outlines tranquillity as a high priority environmental quality of the park. As relevant to this project, the plan lists potential noise impacts to visitors and wildlife as potentially arising from recreational scenic flights and road traffic.

The proposed helicopter use during construction is not classified as recreational use and as such is not covered by the Management Policies and Actions for Recreational and Charter flights (Section 8.17.1 of KNP PoM), however the principle of reducing this impact where possible is noted. Private vehicle use represents the principal generator of noise pollution along key transport corridors of the park.

5. Estimation of emissions

5.1 Noise emissions during construction

Overall sound power levels (SWLs) were predicted for each phase of construction. These phases were determined based on the indicative staging information as outlined in the EIS. The overall SWLs were estimated with reference to individual plant and equipment levels presented in national and international standards and guidelines, as well as from Jacobs measurement database. **Table 5-1** below summarises estimated overall noise emissions for the agreed assessment scenarios. Estimated emissions from blasting should rock be encountered is outlined below in **Section 5.2**.

Table 5-1: Construction stages and equipment sound power levels

Stage	Scenario	Equipment	No. of plant in 15 min period	Individual equipment maximum L_{Aeq} sound power level – dB(A)
Substation				
1 a)	Early works and site establishment	Excavator 10T Franna Truck mounted crane Delivery truck **TOTAL**	1 1 1 2	99 99 94 110 **113**
1 b)	Earthworks and vegetation clearance	Dump truck 20 – 30T Dozer D8 Excavator 40T Rockbreaker 10 – 20T[1] Vibratory roller 20 – 30T[1] **TOTAL**	3 2 2 1 2	111 111 109 118 109 **127**
1 c)	Civil and building works	Concrete truck and pump Franna Truck mounted crane Delivery truck Excavator 10T Angle grinder **TOTAL**	2 1 1 2 1 2	106 99 94 110 99 108 **116**
1 d)	High voltage electricity lines and structures	Truck mounted crane Delivery truck Angle grinder **TOTAL**	2 2 2	94 110 99 **113**
1 e)	Pre commissioning activities	Hand tools **TOTAL**	6	99 **107**
1 f)	Site clean-up and landscaping	Hand tools Franna Truck mounted crane Delivery truck **TOTAL**	6 1 2 2	99 99 94 110 **114**

Stage	Scenario	Equipment	No. of plant in 15 min period	Individual equipment maximum L_{Aeq} sound power level – dB(A)
1 g)	Tie in works	Mobile crane Hand tools **TOTAL**	1 5	94 108 **108**
Transmission line				
2 a)	Site establishment and deliveries	Excavator 10T Chainsaw Franna Truck mounted crane Delivery truck Helicopter **TOTAL**	1 1 1 1 1 1	99 99 99 94 110 125 **125**
2 b)	Access tracks	Grader Dozer D8 Excavator 40T Rockbreaker 10 – 20T[1] Vibratory roller 20 – 30T[1] **TOTAL**	2 2 2 1 2	112 111 109 118 109 **127**
2 c)	Earthworks and clearing	Dozer D8 Excavator 40T Rockbreaker 10 – 20T[1] Vibratory roller 20 – 30T[1] **TOTAL**	2 2 1 2	111 109 118 109 **126**
2 d)	Structure construction	Concrete truck and pump Franna Truck mounted crane 50 – 100T Delivery truck Angle grinder **TOTAL**	2 1 1 2 2	106 99 94 110 108 **116**
2 e)	Overhead stringing of conductors and earth wires	Truck mounted crane 50 – 100T Winch **TOTAL**	2 1	104 108 **110**
2 f)	Site clean-up and rehabilitation	Hand tools Franna Truck mounted crane Delivery truck **TOTAL**	6 1 2 2	99 99 94 110 **114**
2 g)	Commissioning	Hand tools **TOTAL**	6	99 **107**

Stage	Scenario	Equipment	No. of plant in 15 min period	Individual equipment maximum L_{Aeq} sound power level – dB(A)
Other earthworks				
3 a)	Helipad	Dozer D8	2	111
		Excavator 40T	2	109
		Rockbreaker 10 – 20T[1]	1	118
		Vibratory roller 20 – 30T[1]	2	109
		TOTAL		**126**
3 b)	Tensioning and pulling sites	Dozer D8	1	111
		Excavator 40T	1	109
		Rockbreaker 10 – 20T[1]	1	118
		Vibratory roller 20 – 30T[1]	1	109
		TOTAL		**125**

Note 1: Denotes "annoying" item of equipment as defined in the ICNG (i.e. contains characteristics such as impulsiveness, tonality etc.), and as such includes a +5 dB penalty adjustment to predictions.

5.2 Noise emissions during construction blasting activities

Depending on the underlying geology, blasting may be required to facilitate the break-up of rock within the disturbance area. Specific blasting and seismic details would need to be assessed on a site and blast specific basis. It is important that the actual buffer zone distances, associated specifically with this project, be identified and appropriate measures taken to limit overpressure and vibration to acceptable levels at identified sensitive receiver locations.

Estimated maximum instantaneous charges to meet the airblast overpressure and vibration limits listed in **Section 4.4** were determined using formula as outlined in Australian Standard 2187.2-2006, applicable to free-face blasting in 'average field conditions' which states:

Vibration formula:

$$V = 1140\left(\frac{R}{Q^{1/2}}\right)^{-1.6}$$

and

$$P = 516\left(\frac{R}{Q^{1/3}}\right)^{-1.45}$$

Overpressure formula:

Where:

P = pressure (pascals)
V = ground vibration as peak particle velocity in mm/s
R = distance between charge and point of measurement in m
Q = effective charge mass per delay or maximum instantaneous charge in kilograms

5.3 Noise emissions during operation

During operation, the key sources of noise emissions would be from infrastructure at the substation. Estimated emissions from the various sources associated with the substation are listed below in **Table 5-2**. The individual sound power levels listed were provided by TransGrid. It is noted that reactors can typically exhibit 'tonality' or an imbalanced noise spectrum, and so +5 dB(A) corrections were applied consistent with guidance presented in the NPI.

Table 5-2: Noise emissions inventory, operations

Source	Plant/equipment	Estimated individual sound power level dB(A) per unit	Indicative overall sound power level dB(A)
Substation	500 kV transformers x 3 (each transformer comprises of 3 x individual phases)	100 dB(A) per phase	110
	500 kV reactors x 2	95 dB(A)*	
	Auxiliary transformers x 3	85 dB(A)	
	Voltage transformers x 2	85 dB(A)	

Operational noise can also arise from transmission lines. Typical noise effects associated with transmission lines include:

- Corona discharge noise – Audible noise generated by corona on transmission lines has two major components: a 'wideband' crackling noise, and a 'narrowband' tonal hum (the 100 Hz tone being the most significant). The wideband noise is the dominant component of the emitted sound energy. The narrowband tonal noise component does have the potential to become significant on new conductors with a hydrophobic surface, but only under wet conditions. Effects depend on the humidity in the atmosphere surrounding the transmission lines as well as the voltage of the line. The noise is caused by a breakdown of air into charged particles due to the interaction of the associated electrical field and air particles
- Aeolian (wind-induced) noise – during periods of notable wind speed, the resistance caused by air particles flowing across the transmission line has potential to generate audible noise

In a study of corona noise from a 500 kV transmission line undertaken by SLR during damp, foggy conditions a noise level of 44 dB(A) was measured at a distance of 30 m (NGH Environmental, 2013). Noting that corona noise levels vary depending on transmission voltage, meteorological conditions and height, the study estimated a level of 35 dB(A) (i.e. equivalent to night time operational criteria at around 250 m.

5.4 Vibration-generating plant and equipment

Of the plant and equipment expected to be used during construction listed above in **Table 5-1**, the following have the potential to cause vibration-related impacts:

- Rockbreaker 10 – 20T
- Vibratory roller 20 – 30T.

The safe working distances for typical items of vibration intensive plant are listed in **Table 5-3**. The safe working distances are quoted for "cosmetic" damage (refer British Standard BS 7385), human comfort (refer to Assessing Vibration: A technical guideline (DECC, 2006)) and heritage structures (refer to German Standard DIN 4150).

Table 5-3: Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance		
		Cosmetic damage (BS 7385)	Human response (DECC, 2006)	Heritage structures (DIN 4150)
Vibratory roller	<50 kN (typically 1-2 t)	5 m	15 m to 20 m	11 m
	<100 kN (typically 2-4 t)	6 m	20 m	13 m
	<200 kN (typically 4-6 t)	12 m	40 m	15 m
	<300 kN (typically 7-13 t)	15 m	100 m	30 m
	>300 kN (typically 13-18 t)	20 m	100 m	40 m
	>300 kN (> 18 t)	25 m	100 m	50 m
Small hydraulic hammer	300 kg – 5 to 12 t excavator	2 m	7 m	5 m
Medium hydraulic hammer	900 kg – 12 to 18t excavator	7 m	23 m	15 m
Large hydraulic hammer	1600 kg – 18 to 34 t excavator	22 m	73 m	44 m

The safe working distances presented in **Table 5-3** are indicative only and will vary depending on the particular item of plant and local geotechnical conditions.

5.5 Cumulative impacts

Cumulative impacts occur when sensitive receivers are affected by noise and/or vibration impacts from more than one project or development. There is the potential for the nearby receivers (see **Section 3.1**) being affected by noise from the project, as well as from Snowy 2.0. These impacts were evaluated by adding the predicted noise levels from both projects and comparing against the assessment criteria established in **Section 4**.

Cumulative impact from other project including HumeLink and various safety improvements and intersection upgrades along the Snowy Mountains Highway Snowy Mountains Highway which may occur concurrently during construction are not expected to contribute to any cumulative noise impacts due to the lack of sensitive receivers in proximity to the project.

6. Assessment of impacts

6.1 Assessment approach

To evaluate potential construction noise impacts, the Construction Noise Estimator (CNE), (Roads and Maritime Services, 2017) was used. Noise from each stage of construction identified in **Table 5-1** was predicted at each of the nearest noise sensitive receivers identified in **Section 3.1**. Key assessment details are summarised below in **Table 6-1**.

Table 6-1: Construction noise assessment details

Model input	Details
Sources	Stages of construction as listed in.
Prediction methodology	Distance based attenuation with corrections applied to account for shielding effects (e.g. terrain).

These predictions were evaluated by comparing the results against the construction NMLs and sleep disturbance limits established in **Section 4**.

The significance of noise associated with addition traffic movements generated during construction was also evaluated using the CNE. The estimated volumes of project construction traffic (see **Section 2.4.3**) were added to the volumes along haulage roads in the Snowy 2.0 Main works EIS (EMM, 2019) to determine whether the CNVG and RNP criteria would be exceeded at nearby sensitive receivers along these routes.

The potential for vibration-related impacts was evaluated by comparing the recommended safe setback distances for relevant plant and equipment (see above in **Section 5.4**) with the locations of the identified surrounding sensitive receivers and heritage structures.

The potential for airblast overpressure and vibration impacts during blasting activities was evaluated by predicting the safe setback distances to meet ANZEC, 1990 for different maximum instantaneous charges. These setback distances were compared to the relative location of the identified nearby receivers to assess the potential for impacts.

Operational noise levels from the substation were predicted using the CONCAWE algorithm (Manning, 1981) which includes corrections for meteorological effects as well as attenuation associated with source to receiver separation, atmospheric absorption, ground effects and barriers. Levels were calculated at the surrounding receivers identified in **Section 3.1** and evaluated by comparing against the criteria established in **Section 4.2.4**. Corona noise impacts were evaluated by comparing the emissions from a similar 500 kV transmission line with the relative location of the surrounding receivers identified in **Section 3.1**.

Finally cumulative noise impacts were evaluated by adding the predicted noise levels from the project, the Snowy 2.0 project and the HumeLink project at the surrounding receivers identified in **Section 3.1**, and comparing against the assessment criteria established in **Section 4**.

6.2 Predicted construction noise impacts

Predicted noise levels from the project construction activities listed in **Table 5-1** at the identified nearby sensitive receiver locations (with results for A16 also listed) are summarised below in **Table 6-2**.

Table 6-2: Predicted worst-case $L_{eq\ 15\ min}$ dB(A) noise levels, construction

Stage	NML $L_{eq\ 15\ min}$ dB(A) for R20				NML $L_{eq\ 15\ min}$ dB(A) for A3 and A5	Predicted worst-case $L_{eq\ 15\ min}$ dB(A)			
	Day, standard hours	Day, outside standard hours	Evening	Night	When in-use	A3	A5	R20	A16
Substation									
1 a)	45	40	35	35	60	<20	<20	<20	<20
1 b)	45	40	35	35	60	<20	<20	<20	<20
1 c)	45	40	35	35	60	<20	<20	<20	<20
1 d)	45	40	35	35	60	<20	<20	<20	<20
1 e)	45	40	35	35	60	<20	<20	<20	<20
1 f)	45	40	35	35	60	<20	<20	<20	<20
1 g)	45	40	35	35	60	<20	<20	<20	<20
Transmission line									
2 a)	45	40	35	35	60	30	<20	<20	57
2 b)	45	40	35	35	60	32	<20	<20	59
2 c)	45	40	35	35	60	31	<20	<20	58
2 d)	45	40	35	35	60	21	<20	<20	48
2 e)	45	40	35	35	60	<20	<20	<20	42
2 f)	45	40	35	35	60	<20	<20	<20	46
2 g)	45	40	35	35	60	<20	<20	<20	39
Other works									
3 a)	45	40	35	35	60	<20	<20	<20	32
3 b)	45	40	35	35	60	30	<20	<20	57

As displayed, predicted worst-case noise levels during construction were predicted to remain below project NMLs at the identified receiver locations (refer to **Section 3.1**). Levels up to 59 dB(A) were predicted at receiver A16 (Snowy 2.0 works accommodation) although this is not considered to be a sensitive receiver given its association with Snowy 2.0.

Given that construction works are expected to be carried out 12 hours per day, seven days per week between the hours of 6 am and 6 pm, the potential for sleep disturbance impacts from noise during construction activities was also evaluated. As outlined above in **Section 4.1.3,** sleep disturbance impacts from construction noise sources are considered likely when $L_{A1\ (1\ minute)}$ noise levels exceed the $L_{A90\ (15\ minute)}$ by 15 dB(A) or more. Noting the adopted night time $L_{A90\ (15\ minute)}$ (i.e. RBL) or 30 dB(A), this limit equates to $L_{A1\ (1\ minute)}$ 45 dB(A) and applies at residential receiver R20. The highest predicted $L_{A1\ (1\ minute)}$ at R20 for all activities listed in **Table 5-1** was 26 dB(A), well below the sleep disturbance screening criterion. Considering this, it is unlikely that sleep disturbance impacts would occur during construction of the project.

6.3 Predicted construction traffic noise impacts

Additional traffic movements anticipated during construction of the project are outlined in **Section 2.4**. The noise and vibration assessment prepared for the *Snowy 2.0 Main Works EIS* (EMM, 2019) included traffic forecasts along key haulage routes. These forecasts included traffic expected to be from the Snowy 2.0 Main Works. Using these flows to represent existing conditions and applying the maximum expected construction traffic volumes for the project (see **Section 2.4**), **Table 6-3** summarises the results predicted at the most-affected sensitive receivers along each road utilised by project construction traffic.

Table 6-3: Predicted construction traffic noise impacts

Haulage road	Predicted change in noise levels at most-affected receiver dB(A)		Predicted noise levels at most-affected receiver dB(A)		RNP criteria [external] dB(A)	
	Day (7am to 10pm)	Night (10pm to 7am)	Day (7am to 10pm)	Night (10pm to 7am)	Day (7am to 10pm)	Night (10pm to 7am)
Snowy Mountains Highway	+1.0	**+2.6**	54.0	52.2	60	55
Link Road	+1	**+2.4**	52.7	51.2	60	55
Lobs Hole Ravine Road	+0.6	+1.4	53.2	51.8	60	55

As listed, although increases greater than 2 dB(A) at night were predicted at the most affected receivers along the Snowy Mountains Highway and Link Road, the resulting overall levels (including traffic from Snowy 2.0) do not exceed the criteria listed in the RNP. As such, it can be concluded that additional traffic movements from project construction activities are not expected to result in unacceptable changes in traffic noise levels at sensitive receivers along these key haulage routes.

As identified in **Section 2.4.3** there are a number of other roads that would be utilised by project construction vehicles. In the absence of baseline traffic flows it isn't possible to apply the same assessment approach as above. Along these routes it is anticipated that there may be receivers where traffic noise levels may increase by more than 2 dB(A) as a result of the additional traffic from the project. Still, it is not expected that these increases would result in levels exceeding the criteria listed in the RNP and as such, no actions are expected to be required.

6.4 Predicted construction vibration impacts

As identified in **Section 5.4** and **Section 5.2,** the major potential sources of vibration impacts for the project were identified as being the use hydraulic rock breakers and vibratory rollers, as well as blasting activities. Considering the setback distances for hydraulic rock breakers and vibratory rollers in **Section 5.4** and the relative location of the surrounding sensitive receivers, it was concluded that building cosmetic damage and human comfort impacts from the use of these plant and equipment would be unlikely. Care would need to be taken if works involving use hydraulic rock breakers and vibratory rollers is required within 50 m of heritage items R45 and R49, and appropriate measures have been included below in **Section 7**.

6.5 Predicted construction blasting impacts

Using the approach outlined in **Section 5.2,** the setback distances in **Figure 6-1** were estimated to provide an indication of acceptable blast sizes. This graph displays the distance that the criteria listed in **Section 4.4** would be met for different maximum instantaneous charge (MIC) kg values. Again, these values are expected to vary significantly depending on the geological conditions, local shielding and meteorological factors at the site.

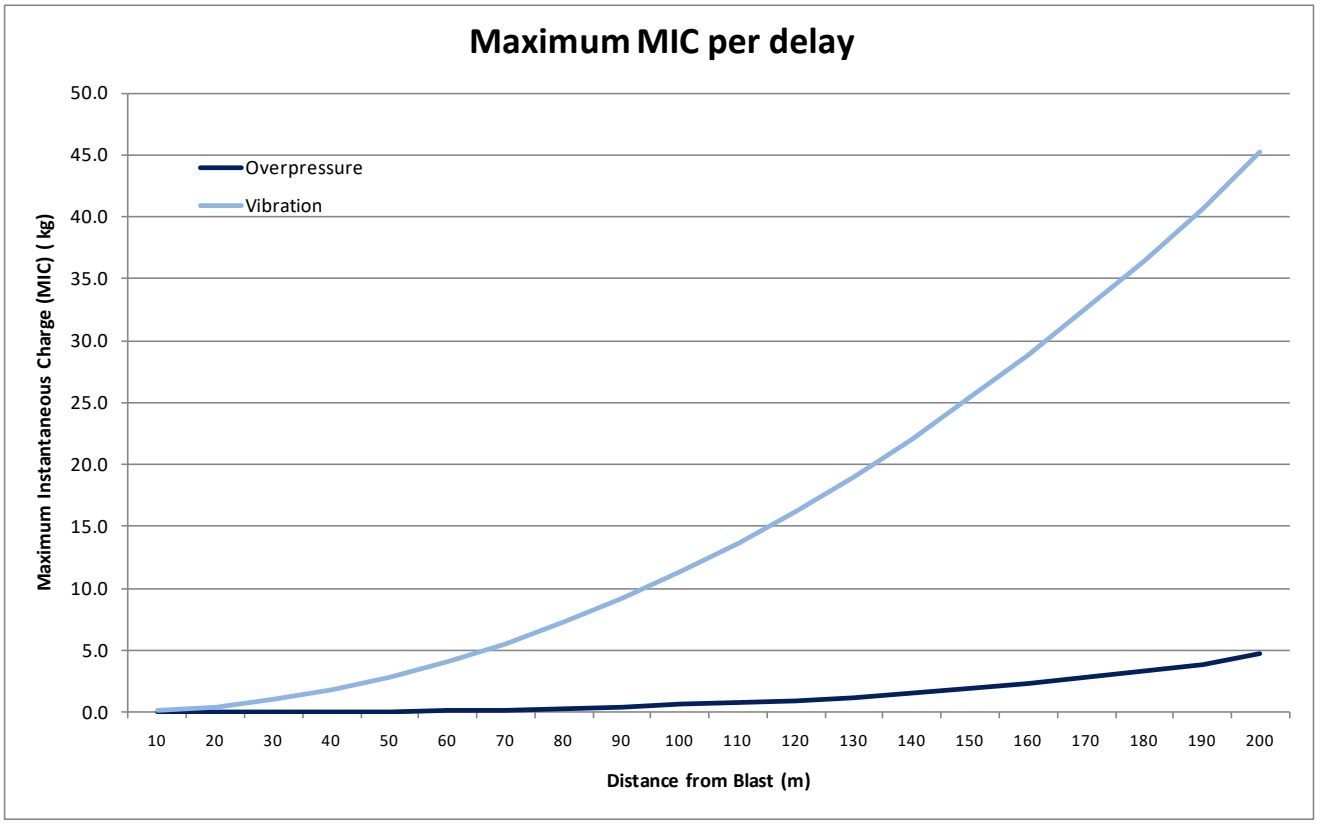


Figure 6-1: Estimated effective mass charges to minimise annoyance

Figure 6-1 shows that the risk of airblast or ground vibration impacts during blasting would be minimal for most vibration sensitive receivers. However, in view of the potential proximity of some heritage items within the Lobs Hole Ravine area, it is important that where blasting is required in this area, monitoring is undertaken at critical locations surrounding the site to confirm predicted over-pressure and vibration levels and to in turn modify the blast design and buffer zones accordingly around the site. Measures to manage potential risks associated with blasting activities are included below in **Section 7**.

6.6 Predicted operation noise impacts

6.6.1 Substation

Predicted noise levels from operation of the substation are summarised below in **Table 6-4**.

Table 6-4: Predicted operational noise levels, substation

Project operational noise criteria $L_{eq\ 15\ min}$ dB(A) for R20			**Project operational noise criteria $L_{eq\ 15\ min}$ dB(A) for A3 and A5**	**Predicted worst-case $L_{eq\ 15\ min}$ dB(A)**			
Day	**Evening**	**Night**	**When in-use**	**A3**	**A5**	**R20**	**A16**
40	35	35	48	<20	<20	<20	<20

Operational noise levels were predicted to be less than 20 dB(A) at the identified receiver locations. This is well below the established operational noise criteria, as well as the operational sleep disturbance screening criterion of $L_{Aeq,15min}$ 40 dB(A) at receiver R20. Considering this, noise impacts from the operation of the substation is not anticipated.

6.6.2 Transmission line

As outlined above in **Section 5.3**, a study of corona noise discharge from a 500 kV transmission line under conducive meteorological conditions study estimated a level of 35 dB(A) (i.e. equivalent to night time operational criteria at around 250 m. Given that all of the sensitive receiver locations identified in **Section 3.1** are more than 1 km from the transmission line, corona noise impacts are not expected and were not considered further in the assessment. Further, it is expected that the transmission line would be designed and constructed to ensure that corona discharge complies with relevant NPI criteria.

6.7 Predicted cumulative impacts

Worst-case cumulative noise levels at the receivers identified in **Section 3.1** are listed below in **Table 6-5**.

Table 6-5: Worst-case cumulative construction noise review

Predicted worst-case $L_{eq\ 15\ min}$ dB(A), project contribution				**Predicted worst-case $L_{eq\ 15\ min}$ dB(A), Snowy 2.0 contribution**				**Predicted worst-case $L_{eq\ 15\ min}$ dB(A), cumulative levels**			
A3	**A5**	**R20**	**A16**	**A3**	**A5**	**R20**	**A16**	**A3**	**A5**	**R20**	**A16**
32	<20	<20	59	38	34	<30	58	39	34	<30	62

Receiver R20: Day time (standard hours) NML = $L_{eq\ 15\ min}$ 45 dB(A); Day time (outside standard hours) NML = $L_{eq\ 15\ min}$ 40 dB(A); evening NML = $L_{eq\ 15\ min}$ 35 dB(A); and night time NML = $L_{eq\ 15\ min}$ 35 dB(A); Receivers A3 and A5: NML when in-use = $L_{eq\ 15\ min}$ 60 dB(A)

At the nearest residential receiver R20, worst-case cumulative noise levels from construction activities associated with the project and Snowy 2.0 were predicted to remain below NMLs for all periods. At recreational receivers A3 and A5, cumulative levels up to 39 dB(A) were predicted, well below the 60 dB(A) NML. Levels up to 62 dB(A) were predicted at receiver A16. It is noted that construction of the HumeLink project may also be underway at the same time, although the environmental impact assessment has not yet been completed for this project so its potential noise impacts are not known. Where construction activities took place at the same time, cumulative noise levels could be as high as 3 dB(A) above the contribution from the noisier project.

Considering the results above, it was concluded that cumulative construction noise impacts from the project and Snowy 2.0 would not result in unacceptable noise levels at the nearest receivers around the project.

As such, it was determined that the potential for noise and vibration impacts during the project is limited. Measures to minimise noise and vibration from the project in line with best practice were developed. These are presented below in **Section 7**.

7. Mitigation and management

Standard techniques for controlling noise impacts during construction are presented in the ICNG. As listed in Table 7-1, this control should be implemented as reasonable and feasible.

Table 7-1: Proposed construction noise management, standard measures

Measure	Details	Timing
Standard best practice ICNG measures	Implementation of relevant standard measures as outlined in Section 6 of the ICNG.	Prior to and during Construction

Assessing Vibration: a technical guideline, (DECC, February 2006) provides general guidance for limiting vibration impacts during construction. Relevant recommendations have been reproduced below and should be considered as appropriate.

Table 7-2: Proposed vibration management, standard measures

Measure	Details	Timing
Controlling vibration levels from the source	Do not conduct vibration intensive works within the recommended safe setback distances. Avoid the use of vibration intensive plant within the nominated human comfort distances.	During construction

Based on the outcomes of the assessment, the following additional measures were also recommended:

Table 7-3: Proposed vibration management, additional measures

Measure	Details	Timing
Controlling vibration levels from the source	• Particular care should be taken when undertaking vibration-intensive activities (e.g. use of hydraulic rock breakers and vibratory rollers, and blasting) within distances approaching the recommended safe setback distances around heritage items R45 and R49. Where maintaining these setback distances isn't possible, a suitably qualified person should be present or monitoring should be undertaken during the works to suspend activities in the instance of any issues • A detailed blast plan would be prepared by the blasting contractor prior to each blast to mitigate the potential for the recommended safe setback distances being encroached	During construction

No noise impacts were determined during operation of the project and therefore no measures have been recommended.

8. Conclusion

An assessment was completed to evaluate the potential for noise and vibration impacts associated with the construction and operation of the project. Potential noise, vibration and airblast overpressure levels at identified surrounding receiver locations were assessed quantitatively using various predictive methods. Results were evaluated by comparing the predictions against limits established based on guidance from relevant NSW, National and international standards and guidelines.

Using this approach, the following potential for impacts were determined:

- Predicted worst-case noise levels during construction were predicted to remain below project NMLs at the identified receiver locations. Levels up to 59 dB(A) were predicted at receiver A16 (Snowy 2.0 works accommodation) although this is not considered to be a sensitive receiver given its association with Snowy 2.0
- Sleep disturbance impacts were not predicted during construction or operation
- Additional traffic movements from project construction activities are not expected to result in unacceptable changes in traffic noise levels at sensitive receivers along the intended haulage routes
- Building cosmetic damage and human comfort impacts from vibration generated from the use of hydraulic rock breakers and vibratory rollers at identified receiver locations would be unlikely. Care would need to be taken if this equipment was required within 50 m of heritage items R45 and R49
- Airblast overpressure and vibration impacts from blasting activities were not anticipated at the identified sensitive receiver locations. Again, care would be required to avoid damage to R45 and R49 if blasting was required around these locations
- Operational noise from substation and transmission lines would not result in unacceptable impacts at the identified sensitive receivers
- The potential for cumulative noise impacts during the construction of the project and Snowy 2.0 was also determined to be negligible with cumulative levels remaining below NMLs at the identified sensitive receiver locations.

Considering these outcomes, it was determined that the potential for noise and vibration impacts during the project was limited. Still, measures to minimise construction noise in line with best practice were recommended as required, with specific measures recommended regarding vibration. No noise impacts were determined during operations and so no measures were recommended.

9. References

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