Shoalhaven Hydro Expansion Project - Main Works

Environmental Impact Statement

SSI-10033

Origin Energy Eraring Pty Ltd

November 2022

Jacobs

Challenging today.
Reinventing tomorrow.

Shoalhaven Hydro Expansion Project - Main Works

Environmental Impact Statement

Acknowledgment of Country

Jacobs proudly acknowledges Aboriginal and Torrens Strait Islander peoples as the Traditional Owners of the lands upon which each Jacobs office is located and those upon which we operate. We recognise that Traditional Owners have cared for and protected these lands for thousands of generations. Traditional Owners always have and always will have strong cultural, social and spiritual connections to the lands, skies, and waters. Jacobs respectfully recognises the Ancestors and Elders, past, present, and future. We acknowledge that sovereignty was never ceded and we are committed to working towards reconciliation.

Jacobs Group (Australia) Pty Limited
Level 7, 177 Pacific Highway
North Sydney, NSW 2060
PO Box 632
North Sydney, NSW 2059
Australia

T +61 2 9928 2100
F +61 2 9928 2444
www.jacobs.com

EIS declaration

Project details	
Project name	Shoalhaven Hydro Expansion Project – Main Works
Application number	SSI-10033
Address of the land in respect of which the development application is made	The development is to be carried out on land in the suburbs of Kangaroo Valley, Barrengarry and Fitzroy Falls. In accordance with Schedule 5 Clause 13 of the State Environmental Planning Policy (Planning Systems) 2021.
Proponent details	
Proponent name	Origin Energy Eraring Pty Limited
Proponent address	Level 28, 180 Ann Street, Brisbane, QLD 4000
Details of person by whom this EIS was prepared	
Name	Thomas Muddle
Address	Jacobs Group (Australia) Pty Ltd 7/177 Pacific Highway, North Sydney, NSW 2060
Professional qualifications	Bachelor of Environmental Science and Graduate Diploma of Urban and Regional Planning
Declaration by registered environmental assessment practitioner	
Name	Thomas Muddle
Registration Number	R80032
Organisation registered with	EIANZ
Declaration	The undersigned declares that this EIS: ▪ Has been prepared in accordance with Schedule 2 of the Environmental Planning and Assessment Regulation 2021 ▪ Contains all available information relevant to the environmental assessment of the development, activity or infrastructure to which the EIS relates ▪ Does not contain information that is false or misleading ▪ Addresses the Planning Secretary's environmental assessment requirements (SEARs) for the project ▪ Identifies and addresses the relevant statutory requirements for the project, including any relevant matters for consideration in environmental planning instruments ▪ Has been prepared having regard to the Department's State Significant Infrastructure Guidelines - Preparing an Environmental Impact Statement ▪ Contains a simple and easy to understand summary of the project as a whole, having regard to the economic, environmental and social impacts of the project and the principles of ecologically sustainable development ▪ Contains a consolidated description of the project in a single chapter of the EIS ▪ Contains an accurate summary of the findings of any community engagement ▪ Contains an accurate summary of the detailed technical assessment of the impacts of the Project as a whole.
Signature	
Date	28 October 2022

Executive summary

Overview

Origin Energy Eraring Pty Limited (Origin) operates the Shoalhaven Pumped Hydro Storage Scheme (the Existing Scheme) which includes the Kangaroo Valley Power Station and Bendeela Power Station. The Existing Scheme forms a component of the larger Shoalhaven Water Supply and Generation Scheme constructed in the 1970's to augment Sydney's water supply by facilitating water transfers from the Shoalhaven catchment to Warragamba Dam whilst also providing peak load power generation.

The Existing Scheme includes the following major assets:

- The Tallawa Dam on the junction of Shoalhaven and Kangaroo Rivers creating Lake Yarrunga
- Bendeela Pumping and Power Station
- Bendeela Pipeline
- Bendeela Pondage
- Kangaroo Valley Pumping and power station
- Kangaroo Valley Switching Station and 330KV transmission line forming part of the National Electricity Market
- Kangaroo Tunnel and Shaft
- Kangaroo Pipeline
- Fitzroy Canal
- Fitzroy Falls Dam on Yarrunga Creek creating the Fitzroy Falls Reservoir.

The Existing Scheme was planned to be constructed in two phases and the construction of the first phase included the provision for expansion including the capacity of the Fitzroy Canal, a switchyard located near the Kangaroo Valley Power Station and transmission lines, and the earthworks for duplicating the Kangaroo Pipeline. The second phase was never progressed.

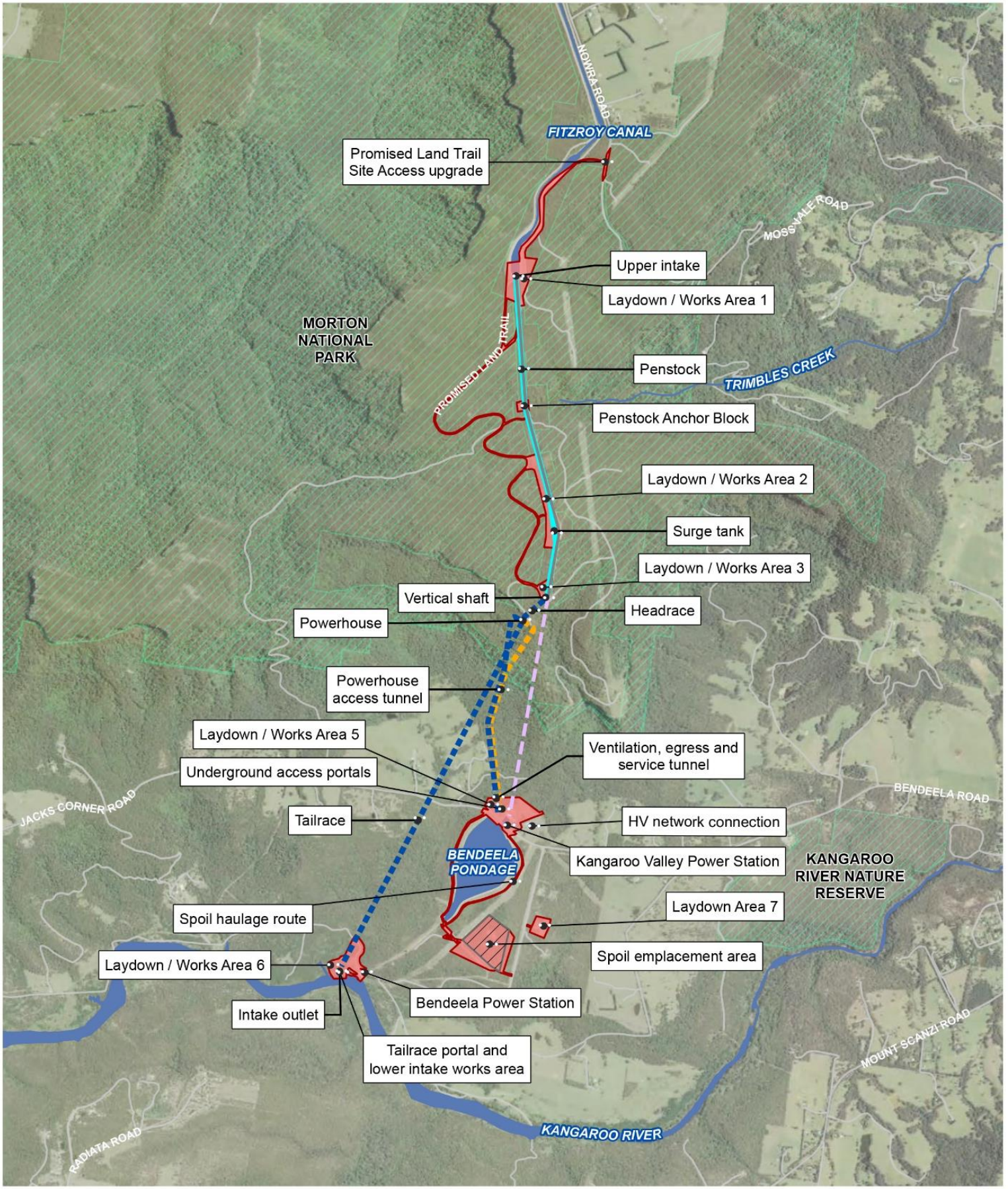
Origin is now proposing to construct and operate the Shoalhaven Hydro Expansion Project (the Project) to almost double the electricity generation capacity of the Existing Scheme, by adding approximately 235 megawatts (MW) of generation capacity. The indicative Project layout is illustrated in **Figure E1**.

The intent of the Project is to address the broadly identified need for long duration energy storage required to facilitate the decarbonisation of the Australian electricity system by facilitating greater penetration of variable energy generation such as wind and solar as recognised in strategies and policies at all levels of government. The development of the Project seeks to maximise the energy generation benefits of the significant infrastructure established through the construction of Shoalhaven Water Supply and Generation Scheme while minimising impacts through targeting areas of prior disturbance and operating the Project within the limits of the Existing Scheme.

Site context

The construction of the Existing Scheme was a major undertaking leading to the current landform and environmental context in which the Project would be established. Key disturbance areas associated with the Existing Scheme that would be prioritised for use in the Project construction are illustrated in **Figure E2** and include the:

- Promised Land Trail access from Nowra Road through Morton National Park requiring re-instatement for use in accessing the Upper Scheme
- Fitzroy Canal intake structure
- Full length of Penstock alignment including Trimbles Creek crossing
- Regrown construction works areas
- Cleared embankment cutting around the Kangaroo Valley Power Station
- Partially cleared and excavated area for planned spoil emplacement.



Legend

- Points of interest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- NPWS Reserve
- Waterbody

0 1 2 km

1:40,000 at A4

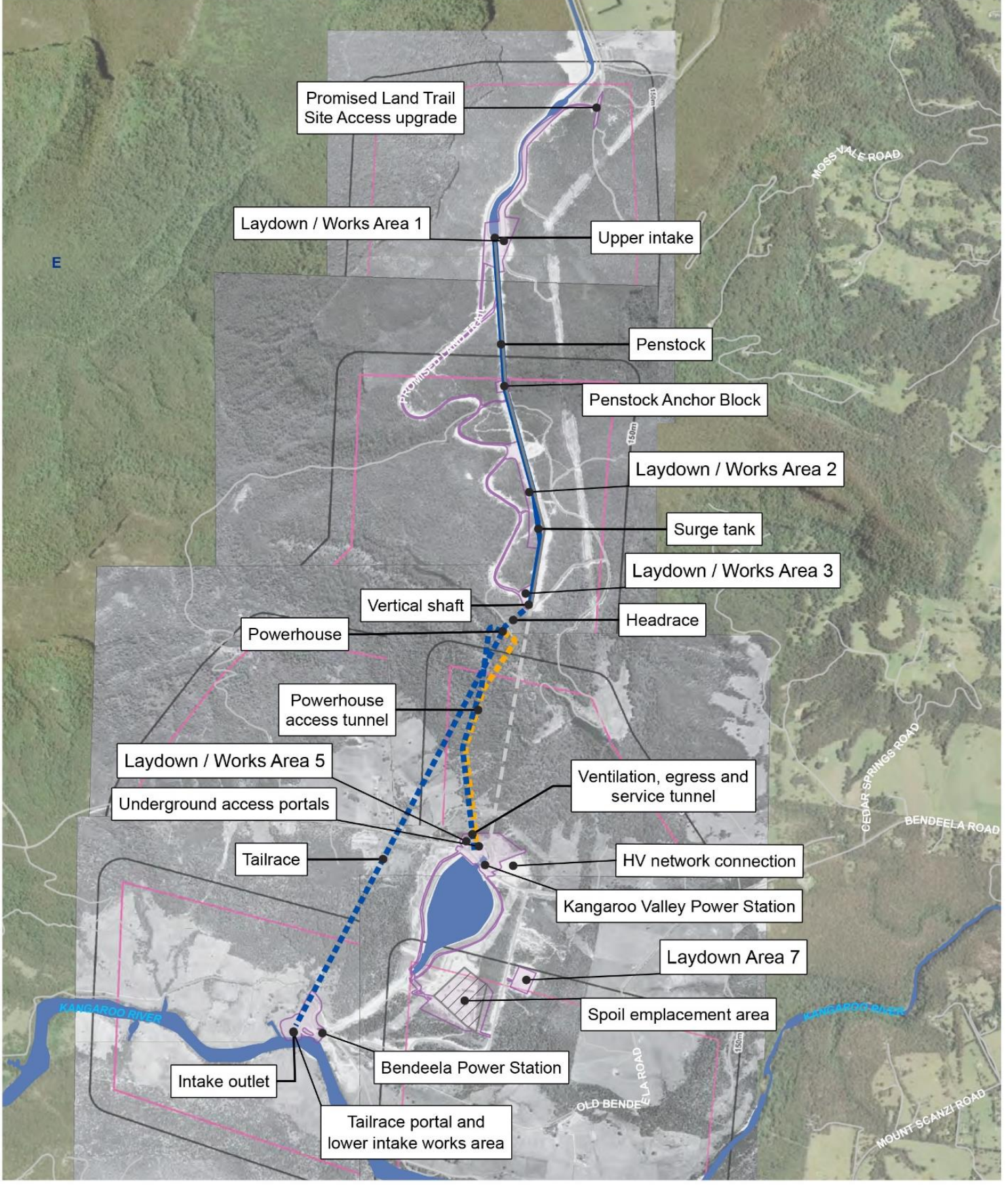
GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure E1 Indicative Project layout

Date: 12/09/2022 Path: \\ausydvs01\GIS\Proj\NSW_IS302600_ShoalhavenEIS\Apps\IS302600_GENERAL.aprx
Created by : NT | QA by : CC



Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Road
- Waterbody

0 0.5 1 km

1:35,000 at A4

GDA2020 MGA Zone 56

N

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure E2 Historical context (1974)

Date: 15/07/2022 Path: \\ausyd0vs01\GISProj\NSW_IS302600_Shoalhaven\IS\Apps\IS302600_Heritage.aprx
Created by : NT | QA by : CC

Project need

The National Energy Market (NEM) requires stable, dispatchable generation to balance network requirements as renewable generation fluctuates depending on the predominate solar and wind resources available at the time. The Australian Energy Market Operator (AEMO) 2022 Integrated System Plan (ISP) identified the increasing penetration of variable generation sources and the need for significant power system engineering investment across both transmission capability and energy storage. AEMO (2022) identifies that these investments including long duration storage in the form of pumped hydro will be critical to satisfy consumer demand for electricity at varying times of the day, and through peak demand periods of summer and winter.

Project opportunity

The Project opportunity has arisen from:

- The increasing prevalence of variable renewable energy (VRE) generation requiring additional energy storage projects which do not rely on the sun or wind
- Existing Scheme infrastructure appropriately sized and constructed in anticipation of future expansion including existing water storages with suitable elevation differences
- Existing water allocation that can accommodate the Project without the need for changes in current upper and lower storage minimum and maximum operating levels
- Available capacity within the existing electricity transmission network
- Future energy contracting via the NSW Government Long Term Energy Service Agreements.

Origin believes these opportunities support the business case for the Project which can be constructed and operated to support the critical needs of the NEM and in a manner such that the long term environmental and social impacts are largely consistent with those associated with the Existing Scheme.

Project objectives

Considering the Project need and opportunity, the objectives of the Project are to:

- Enable storage of VRE, predominantly solar and wind energy, to enable use during periods of higher energy demand
- Meet long duration storage needs for the electricity grid with the Project having a generating period much longer than current battery technologies
- Provide reliable and sustainable energy supply for the electricity users of NSW.

Project summary

The Project involves the construction and operation of a new pumped hydroelectric power station involving water transfer between two existing reservoirs comprising of the Fitzroy Falls Reservoir and Lake Yarrunga. The Project would draw on Origin's existing water allocations to pump water up approximately 612 metres (m) from Lake Yarrunga consuming electricity when demand is low. Electricity would then be generated through the return of water from Fitzroy Falls Reservoir to Lake Yarrunga when demand for electricity increases.

The Project is expected to have a nominal capacity of approximately 235 MW and be capable of generation for over 13 hours in parallel with the Existing Scheme operation or 24 hours where the Existing Scheme is not operating or if directed by AEMO in response to critical needs of the NEM.

The Project would consist of the construction and operation of:

- Upper scheme components (Upper Scheme) including:
    - Connection to existing upper intake control structure at the southern end of the Fitzroy Canal
    - A surface penstock (water transfer pipeline and associated infrastructure) from the existing Fitzroy Canal control structure to the vicinity of the Existing Scheme surge tank
    - A new surge tank adjacent to the Existing Scheme surge tank
    - A further section of surface penstock, adjacent to the Existing Scheme, from the new surge tank to the high pressure vertical shaft

- Underground works (Underground Works) including:
  - Vertical shaft and headrace tunnel connecting to the southern end of Upper Scheme surface penstock to an underground power station
  - An underground power station cavern housing a transformer, reversible motor generator and pump turbine capable of supplying a nominal 235 MW of hydroelectric power
  - Associated access tunnel and multipurpose (egress, ventilation and services) tunnel with an entrance in the vicinity of the existing Kangaroo Valley Power Station
  - A tailrace tunnel, including an underground surge chamber located just downstream of the underground power station, terminating west of the existing Bendeela Power Station on Lake Yarrunga
- Lower scheme surface components (Lower Scheme) including:
  - Lower intake /outlet structure west of the Bendeela Power Station connected to the tailrace tunnel
  - Spoil emplacement facility east of Bendeela Pondage
  - High voltage network connection to existing Kangaroo Valley substation
  - Operational surface infrastructure including administration building, water treatment infrastructure and ventilation building.

The Project has an estimated construction period of five years and design life of 100 years. Construction would employ an average of approximately 250 people while ongoing operational jobs are estimated as three with routine maintenance generating additional contract work over the life of the Project.

Other options considered

Various options to realise the identified opportunity and meet the Project objectives have been considered and will continue through the design and construction contractor selection process and detailed design. Option consideration has been framed by the capacity of the existing infrastructure, in particular the water storages and Fitzroy Canal and transmission network and has included:

- Options more closely aligned with the original second phase including:
  - Installation of 80MW of additional capacity though installation of additional pump / turbine in Kangaroo Power Station and necessitating a new inlet branched off the existing pipeline
  - Installation of 160MW of additional capacity through expansion of the Kangaroo Valley Power Station and requiring duplication of Kangaroo Pipeline, Surge Tank, Tunnel and Shaft
- Establishment of a new surface power station in the vicinity of the Bendeela power station requiring a new inlet/discharge from Fitzroy Canal and new high-pressure penstock, shaft and tunnel to a 200 - 300 MW turbine / pump motor generator at Bendeela Power Station and discharge into Lake Yarrunga
- Establishment of a new underground power station as per the proposed Project considering various locations for the underground power station cavern and resulting changes to access arrangements
- A completely greenfield option with larger capacity but necessitating new transmission connection and reservoir.

The selection of the Project option was on the basis of achieving the Project objectives while balancing the Project opportunities with minimising impacts. The Project was identified as most favourable from hydraulic design, access, constructability and environment impact and approval perspectives while maximising generation capacity.

Impacts

This environmental impact assessment (EIA) is based on a concept design of the Project that Origin has developed over a number of years. Impacts have been avoided or minimised through the concept design development process by way of the following design elements:

- Using the Existing Scheme reservoirs avoiding need for new water storages
- Designing the Project to operate within Origin's water licence conditions. Meaning that the water transfers are within those of the Existing Scheme design and no changes are required to the area of inundation and minimum water level.

- Prioritising the use of existing disturbance areas associated with the Existing Scheme, including use of existing established surface penstock alignment, much of original spoil disposal area and cleared areas adjacent to Bendeela and Kangaroo Valley Power Stations
- Limiting the works in Morton National Park to essential Promised Land Trail upgrades to support construction access requirements
- Narrowing of site access to the Promised Land Trail through an area of identified serious and irreversible impact (SAII) habitat
- Utilisating underground infrastructure to avoid further surface impacts.

Ongoing efforts to avoid and minimise impacts will continue in the detailed design and construction planning and include:

- Refinement of clearing requirements
- Development of detailed erosion and sediment control planning aligned to final disturbance footprint
- Exploration of opportunities to maximise the reuse of water and spoil.

The construction of Project would have a range of impacts, particularly related to traffic, noise and vibration, social, hydrology, biodiversity and Aboriginal heritage. The potential for other impacts related to water quality, air quality, land, waste public safety and visual are identified and require careful management to avoid and otherwise mitigate impacts. Operational impacts are limited and relate to rate of water transfers with other impacts largely consistent with those of the existing scheme. The key impacts of the Project would include:

Biodiversity

The Project infrastructure has been intentionally placed adjacent to the Original Scheme and access will be along previously cleared tracks, within minimal clearing of regrowth required to upgrade. Additionally, previously cleared land (with current regrowth) will be used for spoil emplacement area, and a significant portion of the Project will be placed underground and involve tunnelling. As such, the Project would result in minimal clearing of native vegetation of up to 29.5 ha, of which 25 percent (%) is regrowth vegetation previously disturbed. This is required to allow the construction of, and ongoing operational maintenance of the asset for the life of the Project.

The Project layout has been frequently adjusted since the preliminary design stages in 2018 to account for biodiversity values identified during the survey program. Importantly, the impacts to Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion critically endangered ecological community (CEEC) have been significantly reduced at the intersection of Promised Lands Trail and Nowra/Moss Vale Rd. The original design for more significant clearing at this location for truck access and laydowns has been refined to only 0.23 hectares (ha) of vegetation impacts (along road edges).

The Project would result in the direct removal of about 29.5 ha of native vegetation which includes about 0.23 ha of a threatened ecological community (TEC) which is listed under both the *Biodiversity Conservation Act 2018* (BC Act) and *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The removal of this vegetation would also have direct impacts on 10 threatened species. Where impacts on biodiversity cannot be avoided or minimised, appropriate offsets would be provided

An Assessment of Significance has been conducted for Commonwealth listed threatened ecological communities (TECs) and species that have been positively identified within the Project area or that are considered to have a moderate or high likelihood of occurring in the Project area due to the presence of suitable habitat. The outcomes of the assessment conclude that there will be no significant impact on matters of National environmental significance (MNES).

Key Fish Habitat (KFH) is mapped in the Project area and comprises of Fitzroy Canal, Kings Creek, Bendeela Pondage and Kangaroo River including Lake Yarrunga. All mapped KFH are already affected by the Existing Scheme and the Project operate within the limits of the existing scheme and adopt mitigation measures to minimise further impacts or habitat degradation.

The Project has potential to result in indirect and prescribed biodiversity impacts, namely potential transportation of weeds, potential impacts to water quality at receiving waterways and potential increase in vehicle strikes on resident fauna during construction. With clearing limited to edges of existing disturbance, long term edge effects would be similar to existing.

A strategy to meet the offset obligation will be developed post-approval and consider a range of options, including direct payment into the Biodiversity Conservation Trust Fund and seeking like-for like credits from the offset market.

Aboriginal heritage

No previously identified Aboriginal sites are listed on the Aboriginal heritage information management system as located within the Project area. Archaeological survey resulted in the identification of the Promised Land Trail ST01 (Aboriginal Heritage Information Management System (AHIMS) ID 52-4-0730) outside the Project area and within the Morton National Park. A potential archaeological deposit within the Project area (Bendeela Power Station Potential Archaeological Deposits (PAD)) was confirm as an artifact scatter and named Bendeela AS01 (AHIMS ID 52-4-0729) following Archaeological test excavations.

Discussions with Aboriginal people and knowledge holders have identified various key elements that makeup cultural heritage values within the landscape of the Project area. In addition to the above two specific locations known to have Aboriginal cultural values, the entirety of the Kangaroo Valley has cultural significance to Aboriginal people who have inhabited the region for thousands of years. Based on the aesthetic, historic and social context of the identified Aboriginal objects, the Project area is considered to be of moderate cultural heritage significance. The Aboriginal objects present within the Project area are tangible expressions of Aboriginal life prior to contact and have potential to connect the contemporary community with traditional practices that have been disrupted by colonial activity.

Promised Land Trail ST01 would be avoided while Bendeela Hydro AS01 would be subject to harm by the lower intake construction that will result in a partial loss of value.

Mitigation measures developed in consultation with registered Aboriginal parties will be implemented to manage potential Aboriginal heritage impacts including salvage excavations prior to any impacts to Bendeela Hydro AS01.

Historical heritage

No listed heritage items are located within or near the Project area. There would be no impacts to World, National, Commonwealth, State or locally listed heritage as a result of the construction or operation of the Project.

Construction activities that involve ground disturbance within the maximum Project area have the potential to impact on unexpected remains associated with the former Bendeela Public School (Portion 206) site. However, this is considered unlikely as the potential archaeological assessment has concluded that there is little to no archaeological potential within the site.

Hampden bridge which is listed on the state heritage register would be traversed by some construction generated traffic. The obeyance of existing road and heavy vehicle restrictions on the bridge would avoid impacts to this item.

Land

The potential for land related impacts has considered contamination and use of hazardous substances, soils, land capability, geotechnical stability, spoil management and geochemistry and potential for land use conflicts.

Project land impacts are summarised as follows:

- Contamination: The Project area is not identified as a contaminated site and no evidence has been identified that would indicate the site is contaminated. Given the sensitivity of the Project area, careful management of hazardous substances is proposed
- Soils and land capability: The Project area is mapped as occurring in land with moderate to extreme limitations for most land uses. No potential acid soils or naturally occurring asbestos are likely to be present. Soil properties have been considered in the development of indicative erosion and sediment controls planning and a rehabilitation strategy developed to mitigate potential for further degradation of land use capability.

- Geotechnical stability: The geotechnical model for the Project has been developed and would be refined throughout the detailed design and construction as actual ground conditions are confirmed. The specific risk to most buildings and structures due to ground movement is considered negligible, with superficial damage to buildings unlikely. Typical engineering process for tunnelling Projects are available and considered suitable for managing all ground conditions likely to be encountered
- Spoil management: The Project is estimated to generate 420,000 cubic m of spoil, some of which may be potentially acid forming (PAF). Surplus spoil would require emplacement on site and a spoil management strategy has been developed to manage land and water risks
- Land use conflicts: Construction of the Project is identified as introducing land use conflicts associated with temporary restrictions on access to through construction works areas, traffic and amenity impacts as assessed in the EIS. The use of areas established for the expansion of the Existing Scheme introduces complications for ongoing maintenance of the Existing Scheme which are subject to consultation with WaterNSW. The Project does not introduce new land use conflicts given the presence of the Existing Scheme, other than the impact to the Existing Scheme.

Surface water

The Project would be constructed within and reporting to the Shoalhaven Special Area which forms a key component of the Sydney Drinking Water catchment. Once operational, the Project would transfer water between two existing WaterNSW reservoirs already connected and subject to water transfers by the Existing Scheme.

Without mitigation Project risks to water quality, hydrology and geomorphology could include standard construction risks of erosion and sedimentation of waterways, as well as acid run-off from potential acid generating material excavation and emplacement, tunnel process water discharge, dewatering and increased risk of bank erosion in existing reservoirs.

With the implementation of proposed mitigation measures it was determined that risk of these impacts occurring were low and the Project would be designed, constructed and operated to reduce this risk. As such, the project is expected to have a neutral effect on water quality.

Groundwater

Two main groundwater systems have been identified associated with the Project, these being an upper stratified groundwater system with limited vertical connectivity, and a deeper regional groundwater system. The upper stratified groundwater system is present beneath the elevated plateaus and generally discharges to the escarpments. The regional groundwater system is present beneath the lower study area and is also inferred to extend, at depth, beneath the upper stratified groundwater system.

Groundwater quality is expected to range from relatively fresh at shallow depth and in the vicinity of Lake Yarrunga, to more brackish at depth in the vicinity of the main cavern.

During construction, drawdown related to groundwater inflow is not expected to impact on any groundwater dependent ecosystems or other groundwater users; however, dewatering of the tailrace box-cut excavation is expected to be approximately 88 % sourced from surface water from Lake Yarrunga. A minor baseflow reduction from the lower reaches of Kings Creek is also possible.

During operation, magnitude of predicted drawdown associated with the drained power station cavern is not expected to detrimentally affect the supply capacity from either water supply work.

The Project is also assessed as having potential to result in acid rock drainage adjacent to the tailrace excavation and above drained underground structures. Any identified acid rock drainage in the vicinity of the drained structures will ultimately be captured in the dewatering sump located at the lowest level in the underground works. Captured water will be treated appropriately prior to disposal.

No significant cumulative impacts with respect to groundwater are identified for the Project.

Traffic and transport

The construction of the Project will require the mobilisation of an average workforce of 250 people across variable shifts and require the delivery of machinery and materials by heavy vehicles including approximately 450 oversize or over mass deliveries. Localised spoil haulage is also required. Access to the project would be via a network of local council and state managed roads including Moss Vale Road (B73), Nowra Road (B73), Promised Land Trail, Bendeela Road, Jacks Corner Road and Lower Bendeela Road.

Origin is seeking to prioritise use of busses from local population centres to minimise light vehicle movements. Heavy vehicle movements would be scheduled to avoid parking on local roads and to the be safely accommodated in intersections.

The results of the traffic and transport impact assessment indicate that the construction and operation of the project is expected to have a negligible impact on the performance of key intersections in the study area, while the intersection of Promised Land Trail with Moss Vale Road may require safety improvements including short extension of the lower speed zone and channelised turn movement. The potential impacts to public transport, pedestrians and cyclists, road safety and parking during the construction and operation of the project are also expected to be manageable.

A Construction Traffic Management Plan (CTMP) for the Project would be prepared in consultation with Transport for NSW (TfNSW) and WaterNSW to minimise the potential impacts of the project during construction. Relevant traffic safety measures included in the CTMP would be traffic control and signage, driver conduct, safety protocols and management of Oversized and / or over mass vehicle vehicles.

Noise and vibration

The Project would be constructed and operated in a quiet rural setting adjacent to the Existing Scheme. The construction Program is approximately 5 years and to achieve this Program, underground construction and essential associated surface support activities would be required to occur 24 hours per day and 7 days per week. Other key noise risks include potential need or benefits for underground blasting and limited surface blasting to be undertaken in less sensitive and daytime periods only.

A small number of receivers were predicted to experience noise levels above applicable noise management levels (NMLs). These exceedances are generally expected to be noticeable or clearly audible although over longer durations, rather than being highly intrusive. The duration of exceedances would range from up to 12 weeks for one receptor in proximity to the Upper Scheme works during the Promised Land Trail access upgrade, 2 to 3 years for works associated with 24/7 underground works. Intermittent exceedances over a short duration are also predicted in relation to the delivery of OSOM plant and equipment.

Noise from operations during neutral and adverse, noise-enhancing meteorological conditions were predicted to be below the Project operational noise limits for all periods of the day, evening and night at all surrounding sensitive receivers.

Ground-borne noise from tunnelling if adopting a road header methodology was predicted to slightly exceed the night-time limit of 35 dB(A) at one receiver. Predicted ground vibration levels were also estimated to marginally exceed the criteria for human comfort during the day and night-time periods at two receivers. Detailed design may avoid these exceedances or otherwise quantify them such that appropriate mitigation measures can be established.

The low background traffic levels and close proximity of receptors to roads means increased traffic noise may also be noticeable at nearby receivers along key Project travel roads during construction.

Building cosmetic damage and human response vibration-related impacts for the use of plant and equipment during surface construction activities was not determined to present a risk at surrounding sensitive receivers.

Ground vibration and air blast overpressure are identified as Project risks and require detailed blast planning to comply with the applicable criteria at all receivers and be protective of existing Water NSW infrastructure. Vibration levels from underground blasting activities associated with the underground power station cavern construction at surrounding sensitive receivers were predicted to remain below the adopted criterion. Detailed blast planning is recommended for management of underground blasting particularly should it be required as part of tunnelling works.

The noise and vibration impact assessment has been undertaken based on a conceptual model. Actual impacts and necessary mitigation measures would be confirmed as part of detailed design and documented in a construction noise and vibration management plan.

Air quality

Air quality issues can arise when emissions from an industry or activity lead to deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the Project and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air from the Project could occur from a variety of activities including material handling, material transport, processing and wind erosion from exposed areas. These emissions would occur during the construction phase of the Project. Construction related emissions will most significantly include dust, also referred to as particulate matter.

Construction dust emissions are not expected to cause adverse air quality impacts at nearby sensitive receptors based on modelling which showed compliance with the NSW Environment Protection Authority (EPA) assessment criteria. The Project will have other emission sources that may influence local air quality, particularly plant and equipment engine exhausts. Consideration of these sources and the proximity of sensitive receivers led to the determination there will be no significant air emissions sources during operation of the Project.

Greenhouse gas (GHG)

A GHG inventory (sometimes referred to as a carbon footprint) is an assessment of the life cycle GHG emissions associated with a product, service or event. All GHGs (such as methane and nitrous oxide, as well as carbon dioxide) are aggregated and reported as a single number of 'carbon dioxide equivalents' (CO_2-e). As increasing concentrations of GHGs in the atmosphere are known to contribute to global warming, being able to reduce these emissions across the life cycle will reduce the potential impact of the Project on global warming.

For the purposes of this EIS, GHG emissions have been determined for all operating and construction scenarios. The total emissions related to construction of the Project would be about 97,500 tCO_2-e, of which the majority is related to the embodied emissions of materials. Assuming the pumping component of each generation cycle is powered by the NEM, and adopting the NEM's forecast average carbon intensity as it transitions to a net-zero carbon scenario by 2050, the Project is estimated to contribute about 49 metric tons of carbon dioxide equivalent (tCO_2-e) per gigawatt hour (GWh) generated. Given that the NEM GHG intensity at the time of writing is estimated at 1,000 tCO_2e/GWh, the Project is anticipated to represent a significant saving in GHG emissions compared to the existing energy market. With the long-term reduction in fossil fuel based generated electricity, this saving is anticipated to become more efficient over time, which will support Origin's commitment to be net zero emissions by 2050.

Waste and Spoil Management

Waste would be generated during construction of the Project. This waste would be typical of construction projects and would be classified and managed in accordance with industry standard practices.

A key issue for the Project is the need to manage spoil generated from underground works and surface exactions. Approximately 420,000 cubic m of spoil is estimated as being generated and would require permanent emplacement within the Project area in the absence of beneficial re-use options. The proposed approach to spoil management and emplacement would be undertaken as per the Spoil Management Strategy such that consequences to the environmental are minimised.

The operation of the Project would not generate notable additional waste streams or alter currently waste management processes.

Waste management for the Project would be based on the waste management hierarchy established by the objectives of the *Waste Avoidance and Resource Recovery Act 2001*. Any necessary waste disposal would be undertaken using licenced waste transporters and facilities.

Public safety

The Project risk assessment focussed on known hazards associated with development aspects related to the Project and the Project area as a qualitative assessment based on industry experience and judgement.

The assessment concludes that at the current stage of development there are no hazards causing unacceptably high risks that could result in significant offsite public safety effects that are not manageable through application of inherent safety in design principles and mitigation measures.

The Project is in sensitive environments which require specific and carefully considered controls; however, they are not considered any more complex than similar pumped hydro storage or underground works projects and well within the capability of an experienced construction contractor and operator to control.

Social and economic impacts

The local amenity and character of the area surrounding the Project is dominated by natural features such as Morton National Park and Kangaroo River; WaterNSW assets including Fitzroy Falls Reservoir; and farmland and rural landscapes, that are important to communities and visitors for the conservation, ecology and biodiversity, scenic amenity, recreation, and economic values that they offer. The Shoalhaven Pumped Hydro Scheme has also been a feature of the Kangaroo Valley since the mid-1970s when it was established as part of a dual purpose water supply and hydro-electric power generation scheme.

The Kangaroo Valley is known for its scenic beauty and tranquil surroundings and is a popular destination for visitors who are attracted to the area for its rural lifestyle and amenity, historic heritage such as historic buildings in the Kangaroo Valley township and the landmark Hampden Bridge across the Kangaroo River, natural landscapes, and nature-based recreational opportunities such as bushwalking, kayaking and fishing.

The project would provide long-term benefits for business, industry and domestic energy customers across NSW through improved energy security and reliability of supply to the NEM during periods of high demand. Locally, potential socio-economic impacts would mainly be associated with the construction phase and would generally relate to:

- Disruption to local amenity for users of properties near to construction works due to increased construction noise, dust and traffic
- Amenity changes for businesses immediately surrounding the Project construction, discouraging people from using local accommodation and wedding businesses
- Changes to local amenity of nature-based recreation areas, possibly deterring people from accessing these facilities
- Impacts on the use of Bendeela Recreation Area due to construction traffic use of Lower Bendeela Road

Ongoing communication with affected stakeholders and monitoring of potential impacts and the effectiveness of mitigation measures, including identification of additional management measures as required would be important in managing any ongoing impacts.

Visual impacts

The Kangaroo Valley is known for its scenic beauty and tranquil surroundings and is a popular destination for visitors who are attracted to the area for its rural lifestyle and amenity. The B73 Moss Vale Road is identified as part of the 'Coast to the Highlands scenic drive – Kangaroo Valley' noted for its lookouts and 'breathtaking scenic views' across Morton National Park. Morton and Budawang National Parks Plan of Management recognises the important landscape, geology, biodiversity, heritage and wilderness values of the Morton National Park.

Visual impacts during construction could include a reduction in the visual amenity associated with the presence of construction activities. The majority of works associated with construction of the pipeline, surge tank, underground power station and tail race take place away from publicly accessible areas or underground, and therefore would not impact visual amenity for members of the public.

The Promised Land Trail would be used for construction and if unclosed would provide potential visual amenity impacts for trail users noting that views into the works areas are limited. Construction works, plant and equipment at laydown/works areas would be visible to the public to a limited extent.

Consideration of viewshed analysis undertaken identified the following permanent visual impacts resulting from establishment of permanent built features:

- Views of the of the surge tank and surface penstock would be limited due to existing dense vegetation and topography and limited to distant views resulting in negligible visual impact
- Operational buildings and landform changes at Kangaroo Valley Power Station would be visible from vehicles, cyclists and pedestrians passing on Bendeela Road/Jacks Corner Road with low sensitivity of view by due to Existing Scheme context
- The spoil emplacement facility has been conceptually designed such that its highest point would be below the height of the existing vegetation that would screen it from Lower Bendeela Road
- Views of the lower intake would be available to recreational users of Lake Yarrunga and occur in the context of proximity to the more visually intrusive Bendeela Power Station.

Cumulative impacts

Cumulative effects occur where construction works overlap in terms of timing and / or location with other local projects. Cumulative effects from construction activities usually relate to biodiversity, water, amenity (visual, air quality, noise and vibration), traffic and access. The scale of the impacts largely depends on the type of work, its duration, and the sensitivity of surrounding land uses. Identified proposed and existing local projects would not interact with the Project in a manner likely to lead to any cumulative impacts due to the distance away from the Project.

The potential cumulative socio-economic impacts with other projects are anticipated to mainly occur during the construction phase and would mainly be associated with:

- Demand for local construction workers and resulting reduced availability of local workers for the Project, increasing the need for construction workers to be sourced from further afield
- Increased demand for visitor accommodation and rental housing to accommodate construction workers
- An increase in the number of non-local workers exacerbating potential impacts on community cohesion and demand for social infrastructure, and further increasing the possibility that some community members will feel resentment to non-local workers and the Project.

Mitigation

The EIS is based on the current design status for each Project component which may be amended through the detailed design process. Construction methods may also vary subject to design refinements and the selection of the construction contractor. The assessment of the Project within the EIS is based on consideration of reasonable worse case environmental impacts to allow flexibility in design and construction methodology. The ongoing design of Project components would deliver the identified performance outcomes for the Project as identified in the EIS.

Following the engagement of a contractor, a risk assessment would be completed on the actual methods to be implemented and environmental management plans prepared that incorporates the Project commitments and conditions of approval. Further consultation with relevant agencies would be undertaken and necessary approvals of final designs and methods sought. The risk assessments, final design plans and management plans would be used to confirm that no greater impact than that assessed in this EIS would occur.

Origin proposes to develop an overarching Construction Environmental Management Strategy for the Project that would be adopted and implemented through the development of contractor's construction environmental management plans and sub-plans. The Construction Environmental Management Strategy would document the required environmental performance outcomes, management commitments and conditions of approval for the Project. The contractor's construction environmental management plans and sub-plans would document reasonable and feasible measures to achieve established performance expectations and compliance obligations.

The following management plans are proposed to document detailed design and selected construction methods and the necessary consultation requirements such that impacts remain consistent with those assessed in the EIS:

- Environmental management strategy - Origin's approach to environmental management and compliance oversight

- Stakeholder and Community Engagement Plan - prepared to guide communication and engagement activities to ensure the timely and accurate provision of information to the community and stakeholders during construction
- Construction environmental management plan - Contractor's detailed environmental management processes and procedures for the Project
- Spoil management plan based on spoil management strategy in EIS to document and resolve spoil generation rates and volumes, haulage details, potential acid forming material testing and management, emplacement design and emplacement drainage and water management in consultation with Water NSW and EPA
- Construction traffic management plan - to confirm traffic controls, over size and over mass vehicle licencing, detailed route analysis based on Contractor's construction methodology in consultation with TfNSW, Council, WaterNSW and NPWS
- Noise and vibration management plan including blast management plan adopting contractor construction methodology and confirming predicted noise impacts and reasonable and feasible mitigation measures to be adopted in consultation with WaterNSW and EPA
- Construction soil and water management plan including first iteration of progressive erosion and sediment control plans, dewatering management plan including water treatment plant details and results of discharge impact assessment to establish discharge criteria in consultation with WaterNSW and EPA
- Accommodation strategy in consultation with Council and Department of Planning and Environment (DPE)
- Biodiversity management plan including rehabilitation management plan in consultation with Biodiversity Conservation Service (BCS), WaterNSW and NPWS
- Cultural Heritage Management Plan in consultation with Registered Aboriginal Parties, Heritage NSW, NPW and WaterNSW
- Construction Safety Plan including Bush Fire Emergency Management and Evacuation Plan and Emergency Response Plan in consultation with Rural Fire Service (RFS), NPWS and WaterNSW
- Waste management plan
- Operational environmental management plan includes necessary ongoing actions and monitoring requirements from above plans.

Engagement

Stakeholder engagement commenced in October 2018 with the public announcement of the Project and continued through to October 2022 with a pause between 2019 and late 2021. Engagement activities have included consultation with neighbours and community stakeholders, agencies and Registered Aboriginal Parties.

The key community concerns raised through consultation include:

- Property and land use impacts
- Business impacts and opportunities
- Noise and vibration impacts
- Traffic and access impacts
- Potential hazard and risks
- Biodiversity impacts
- Amenity impacts
- Community uses
- Housing and accommodation.

Council and agency concerns were aligned with their inputs to the Secretaries Environmental Assessment Requirements and cover the agencies relevant areas of interest.

Aboriginal community consultation has been undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* and has included establishment of Registered Aboriginal Parties for the Project, provision of information about the Project, full involvement in site survey and a test excavation program. Discussions with Aboriginal people and knowledge holders have identified various key elements that makeup cultural heritage values within the landscape of the Project area specific locations within the Project area and that the entirety of the Kangaroo Valley has cultural significance to Aboriginal people who have inhabited the region for thousands of years. The Kangaroo River is of particular significance to contemporary Aboriginal people for its connection with ancestors.

Engagement to date has influenced the design of the Project through the relocation of the cavern location such that a ventilation building near Jacks Corner Road is no longer proposed. Engagement inputs are also shaping the mitigation measures and development of management plans that would occur as part of detailed design.

Next steps

Origin is seeking approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) from the Minister for Planning for the construction and operation of the Project. Approval is also required under the EPBC Act and is being assessed under the Bilateral Assessment Agreement between NSW and the Commonwealth Government. Steps in the process include:

- Exhibition of the EIS for a minimum of 28 days in accordance with statutory requirements and invitation for the community and stakeholders to make submissions
- Consideration of submissions. Submissions received by the Secretary of DPE would be provided to Origin. Origin would be required to prepare and submit:
    - A submissions report, responding to issues raised in the submissions
    - If necessary, a preferred infrastructure report, outlining any proposed changes to the Project to minimise its environmental impacts or to deal with any other issues raised
- Assessment by the Department of Planning and preparation of a Report by the Secretary of the DPE for provision to the Minister for Planning and the Commonwealth Department of Climate Change, Environment, Energy and Water with recommendation for or against approval and any recommendations on conditions
- Determination of the application by Minister for Planning and if approved, setting conditions of approval
- Determination by the Commonwealth Minister for the Environment with any additional conditions if required.

During the exhibition period, the EIS will be available for viewing at the DPE's major project planning portal: www.planningportal.nsw.gov.au/major-projects/projects/on-exhibition

In parallel to the approval process, Origin is progressing the engagement of a design and construction contractor to undertake detailed design and, if approved, construction of the Project. The detailed design will include consideration of submissions received, agency advice and conditions of approval. Furthermore, impacts would be minimised through the development and implementation of a comprehensive set of social and environmental management plans for the Project.

Consultation with the community and stakeholders would continue throughout the detailed design and construction phases as required.

Contents

Appendices

Tables

Figures

Pictures

Acronyms, terms and abbreviations

Term	Definition
%	Percent
ABS	Australian Bureau of Statistics
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACHCRP	*Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*
ACM	Acid Consuming Materials
AEI	Areas of Environmental Interest
AEMO	Australian Energy Market Operator
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ANFO	Ammonium nitrate for blasting
APZ	Asset Protection Zone
ASS	Acid Sulfate Soils
AWS	Automatic Weather Station
BAL	Bushfire Attack Level
BAM	Biodiversity Assessment Method
BCS	Biodiversity Conservation Service
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BC Act	*Biodiversity Conservation Act 2018* (NSW)
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CHMP	Cultural Heritage Management Plan
CSP	Community Strategic Plan
CSSI	Critical State Significant Infrastructure
CSWMP	Construction Soil and Water Management Plan
CTMP	Construction Traffic Management Plan
dB(A)	The A-weighted sound pressure level in decibels, denoted dB(A) is the unit generally used for the measurement of environmental, transportation or industrial noise. The A-weighting scale approximates the sensitivity of the human ear when it is exposed to normal levels and correlates well with subjective perception over a number of different types of sounds. An increase or decrease in sound level of approximately 10 dB corresponds to a subjective doubling or halving in loudness. A change in environmental noise level of 2 dB is considered to be just noticeable.
DEC	Department of Environment and Conservation NSW (former)
DECC	Department of Environment and Climate Change NSW (former)
DECCW	Department of Environment, Climate Change and Water NSW (former)
DCCEEW	Commonwealth Department of Climate Change, Environment, Energy and Water
Disturbance area	For the purposes of identifying and assessing 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 surface components of the Project. The total disturbance area is about 53 hectares (ha) consisting of 23 ha in the Upper Scheme and 30 ha for Lower Scheme.
DPE	Department of Planning and Environment (NSW)
DPI	Department of Primary Industries (NSW)
DPIE	Department of Planning, Industry and Environment (NSW)

Term	Definition
EIA	Environmental Impact Assessment
EMF	Electric and magnetic fields
ENSA	East Nowra Sub Arterial Road
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environmental Protection Biodiversity Conservation Act 1999* (Commonwealth)
EPBC Regulation	Environment Protection Biodiversity Conservation Regulation 2021 (Commonwealth)
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plans
ESD	Ecologically Sustainable Development
Existing Scheme	The existing Shoalhaven Pumped Hydro Scheme (owned and operated by Origin)
FCAS	Frequency Control Ancillary Services
FID	Financial Investment Decision
FM Act	*Fisheries Management Act 1994*
FSL	Full Supply Level
FTE	Full Time Equivalent
GDE	Groundwater Dependant Ecosystems
GHG	Greenhouse Gas
GSNSW	Division Of Resources & Geoscience NSW
GWh	gigawatt hour
ha	Hectares
Heritage Act	*Heritage Act 1977*
IAP2	International Association for Public Participation
IBRA	Interim Biogeographic Rationalisation for Australia
ICNG	Interim Construction Noise Guideline
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standardisation Organisation
ISP	Integrated System Plan
KFH	Key Fish Habitat
km	Kilometres
km^2	Square kilometre
LALC	Local Aboriginal Land Council
LEP	Local Environment Plan
LGA	Local Government Area
Lower Scheme	The Lower Scheme refers to works carried out at Kangaroo Valley portal, tail race portal, Laydown Area 7 and spoil emplacement area and traffic between portals and storage/spoil sites.
LSC	Land and Soil Capability Classes
LUCRA	Landuse Conflict Risk Assessment
m	Metres
m^2	Squared metres
m^3	Cubic metres
MNES	Matters of National Environmental Significance
NAF	Non-Acid Forming
NCA	Noise Catchment Areas

Term	Definition
NDC	Nationally Determined Contribution
NEM	National Energy Market
NML	Noise Management Levels
NPI	*Noise Policy for Industry*
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	National Park and Wildlife Service
NSW	New South Wales
OEH	Office of Environment and Heritage
Origin	Origin Energy Eraring Pty Limited
OSOM	Oversized Overmass
PAD	Potential Archaeological Deposits
PAF	Potentially Acid Forming
PBP	Planning for Bushfire Protection
PCT	Plant Community Types
Penstock	A water transfer pipeline and associated infrastructure also referred to as a pipeline
POEO Act	*Protection of the Environment Operations Act 1997*
PPV	Peak Particle Velocity
Project	Shoalhaven Hydro Expansion Project
Project area	The project area encompasses the disturbance area and indicative underground works
RAP	Registered Aboriginal Parties
RBL	Rating Background Noise Levels
Ref	Reference
Resilience and Hazards SEPP	*State Environmental Planning Policy (Resilience and Hazards) 2021*
RFS	Rural Fire Service
RNE	Register of National Estate
s170	Section 170 Registers
SAII	Serious and Irreversible Impact
SAL	Suburbs and Localities
SCEP	Stakeholder and Community Engagement Plan
SEARs	Secretary's Environmental Assessment Requirements
SEIA	Socio-economic Impact Assessment
SEPP	State Environment Planning Policies
SHR	State Heritage Register
SISD	Safe Intersection Sight Distance
SPL	Sound Pressure level (dB)
SRE	Sensitive Receiving Environments
SSD	State Significant Development
SSI	State Significant Infrastructure
Study area	The study area encompasses the project area and the area that may be indirectly impacted by the project. The study area varies for specialist assessments and has been defined throughout **Chapter 6**
SWSM	Safe Working Method Statements
t	Tonnes
tCO2-e	metric tonnes of carbon dioxide equivalent

Term	Definition
TEC	Threatened Ecological Community
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
Upper Scheme	The Upper Scheme refers to works carried out above Kangaroo Valley portal revolving around site access improvements, upper laydown works, pipeline installation and shaft boring.
VRE	Variable Renewable Energy
WAL	Water Access Licence
WBCSD	World Business Council for Sustainable Development
WHS Act	*Work Health and Safety Act 2011*
WNSW Act	*Water NSW Act 2014*
WTP	Water Treatment Plan
°C	Degrees Celsius

1. Introduction

This chapter provides a general overview of the background for the Shoalhaven Hydro Expansion Project. It also describes the proponent, outlines the strategies to avoid and or minimise environmental impacts and provides the purpose and structure of this environmental impact statement (EIS).

1.1 Project overview

Origin Energy Eraring Pty Limited (Origin) operates the Shoalhaven Pumped Hydro Storage Scheme (the Existing Scheme) which includes the Kangaroo Valley Power Station and Bendeela Power Station. These two power stations are constructed in series, capturing energy from a multi-stage elevation drop between the existing Fitzroy Canal control works and Lake Yarrunga via surface and underground pipelines, with water between the two power stations regulated by Bendeela Pondage. The Existing Scheme comprises of water storage and transfer infrastructure owned by WaterNSW and two power stations and associated electrical infrastructure owned by Origin located on WaterNSW land under a long-term lease.

Origin proposes to construct and operate a new pumped hydropower station on and under the land between the Fitzroy Falls Reservoir and Lake Yarrunga (the Project). The Project would utilise Origin's existing water allocations to pump water up from Lake Yarrunga to the Fitzroy Falls Reservoir (preferentially during low demand periods), then generate energy through the return of water from Fitzroy Falls Reservoir to Lake Yarrunga when additional electricity supply is required.

The Project would almost double the electricity generation capacity of the Existing Scheme, by adding approximately 235 megawatts (MW) of generation capacity. The operation of the expanded scheme would respond to the needs of the National Energy Market (NEM) by providing additional dispatchable generation and grid stability when needed, with the flexibility to perform several pumping and generation cycles per day dependent on market requirements. A generation cycle that transfers the full water allocation would involve up to 13 hours of generation and 16 to 18 hours of pumping. Generation and pumping modes are likely to be divided into shorter durations to best satisfy the needs of the NEM. The duration of generation may also be extended to over 24 hours where the Existing Scheme is not operating or under the direction of the Australian Energy Market Operator (AEMO) subject to water access licence (WAL) requirements.

The Project location is shown in **Figure 1-1**. An indicative Project layout based on Origin's reference concept is provided in **Figure 1-2** and consists of the construction and operation of:

- Upper scheme components (Upper Scheme) including:
  - Connection to existing upper intake control structure at the southern end of the Fitzroy Canal
  - A surface penstock (water transfer pipeline and associated infrastructure) from the existing Fitzroy Canal control structure to the vicinity of the Existing Scheme surge tank
  - A new surge tank adjacent to the Existing Scheme surge tank
  - A further section of surface penstock, adjacent to the Existing Scheme, from the new surge tank to the high pressure shaft
- Underground works including:
  - Vertical shaft and headrace tunnel connecting to the southern end of Upper Scheme surface penstock to an underground power station
  - An underground power station cavern housing a transformer, reversible motor generator and pump turbine capable of supplying a nominal 235 MW of hydroelectric power
  - Associated access tunnel and multipurpose (egress, ventilation and services) tunnel with an entrance in the vicinity of the existing Kangaroo Valley Power Station
  - A tailrace tunnel, including an underground surge chamber located just downstream of the underground power station, terminating west of the existing Bendeela Power Station on Lake Yarrunga

- Lower scheme surface components (Lower Scheme) including:
  - Lower intake /outlet structure west of the Bendeela Power Station connected to the tailrace tunnel
  - Spoil emplacement facility east of Bendeela Pondage
  - High voltage network connection to existing Kangaroo Valley substation
  - Operational surface infrastructure including administration building, water treatment infrastructure and ventilation building.

The Project would also require ancillary works which may include the carrying out of works to upgrade or construct access roads, spoil disposal sites, utilities infrastructure as well as the use of construction compounds, construction power and water supply.

The Project would be located in the Wingecarribee and Shoalhaven Local Government Areas (LGAs) located in the New South Wales (NSW) Southern Highlands, approximately 150 kilometres (km) south east of Sydney (refer to **Figure 1-1**). Access to the Upper Scheme area on the plateau, for pipeline, surge tank and vertical shaft construction would be via the Promised Land Trail. The Promised Land Trail is accessed from Moss Vale Road and traverses both WaterNSW land and the Morton National Park, and was constructed during original development of the Existing Scheme. Access to the Lower Scheme area within Kangaroo Valley would be via Bendeela Road from Moss Vale Road in the vicinity of the townships of Kangaroo Valley and Barrengarry.

Importantly, the Existing Scheme was developed with a view to future expansion, including water storage capacity and provision for an additional pipeline. As a result, the Project does not propose any new water storages or modification of waterbodies, and would utilise the pre-planned and largely cleared and excavated penstock alignment alongside the existing penstock. In addition, no electricity transmission line augmentations would be required to connect the Project to the existing Kangaroo Valley Power Station substation.

Legend

- Points of interest
- Indicative Project area
- Project location
- NPWS Reserve
- State Forest

0 5 10 km

1:300,000 at A4

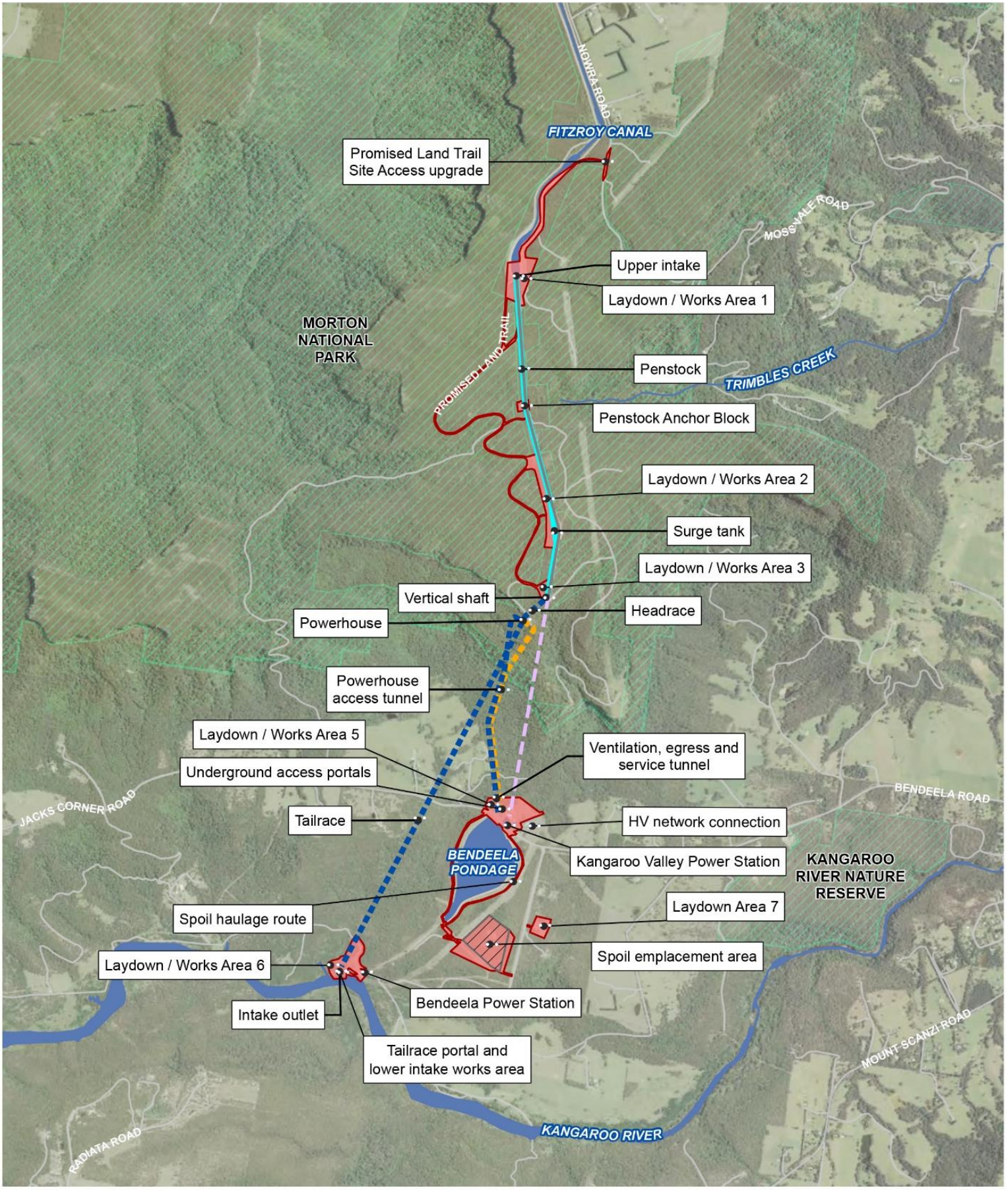
GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 1-1 Shoalhaven Hydro Expansion Project location

Date: 1/08/2022 Path: \\ausydfs01\Projects\NSW_IS382600_Shoalhaven\GIS\Apps\IS382600_GENERAL.aprx
Created by: JB | QA by: HK



Legend

- Points of interest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- NPWS Reserve
- Waterbody

0 1 2 km

1:40,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 1-2 Indicative Project layout

Date: 12/09/2022 Path: \\aursyd0vs01\GIS\Proj\NSW_IS392600_Shoalhaven\E15\Apps\IS392600_GENERAL.aprx
Created by: NT | QA by: CC

1.2 Background and objectives

Origin is the current operator of the Existing Scheme. The Existing Scheme was commissioned in 1977 and currently has a generating capacity of 240 MW. Origin proposes to almost double the electricity generation capacity of the Existing Scheme with the development of the Project, which will add approximately 235 MW of pumped hydroelectric energy storage capacity.

The Existing Scheme was designed and constructed as a dual-purpose system, having both pumped storage generation capacity and inter-region water supply ability to move water from the Shoalhaven catchment to the Sydney Drinking Water Catchment.

The Existing Scheme was designed in the late 1960's and Stage 1 Phase 1 was constructed in the 1970's including two generating / pumping units at Kangaroo Valley Power Station and two generating / pumping units at the Bendeela Power Station. The Origin Energy Limited group purchased the two power stations and the operating rights for the generation and pumping assets within the Existing Scheme from the State of NSW in 2013. Origin has since been progressively undertaking upgrades of the two power stations to improve reliability of the Existing Scheme for future use out to at least 2070 under agreements with WaterNSW. Following the sale in 2013, WaterNSW retained ownership of the water storage and transfer infrastructure including the Fitzroy Canal, existing above ground and below ground pipelines, Bendeela Pondage and Lake Yarrunga. Origin has a long-term agreement in place with WaterNSW to support its operation of the Existing Scheme.

The Existing Scheme was designed to allow for expansion (Phase 2) and much of the infrastructure required for the Project is already in place. Phase 2 of the original scheme, involving the installation of an additional two generation units at the Kangaroo Valley Power Station was planned for the 1990's but was not completed. As a result, there is unconstructed expansion capacity at the site. This was allowed for in the existing Fitzroy Canal, switchyard located near the Kangaroo Valley Power Station and transmission lines. The earthworks for duplicating the above ground penstock on the plateau was also completed during construction of the Existing Scheme.

In 2019 with support from the Australian Renewable Energy Agency, who committed $2 million to help fund the early development work under its Advancing Renewables Fund, Origin completed a Feasibility Study for the Project. Until recently, market conditions did not support further development of the Project. However, since completion of the Feasibility Study in early 2020, Origin has continued to progress planning and environmental approvals for the Project. The rapid increase of Variable Renewable Energy (VRE) supply in the market since 2019 and the NSW Government's Electricity Infrastructure Roadmap have changed the opportunity for the Project. As such Origin is now undertaking activities to prepare the Project for a financial investment decision (FID) by the Origin Board. Pre-FID activities include:

- Jacobs Group (Australia) Pty Limited (Jacobs) has been engaged as Owners Engineer to support Pre-FID activities, including the environmental assessment
- The NSW Government has declared the Project to be Critical State Significant Infrastructure (CSSI) to be assessed under a full merits based assessment under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)
- An application to the NSW Department of Planning and Environment (DPE) has been approved for Geotechnical Investigations to allow this work to proceed in advance of the full DPE approval for the Project, and four of the proposed eight boreholes have been completed under this approval. A modification application is under consideration to facilitate a further borehole to investigate the proposed underground power station cavern location
- In September 2022, the Project was one of six pumped hydroelectric energy storage projects to receive funding under the NSW Government's recoverable grants initiative
- Origin is now working to identify and select contractors to undertake engineering design (and construction) to progress the Project toward FID.

The Project will be designed to operate within the parameters of the Existing Scheme water allocations without adversely impacting the maximum and minimum water levels and environmental flows within and from the Fitzroy Falls Reservoir and Lake Yarrunga based on Origin's existing water licence. Importantly, no new dams or dam expansions are required for the Project, nor construction of new transmission lines from the Kangaroo Valley Power Station substation.

Origin considers that the Project will address essential economic, social and environmental needs for NSW by providing stable and rapidly dispatchable energy generation that will address intermittency risk and result in improved energy security.

The objectives of the Project are to:

- Store VRE (predominantly solar and wind energy), to enable generation during peak period or periods of non production from VRE
- Meet long duration storage needs for the electricity grid with the Project having a generating period much longer than current battery technologies
- Achieve sustainable energy storage requirements for the electricity users of NSW.

1.3 Proponent

Origin is the Project proponent and the entity that owns the generating and pumping assets (Kangaroo Valley and Bendeela Power Stations) of the Existing Scheme. WaterNSW own the water storage, existing connection pipelines and tunnel between the reservoirs.

Origin is Australia's largest energy retailer by customer accounts, with 4.5 million customers across electricity, natural gas and liquid petroleum gas. Origin has a 7,300 MW generation portfolio, including 1,245 MW owned and contracted renewables and storage, employing over 5,000 employees with a market capitalisation of around $10.15 billion (Australian Dollar as of Sept 2022).

Origin is committed to 'getting energy right for customers, the community and the planet' by leading the energy transition through cleaner energy and customer solutions. Origin has committed to do this by delivering across three key areas of focus:

- Provide unrivalled customer solutions that enable customers to decarbonise
- Accelerate renewable and cleaner energy by growing their portfolio of renewables and cleaner energy
- Deliver reliable energy through the transition and reduce emissions of our existing operations.

The details of the Proponent are provided in **Table 1-1**.

Table 1-1. Proponent details

Name	Origin Energy Eraring Pty Limited
Postal address	Level 28, 180 Ann Street, Brisbane QLD 4000
ABN	31 357 688 069

1.4 Strategies to avoid or minimise impact

The Project has a number of benefits over other options, including avoidance and minimisation of impacts. Alternatives considered for the project are discussed in **Section 2.5**. Key strategies to avoid and minimise impacts of the Project include:

- Using the Existing Scheme reservoirs avoiding need for new water storages
- Designing the Project to operate within Origin's existing water licence conditions. Meaning that the water transfers are within those of the Existing Scheme design and no changes are required to the area of inundation and minimum water level.
- Prioritising the use of existing disturbance areas associated with the Existing Scheme, including use of existing established surface penstock alignment, much of original spoil disposal area and cleared areas adjacent to Bendeela and Kangaroo Valley Power Stations
- Limiting the works in Morton National Park to essential Promised Land Trail upgrades to support construction access requirements
- Narrowing of site access to the Promised Land Trail through an area of identified serious and irreversible impact (SAII) habitat
- Utilisating underground infrastructure to avoid further surface impacts.

Ongoing efforts to avoid and minimise impacts will continue in the detailed design and construction planning and include:

- Refinement of clearing requirements
- Development of detailed erosion and sediment control planning aligned to final disturbance footprint (Project area)
- Exploration of opportunities to maximise the reuse of water and spoil.

1.5 Related development

The EIS has considered all activities that are currently anticipated to be required to facilitate the construction and operation of the Project. Detailed design and construction planning may identify additional requirements and these would be dealt with via subsequent assessment as they arise.

With a planned design life of 100 years, a future assessment of decommissioning of the Project would be required at a later date.

1.6 Report structure

This EIS has been prepared to support approval of the development application for the Project in accordance with Division 5.2, Part 5 of the EP&A Act and Division 5 of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation).

The structure and content of this EIS is outlined in **Table 1-2** and has regard to *Appendix B to the state significant infrastructure guidelines – preparing an environmental impact statement* (DPE 2021).

Table 1-2. Structure and content of this EIS

Chapter	Description
Chapter 1 – Introduction	Sets the context for the detailed assessment of the Project in the next sections of the EIS.
Chapter 2 – Strategic context	Identifies the key strategic context issues that are relevant to the assessment of the Project
Chapter 3 – Project description	Provides a consolidated description of the Project for which approval is sought.
Chapter 4 – Statutory context	Identifies the relevant statutory requirements for the Project
Chapter 5 – Engagement	Provides a summarise the findings of the community engagement undertaken by Origin for the Project during the preparation of the EIS and Origin's plans for further community engagement.
Chapter 6 – Assessment of impacts	Provides a detailed summary of the results of the assessment of the potential impacts of the Project.
Chapter 7 – Justification of the project	Provides a justification and evaluation of the Project as a whole, having regard to its economic, environmental and social impacts and the principles of ecologically sustainable development.
Appendix A-Q	▪ A Planning Secretary's environmental assessment requirements (SEARs) table, identifying where the SEARs have been addressed in the EIS and in the specialist assessment reports ▪ A statutory compliance table, identifying where the relevant statutory requirements have been addressed in the EIS ▪ A community engagement table, identifying where the issues raised by the community during engagement have been addressed in the EIS ▪ A table of the proposed mitigation measures for the Project ▪ Supporting detailed technical reports prepared by specialists.

2. Strategic context

This chapter provides the need for the Project, strategic context and detailed consideration of the capability of the Project to contribute to the security and reliability of the electricity system in the NEM. It also details the key features of the Project surround and alternatives considered.

2.1 Project need and opportunity

Since the maturation of VRE sources, Origin has sought to secure additional dispatchable energy generation capacity to support decarbonisation of the Australian electricity system by facilitating greater penetration of VRE through increased storage capacity. The NEM requires stable, dispatchable generation to balance network requirements as renewable generation fluctuates depending on the predominate solar and wind resources available at the time.

The AEMO 2022 Integrated System Plan (ISP) identified the increasing penetration of VRE sources and the need for significant power system engineering investment across both transmission capability and energy storage. These investments will be critical to satisfy consumer demand for electricity at varying times of the day, and through peak demand periods of summer and winter. AEMO also identified that long duration storage (including pumped hydro generation) is vital to support increased VRE supply as follows:

> "As the power system approaches 100 percent (%) instantaneous renewable penetration, AEMO must be able to securely dispatch the available renewable resources, using storage to help absorb local supply excesses"…
>
> *"The most pressing need in the next decade (beyond what is already committed) is for dispatchable batteries, pumped hydro or alternative storage to manage daily and seasonal variations in the output from fast-growing solar and wind generation….*
>
> *New utility-scale battery and pumped hydro storage, located at appropriate parts of the network, will enable more effective dispatch of clean electricity on demand, increase resilience by shifting energy through time to manage weather variations, and provide critical system security services."* (AEMO 2022).

Origin has undertaken a review of how the intermittency of VRE may be managed, and believes that the additional, rapidly dispatchable long duration energy storage provided by the Project would contribute significantly to supporting greater VRE penetration in NSW.

The Project opportunity has arisen from:

- The prevalence of VRE displacing baseload coal generation
- The existing major water storage infrastructure at appropriate elevations
- Existing Scheme infrastructure appropriately sized and constructed in anticipation of future expansion
- Existing water allocations that can accommodate the expansion without need for changes in current upper and lower storage minimum and maximum operating levels
- Available capacity within the existing electricity transmission network
- Future energy contracting via the NSW Government's Long Term Energy Service Agreements.

Origin believes these opportunities support the business case for the Project which can be constructed and operated so that the long term environmental and social impacts are largely consistent with those associated with the Existing Scheme.

2.2 Climate change

The Commonwealth Government's approach to better anticipate, manage and adapt to climate change is documented in its *National Climate Resilience and Adaptation Strategy* (Department of Agriculture, Water and Environment, 2021). The objective of this strategy is to:

- Drive investment and action through collaboration
- Improve climate information and services
- Assess progress and improve over time.

The strategy operates across four domains – natural, built, social and economic, and is designed to support governments, communities and businesses to better adapt to climate change, recognising that adaptation is a shared responsibility that requires sustained and ongoing action.

With respect to the 'built' domain, the strategy is looking to manage and reduce climate risks and build resistance in the infrastructure space. The strategy specifically discusses the importance of partnerships and collaboration between private and public stakeholders at state and national levels to deliver climate change resilient public infrastructure in urban and regional settings. Further, the importance of cross-sectoral partnerships between the built, economic, social and natural domains within the strategy is recognised within the strategy as an integral component to achieve successful climate change adaptation and resilience programs.

The following sections provide consideration of climate change risks based on review of historic climate change data and climate change projections from the Intergovernmental Panel on Climate Change (IPCC) *Sixth Assessment Report* (IPCC 2021).

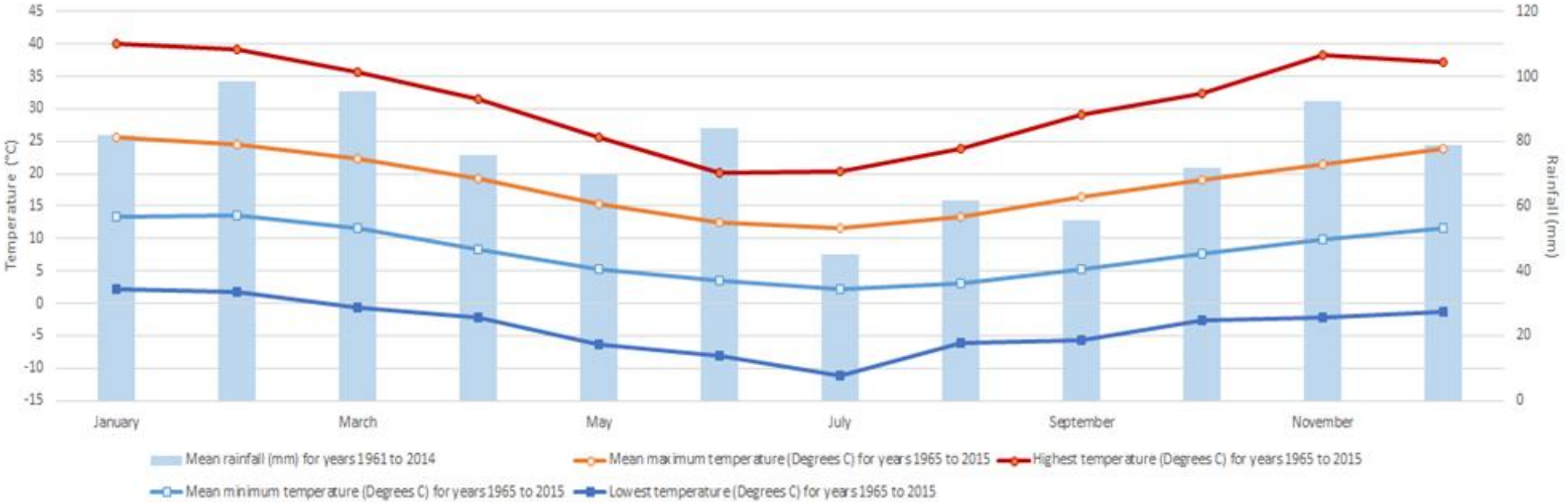
2.2.1 Historical climate

Historical climate data for the region has been reviewed and summarised based on the following three Bureau of Meteorology (BOM) stations representing the Project site:

- Primarily the Bowral (Parry Drive) Automatic Weather Station (AWS) (BOM number 068102) was used, located approximately 27 km north-east of the Project site. Data has been captured from 1961 to 2015.
- The Nowra RAN Air Station (BOM number 068076), located approximately 25 km south-east was used to fill data gaps in the Bowral AWS data. Data has been captured from 1942 to 2000.
- The Moss Vale AWS (BOM number 068239), located approximately 23 km north-east, used for data after 2015 to present. Data has been captured from 2001 to present.

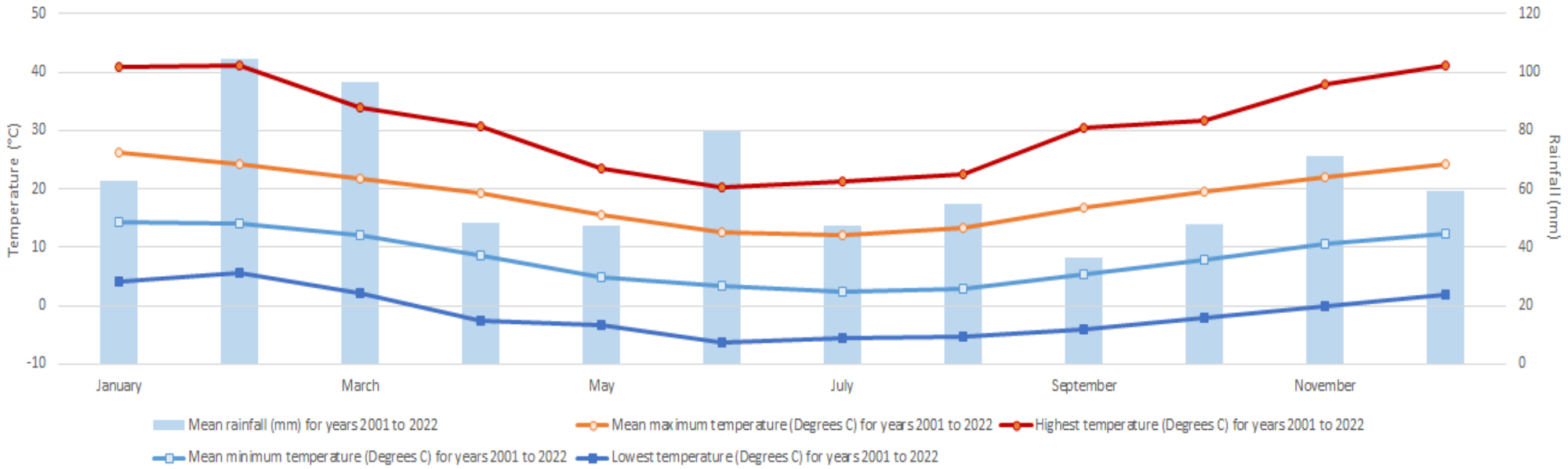
Average annual rainfall for the three representative weather stations for their respective period of data collection was between 713 mm and 1,133 mm, with annual totals ranging between a minimum of 489 mm (Moss Vale) and a maximum of 2,053 mm (Nowra). Rainfall is (approximately) bimodally distributed, with late winter and early spring typically receiving less rain than other seasons (**Figure 2-1** and **Figure 2-2**).

Seasonal patterns in temperature are as expected for coastal NSW, with warmer temperatures recorded during summer and the shoulder periods of Spring and Autumn either side, and cooler temperatures recorded during winter, particularly in valley areas. Extremely high summer temperatures have been recorded, with maximum temperatures of 40°C or more having been recorded in January (occurring in 2020; maximum recorded temperature is 41.2°C). Average maximum temperatures range between 11.6°C (Bowral Parry Drive) in July and 26.3°C in January (Moss Vale), with average minimum temperatures ranging between 2.1°C in July (Bowral Parry Drive) and 16.3°C in February (Nowra). The lowest recorded temperature is 11.2°C (June 1971).



Bowral (Parry Drive) records comprise: average monthly total rainfall (rainfall), monthly average maximum temperature (Tmax), highest recorded temperature in the month (Highest temp), monthly average minimum temperature (Tmin) and lowest recorded temperature for the month (Lowest temp).

Figure 2-1. Average Climate Conditions for the Project -Bowral (Parry Drive) AWS



Moss Vale AWS records comprise: average monthly total rainfall (rainfall), monthly average maximum temperature (Tmax), highest recorded temperature in the month (Highest temp), monthly average minimum temperature (Tmin) and lowest recorded temperature for the month (Lowest temp).

Figure 2-2. Average Climate Conditions for the Project – Moss Vale AWS

2.2.2 Rainfall and temperature trends

Year-to-year variations in rainfall and temperature for the region are shown in **Figure 2-3**. The yearly maximum and average temperatures have trended upwards over the recorded period, by approximately 0.4 and 0.2°C/decade, respectively. Total annual rainfall has trended downwards over the recorded period, between 0 and 20 mm/decade.

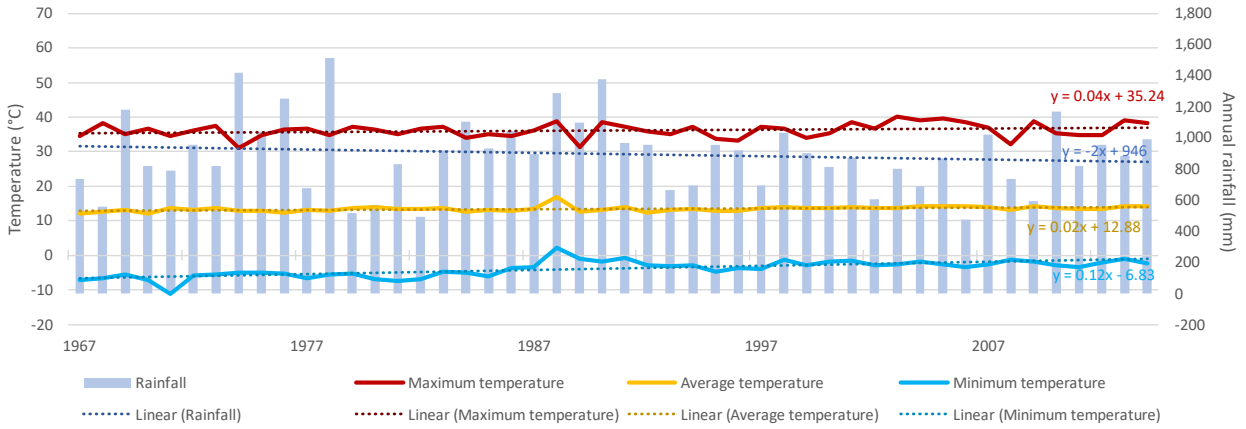


Figure 2-3. Historical Trends in Rainfall and Temperature

2.2.3 Climate change projections

The IPCC's *Fifth Assessment Report* (AR5; IPCC, 2013) provides a synthesis of climate change modelling undertaken by leading international climate research organisations. Outputs from this work for Australia are published on the Climate Change in Australia website (www.climatechangeinaustralia.gov.au). They consolidate projections from General Circulation Model (global climate model) runs for the 21st century under a range of greenhouse gas (GHG) emissions and Representative Concentration Pathway scenarios and include data for a wide range of climate parameters, including rainfall, temperature and wind speed. Based on a review of the climate change modelling the following projects are made:

- *Temperature:* average annual temperatures are projected to increase by an average of 0.4 to 1.2°C by 2030, with average temperatures increasing by 2.4 to 4.0 °C by 2090. Days below 2°C are projected to decrease in frequency by approximately 400 % by 2090. Days with maximum temperatures above 35°C are projected to experience up to a fivefold increase in frequency by 2090. The incidence of days over 40°C are rare based on historical data, however this is set to increase to an average of at approximately to 0.5 to 2.5 days every year by 2090. Temperatures above 45°C have never been recorded and have not been projected to occur at all by 2090
- *Rainfall:* Average annual rainfall projections vary between decreasing by 15 % to increasing by 12 % by 2030. This range increases further by 2070 (decrease 20% to an increase of 12 %), and further by 2090 (decrease 25 % to an increase of 15 %). The 1-in-40 year rainfall, maximum daily rainfall is expected to increase by 3 and 6 % by 2030 and by 13 % to 21 % by 2090
- *Windspeed*: average wind speeds are not projected to change materially with climate change over the course of this century. Winds are projected to remain stronger through spring and early summer than at other times of the year and may weaken slightly at other times. Strengthening of the sub-tropical ridge and expansion of the tropical Hadley Cell circulation is projected to contribute to reductions in storminess and related severe winds over southern Australia. Intense frontal systems affecting south-eastern Australia during summer may become more frequent, potentially leading to increases in strong wind events (McInnes et al. 2015).
- *Humidity and evaporation*: Relative humidity is projected to decline slightly in Eastern Australia (Dowdy, A. et al. (2015)). Potential evapotranspiration will increase with temperature, with the change projected to be less than 5 % by 2030 and as much as 10-20 % by 2090 (Dowdy, A. et al. (2015))
- *River and storm water flows, groundwater recharge*: soil water storage is projected to change in line with rainfall and potential evaporation. It is projected to decline in Eastern Australia in all seasons (Dowdy, A. et al. (2015)), but by a greater extent during winter and spring, due to rising temperatures and declining rainfall in those seasons. Drier soils will lead to reductions in annual average run-off, river flows (by up to

60 % in eastern Australia) and groundwater recharge. Due to increased intensity of extreme rainfall events, riverine floods may be enhanced by climate change.

2.3 Strategic policies and plans

2.3.1 Commonwealth policy context

Australia is party to the Paris Agreement, which came into force in 2016. Parties to the Paris Agreement reached consensus at the 2015 United Nations Climate Change twenty-first Conference of the Parties (COP21) to strengthen the global response to climate change by:

- Keeping the increase in global average temperature to less than 2 degrees Celsius (°C) above pre-industrial levels
- Pursuing efforts to limit temperature increase to 1.5°C.

As part of the 2021 United Nations Climate Change twenty-sixth Conference of the Parties (COP26), the parties reaffirmed the global targets above to keep temperature rise at 1.5°C, and sought to accelerate the phase-out of coal. At COP26 agreement was reached to make the Paris Agreement fully operational (UNFCCC, 2021).

In 2022, the Australian Government legislated the commitment to reduce GHG emissions by 43 % below 2005 levels by 2030. This updated Nationally Determined Contribution (NDC) has been communicated to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat. The updated NDC also reaffirmed the target to achieve net zero emissions by 2050 (UNFCCC, 2022).

The energy sector is a key part of the low emissions effort, as electricity generation contributes to a significant proportion of total carbon emissions and the development of additional of pumped hydroelectric generation and storage capacity will be a significant part of the transition to a low emission future.

Australia's Long-Term Emissions Reduction Plan (Commonwealth of Australia, 2021) and Technology Investment Roadmap First Low Emission Technology Statement 2020 (Commonwealth of Australia, 2020b) include low emissions technology stretch goals aimed at enabling Australia to achieve the NDC committed targets. The Project would play a critical role in supporting VRE initiatives which will help drive down emissions in the energy sector.

2.3.2 State policy context

2.3.2.1 NSW Net Zero Plan Stage 1: 2020-2030

The NSW Net Zero Plan Stage 1: 2020-2030 (Net Zero Plan) (NSW Government, 2020a) outlines the NSW Government's approach to growing the economy and employment and reducing emissions over the current decade. This includes investments in emissions reduction, particularly within regional NSW. The Net Zero Plan targets net zero emissions by 2050 in NSW. Where previously the emissions reduction target under the Net Zero Plan was 35 % by 2030, the NSW Government has announced in 2021 that the new objective is to deliver a 50 % reduction by 2030, compared to 2005 emissions levels.

The Net Zero Plan: Stage 1 Implementation Update (NSW Government, 2021b) builds on the Net Zero Plan. The Plan is forecast to reduce the State's annual emissions by 28.6 to 37.3 million tonnes (t) of carbon dioxide equivalent by 2030 and this has been reinforced in the Implementation Update. This means the State's annual emissions are projected to reduce to 47 % to 52 % below 2005 levels by 2030. The Plan is also:

- Positions NSW industries to take advantage of the growing demand for low carbon products in global markets
- Supports NSW businesses in attracting low-cost finance from investors in sustainable assets
- Helps NSW businesses reduce their climate related financial risks (NSW Government, 2021b).

The Project would align with the emissions reduction target in NSW by developing pumped hydroelectric energy infrastructure and contributing to decarbonisation and the transition away from coal in the electricity sector.

2.3.2.2 NSW Electricity Infrastructure Roadmap 2020

The objectives of the Electricity Infrastructure Roadmap are to encourage investment in new generation, storage and transmission in Renewable Energy Zones, while using a holistic approach to land-use planning and community consultation to drive social and economic development in regional NSW. Projects supported under the Electricity Infrastructure Roadmap will be required to address and assess potential social impacts, local economic benefits, and use best practice community engagement with local and regional stakeholders (DPIE, 2020a).

The Project is consistent with the objectives of the Electricity Infrastructure Roadmap and would promote energy security through renewable energy generation and long duration energy storage.

2.3.3 Regional and local policy context

The Project would align with various strategies, policies and plans across National, NSW, regional, and local contexts. The strategic framework for the Project is outlined in **Table 2-1**.

Table 2-1. Alignment with key strategic documents

Policy	Objectives or targets	How the Project aligns
South East and Tablelands Regional Plan 2036	The Plan guides the NSW Government's land use planning priorities and decisions over the next 20 years and includes four goals as follows: ▪ A connected and prosperous economy ▪ A diverse environment interconnected by biodiversity corridors ▪ Healthy and connected communities ▪ Environmentally sustainable housing choices The Plan includes Direction 6: Position the region as a hub of renewable energy excellence, which aims to promote new opportunities for renewable energy industries and encourage the co-location of renewable energy projects to maximise infrastructure.	The Project would be consistent with the Plan and Direction 6 and support long duration energy storage through renewable pumped hydroelectric energy generation.
Illawarra Shoalhaven Regional Plan 2041	The Plan sets the strategic framework for the Illawarra and Shoalhaven region to plan for a sustainable future through 2041, and for the region to be: ▪ Productive and innovative ▪ Sustainable and resilient ▪ Smart and connected ▪ A region that values its people and places. The vision for the region seeks to transition to a low-carbon economy and continue as a hub for clean energy, including having pumped hydro in Shoalhaven. Objective 15 of the Plan would contribute to a sustainable and resilient region by planning for a Net Zero region by 2050. Strategy 15.3 specifically aims to promote opportunities for clean energy including pumped hydro, hydrogen and biogenic gas.	The Project would be consistent with the Plan, including Objective 15 and Strategy 15.3 and support pumped hydro infrastructure in Shoalhaven to enable the region to transition towards net zero targets.
Shoalhaven 2027 Community Strategic Plan (CSP) and draft 2032 plan (CSP)	The CSP is a long-term plan that identifies the main priorities and aspirations of the community for the future. The vision statement for the plan includes for 'sustainable growth, development and environmental protection' and 'a unique and relaxed lifestyle' in the Shoalhaven community. Renewable energy is identified as an important issue for the community in order to achieve sustainable, liveable environments. The draft 2032 CSP updates on the 2027 CSP following community consultation. Sustainable and liveable environments remains a priority for the community, with key outcomes of the strategy including: ▪ Infrastructure is planned for the long term ▪ Increased investment and new business ▪ Environmentally sound and climate resilient development.	The Project would be consistent with the 2027 CSP, as well as the strategies in the draft 2032 CSP, by building renewable energy infrastructure and expanding the Existing Scheme to store VRE for NSW consumers and businesses.

Policy	Objectives or targets	How the Project aligns
Wingecarribee 2031 Community Strategic Plan	The Wingecarribee 2031 Community Strategic Plan is a long term plan to identify community aspirations and priorities for the future and links together with State Government strategies such as the South East and Tablelands Regional Plan. The plan identifies key issues for the community including population growth and ageing population, provision of diverse local employment opportunities, and environmental issues such as climate change, biodiversity, waste, water, energy and carbon reduction (Wingecarribee Shire Council, 2017). The vision for the Wingecarribee community is 'a healthy and productive community, learning and living in harmony, proud of our heritage and nurturing our environment'. Strategic priorities identified in the Wingecarribee Community Strategic Plan include the following that are relevant to the Project: ▪ Identify and protect the unique characteristics of towns and villages to retain a sense of place ▪ Sustainably manage natural resources for broader community benefit ▪ Manage Council's resource consumption, with significant increases in efficiency and adoption of renewable energy ▪ Increase local employment opportunities for people in all stages of life ▪ Promote business and industry development opportunities suited to our distinct region.	The Project would be consistent with the 2031 CSP, by providing sustainable use of natural resources to store VRE and generate electricity increasing local employment opportunities in Wingecarribee LGA as well as surrounding LGAs.

2.4 Key features of Project surrounds

The Project area is located in the NSW Southern Highlands, approximately 150km southeast of Sydney. The Project would be predominantly located within the Shoalhaven LGA with access and water for the scheme drawn from and returned to the existing Fitzroy Falls Reservoir located within the Wingecarribee LGA.

The Project's surface works would be largely limited to land owned by WaterNSW associated with the existing Kangaroo Valley and Bendeela Power Stations and water transfer operations (refer to **Figure 1-1**). WaterNSW owns the land either side of the existing surface pipeline and surge tank at the top of the plateau and land between Jacks Corner Road and Lake Yarrunga.

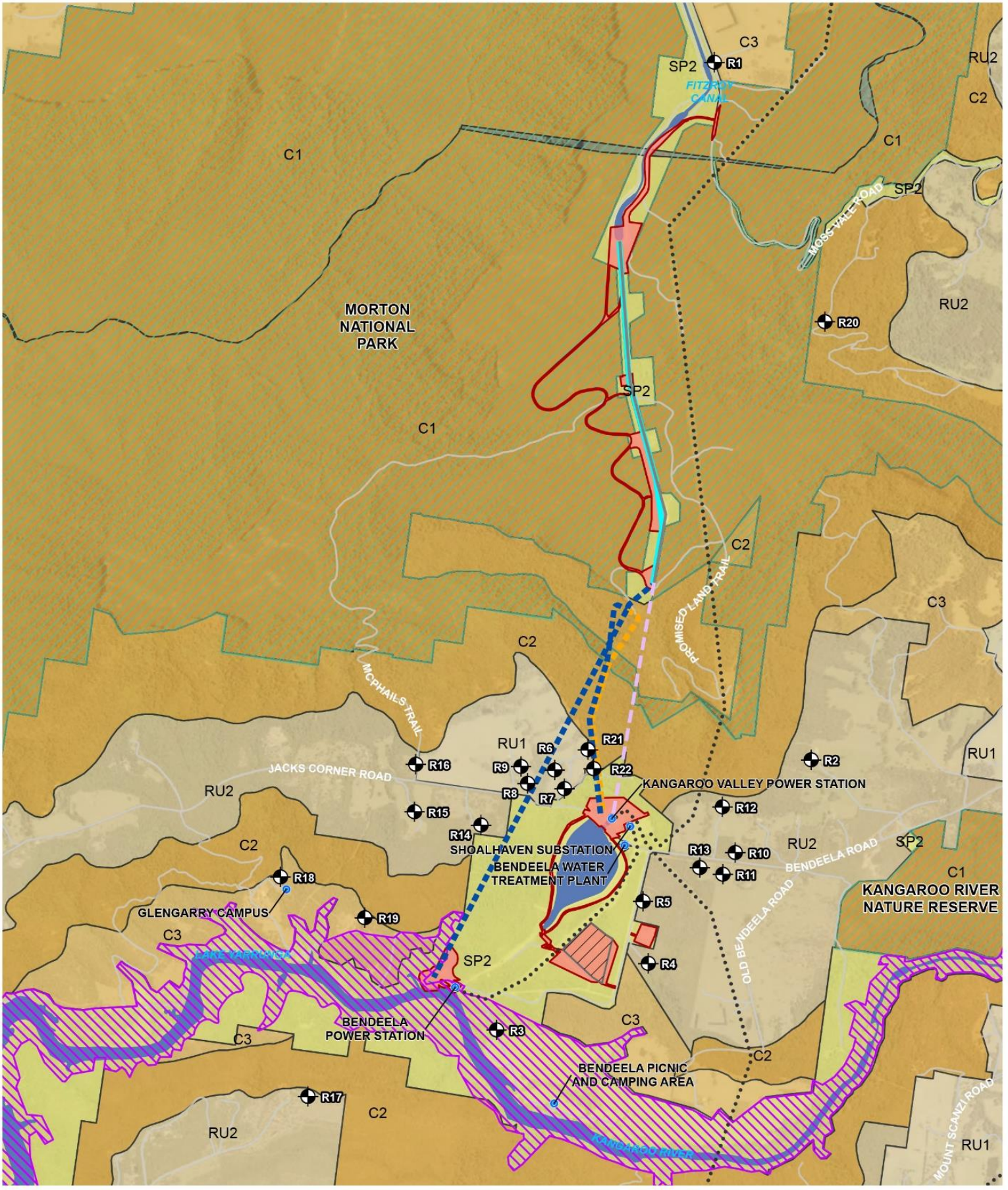
Access to the existing Fitzroy Canal control structure, surface pipeline, surge tank and vertical shaft on the plateau during construction would be required via existing access tracks through the Morton National Park.

Below ground works for the high-pressure shaft and headrace tunnel would be required beneath a 100-metre-wide strip of Morton National Park located below the escarpment. These works would also be required beneath (at significant depth) private freehold land located between the surge tank and Jacks Corner Road.

The major features of the area surrounding the Project are illustrated in **Figure 1-2** and include:

- The Existing Scheme
- Morton National Park
- Shoalhaven Special Area
- Bendeela Recreation Area
- Rural landholdings and associated private dwellings.

The land use context is illustrated in **Figure 2-4** and the environmental constraints are shown on **Figure 2-5.**



Legend

- Sensitive receptors
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Shoalhaven special area

Land use

- C1 National Parks and Nature Reserves
- C2 Environmental Conservation
- C3 Environmental Management
- RU1 Primary Production
- RU2 Rural Landscape
- SP2 Water Supply System
- Transmission lines

- Points of interest
- Road
- Waterway
- Waterbody
- NPWS Reserve

0 1 2 km

1:37,500 at A4

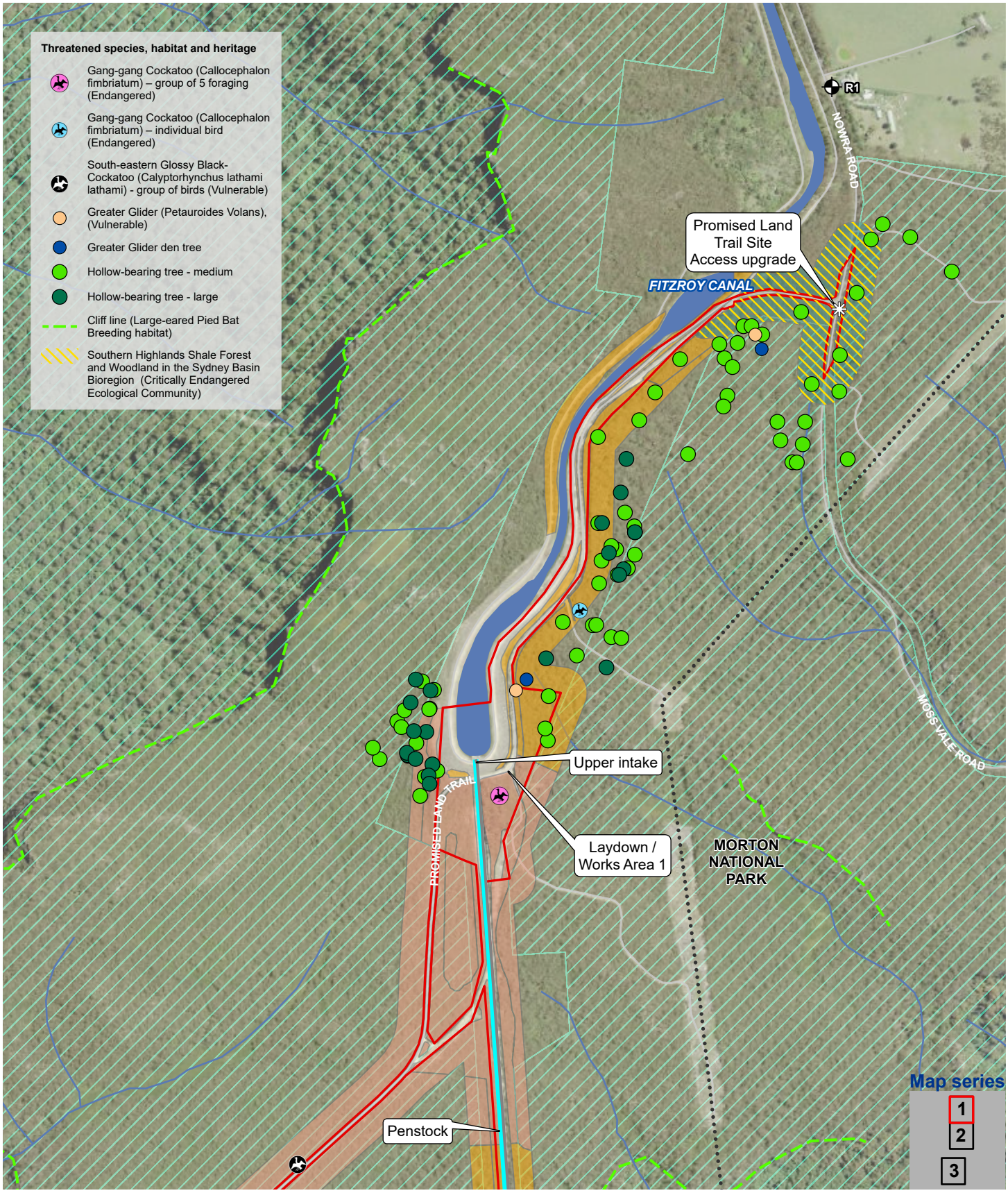
GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 2-4 Land use context

Date: 10/8/2022 Path: \\ausyd0vs01\GIS\Proj\NSW_IS362600_Shoalhaven\IS\Apps\IS362600_Acoustic.aprx
Created by: JB | QA by: AA



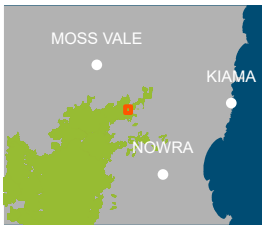
Legend

- Project area
- Existing scheme pipeline
- Indicative above ground pipeline
- Site access
- Non-associated sensitive receptors
- Transmission lines
- Road
- Waterway
- Waterbody
- NPWS Reserve
- PCT 1082 - Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion
- PCT 1156 - Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateaux, southern Sydney Basin Bioregion
- PCT 1254 - Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

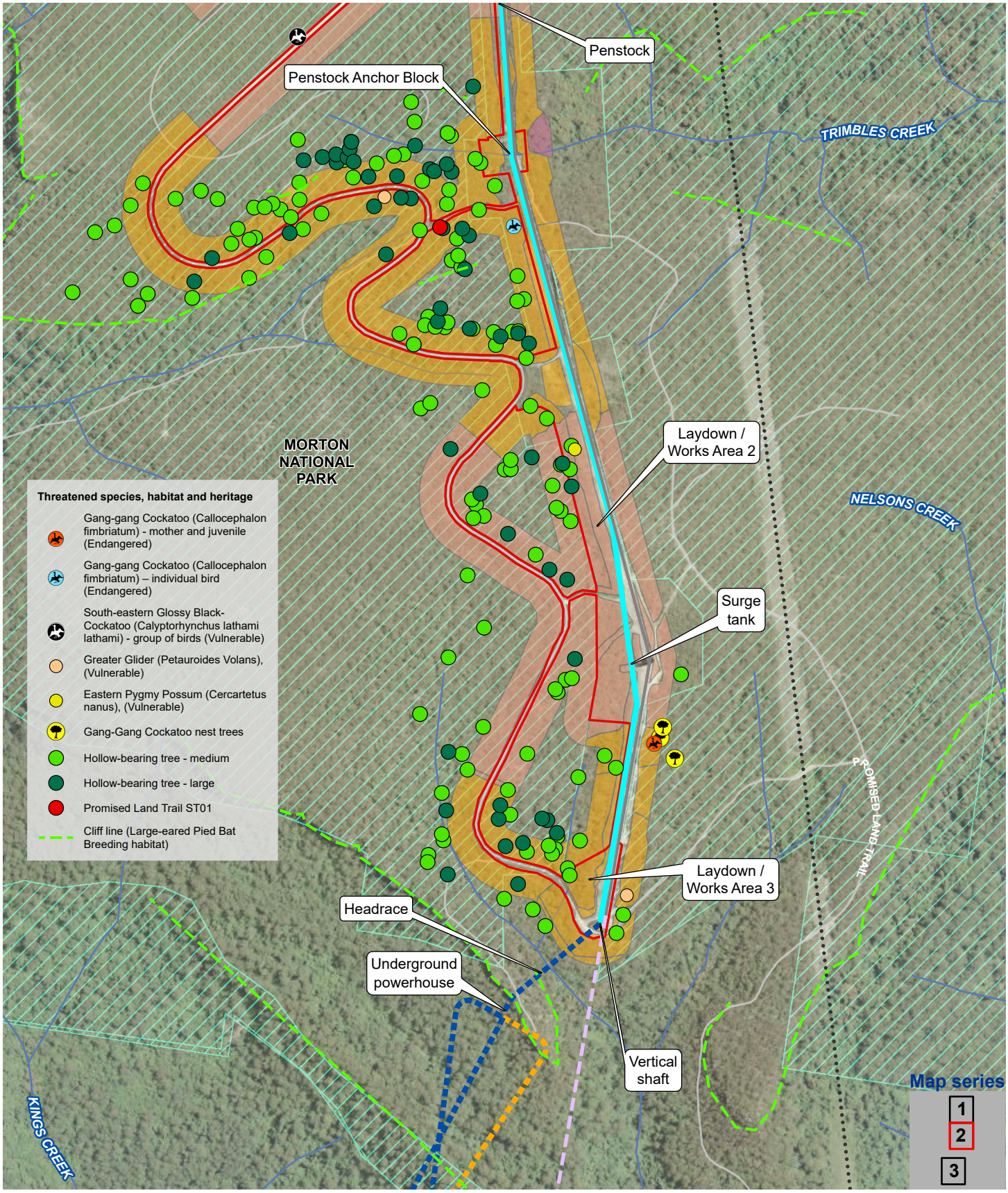


Data sources1

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 2-5 Project constraints

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC



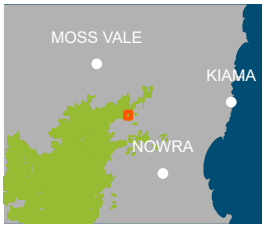
Legend

- Project area
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Transmission lines
- Road
- Waterway
- NPWS Reserve
- PCT 769 - Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion
- PCT 1082 - Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion
- PCT 1156 - Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateaux, southern Sydney Basin Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

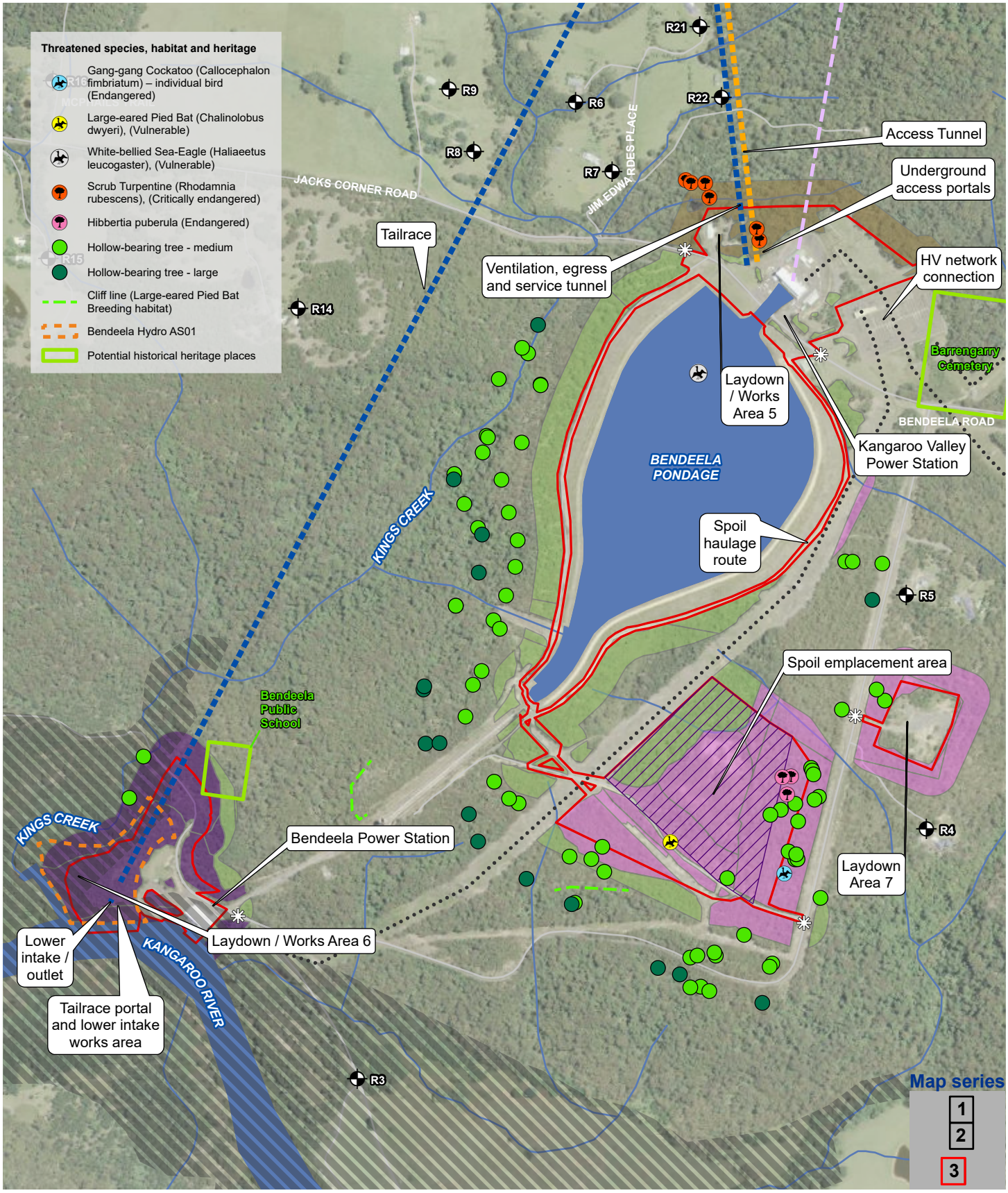


Data sources2

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 2-5 Project constraints

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC



Legend

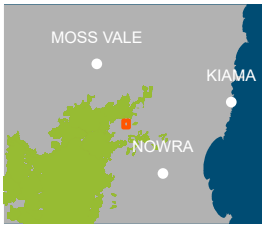
- Project area
- Spoil site
- Existing KV tunnel alignment
- Indicative tunnel alignment
- Indicative access tunnel
- Site access
- Non-associated sensitive receptors
- Transmission lines
- Road
- Waterway
- Waterbody
- Shoalhaven special area
- PCT 1083 - Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
- PCT 1108 - River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
- PCT 1245 - Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion
- PCT 1283 - Turpentine - Red Bloodwood - Sydney Peppermint shrubby open forest on the foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

N



Data sources3

Jacobs 2022

Department of Planning and Environment 2022

© Department of Customer Service 2020

Figure 2-5 Project constraints

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC

2.4.1 The Existing Scheme

The Existing Scheme was designed and constructed as a dual-purpose water supply and pumped storage hydro-electric project by the Sydney Metropolitan Water, Seage and Drainage Board and the Electricity Commission of NSW. The Existing Scheme intent was to augment Sydney's water supply by facilitating water transfers from the Shoalhaven catchment to Warragamba Dam whilst also providing peak load power. The Existing Scheme was constructed as the Kangaroo-Fitzroy project in parallel with a separate Burrawang-Wingecarribee project. The Existing Scheme operations under the Environment Protection Licence (EPL) 10595.

The Existing Scheme includes the following major assets:

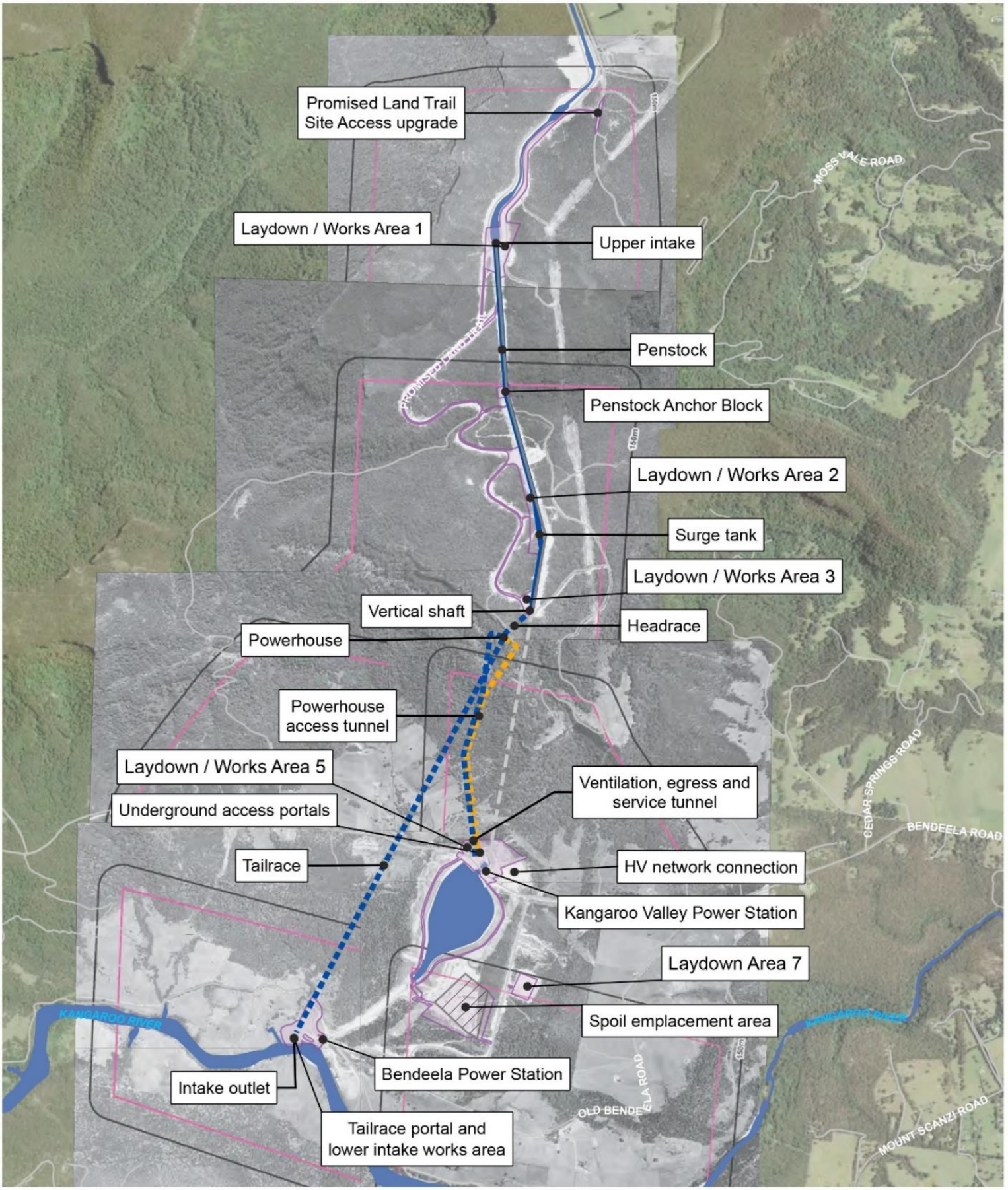
- The Tallawa Dam on the junction of Shoalhaven and Kangaroo Rivers creating Lake Yarrunga
- Bendeela Pumping and Power Station
- Bendeela Pipeline
- Bendeela Pondage
- Kangaroo Valley Power Station
- Kangaroo Valley Switching Station
- Kangaroo Tunnel and Shaft
- Kangaroo Pipeline
- Fitzroy Canal
- Fitzroy Falls Dam on Yarrunga Creek creating the Fitzroy Falls Reservoir
- Kangaroo Valley Switchyard and 330KV transmission line.

The construction of the Existing Scheme was a major undertaking leading to the current landform and environmental context in which the Project would be established. Key disturbance areas prioritised for use in the construction of the Project are illustrated in **Figure 2-6** and include the following:

- Promised Land Trail access from Nowra Road through Morton National Park requiring re-instatement for use in accessing the Upper Scheme
- Fitzroy Canal intake structure, refer to
- Full length of Penstock alignment including Trimbles Creek crossing
- Regrown construction works areas
- Cleared embankment cutting around the Kangaroo Valley Power Station
- Partially cleared and excavated area for planned spoil emplacement
- Area proposed for Laydown Area 7.

These disturbance areas are illustrated in **Picture 2-1** to **Picture 2-5**.

The targeting of areas of prior disturbance has been a strategic consideration of the Project design to avoid impacts while fully realising the social and economic benefits of long duration storage envisaged in the Original Scheme.



Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Road
- Waterbody

0 0.5 1 km

1:35,000 at A4

GDA2020 MGA Zone 56

N

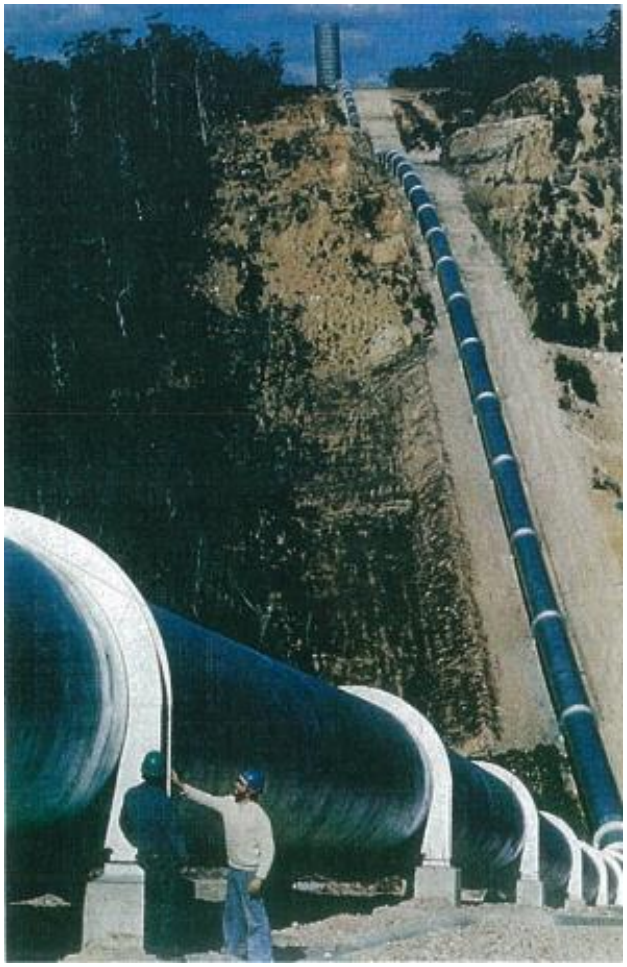
Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

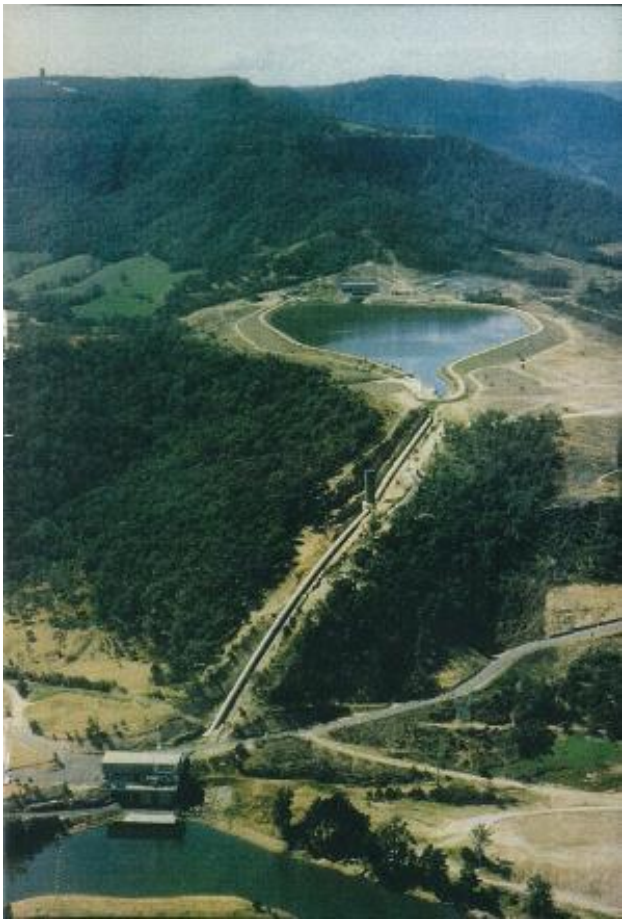
Figure 2-6 Historical context (1974)

Picture 2-1. Promised Land Trail access, Fitzroy Canal and Laydown Works Area 1 shortly after Original Scheme construction

Picture 2-2. Existing Fitzroy Canal intake structure



Picture 2-3. Existing Scheme Penstock construction disturbance (looking south across Trimbles Creek to Surge Tank)



Picture 2-4. Lower Scheme historic disturbance looking North across Bendeela Power Station (foreground) across Bendeela Pondage and proposed Spoil Emplacement (centre right) and Kangaroo Valley Power Station

Picture 2-5. Current penstock alignment

2.4.2 Morton National Park

The Morton and Budawang National Parks together comprise an area of over 190,000 hectares (ha) on the eastern escarpment of the Southern Tablelands. The park stretches from Bundanoon in the north to southeast of Braidwood and covers a diverse, rugged and scenically magnificent landscape. The Morton National Park is managed in accordance with the Morton and Budawang National Parks Plan of Management (NSW NPWS, 2001) (Plan of Management). This document recognises the important landscape, geology, biodiversity, heritage and wilderness values of the Morton National Park. The document also recognises existing uses associated with water and electricity infrastructure.

The Morton National Park was established in 1969 from a number of reserves dating back to 1824. The *National Parks and Wildlife Act 1974* (NPW Act) recognised the planning for the Existing Scheme through reference to the site selection and design process that had commenced in accordance with the preceding act of 1967. Specifically, Clause 182 of the NPW Act makes provision for the conclusion of site selection and subsequent revocation of the subject land from the park and vesting in the Sydney Catchment Authority and that the Minister may, from time to time, grant to the Authority such easements and licences over lands within the Park for pipelines, power lines and other purposes as may be necessary for or in connection with the use and operation of the dam and reservoir and ancillary works.

The Existing Scheme is also recognised as an 'Alien Use' in the Plan of Management as follows:

> *Sydney Catchment Authority, Shoalhaven Council, State Forests, Transgrid, Telstra, National Transmission Agency, Integral Energy, Duke Energy and the Department of Land and Water Conservation maintain facilities in the parks. These include river and rain gauging stations, Porters Creek Dam and treatment works, pipelines, powerlines, cables, a fire tower, radio aerials, a television translator station, trigonometrical stations and access roads. There are also a number of access roads to inholdings and to apiary sites.*

The Project would require access during construction as with ongoing operation via short sections of existing access tracks established as part of the construction of the Existing Scheme. It would also involve the establishment of a tunnel deep below a small section of the Morton National Park.

The Plan of Management includes a policy that new works, facilities or operations proposed by any organisation or individual will not be permitted unless they are consistent with the purposes of reservation of the park and the plan of management.

The *Developments adjacent to NPWS lands: Guidelines for consent and planning authorities* (NPWS, 2020), aim to guide consent and planning authorities in their assessment of development applications that are adjacent to land managed by National Parks and Wildlife Service (NPWS) to avoid any direct or indirect adverse impacts on NPWS parks. These guidelines specify that the consent authority needs to consider the following issues when assessing proposals adjacent to NPWS land and, in particular, their impacts on the park, its values and NPWS management of the park:

- Erosion and sediment control
- Stormwater runoff
- Wastewater
- Management implications relating to pests, weeds and edge effects
- Fire and the location of asset protection zones
- Boundary encroachments and access through NPWS lands
- Visual, odour, noise, vibration, air quality and amenity impacts
- Threats to ecological connectivity and groundwater-dependent ecosystems
- Cultural heritage
- Road network design and its implications for continued access to the park.

These considerations are consistent with the SEARs for the Project and assessment and mitigation measures identified in Section 6 are aligned with the recommended approaches to these issues outlined in the guideline. While some construction impacts are unavoidable, they are being minimised through the use of Existing Scheme disturbance areas and access arrangement. As such no increased ongoing impacts to the Morton National Park are anticipated as a result of the Project.

Section 153(1) of the NPW Act empowers the Minister administering the NPW Act to grant easements over land reserved as a national park for various purposes, including the construction of pipelines or for any other

purpose deemed necessary by the Minister. Origin proposes to seek easements to obtain access and permanent tenure over those areas of the Morton National Park required for the Project.

2.4.3 Shoalhaven Special Area

The Shoalhaven Special Area was established in 1970 and consists of 1467 ha of land surrounding lake Yarrunga. The Shoalhaven Special Area forms part of the Sydney Drinking Water Catchment.

Special Areas are lands declared under the *Water NSW Act 2014* (WNSW Act) for the following purposes:

- Protecting the quality of stored waters, whether intended for drinking or other purposes
- Maintaining the ecological integrity of an area of land declared to be a Special Area in a manner that is consistent with WaterNSW's objectives

Strategic management objectives for special areas are established in the Special Areas Strategic Plan of Management 2015 (WaterNSW and Office of Environment and Heritage,2015) as follows:

- Pollutants are controlled so that impacts on water quality and natural and cultural values are minimised
- Surface and groundwater sources and their interactions will be better understood so decisions are made that seek to minimise impacts on Special Areas hydrological integrity
- Pests and weeds are controlled so that impacts on water quality and ecological integrity are minimised
- Measures are in place to minimise the impacts of built assets within the Special Areas on water quality, ecological integrity and cultural values
- Access to the Special Areas is controlled to protect water quality and ecological integrity while providing for appropriate visitor opportunities
- Fire management within Special Areas maximises protection of life and property, and minimises impact on water quality and ecological integrity
- Ecological integrity including threatened plant and animal species, endangered populations, endangered ecological communities, geodiversity and other natural values are maintained
- Cultural heritage values are acknowledged and conserved, and community associations supported
- Management of Special Areas is supported by appropriate policy, planning and evaluation.

Laydown / Works Area 6 is within the Shoalhaven Special Area while the remainder of the Project area is within its hydraulic catchment. The Existing Scheme has the purpose of connecting the special area to the Sydney water supply system and the Project would provide a parallel connection but operate within the same limitations.

The EIS proposes mitigation measures to minimise impacts addressing the objectives in the Special Areas plan of Management.

Water NSW, as the owner of the land within the Shoalhaven Special Area, has the power to grant access and interests over that land provided the interests granted do not amount to alienating, mortgaging, charging or demising that land, which is prohibited in respect of land in a special area under section 48 of the Water NSW Act. Origin is still considering the form of tenure most appropriate for works proposed within the Shoalhaven Special Area. At this stage, it is considered that either a licence or easement would be sufficient, both of which are capable of being granted by Water NSW under the Water NSW Act.

2.4.4 Bendeela Recreation Area

The Bendeela Recreation Area is located within the Shoalhaven Special Area on the northern bank of Lake Yarrunga to the east of the Existing Scheme. The Bendeela Recreation Area consists of a popular, serviced campground operated by WaterNSW on WaterNSW land. Access to the campground may be affected by construction traffic during construction but no ongoing impacts post construction are anticipated.

2.4.5 Surrounding landholdings

There are several communities and townships near the Project. These include Barrengarry and Kangaroo Valley in the vicinity of the Lower Scheme and Fitzroy Falls, Wildes Meadow and Avoca in the vicinity of the existing Fitzroy Falls Reservoir.

Surrounding landholdings are rural in nature consisting of isolated dwellings to the east and west of the Project and are accessed off Bendeela Road and Jacks Corner Road. Some rural properties support holiday and recreational enterprises.

The Project would require the construction of the Underground Works beneath private rural properties.

The Scots College Glengarry Campus is located approximately 500 m to the west of the proposed water outlet works at Lake Yarrunga.

2.5 Alternatives considered

The original design of the Existing Scheme allowed for the expansion of the Kangaroo Valley Power Station and construction included sufficient capacity for the power station services including the transmission lines, Fitzroy Canal and canal interface structures (inlet gates and pipe head). However other works such as additional power station structures, above ground pipeline and tunnels, turbines and pumps were not completed as part of the original build. Four augmentation options were identified in 2017 as part of the Kangaroo Valley Hydro Station Expansion feasibility study, as follows:

- Option 1 – duplicating the Kangaroo Valley Power Station capacity with the addition of two 80 MW pump/turbine units. The Kangaroo pipeline, surge tank, shaft and tunnel would be duplicated, the underground power station building would be expanded and additional excavation and concrete works would be needed to house the new turbine/pump/generators. At the canal, a new outlet would be added while an additional inlet, bifurcation and discharge would be added at the Kangaroo Valley power station for the new generating units
- Option 2 – increasing the Kangaroo Valley Power Station maximum generating capacity by 160 MW using a single reversible pump/turbine unit. The Kangaroo pipeline, surge tank, shaft and tunnel would be duplicated while additional deep excavation and concrete works would be needed to house the new turbine/pump/generator in the existing underground power station building. At the canal, a new outlet would be added while additional inlet and discharge would be added at the power station for the new generating unit.
- Option 3 – increasing the Kangaroo Valley Power Station installed generating capacity by 80 MW by adding a single 80 MW unit. For this option, no change to the Kangaroo pipeline, surge tank, shaft or tunnel would be required. At the power station, a new inlet would be branched off the main pipeline upstream of the existing bifurcation. The discharge would be separate, with a draft tube leading into the pond and excavation and concrete works to house the new unit would be required.
- Option 4 – increasing the power generating capacity with a single 200 MW to 300 MW generating unit to be located at the Bendeela Power Station by utilising the elevation difference between the Fitzroy Falls Reservoir and Lake Yarrunga. This option would include a new inlet / discharge from Fitzroy Canal, an extended new high-pressure pipe/shaft/tunnel/penstock, a 200 MW to 300 MW turbine/ pump/ motor generator at Bendeela Power Station and discharge into Lake Yarrunga.

A further three options were considered in 2018, as follows:

- Option 5 – establishing an underground power station with single 235 MW unit, requiring a duplicate pipeline to a new surge tank adjacent to existing tank, shaft to high pressure tunnel, access adit/cable tunnel from existing Kangaroo Valley switchyard area, tailrace to Lake Yarrunga with underground surge chamber adjacent to underground power station and new intake/outlet on Lake Yarrunga downstream of existing Bendeela intake/outlet
- Option 6 – As per Option 5 but with an underground shaft directly from the intake/outlet on Fitzroy Canal instead of duplicate surface pipeline and surge tank
- Option 7 – Potential for a 500 MW scheme largely independent from the Existing Scheme including an underground shaft from a new intake/outlet on Fitzroy Falls Reservoir with a high-pressure tunnel, underground power station with two units, cable shaft to new substation near Fitzroy Falls Reservoir and access adit to Carters Road, Barren Garry, tailrace to new intake/outlet on new 50 ha pondage on Barren Garry Creek.

Of these, Option 5 was identified as the technically least complex option, and most likely to succeed on the basis of constructability and environmental impacts as summarised in **Table 2-2**.

Table 2-2. Options consideration summary

Option	Nature of development	Description	MW	Value Drivers	Exclusion drivers
Option 1	Brownfield	Expansion of original Scheme. 2 x 80MW at Kangaroo Valley Power Station. Duplicate pipeline and head race tunnel	160		Impact to existing operation. Limited mechanical plant options. Cost of multiple units.
Option 2	Brownfield	1 x 160MW expansion at Kangaroo Valley Power Station	160		Impact to existing operation.
Option 3	Brownfield	1 x 80MW serviced by existing pipeline and head race tunnel at Kangaroo Valley Power Station	80	Cost minimisation	Impact to existing operation.
Option 4	Brownfield	Bendeela capacity expansion utilising full head difference from Fitzroy canal. 1 x 200 - 300MW unit. Duplicate pipeline, new tunnel.	200	Improved cost benefit over options 1 and 2	Impact to existing operation.
Option 5	Greenfield	Duplicate pipeline. New tunnels and underground power station. 1 x 235MW. Shaft at existing surge tank location	235	Lowest risk / benefit. Min disruption.	
Option 6	Greenfield	New tunnels and underground power station. 1 x 235MW. Shaft at Fitzroy canal outlet works (No pipeline)	235		Cost of tunnelling vs pipeline construction. Compared to Option 5.
Option 7	Greenfield (remote from Existing Scheme)	New independent scheme 2 x 250MW including lower pond. New offtake direct from the Fitzroy Falls reservoir.	500		Complexity of siting and operability limitations.

Based on the above, Option 5 was selected for additional optimisation based on key comparative criteria including:

- Hydraulic design
- Geology / geomorphology
- Construction complexity and constructability
- Environment and permitting
- Operability and life cycle cost
- Capital cost
- Accessibility
- Schedule
- Safety.

To date, this optimisation has considered three variations to the general Option 5 arrangement as follows:

- The base case configuration with underground power station located at a depth of 330 m below ground level and below the vegetated lower portions of the escarpment with access to the power station cavern via tunnel from the Kangaroo Valley Power Station
- Alternative configuration 1 positioning the power station cavern closer to the vertical shaft from the new surge tank with access via the Kangaroo Valley Power Station reducing requirements for high pressure steel and simplifying access tunnel alignment
- Alternative configuration 2 positioning the underground power station closer to Lake Yarrunga at a shallower depth and lower relative level compared to configuration 1 and the base case, and with access from the vicinity of Bendeela Power Station.

Alternative configuration 1 has been identified as the preferred option and forms the basis of the concept design and construction methodology and is the subject of this EIS. This preferred option was identified as most favourable from hydraulic design, geology / geomorphology, environment and permitting, and

accessibility perspectives. From an environmental perspective, alternative configuration 1 was identified as the preferred option due to:

- Generating similar volumes of spoil with longer larger tailrace tunnel offset by simpler access arrangements compared to Alternative configuration 2
- Requiring the least impact on higher quality vegetation through locating access portal in existing cleared area adjacent to Kangaroo Valley Power Station
- Requiring the lowest volume of works impact beneath private freehold land
- Providing easier access to most favourable spoil location in close vicinity to access tunnel.

The selection of a preferred option is not intended to limit ongoing Project optimisation through the detailed design process. Option selection is instead required to establish the concept design and construction methodology and underpinning assumptions to be assessed in the EIS.

2.5.1 Do nothing option

While the option of not undertaking the Project would avoid the impacts identified in the EIS, the consequences of not undertaking the Project would include:

- Failure to achieve the Project objectives and resulting increased reliance on other means of supporting the development of a net zero and reliable electricity supply in NSW the avoidance of impacts
- Not realising the benefits of the construction of the Existing Scheme
- Not providing an alternate means of backup water transfers for the Sydney drinking water supply in the event of the Existing Scheme is out of service.

3. Project description

This chapter provides a detailed description of the Project features including infrastructure components and proposed construction methodology as well as operational aspects based on current available design information.

3.1 Overview

The Project involves the design, construction and operation of a new pumped hydroelectric power station involving water transfer between two existing reservoirs comprising of the Fitzroy Falls Reservoir in the Upper Scheme and Lake Yarrunga on the Lower Scheme. The Project would draw on Origin's existing water allocations to pump water up approximately 612 m from Lake Yarrunga and consuming energy when demand is low. Electricity would then be generated through the return of water from Fitzroy Falls Reservoir to Lake Yarrunga when demand for electricity increases.

The Project is expected to have a nominal capacity of approximately 235 MW and be capable of generation for over 13 hours in parallel with the Existing Scheme operation. The parallel operation of the Project and Existing Scheme is supported by Origin's existing water allocations under normal operations, however additional water can be taken if required to support certain network conditions if Origin is directed to operate by AEMO.

The Project layout based on the current reference concept is provided in **Figure 1-2** and an indicative cross section of the Project is provided in **Figure 3-1**. The alignment is indicative at this stage and has been used for the purposes of the environmental impact assessment (EIA), including all specialist investigations. During detailed design the alignment may change. Any changes to the alignment would be reviewed for consistency with the assessment contained in this EIS including relevant mitigation measures, performance outcomes and any future conditions of approval.

3.2 Design status and strategy

Origin is currently working to identify and select contractors to undertake engineering design (and construction) to progress the Project toward an FID. While this process will not be completed prior to the EIS exhibition, it will result in increased confidence and definition in the Project design and construction methodology. However, as this EIS has been prepared prior to the appointment of a design and construction contractor, the design and construction strategy presented and assessed in this EIS aims to provide an assessment of probable construction methodologies, while retaining some flexibility for the contractor to refine the design and construction methodology following their appointment.

The concept design would continue to be refined where relevant to improve operational performance and safety, minimise impacts on receivers and the environment, and in response to feedback from stakeholders.

Until the detailed designs are complete, there will remain a range of potential concept design and construction methodology refinements which may include, but not be limited to:

- Difference in performance capabilities of the reversable pump / turbine balancing output capacity, available flow rates and round-trip energy efficiency
- Resultant hydraulic requirements and design solutions for their management affecting items such as surge tank size and location, lining requirements and pipe dimensions
- Final location of the underground power station balancing geotechnical conditions, hydraulic performance, spoil generation, lining requirements and access tunnel design
- Tunnelling methods including selection of use of road header, drill and blast or tunnel boring machine balancing mobilisation risks and tunnelling rates and considering environmental and amenity impacts
- Location of tunnel support services balancing avoidance of clearing with amenity impacts within available land
- Use of off-site construction ancillary facilities potentially including temporary laydown areas, parking and workers accommodation.

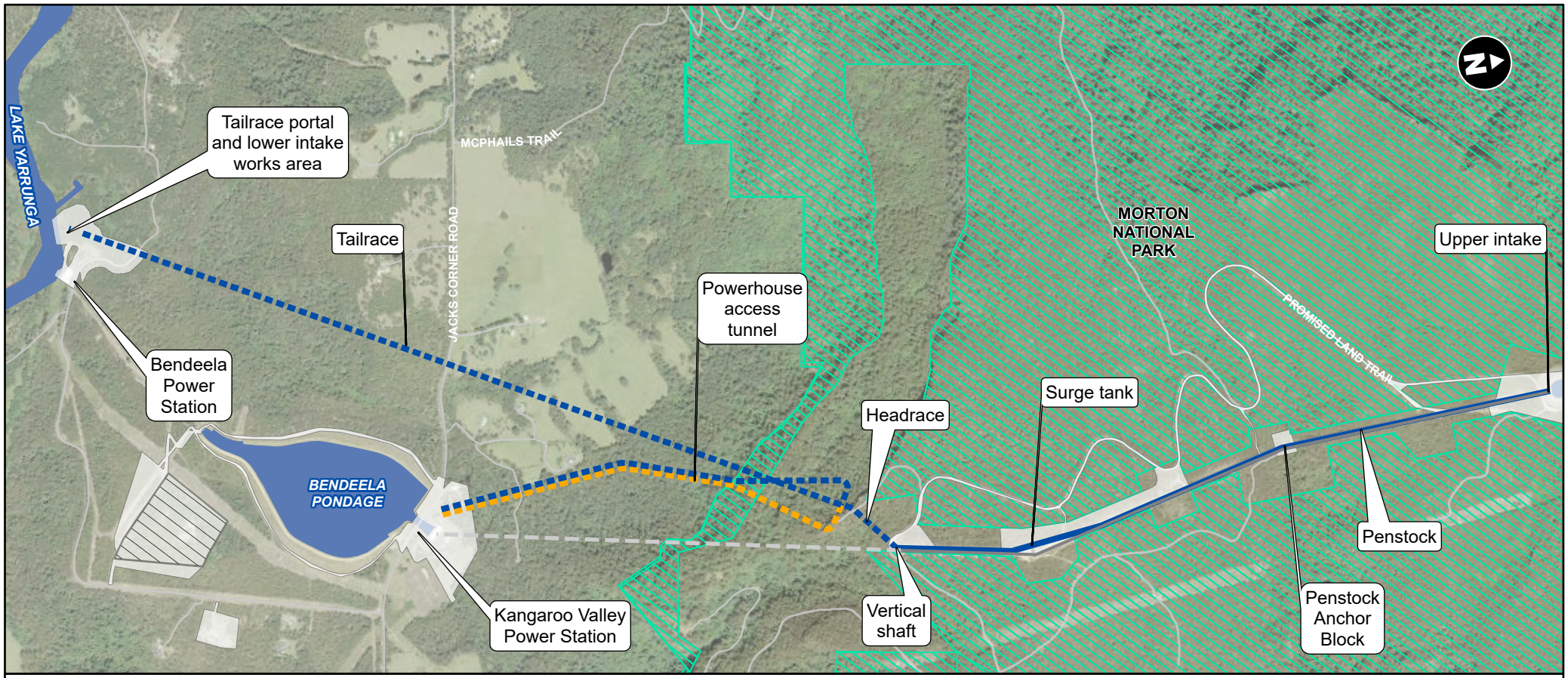


Figure 3-1 Cross Section

Data sources

Jacobs 2022
NSW Spatial Services 2022

Date: 10/27/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : AA

For technical and practical reasons, there may also be a requirement to reconsider elements of the concept design and construction methodology during the detailed design and into the construction phase. Potential refinements may include but not be limited to:

- Repositioning of Project components where required for constructability, environmental impact avoidance, efficiency or cost and balancing environmental and social impacts
- Altered construction methods where justified based on minimisation of environmental or social impact, construction duration or cost
- Generation capacity or duration due to improvements in technology.

It is desirable that flexibility is provided in the concept design and construction methodology to allow the final design and specifications for the Project to be determined based on selection of preferred technology and optimisation of layout to achieve an appropriate balance of economically, environmentally and socially targeted development outcomes. The assessment of the Project within this EIS is based on the identified reasonable worst case impact scenarios and generally adopting higher impact methodologies under consideration at the time of lodgement that may ultimately not be selected.

A summary of the main Project elements is provided in **Table 3-1**.

Table 3-1. Project summary table

Project element	Summary of the Project
Site Description	
LGA	Construction and operational components predominantly within the Shoalhaven LGA with the exception of the northern extent of the Promised land trail and associated access upgrade on Nowra Road which are located in Wingecarribee LGA.
Project location	Suburbs of Kangaroo Valley (Shoalhaven LGA) with access via Fitzroy Falls (Wingecarribee LGA) and Barrengarry (Shoalhaven LGA) in accordance with Schedule 5 Clause 13 of the *State Environmental Planning Policy (Planning Systems) 2021*.
Zoning	Plateau: SP2 Infrastructure (Water Supply System) with access through C1 National Parks. Valley: Above ground Project area limited to SP2 Infrastructure (Water Supply System), Underground Works below RU1 Primary Production, C2 Nature Conservation and C1 National Parks.
Access	Upper Scheme: Access via Promised Lands Trail off Nowra Road between Fitzroy Falls and Barrengarry Lower Scheme: Access via Jacks Corner Road and Lower Bendeela Road of Moss Vale Road between Shoalhaven and Barrengarry.
Specification	
Capacity	Minimum of 235 MW
Pump and Generation minimum cycle efficiency	Minimum 79 %
Project components	
Upper Intake	Connection to existing control structure on Fitzroy Canal
Surface pipeline	Approximately 2.5 km in length and 3.1 metres (m) in diameter running south from the upper intake within the established corridor established as part of the Existing Scheme.
Surge Tank	A lined surge tank on the surface pipeline with diameter of approximately 15 m and approximate height of 48 m approximately 2 km south of the upper intake structure
Shaft	Bored and lined shaft approximately 550 m deep with an approximate internal diameter of 3.5 m connecting to the southern end of the surface pipeline
Headrace tunnel	Approximate 300 m lined tunnel with approximate internal diameter of 3.5 m.
Power House and Transformer Cavern	Power station cavern to be excavated approximately 475 m below ground level to house reversable pump turbine /motor generator connected to the headrace tunnel with connection to the grid via a step-up transformer
Tailrace tunnel	Approximately 3 km lined tunnel with internal diameter of 5.5 m and associated underground surge chamber with internal diameter of 10 m and 90 m in height.

Project element	Summary of the Project
Lower Intake/ Outlet works	Concrete canal of approximately 50 m in length and 22 m in with a finished depth of 18 m with associated control structures connecting the tailrace tunnel to the northern bank of Lake Yarrunga west of the Bendeela Power Station.
Access tunnel	Shotcrete lined tunnel with concrete road surface approximately 1.8 km in length and 7.5 m in diameter providing access to the power station cavern via a portal located west of existing Kangaroo Valley Power Station.
Multipurpose tunnel	Segregated and shotcrete-lined ventilation, egress and services tunnel approximately 1.8 km long with 5.5 m finished internal diameter connecting to the power station cavern via a portal immediately west of the Kangaroo Valley Power Station.
Grid connection	Step-up transformer connected to the network via 330 Kilovolt (KV) cable routed through the multipurpose tunnel and underground conduit to the existing Kangaroo Valley Switchyard located immediately east of the Kangaroo Valley Power Station.
Access, tracks and parking	Reinstatement and use of existing all weather Promise Land Trail access from Nowra /Moss Vale Road and establishment of additional on-site access tracks as necessary to facilitate construction. The use of off-site parking and shuttle arrangement would be considered to avoid unnecessary impacts associated with provision of on-site parking during construction.
Operational buildings	Surface infrastructure adjacent to existing Kangaroo Valley Power Station includes parking, water tanks, water treatment, emergency generator and ventilation system.
Spoil management area	A permanent spoil emplacement located predominantly in previous disturbance area of the Existing Scheme with controls for managing surplus excavated material which may include crusher plant for reuse, treatment area for potential acid forming (PAF) materials if encountered, encapsulation area if necessary and drainage and water treatment facilities.
Construction	
Main ancillary construction works areas (surface works)	Upper Scheme works areas (from north to south) include: ▪ Promised land trail access upgrades ▪ Works area 1 adjacent to upper intake ▪ Surface pipeline and anchor block ▪ Works area 2 including surge tank ▪ Works area 3 including vertical shaft top. Lower Scheme works areas include: ▪ Works area 4 spoil emplacement area ▪ Works area 5 including access and multipurpose tunnel portal and grid connection near Kangaroo Valley Power Station ▪ Works area 6 including lower intake and tailrace portal west of Bendeela Power Station ▪ Works area 7 depot laydown only.
Below ground works	Approximately 6.8 km of tunnelling, 530 m of vertical boring and 12,000 cubic metres (m^3) of cavern excavation
Spoil generation	Estimated 420,000 m^3 of spoil
Project area (also referred to as Development site in Biodiversity Development Assessment Report (BDAR)	Above ground construction disturbance area of approximately 53 ha consisting of 23 ha in the Upper Scheme and 30 ha for Lower Scheme including areas of existing cleared land.
Anticipated clearing	Native vegetation clearing of approximately 29 ha subject to full maximum disturbance area being required with remaining Project area consisting of existing disturbance associated with the Existing Scheme or non-native vegetation.
Construction Workforce	Average 250 Full Time Equivalent (FTE) with a three-month peak of up to approximately 370.

Project element	Summary of the Project
Hours of work	
Standard construction hours	Monday-Friday 0700-1800, Saturday 0800-1300 and no Sunday or public holiday work.
Blasting on and close to the surface	Monday to Friday 0900 – 1700, Saturday 0900 to 1300 and No blasting on Sundays or public holidays
Underground construction and essential associated surface support activities	24 hours per day, seven days per week and includes: ▪ Operation of surface plant essential to underground works including ventilation, grout and water treatment facilities ▪ Tunnel, shaft and underground power station excavation, support and lining activities including rock hammering, blasting, mucking, rock bolting, reinforcement, shotcreting / concreting, grouting and installing steel lining.
Out of hours works	▪ Receipt and unloading where necessary of oversize and over mass deliveries where required due to transport restrictions ▪ Non-disruptive preparatory work, repairs or maintenance ▪ Other works to facilitate reduced program or other impacts as set out in the EPL issued by the NSW Environment Protection Authority (EPA)which may include spoil haulage.
Indicative construction schedule	Project construction is targeting commencement in 2023 and has an approximate five year duration including (not consecutive): ▪ Six month planning and mobilisation stage – early works ▪ Thirty month Upper Scheme works ▪ Thirty-six month tunnelling and power station cavern excavation works and associated spoil haulage and emplacement ▪ Twelve months outlet works construction period ▪ Twelve month underground power station fit-out ▪ Three month testing and commissioning stage.
Vehicle movements	
Total vehicle movements	The following vehicle movements are required to facilitate construction: ▪ Approximately 3,700 truck movements including 550 oversize / over mass vehicles ▪ Approximately 36,000 truck movements associated with spoil haulage ▪ Approximately 13,700 bus movements associated with workforce transport ▪ Approximately 41,000 light vehicle movements associated with workforce transport. These movements would be spread over the duration of the Project resulting in typical daily movements as follows: ▪ 2 – 100 heavy vehicle movements associated with deliveries ▪ 20 – 60 spoil truck movements ▪ 7 – 16 bus movements associated with workforce transport ▪ 20 light vehicle movements associated with workforce transport. On the basis of an indicative construction sequencing it is likely that spoil haulage, deliveries and workers transport would be compressed over a period during peak tunnelling works. Peak daily traffic movements for intersection performance modelling purposes is summarised below.

Project element	Summary of the Project
Modelled peak daily traffic volumes (workforce and deliveries)	The following traffic movements have been considered associated with the Upper Scheme: ▪ Eight shuttle buses, 12 light vehicles and 6 heavy vehicles per hour during modelled peaks associated with shift start / end times ▪ Fifteen heavy vehicles and 2 light vehicles per hour outside of shift start / end peaks ▪ Approximately 400 out of hours delivery of oversize and over mass components at approximately four per hour over multiple nights. ▪ The following traffic movements have been considered associated with the Lower Scheme: ▪ Eight shuttle buses, 12 light vehicles and 6 heavy vehicles per hour during modelled peaks associated with shift start / end times ▪ Fourteen heavy vehicles and 6 light vehicles per hour outside of shift start / end peaks ▪ Approximately 150 out of hours delivery of oversize and over mass components. Where a vehicle movement is defined as one vehicle entering and leaving.
Spoil haulage	Estimated bulked spoil generation of 420,000m^3 involving the following haulage movements: ▪ Approximate peak of 62 haulage movements per day from access and multipurpose tunnel to spoil emplacement targeting use of internal access tracks ▪ Approximate peak of 14 haulage vehicles per day from Tailrace tunnel portal to spoil emplacement via Lower Bendeela Road ▪ Approximate peak of 19 haulage movements per day from Promised Land Trail to spoil emplacement via Moss Vale Road, Bendeela Road, Jacks Corner Road and internal access track (scheduled so as not to exceed heavy vehicle daily traffic volumes considered above).
Materials and components	Major material volumes are estimated as follows: ▪ Steel – approximately 7500 t in total including pipe, transformers, turbines, generators and all incidentals. ▪ Concrete - 45,000 m^3 ▪ Grout – 5,000 m^3 Oversize components with approximate weights: ▪ Pump/Turbine runner (30 t) ▪ Upper casing (30 t) ▪ Lower casing (30 t) ▪ Generator stator (100 t) ▪ Generator rotor (100 t) ▪ Main Inlet Valve (50 t) ▪ Generator Step Up Transformer (150 t) ▪ Construction equipment such as mobile cranes (100 t) ▪ Steel Pipe segments (oversize). Construction water requirements are estimated at 362 megalitres (ML) over the 5 year construction period predominantly associated with dust suppression, tunnelling and concrete batching. Some of this water would be sourced from recycled / captured groundwater noting that there is a water balance surplus predicted. Make-up water would be sourced from Bendeela Pondage and Fitzroy Canal subject to water access agreement with WaterNSW.
Operations	
Operational life expectancy	100 years
Operational workforce	Approximately three additional FTE when considered in operation with the existing plant. This excludes outage and maintenance staff requirements.
Daily Operation Traffic Movements	Two (light vehicles) and ad-hoc heavy vehicles associated with maintenance activities.
Maximum operating scenario	Daily cycling in response to market requirements with peak generation of up to 13 hours in parallel with Existing Scheme operation or more when Existing Scheme is offline.

Project element	Summary of the Project
Pumping power supply	The Project would be powered by direct connection to the NEM and for the purposes of the EIS is assumed to draw power at projected average carbon intensity of the NEM. In reality, power consumption for pumping mode is likely to coincide with periods of low-cost energy supply which are predominantly driven by daytime solar generation. Origin may also enter into renewables power purchasing agreements or use its own Variable Renewable Energy to essentially power the scheme via renewable energy.
Permanent infrastructure footprint	Permeant footprint comprising: ▪ Lower intake structure, controls and access – 0.4 ha of vegetation clearing ▪ Access and ventilation tunnel portal, operations buildings and ancillary infrastructure (water treatment, ventilation, emergency generator and network connection) – 0.3 ha of vegetation clearing ▪ Surface penstock surge tank and top of high pressure shaft – 14 ha within existing cleared alignment ▪ Rehabilitated spoil emplacement area including drainage and water treatment infrastructure – 10 ha.

3.3 Concept design overview

The Project will create a second link between Fitzroy Falls Reservoir and Lake Yarrunga through a new series of surface penstock (running alongside the existing penstock alignment), high pressure shaft, underground hydroelectric power station and tailrace tunnel. The Project will use Existing Scheme components that were designed and constructed to support future expansion including Fitzroy Canal and the canal upper intake control structure, surface pipeline preparatory earth works and Kangaroo Valley switchyard and transmission connection.

An access tunnel and multi-purpose ventilation, egress and services tunnel will provide maintenance access to the underground power station. The grid connection will be via the existing switchyard located immediately east of the Kangaroo Valley Power Station.

The Project will be designed for unmanned operation and under normal operating conditions, operations and maintenance activities will be limited to routine operations surveillance or routine maintenance consistent with good international hydro power practices. The Project will be designed for fully automatic remote control, start up and shutdown in all modes of operation from the Kangaroo Valley Power Station.

The Project will have a nominal rated capacity of 235 MW at 50 hertz (Hz) and export to the grid at 330 KV. Primary operation of the Project is likely to prioritise round trip energy costs and target daily pumping and generation in response to market needs. The Project will also be designed to be capable of operating as a synchronous condenser, and provide black start capability compliant with the AEMO requirements to participate in System Restart Ancillary Services market. From time to time when there is volatility in the Frequency Control Ancillary Services (FCAS) market, the Project may reduce generation to provide FCAS headroom and fast response.

The Project is designed to operate using water allocations linked to the Existing Scheme without constraining operation of the Existing Scheme.

3.3.1 Project components

The Project design includes the following permanent infrastructure:

- Upper Scheme surface pipeline and associated existing intake control structure, anchor block and surge tank
- Vertical shaft and headrace tunnel
- Power station cavern and generating unit
- Transformer/s
- Tailrace tunnel
- Outlet works
- Access and multipurpose egress and ventilation tunnel
- Ancillary surface infrastructure.

Permanent infrastructure is described in more detail in the subsequent sections.

3.3.1.1 Surface pipeline

A surface pipeline will be used to convey water from the end of the Fitzroy Canal to the vertical shaft. The pipeline will connect into the existing intake works via an existing connection portal (refer to **Picture 3-1**).

Picture 3-1. Upper intake connection portal

The surface pipeline will occupy the constructed earthworks alignment adjacent to the existing above ground pipeline (refer to **Picture 3-2**), essentially duplicating the existing pipeline depicted.

Picture 3-2. Connection penetration into Fitzroy Canal for replicated pipeline

Similar to the existing pipeline, the proposed surface pipeline will be approximately 2.5 km in length and approximately 3.1 m in diameter. The pipe will be constructed of steel and secured on footings with an

anchor block located in the valley adjacent to Trimbles Creek. The pipeline will be structurally supported along its alignment by approximately 98 stiffener rings that also serve as saddle supports. The rings will be welded to the penstock and form sliding supports adjoining pre-cast support foundations as illustrated in **Picture 3-3**.

Picture 3-3. Example of a penstock saddle supports

From the intake structure to the surge tank, the penstock route runs adjacent to the existing operational surface penstock servicing the Kangaroo Valley Power Station. The new pipeline will be constructed adjacent to this pipeline along an existing easement corridor that was created for a future expansion of the Existing Scheme. The easement was substantially excavated with the original construction to the same level as the existing adjacent pipeline. The route traverses a valley with two main inclines, the steepest being approximately 36 % slope. South of the surge tank, the penstock deviates slightly from the existing alignment towards the southwest.

At its northern end, the surface pipeline will connect into the existing Fitzroy Canal control works. The control works structure at Fitzroy Canal exists for the Project and was installed as part of the Existing Scheme. It is owned and operated by WaterNSW and includes:

- The civil structure
- Integrated structural components such as trash rack and stoplog runner slots
- Integrated access structures such as ladders to enter the intake
- Stoplogs and trash racks
- A local weatherproof electrical equipment building with sufficient capacity to house expanded power, control and backup power supplies.

In addition to the Fitzroy Canal control works structure, the surface pipeline will be anchored at the low point in the vicinity of Trimbles Creek. The pipeline will also be fitted with a controlled dewatering point at this low-point for maintenance and emergency de-watering to Trimbles Creek.

Access for maintenance to the pipeline will be provided at four locations along the alignment including:

- Adjacent to the expansion joint at the upper intake control works

- The thrust block location
- Adjacent to the surge tank
- On the surge tank above the tank inlet level.

3.3.1.2 Surge tank

The surface pipeline will connect to a surge tank with a diameter of approximately 10 m and approximate height of 48 m. The surge tank operates to dissipate pressure changes following planned or unplanned disruption of flow including switching operation modes such that they do not lead to pipe failure.

The size and location of the surge tank would be dictated by hydraulic considerations of the selected design but for the purposes of the EIS will be similar to the surge tank used in the Existing Scheme (refer to **Picture 3-4**) and be located approximately 40 m to the west.

Picture 3-4. Existing surge tank

3.3.1.3 Vertical shaft and headrace tunnel

A vertical shaft and inclined headrace tunnel will operate to convey water from the above ground pipeline to the underground power station. The vertical shaft will be approximately 550 m deep. The headrace tunnel is anticipated to be 10 % inclined and approximately 250 m in length from the power station cavern to the base of the vertical shaft. The vertical shaft and the headrace tunnel will have an approximate internal diameter of 3.5 m (5.5 m tunnelled diameter) and are anticipated to be lined.

3.3.1.4 Powerhouse

The key component of the Project is the underground power station which would operate to pump water up from Lake Yarrunga to the Fitzroy Reservoir and use potential energy to generate electricity through releasing water the other way.

The power station would be comprised of a single reversable turbine / pump and associated motor generator, step up transformer(s) and electrical equipment with a nominal rated generation capacity of 235 MW. The

underground power station and transformer will be located approximately 550 m below ground level within a cavern and include the following components:

- A power plant consisting of a single Francis Reversible Pump Turbine, capable of operating and switching between generation and pump mode
- Motor generator
- Step-up transformer
- Operation facilities including underground parking, office and welfare facilities, warehouse and maintenance facilities warehouse
- Maintenance structures including gantry crane and erection bay
- Ventilation and fire detection and suppression systems.

3.3.1.5 Tailrace

The tailrace tunnel would operate to transfer water between Lake Yarrunga and the underground power station. The tailrace would be a low-pressure tunnel with steel lining (or similar) located immediately adjacent to the underground power station before transitioning to concrete lining to the inlet / outlet works at Lake Yarrunga. Note that the final selection of lining materials may change and are subject to the final detailed design. The tailrace tunnel would have an internal finished diameter of approximately 5.5 m. Subject to detailed design, the tailrace would be connected to an underground surge chamber connected to the access or multipurpose tunnel to dissipate pressure changes for the same purpose as the surge tank.

3.3.1.6 Lower outlet/intake

The tailrace tunnel will connect to Lake Yarrunga via a new outlet / intake structure. The outlet/intake structure would be located approximately 80 m downstream (west) of the Bendeela Power Station and would be configured with a gate or bulkhead and trash-racks. The intake structure would be located approximately 60 m inland from the existing bank of Lake Yarrunga and connected to lake via a channel to be cut through the rock bank.

The design of the inlet / outlet to Lake Yarrunga would allow operation of the Project within the parameters of the existing water allocation, including minimum and maximum water levels. Flow rates within the channel to Lake Yarrunga would be designed and managed to avoid scouring.

3.3.1.7 Access and multi-purpose tunnels

The underground power station will be accessed by an inclined tunnels approximately 1.8 km in length. This tunnel is anticipated to have internal dimensions of up to 8 m in diameter and be configured to allow delivery vehicles to turn-around below ground. It is anticipated that both the access and multi-purpose tunnel would be connected to Jacks Corner Road west of, and within the compound of, the existing Kangaroo Valley Power Station.

3.3.2 Ancillary operational components

Various ancillary components are required for the operation of the Project, including:

- Grid connection infrastructure to convey electricity to and from the generator to the existing switch yard at the Kangaroo Valley Power Station
- Water, sewage, power, communications and other services, including as required connections to the Kangaroo Valley Power Station
- An operations compound and buildings including fire water tanks, ventilation plant, backup generator and access structures proposed to be to be located either within the existing Kangaroo Valley compound or underground.

3.4 Construction strategy

An overview of the key features of the Reference Concept construction methodology for the Project is outlined below. These methods are subject to change based on detailed design and constructability consideration.

The management of environmental impacts during construction would be documented in a construction environmental management plan (CEMP) that will prepared prior to construction. The CEMP would provide a centralised mechanism through which all potential construction-related environmental impacts will be managed. It would also provide the overall framework for the system and procedures to ensure that environmental impacts are minimised, and that legislative and approval requirements are fulfilled.

3.4.1 Upper Scheme construction

Upper Scheme construction would include:

- Promise Land Trail access upgrade from Nowra / Moss Vale Road
- Establishment of preliminary and progressive erosion and sediment controls
- Restoration of full width of the Promise Land Trail including clearing and safety and drainage improvements
- Establishment of temporary laydown and works areas
- Establishment of anchor block at Trimbles Creek
- Establishment of anchor at the vertical shaft
- Surge tower construction including excavations, foundation works and steel structure erection
- Installation of pipeline including support excavation, saddle support installation, pipe placement and welding
- Tie-ins to existing upper intake pipe stub
- Boring and lining of high pressure shaft.

The surface penstock construction along the alignment has considered the use of methods such as cable crane and / or winch and rail and pipe laying cranes. The methods deployed may vary subject to detailed design and construction planning. The sections that follow outline the reasonable worst-case approaches that underpin impact assessment findings. In all cases, clearing will be limited to the extent reasonable and feasible and avoiding encroachment into the Morton National Park with the exception of the required works to the Promised Land Trail.

3.4.1.1 Upper Scheme logistics

The transport of materials will require the reinstatement of the Promised Land Trail to its original width and may require and upgrade to the intersection of Moss Vale / Nowra Road to improve safety. Vegetation clearance and road upgrades will occur along the Promised Lands Trail within the approved disturbance areas to facilitate the delivery of construction materials and access by workers, plant and equipment. An indicative intersection concept layout for the Promised Land Trail access upgrade is provided in **Appendix B** and would be finalised in consultation with the relevant road authority. The Promised Land Trail is not a public road and design, construction, use, maintenance and rehabilitation would be agreed with the relevant landowners (NPWS within the Morton National Park and otherwise WNSW).

Materials may also be transported down the pipeline alignment using winch and rail or cable crane system. If adopted, this would occur within the assessed Project area.

The transport of heavy and large dimensional materials and equipment along the plateau includes, but is not limited to:

- Penstock pipe sections
- Headrace liner sections
- Headrace elbow
- Raise bore and blind bore drilling plant
- Concrete and steel bar for surge tank and anchor construction
- Construction ancillary plant and equipment such as water tanks, fuel tanks, temporary power generators, crib huts, cranes
- Plant and equipment for temporary support and grouting of the shaft.

3.4.1.2 Upper Scheme Laydown and construction works areas

Three main work areas are anticipated and are shown in **Figure 1-2**.

- Adjacent the Fitzroy Canal – Laydown / Works Area 1
- At the surge tank – Laydown / Works Area 2
- At the headrace shaft location – Laydown / Works Area 3.

Laydown / Works Area 1 would be used predominantly for the construction of the upper intake control works but may also be used to accommodate equipment and material unloading and transfer to the penstock alignment or transport to other works areas at a later date. Works would be limited to standard construction hours but may be extended on Saturdays where able to achieve noise management levels (NMLs).

Laydown / Works Area 2 would be used for the construction of the surge tank and as the primary storage and works area for the penstock construction. Works would be limited to standard construction hours but may be extended on Saturdays where able to achieve NMLs or where necessary for continuous works such as concrete pours for surge tank foundations subject to out of hours works protocols.

Laydown / works Area 3 would be used for the construction of the vertical shaft, and due to space limitations is unlikely to support worker amenities and instead rely on Works Area 2. Works would be limited to standard construction hours but may be extended on Saturdays where able to achieve NMLs or where necessary for continuous works such as boring.

A works area is also allowed for at the anchor block location at Trimbles Creek.

3.4.1.3 Erosion management and penstock drainage control

As soon as practicable after mobilisation, and generally before other clearing and ground disturbance, erosion and sediment controls will be implemented. Detailed erosion and sediment control plans (ESCP) would be progressively implemented. Provision for space for a number of sediment basins has been made on the basis of complete ground disturbance over the identified disturbance area with need and sizing to be resolved through the detailed design process.

In addition to standard controls, slope protection will be employed along the width of the surface penstock where surface inclinations exceed 25 degrees (approximately 450 m). Drainage control civil works will be constructed at the surface penstock low point to Trimbles Creek to direct pipeline drainage water to the waterway in a controlled manner consistent with the Existing Scheme.

3.4.1.4 Surface penstock construction methodology

The new surface penstock would be constructed to the west of the existing surface penstock within a right of way that was finished (excavated and backfilled) to the same level as the existing penstock when constructed in the 1970's. The existing treatment of the right of way substantially limits clearing, cut and fill required to install the surface pipeline. As such the works sequence for pipeline installation is expected to require:

- Clearing within alignment and overhanging vegetation which poses a potential safety risk to workers to facilitate construction
- Establishment of progressive erosion and sediment controls
- Localised excavations for pipeline saddle foundations
- Excavations to achieve suitable gradients where alignment deviates around the Existing Scheme surge tower, to establish foundations for the surge tank and anchor block
- Drainage improvements
- Provision for relocation of existing services and communications
- Pipeline installation and welding.

The finished minimum pipeline-to-pipeline distance between the Project and Existing Scheme will be in the order of 2.1m.

Multiple work fronts may be adopted with different penstock sections proceeding concurrently and in either direction. The construction of the penstock can be performed independently of the Lower Scheme works, and its duration is not critical from an overall Project perspective.

3.4.2 Vertical Shaft construction

For purposes of the concept design the vertical shaft will be constructed by raise boring to achieve the final excavated shaft diameter. The basis for this method includes the following:

- Origin's decision to limit spoil removal and placement on the plateau, and limit truck movements on Moss Vale Road
- Minimising construction within the Morton National Park.

Shaft construction is expected to involve the following steps:

- Excavation and establishment of primary support of the headrace tunnel (refer below for tunnel construction methods) and works cuddy at the foot of the high-pressure shaft
- Drilling a pilot hole (indicatively 150 millimetres (mm)) for the raise bore drive shaft from the surface to the headrace alignment at the end of the surface pipeline
- Transportation and positioning of a raise bore cutting head to the foot of the shaft via access tunnel and assembly to the drive shaft
- Raise boring with cut material removed via the access tunnel
- Construction and grouting of the steel elbow connecting the shaft and headrace liner will commence to form the anchor point for parallel shaft and headrace lining once the shaft has been excavated and supported
- Transporting the steel liner to and lowering safe engineered sections via a portal crane into position for welding
- Welding operations would likely be semi-automatic with personnel involved in set up lowered by cage to temporary platforms
- Construction of the civil works for the top anchor for connection of the surface penstock to the shaft once the liner is installed to the surface.

All spoil from the shaft and headrace excavations other than minor pilot hole boring at the surface would be transported via the headrace and access tunnel to the spoil emplacement area. While unlikely, the shaft may be an option for transport of excess spoil in the Upper to the Lower Scheme and subsequently the spoil emplacement area, if safe to do so.

Vertical or incline shaft construction may be deployed, or other alternatives which may involve shaft boring from the surface.

3.4.3 Lower Scheme construction

Lower Scheme construction would include:

- Establishment of traffic and access controls
- Establishment of preliminary and progressive erosion and sediment controls
- Establishment of temporary laydown and works areas
- Tunnel portal construction (access, multipurpose egress and ventilation and tailrace)
- Tunnelling works including access, multipurpose egress and ventilation and tailrace and various adits and underground surge chamber
- Underground power station cavern construction and power station fit out
- Lower intake control structure and connection to Lake Yarrunga
- Establishment, use and rehabilitation of spoil management and emplacement facility.

3.4.3.1 Lower Scheme logistics, transport and access controls

The transport of materials and spoil would require the establishment and upgrade of controlled access points comprising:

- Access from Jacks Corner Road west of Kangaroo Valley Power Station to works areas at the access and multi-purpose tunnel works site and associated traffic controls
- Access from Jacks Corner Road east of Kangaroo Valley Power Station to existing access track east of Bendeela pondage and upgrade, use and maintenance for spoil haulage
- Upgrade, use and maintenance of existing access points east and west of Lower Bendeela Road for laydown area and spoil disposal area access

- Expansion of access track past Bendeela Power Station to service Tailrace and lower intake control structure works area.

The transport of heavy and large dimensional materials and equipment to the Lower Scheme construction areas would be predominantly from the North on Moss Vale Road due to limits on the heritage listed Hampton Bridge at Kangaroo Valley. From Moss Vale Road, the haulage route would use Bendeela Road and Jacks Corner Road to Kangaroo Valley power station and Lower Bendeela Road to the laydown area and Tailrace Tunnel and lower intake works area.

Plant and equipment deliveries would include but not be limited to:

- Mobilisation of construction plant could include road headers, drill rigs, and specialized underground and standard excavation equipment
- Delivery of demountable site office building, water treatment plant, batching plant and ventilation components
- Concrete deliveries including premixed and batching components
- Tunnel liner sections
- Headrace elbow
- Construction ancillary plant and equipment such as water tanks, fuel tanks, temporary power substations and generators, crib huts, cranes
- Powerhouse components including turbine, generator and transformers
- Cable for network connection and associated connection structures and components.

Tunnelling and cavern construction will also generate spoil requiring management. Spoil is proposed to be hauled from the access and multipurpose tunnel portals to the spoil management and emplacement area by truck and via Jacks Corner Road and an internal access track east of Bendeela Pondage subject to the outcomes of a dam safety risk assessment and from the tailrace portal via Lower Bendeela Road and access track south of the emplacement area.

3.4.3.2 Erosion management

As soon as practicable after mobilisation, generally before other clearing and ground disturbance, erosion and sediment controls would be implemented. Detailed ESCP would be progressively implemented. Provision of space for a number of sediment basins has been made on the basis of complete ground disturbance over the Project area with need and sizing to be resolved through the detailed design process.

In addition to standard controls, package type water treatment plants are proposed to treat tunnel process water prior to discharge.

3.4.3.3 Lower Scheme laydown and construction works areas

Four main work areas are anticipated and are shown in **Figure 1-2** associated with Lower Scheme construction as follows:

- West of Kangaroo Valley power station – Laydown / Works Area 5
- West of Bendeela power station – Laydown / Works Area 6
- East of Lower Bendeela Road at existing depot site – Laydown / Works Area 7
- South of Bendeela Pondage – Spoil management and emplacement area.

Works Area 5 would be used for the construction of the access and multipurpose ventilation and egress tunnel portal and ongoing tunnelling works including point of access for cavern excavation and fit out. It would also be used to establish the short network connection to the Kangaroo Valley Switch Yard. Surface works would be limited to standard construction hours with the exception of essential tunnelling support activities such as ventilation, spoil handling and water treatment. It has been assumed that concrete batch plant would be located here to supply the concrete that would be used to line tunnels and construct the underground power station caverns.

Works Area 6 would be used for the construction of the lower intake control structure and tailrace tunnel portal and ongoing tunnelling. Surface works would be limited as per Works Area 5. Works Area 7 would be used for parking, construction offices and laydown area. Works Area 7 activities would be limited to standard construction hours with the exception of the receipt and limited unloading of oversize or over mass component deliveries.

The spoil management and emplacement area would be used to accept, potentially crush for reuse and emplace surplus spoil from the tunnels and Upper Scheme. Establishment works and works to compact and form the emplacement would be limited to standard construction hours. The receipt and unloading of spoil at night would be subject to avoidance of noise impacts. The spoil emplacement area may also be used to accommodate concrete batching plant, laydown, site sheds, parking and water management subject to space requirements.

3.4.3.4 Establishment of tunnel portals

Construction in the lower portion of the Project will commence with concurrent works on the access tunnel, multi-purpose ventilation and egress tunnel and tailrace tunnel.

The access tunnel and multipurpose tunnel portals will be established in the existing slopes established for the Kangaroo Valley power station construction. Subject to geotechnical conditions, the portals may comprise excavations which will largely be rock slope with shotcrete and permanent bolts and / or cut and cover with a secondary structure required until competent self-supporting geology is reached. When in soil the slopes will either be soil nailed or battered.

The tailrace tunnel drive commences at the lower intake works from within an open surface excavation adjacent to Lake Yarrunga. The excavation will serve as an access location to commence tunnelling operations and ultimately form part of the intake channel and intake control structure foundations and civil works. The size of the required excavation is expected to be approximately 60 m long, 23 m deep and 22 m base width). A pillar of natural rock between Lake Yarrunga and the excavation is anticipated to act as a natural rock plug during construction. The distance from the rock plug to the tunnel entrance will be in the order of 40 m.

The tailrace at entry from the excavation would be aligned at an approximate 10 % incline.

3.4.3.5 Tunnelling works

Construction of the access tunnel, multipurpose tunnel and tailrace excavation and tunnel are assumed to be undertaken concurrently and commence within close timing. Works are assumed to commence on construction of the portal structure followed by excavation and primary support of the tunnel drive.

Following tunnel portal establishment, tunnelling is expected to progress using road headers ,drill and blast or tunnel boring machine methodologies. Tunnel spoil may be mucked out and transported to the spoil emplacement facility by truck or conveyor.

Tunnels would be excavated to their unfinished dimensions as generally described in **Section 3.3.1**.

Installation of tunnel supports in the form of rock bolts would follow behind tunnel excavation as would the application of shotcrete and drainage controls. The Tailrace would be lined as required by the prevailing geological conditions.

In addition to permanent tunnels, tunnelling works is also required to establish construction adits to facilitate multiple work fronts on the tailrace and to bypass the cavern to reach the base of the high-pressure shaft. Excavation of these adits would be undertaken using a standard approach to tunnelling.

Tunnelling works will be undertaken on a continuous basis. Essential surface works to facilitate tunnelling are expected to include the operation of workshops, storage facilities, ventilation and water treatment facilities. Spoil haulage would also occur on a 24 hour basis where noise is able to be mitigated to achieve NMLs or otherwise stockpiled at the tunnel portal for haulage during standard hours noting non-continuous haulage may increase program, require inefficient double handling of materials with associated noise and fuel use.

3.4.3.6 Power station cavern construction

Excavation and support of the underground power station and transformer cavern will be undertaken by conventional methods with bench excavation sequences commencing at the crown. The crowns would be accessed by temporary pilot tunnels excavated from the access tunnel.

Construction of civil and structural works within the cavern will be by conventional means and phases commencing with draft tube installation progressively working up to the generator floor.

Electrical and mechanical fit out of the underground power station and transformer caverns will occur in stages co-ordinated with the civil and structural works sequence. The majority of plant and equipment will be delivered via the access tunnel.

3.4.3.7 Underground Works drainage

The caverns, access tunnel and multipurpose tunnels will be designed as drained structures while the tailrace, high pressure tunnel and vertical shaft are undrained. Underground drainage would involve the following:

- Moderation of groundwater water infiltration through underground structures will be managed principally by grouting
- Collection of groundwater seepage by a temporary drainage system within the undrained structures, and by permanent drainage system in the drained structures
- Collection of groundwater leakage from geological formations into underground structures to then be pumped for treatment and reuse or discharge
- Reuse of groundwater in the construction process may include such things as water for dust suppression during excavation and spoil emplacement and for concrete and grout batching where suitable
- Confirmation of the primary water treatment process would occur as part of detailed design to achieve acceptable water quality for discharge.

3.4.3.8 Lower Intake Control structure

The construction of the lower intake control structure will involve excavation either as part of the tailrace portal or offline. Civil works will include construction of the lower intake control structure and canal followed by structural, electrical and mechanical fit out including emergency shut off and trash racks.

The top of the control structure between the tunnel transition and the trash racks will be backfilled and a level concrete platform constructed to accommodate access to and between the stop log and trash rack structures (operations deck). Stairs and platforms will be constructed to access the operations deck from the finished level of the permanent access road where necessary. Removal and shoring up the natural rock barrier will be completed prior to wet commissioning and may require blasting.

Works in the bank and bed of lake Yarrunga may be required to remove sediment build-up. All works in Lake Yarrunga would occur within a sediment curtain, coffer dam or alternate measure to manage water quality.

3.4.3.9 Grid connection

The generator would be connected to the grid via a step-up transformer connected to the network via 330 KV cable routed through the multipurpose tunnel and underground conduit to the existing Kangaroo Valley Switchyard located immediately east of the Kangaroo Valley Power Station.

Origin is planning on utilising existing connection arrangements to connect the Project to the existing TransGrid Kangaroo Valley Switchyard. This would involve combining two existing feeders from the Kangaroo Valley Power Station in to one and using the resulting spare connection point for the new Project. As such, limited works are proposed within the Kangaroo Valley switchyard are limited to:

- Works to re-route and combine existing overhead wires from the Kangaroo Valley Power Station on to one existing feeder
- Establishment of the repurposed connection for Project including stringing and connecting one overhead conductor inside the substation fenceline
- Underground cabling from outside the fenceline to the Multipurpose Access Tunnel and supply transformer located underground.

3.4.4 Spoil management

The strategy for the management of spoil would aim to maximise the beneficial re-use of materials for construction activities, which may include the reuse of road base, landscaping or other uses with the excess spoil to be suitably managed and disposed of.

The project is expected to generate up to 715,000 tonnes of excavated spoil, which would constitute about 296,000 m^3 in bank volume and about 420,00 m^3 when bulked from the underground works. To manage this spoil a spoil management strategy has been prepared, refer to **Appendix K**. The spoil management strategy will be finalised subject to detailed design into a spoil management plan by the selected construction contractor. The current spoil management strategy includes:

- Establishment of an adequately sized water management system including testing and treatment as necessary
- Vegetation clearing
- Limited removal of topsoil where present and minor grading to achieve a competent base
- Installation of controls necessary to prevent acid rock drainage from emplacement area if confirmed to be present and unable to be blended with expected acid consuming materials (ACM) or otherwise treated to neutralise
- Establishment of a noise bund behind which emplacement can occur
- Testing, treatment and segregation of spoil suitable for reuse, benign materials and PAF materials
- Establishment of encapsulation area if necessary for acid forming materials if present and unable to be treated or otherwise managed
- Blending or treatment of PAF materials with ACM prior to emplacement
- Emplacement of surplus spoil
- Capping and rehabilitation to achieve non-intrusive, safe, stable and non-polluting landform.

Under the spoil management strategy, generally spoil generated by underground works would be transported within the Project area by trucks and/or conveyor systems to the either the temporary spoil stockpiles or permanent spoil emplacement area. Spoil that is transported via truck would be along small distances of public and private access roads.

Once at the dedicated spoil emplacement area, spoil will be treated and managed to acceptable environmental standards in accordance with a spoil management plan. Temporary stockpile management during construction would be detailed in the Construction Soil and Water Management Plan (CSWMP).

The location, indicative capacity and estimated size of temporary stockpiles is outline in **Table 3-2.**

Table 3-2. Temporary spoil stockpiles

Temporary stockpile area	Estimated capacity (t)	Estimated size (m^2)
Main Access Portal	1,000	445
Tailrace area	200	225

An area to the east of the Bendeela Pondage (refer to **Figure 1-2)** was selected as the permanent spoil emplacement area as it would be located:

- Above the maximum probable flood level
- In an area where the groundwater table is well below the surface and away from natural waterways
- In an area of low biodiversity and cultural values (i.e. previously disturbed site) and where visual, noise and dust impacts can be reasonably engineered and managed
- Close to the source of spoil to reduce haulage distance and the associated indirect sustainability footprint of the Project.

In addition, this location has been selected as a favourable location for a landform that is consistent with existing topography and would be revegetated as part of the rehabilitation management plan.

Where on-site disposal is not considered appropriate, PAF spoil may be disposed of off-site. While this is considered unlikely, off-site disposal would be managed in accordance with the EPA guidelines and the *Industrial Waste Management Policy*.

The strategy for the management and disposal of excavated spoil material in from the Upper and Lower Scheme on the plateau area is documented in the spoil management strategy and is expected to be managed as outlined below.

3.4.4.1 Upper Scheme spoil management

The Project construction methodology is predicated on generating as little spoil material on the plateau to the extent reasonable and feasible.

Earthworks associated with the surface penstock include an estimated 1,900 m^3 (bulked volume) of spoil associated with the saddle supports and thrust blocks. The open excavation for the pipeline easement over the 250 m section north of the surge tank are expected to generate approximatly10,000 m^3 of spoil while the foundations of the surge tank and pilot hole of the vertical shaft are estimated to contribute some 3,400 m^3. The Project assumes that some of this spoil can be beneficially reused to level portions of the construction area between the Promised Lands Trail and the pipeline easement and for upgrading of the access tracks.

Excess spoil in the Upper Scheme and material would be transported to the spoil emplacement area proposed to be established adjacent to the Bendeela Pondage either by road or through the headrace shaft and mucking via the access tunnel if found to be feasible.

3.4.4.2 Lower Scheme spoil management

The bulk of tunnel and cavern excavation spoil other than the tailrace tunnel spoil will be transported via the access tunnel and portal to allow the tailrace tunnel permanent lining to proceed without disruption.

Spoil will be transported (about 1,500m) by truck or conveyor to a dedicated spoil disposal location adjacent to Bendeela Pondage where it will be treated and managed as described in the spoil management strategy. Tailrace spoil will be mucked out and transported by truck to the spoil disposal area via the Lower Bendeela Road due to terrain being unsuitable for conveyor systems.

All spoil from the vertical shaft and headrace excavations, other than minor volumes associated with the pilot hole boring, will be transported via the headrace and access tunnel to the spoil disposal area.

3.4.5 Traffic management

The construction of the project would be subject to comprehensive traffic management measures to ensure the ongoing functionality of surrounding roads, and the safety of members of the public, motorists and construction workers. Temporary lane and/or road closures would be required to enable the construction of required road works and traffic controls such as temporary traffic lights used to facilitate construction traffic movements.

Temporary changes to access arrangements would also be required during construction. Specific engagement with affected properties during further design development would be required to determine appropriate mitigation measures.

In addition, over-size and over-mass (OSOM) vehicles would be required for the delivery and removal of large plant and equipment on discrete occasions. There would be a higher proportion of these movements during site establishment, transportation of underground power station components and site closure, as large plant and equipment are moved to and from site respectively. These items of plant and equipment may be transported from Port Kembla, Sydney Harbour/ Port Botany or the Newcastle Harbour and some items can only be transported at night under police escort and/or under lane or road closures.

3.4.6 Utilities management

Utilities would need to be adjusted, relocated and/or protected where there is a possibility they would otherwise be impacted by construction. Utilities which may require protection and/or relocation include water, sewer, stormwater, drainage, recycled water, electricity, gas and communications assets. Further investigation and consultation with service asset owners would be carried out as the design develops to confirm exact locations, heights and depths of the utilities.

Where an existing utility conflicts with the proposed design, it may be necessary to:

- Provide physical protection for the utility where the utility is not directly affected but may be indirectly affected by vibration or accidental impact
- Relocate the utility.

3.4.7 Geotechnical stability and landform

A strategy for managing the geotechnical stability of the Project landforms during construction and operation has been developed and would continue to be refined through detailed design. It is expected that Project-specific geological, geotechnical, hydrogeological and geophysical investigations will be undertaken throughout the Project area to inform the design and the that the permanent landform would be designed considering geotechnical short-term stability and any potential seismic impacts.

The temporary landform associated with construction such as laydown and work areas, site offices, batching plants and warehouses where not required for Project operation, would be rehabilitated in accordance with the rehabilitation management plan (refer to **Section 3.4.9**) that will be prepared for the Project.

The strategy for managing the long-term stability for the Project landforms would continue to be refined through detailed design. Permanent landform changes would be required for permanent and operational components of the Project, including:

- Vertical shaft
- Underground access portal
- Intake outlet
- Permanent spoil emplacement area.

Where relevant, batter slopes would be designed by a geotechnical engineer and would consider the long-term stability of the landform, including appropriate drainage and erosion measures. Slope stability measures, including shotcrete and rock bolts, would be utilised if required. The option of backfilling excavated areas to pre-disturbed conditions will be investigated as part of the detailed design.

The final landform design will be developed as part of the detailed design where opportunities to reinstate local landform changes to complement the surrounding topography and reduce visual impacts will be investigated.

A rehabilitation management plan will be prepared for the permanent landform changes based on the final land use and operational requirements.

3.4.8 Blasting management

Due to geological profile of the anticipated ground conditions, controlled blasting may be required in addition to the other excavation methods.

The benefits of using controlled blasting over other excavation methods may include a reduction in the following:

- Overall construction noise and vibration impacts
- Duration of excavation, including the associated noise impacts.

Controlled blasting has the potential to result in brief ground vibration and air overpressure impacts at nearby receivers. Where controlled blasting is used to substitute or complement the operation of construction equipment to break rock, blasting can substantially reduce the length of time that noise and vibration impacts occur when compared to rockbreaking alone. Blasting also reduces the energy usage (electricity and fuel) compared to other excavation methods.

An explosive storage magazine would be located in the vicinity of the ancillary worksites or underground in accordance with legislative requirements.

Blasting would be subject to stringent processes in accordance with the legislative and project requirements. The Interim Construction Noise Guideline (ICNG) recommends blasting on the surface occur between Monday to Friday (9am to 5pm) and Saturday (9am to 1pm) with no blasting on Sundays or public holidays unless otherwise agreed by the EPA. Blasting on the surface would be planned during hours that would cause the least disruption and disturbance to the nearest receivers. Notification protocols prior to blasting for the nearest sensitive receivers would be established. Blasting underground may occur 24/7 where there is no material impact to sensitive receivers.

Should the contractor undertake blasting to construct the project, a Blast Management Strategy would be prepared to address:

- Details of blasting to be performed
- Identification of all potentially affected sensitive sites including heritage buildings and utilities
- Establishment of appropriate criteria for blast overpressure and ground vibration
- Details of the transportation, storage and handling arrangements for explosive materials
- Determination of potential noise and vibration and risk impacts and appropriate best management practices, including:
  - A trial blast strategy
  - Additional pre- and post-dilapidation surveys
  - Community consultation and information program
  - Reasonable and feasible mitigation
- The necessary blast trials to establish conformance with the criteria.

The blast management strategy would be endorsed by a suitably qualified and experienced person.

3.4.9 Construction demobilisation and rehabilitation

On completion of construction and commissioning, all temporary works areas not required for ongoing operational, or maintenance purposes would be removed and rehabilitated to reflect their pre-construction land use. This would include:

- Removal of plant and equipment
- Removal of temporary environmental management measures once permanent controls are established as effective
- Landscaping and rehabilitation planting considering bushfire protection requirements and using locally endemic species consistent with surrounding plant community types (PCTs).

The rehabilitation strategy is provided in **Table 3-3** and would form the basis of the rehabilitation management plan which would be prepared to guide the long-term rehabilitation of the Project area. The rehabilitation management plan would consider the permanent landform changes based on the final land use and operational requirements. All rehabilitation activities would be accordance with the rehabilitation management plan for the project.

Table 3-3. Rehabilitation strategy

Rehabilitation phase	Rehabilitation activities
Site preparation	▪ Collection and stockpiling of organic matter from removal of vegetation during construction, including topsoil, woodchip and organic matter for use in rehabilitation.
Site stabilisation and landscaping	Site stabilisation activities would be carried out both during and post construction and would include the following: ▪ Stabilisation of exposed areas and prepare the sites for revegetation ▪ Installation of erosion and sediment controls at the work sites to manage impacts both during and post construction ▪ Seeding soil slopes to assist in stabilisation ▪ planning vegetation in disturbed area to be rehabilitated ▪ Mulching of stabilised and revegetated areas where required. Species used in landscaping would be consistent with existing PCT of the area.
Maintenance and monitoring	Ongoing maintenance and monitoring of rehabilitation works would include: ▪ Monitoring revegetated areas ▪ Monitoring on the performance of erosion and sediment controls ▪ Weed control and monitoring ▪ Maintaining any fencing placed around rehabilitation areas ▪ Re-mulching of stabilised and revegetated areas where required.

Rehabilitation phase	Rehabilitation activities
Demobilisation	Following the completion of construction, demobilisation activities would be carried out and would likely include: ▪ Removal of any temporary fencing around the works sites and site compound areas ▪ Disassembling and removal on any temporary on-site infrastructure including site offices, amenities, equipment storage, and maintenance sheds within the site compound areas ▪ Removal of all construction equipment and machinery from the site compound areas and work sites ▪ Removal and disposal of any remaining stockpiles and other waste materials from the site compounds and other laydown areas ▪ Removal of any temporary environmental controls (e.g. erosion and sediment controls) which are no longer required. The rehabilitation phases described above would coincide with the work site demobilisation activities.

3.4.10 Construction schedule

Construction is anticipated to take approximately five years including mobilisation and commissioning. The completion of construction is targeting mid-2028. Completion at this time would be subject to outcomes of competitive tendering and obtaining necessary approvals.

To achieve this timeframe, some construction, particularly below-ground works and associated surface support works, would be required to be undertaken on a 24 hour per day and seven days per week basis. Other construction activities would generally be limited to standard construction hours or otherwise be subject to regulation by the EPA under an EPL.

3.4.11 Construction workforce and accommodation

Workforce numbers are expected to peak at approximately 370 over a limited period during power station cavern construction and fit-out whilst tunnelling and Upper Scheme works are ongoing. Outside peak, average construction workforce is anticipated to be approximately 250 workers.

Where possible, workers would be sourced locally and be accommodated in existing facilities in the surrounding towns. Should a shortage of accommodation be identified associated with cumulative impacts of concurrent construction projects, temporary worker accommodation would be considered at an appropriate location within the wider region. The need for the establishment of workers accommodation is currently being investigated, noting recent concerns raised by Shoalhaven Council regarding housing availability and affordability.

The following locational and design criteria would be used as part of determining the preferred location for workers accommodation:

- Availability of services (water, power and sewerage)
- Minimising potential traffic impacts
- Minimising any required vegetation removal
- Avoiding direct impacts on heritage items
- Avoiding flood prone land
- Identification and agreement of tenure of suitable land.

The preferred location for workers accommodation, if required, would be confirmed in consultation with Council and other stakeholders.

3.5 Operations

Origin owns and operates a diverse generation portfolio, is a significant electricity retailer and currently operates the two-stage Shoalhaven pumped hydro scheme directly adjacent to the Project. Consequently, Origin could use the new scheme in multiple ways to best service the NEM and NSW electricity customers. The Project design is intended to provide opportunity to dispatch electricity at high cycle efficiencies while using the other operating assets to maintain flexibility to manage the electricity market dispatch requirements. It is expected that the Project will be available to operate in pumping and generation cycles between major offline inspection services with high availability to respond to variations in grid energy supply and demand.

During operations, the Project will convey water through a surface pipeline parallel to the Existing Scheme pipeline from the existing intake works at the end of Fitzroy Canal to a surge tank located adjacent to the existing surge tank. The conveyance will continue through a vertical shaft that will connect to a headrace tunnel. The headrace tunnel will then link to the pump-turbine in the new underground power station, through to the tailrace tunnel and finally discharge to the lower intake/outlet works at Lake Yarrunga.

The Project would operate independently from the Existing Scheme with the implications of concurrent operations resulting in the existing water allocation being drawn and returned over shorter cycles. While this will not change the maximum and minimum water levels in either Lake Yarrunga or Fitzroy Falls Reservoir, the rate at which water levels change will increase.

3.5.1 Operational stage duration and schedule

The Project has an operational life expectancy of 100 years and would operate daily on a 24-hour basis. Cycle duration would be flexible and respond to the needs of the NEM but is currently expected to involve predominantly daytime pumping using surplus renewable generation and generation during times of peak demand typically during morning and evening periods.

Under normal NEM conditions, generation of around 13 hours would be possible within existing water allocations. Under abnormal NEM conditions, these water allocations can be more than doubled to facilitate around 24 hours of continuous discharge capacity.

3.5.2 Operational water supply and transfers

The operation of the Project would not result in any loss of water from the Existing Scheme. No initial fill of reservoirs or make-up water is required. The drained underground structures will take small amounts of water from groundwater aquifers and appropriate groundwater licences would be obtained for this purpose. Any groundwater take would be returned to the Existing Scheme following any necessary treatment such that no loss of water supply would occur.

The Project operates between the upper reaches of Lake Yarrunga (36,072 ML full storage volume) and a purpose-built canal from the Fitzroy Falls Reservoir (10,054 ML full storage volume) to the existing upper intake control works. Origin has a license to transfer a total of 4,021 ML of water between the upper and lower reservoirs for the Existing Scheme and are updating this licence to facilitate combined use by the Project.

For reference, assuming no other net inflow or outflows, the drop in water level from generation operation from the normal Top Operating Level when transferring Origin's full water allocation for the Fitzroy Falls Reservoir is calculated at 0.81m. Similarly, the drop in water level from pumping operation from the Spillway Level storage volume and use of the full water allocation for Lake Yarrunga is calculated at 0.49m. These water level changes can occur across the full operational range of full supply level (FSL) and minimum operation level within Origin's water license which for the Fitzroy Reservoir is 2.13m and for Lake Yarrunga is 4.18m.

Maximum permissible rated flow in the Fitzroy Canal and the upper intake control structure is 85 m^3/s of which the flow to Existing Scheme at full load requires 39 m^3/s. The lower rated flow of the Existing Scheme is due to limitations caused by the operation of Bendeela pondage and Bendeela Power Station. The Project would be designed to use the remaining permissible rated flow in the Fitzroy Canal.

The Project would also be designed to operate across the full range of water level variations in the reservoirs and for various combined operational with the Existing Scheme scenarios within the operational parameters of the water licence.

3.5.3 Operational workforce

The operation of the Project is expected to require a permanent workforce of approximately four people. Periodic maintenance would be undertaken by a larger but temporary contractor workforce.

3.6 Decommissioning

The SEARs require a full description of the Project including likely staging or sequencing including decommissioning and rehabilitation and a strategy for the rehabilitation of the site. The rehabilitation strategy is described in **Section 3.4.9.** The SEARs do not require the assessment of decommissioning within the EIS and at the time of decommissioning, it is expected that the DPE and relevant agencies would request that additional requirements are met and some further approvals such as a decommissioning and rehabilitation management plan would be required.

The proposal has a design operational life of 100 years, which could be extended as dictated by energy market conditions and operational capability of the power station at that time. The National Electricity Rules promote reliability in the NEM by requiring large generators to advise the AEMO of the expected closure year. It also requires generators to give the AEMO at least three years' notice of their intention to permanently close a generating unit.

It is not anticipated that the Project area would contaminate soils, water or groundwater, and operational processes would be put in place to ensure this. At the time of decommissioning, site specific investigations would be completed to confirm the absence of any contamination caused by the power station activities, or the need for localised remediation. It is anticipated that the Project area would not require remediation, and would continue to be used for other land uses compatible with the adjacent land uses at the time which may include continuation of water transfers for water security purposes.

In order to address decommissioning requirements and to manage potential environmental impacts at the time, a decommissioning and rehabilitation management plan would be developed including the following:

- An appropriately sequenced, staged and communicated shutdown procedure to manage operating hazards and risks and manage any potential energy market impacts
- Removal of all dangerous goods and hazardous substances
- Planning for future land use including rehabilitation outcomes to be achieved
- Soil, surface water and groundwater testing and remediation of any contamination
- Development of mitigation and management measures for decommissioning including management of demolition waste and recycling of materials.

The plan would meet DPE requirements and be developed in consultation with DPE, WaterNSW, Council, stakeholders and all other relevant agencies.

4. Statutory context

This chapter provides an overview of the NSW planning framework and identifies the relevant statutory requirements for the Project.

4.1 Planning framework

The EP&A Act and the EP&A Regulation provide the framework for planning and approval and environmental assessment in NSW. The EP&A Act and Regulation are supported by a number of Environmental Planning Instruments, which include State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs). The applicable Environmental Planning Instruments and the Regulations made under the EP&A Act determine the relevant planning approval pathway and the associated environmental assessment requirements for proposed development activities. The relevant NSW statutory requirements for the Project are presented in **Table 4-1**. Other relevant statutory requirements for the Project and where they have been addressed in this EIS is provided in Appendix C.

Table 4-1. Relevent NSW statutory requirements

Category	Requirement
Power to grant consent	The Project is declared CSSI under Section 5.13 of the EP&A Act through the application of Section 2.15 of *State Environmental Planning Policy (Planning Systems) 2021* as it is listed in section 13 in Schedule 5 as follows: *(1) Development for the purposes of the Shoalhaven Hydro Expansion Project.* *(2) The Shoalhaven Hydro Expansion Project includes the following—* *(a) exploratory geotechnical works for the design of the Project,* *(b) a new underground pumped hydro power station,* *(c) tunnels and underground and overground water pipelines,* *(d) surge tanks and intake and outlet structures,* *(e) the decommissioning of the underground pumped hydro power station and rehabilitation of the site.* *(3) Development that is ancillary to other development in this section (including the upgrading or construction of access roads, utilities infrastructure, construction accommodation and construction compounds).* *(4) The development is to be carried out on land in the suburbs of Kangaroo Valley, Barrengarry and Fitzroy Falls.* *(5) In this section, development does not include the carrying out of surveys, sampling, environmental investigations, archaeological excavations or other tests or investigations for the assessment of the Project.* Section 5.14 of the EP&A Act requires the Minister's approval for state significant infrastructure (SSI) and Section 2.4(3) prevents the Minister delegating their function of determining an application for approval to carry out critical State significant infrastructure. The NSW Minister for Planning as such the approval authority for CSSI. Section 5.19 provides the Minister with the powers to grant consent to CSSI where an application has been made and the minister has been provided with the Planning Secretary's report.
Permissibility	Under Section 2.15 of *State Environmental Planning Policy (Planning Systems) 2021*, Development specified in Schedule 5: *(a) may be carried out without development consent under Part 4 of the Act, and* *(b) is declared to be State significant infrastructure for the purposes of the Act if it is not otherwise so declared, and* *(c) is declared to be critical State significant infrastructure for the purposes of the Act.* As the project is specified in Schedule 5, it is permissible without consent as CSSI and SSI. Under Section 5.22 of the EP&A Act, Part 3 and EPLs, including LEPs and SEPPS, do not apply to SSI except that they apply to the declaration of infrastructure as SSI or as CSSI and so far as they relate to Section 3.16 to enabling development to be carried out in accordance with an environmental planning instrument or in accordance with a consent granted under this Act. As such zoning provisions under the local environmental planning policies have no bearing on the Projects permissibility.

Category	Requirement
Other approvals	
Approvals that cannot be refused if necessary for carrying out an approved SSI and are to be consistent with the terms of the SSI approval under Section 5.24 of the EP&A Act	*Petroleum (Onshore) Act 1991* The Project would not require a production lease under the *Petroleum (Onshore) Act 1991*.
	Protection of the Environment Operations Act 1997 (POEO Act) The Project would require an EPL under Chapter 3 of the POEO Act to be obtained prior to the commencement of construction of the Project for scheduled activity of electricity generation and possibly crushing, grinding and separating and associated scheduled development works.
	Roads Act 1993 The Project would require consent from the appropriate roads authority under Section 138 of the *Roads Act 1993* for any works undertaken on public roads. The impacts of the Project on roads, access and traffic are assessed in **Appendix L**.
	Pipelines Act 1967 The Project involves the construction and operation of water pipelines and could obtain, but does not trigger the need for, a licensing under the *Pipelines Act 1967*. In the event that the requisite access rights and tenure are not able to be obtained by agreement over the necessary land within the Morton National Park and Shoalhaven Special Area, it is noted that Origin could obtain a licence under the Pipelines Act which would enable those interests to be compulsorily acquired and vested in it as the holder of a pipeline licence.
Approvals that are not required for approved SSI under 5.23 of the EP&A Act	*Fisheries Management Act 1994* (FM Act) A permit under the FM Act to block fish passage or dredge or carry out reclamation work on water land will not be required pursuant to Section 5.23 of the EP&A Act. No new dams or reservoirs are proposed that could block fish passage. Dredging associated with the lower intake connection to Lake Yarrunga may be required. Impacts to aquatic ecology are considered in the BDAR in **Appendix F**.
	Heritage Act 1977 (Heritage Act) An approval under Part 4, or an excavation permit under Section 139, of the Heritage Act will not be required pursuant to Section 5.23 of the EP&A Act. Potential heritage impacts are assessed in **Appendix H**.
	NPW Act An Aboriginal heritage impact permit under Section 90 of the NPW Act will not be required pursuant to Section 5.23 of the EP&A Act. Impacts to Aboriginal heritage values are considered in the Aboriginal Cultural Heritage Impact Assessment in **Appendix G**.
	Rural Fires Act 1997 A bushfire safety authority under Section 100B of the *Rural Fires Act 1997* is not requires as the Project does not constitute a special fire protection purpose or involve residential subdivision. An assessment of bushfire risks is provided in **Appendix O**.
	Water Management Act 2000 A water use approval under Section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the *Water Management Act 2000* will not be required pursuant to Section 5.23 of the EP&A Act. The Project involves works in waterfront land, aquifer interference, water management works and water use. These activities are considered in **Appendix I** (Surface water quality, hydrology and geomorphology impact assessment) and **Appendix J** (Groundwater impact assessment) respectively.

Category	Requirement
WNSW Act and *Water NSW Regulation* 2020	Part 4 of the WNSW Act provides for the declaration of Catchment Areas, Special Areas and Controlled Areas. Shoalhaven Catchment Area is proclaimed as Schedule 2 land under the Water NSW Regulation. Section 52 of the WNSW Act requires the preparation of a plan of management for special areas, which has been satisfied through the adoption of the Special Areas Strategic Plan of Management 2015 (WaterNSW and Office of Environment & Heritage, 2015). Section 53 requires that, subject to the requirements of any other Act or any instrument under any other Act, no operations are to be undertaken by the joint sponsors, being WaterNSW and NPWS, in relation to the lands within the Special Area unless the operations are in accordance with the Plan of Management. Third party projects approved under the EP&A Act do not need to be undertaken in accordance with the Plan of Management and are regulated separately. In particular, Section 51 established that regulations may make provision for or with respect to special areas. It also establishes that the regulations made under Division 2 of Part 4 of the WNSW Act prevails to the extent of any inconsistency with an instrument made under another act other than a State environmental planning policy under the EP&A Act. Water NSW, as the owner of the land within the Shoalhaven Special Area, has the power to grant access and interests over that land provided the interests granted do not amount to alienating, mortgaging, charging or demising that land, which is prohibited in respect of land in a special area under section 48 of the *Water NSW Act*. Origin is still considering the form of tenure most appropriate for works proposed within the Shoalhaven Special Area. At this stage, it is considered that either a licence or easement would be sufficient, both of which are capable of being granted by Water NSW under the *Water NSW Act*. Various offenses are established under the Water NSW Regulation 2020. However, under clause 9, a person does not commit such an offence by reason of anything done with the consent of Water NSW where they comply with the conditions to which the consent is subject. WaterNSW has provided Origin with an access agreement in relation to the ongoing environmental investigations. An extension of this agreement or a separate licence to access and occupy the Project area to cover the proposed scope of the Project is being progressed concurrently with the approval process. Such an agreement would constitute the consent of WaterNSW under clause 10 of the Water NSW Regulation 2020 and, if undertaken in accordance with any conditions of the access agreement, the Project would comply with the requirements of the WNSW Act and Water NSW Regulation 2020.
NPW Act	The Project requires the tunnelling under approximately 100 m of the Morton National Park and reinstatement of full width and use of existing Promised Land Trail access track within the Morton National Park which is reserved under the NPW Act. The NPW Act recognises the Existing Scheme through section 182 which made provision for the revocation and vesting with the Sydney Catchment Authority of land required for the Existing Scheme. Section 182 also allows the minister to grant to the Sydney Catchment Authority such easements and licences over lands within the Park for pipelines, power lines and other purposes as may be necessary for or in connection with the use and operation of the Existing Scheme. While the expansion of the Existing Scheme was always considered, Section 182 of the NPW Act only provides the benefits for the Sydney Catchment Authority and as such a separate means of securing tenure for works in the Morton National Park is required. Part 12 of the NPW Act allows for the granting of leases, licences, easements and rights of way for activities within reserved lands for various purposes. Of most relevance is that Section 153(1) which empowers the Minister administering the NPW Act to grant for joint or several use easements or rights of way through, upon or in a national park, historic site, state conservation area, regional park, nature reserve or karst conservation reserve for the purpose of providing access to any area included in any lease or licence within the park, site, area or reserve, or for the construction of pipelines, or for the erection of standards, posts, wires and appliances for the conveyance or transmission of electricity, or for any other purpose deemed necessary. Origin proposes to seek easements to obtain access and permanent tenure over those areas of the Morton National Park required for the Project.

Category	Requirement
Water Management Act 2000 (WM Act)	The WM Act presents the framework for sustainable and integrated water management in NSW. In addition to controlled activity approvals, water supply works approvals and water use approvals which are not required for approved SSI as per Section 5.23 of the EP&A Act, the WM Act requires a WAL to take water from a water source. Origin currently holds a WAL (no. WAL27432) under the water sharing plan for the Greater Metropolitan Regional Unregulated River Water Source to extract water for the purposes of electricity generation (DPI, 2013a). Under the WAL, Origin must adhere to the conditions outlined within the WAL which include volumetric limits for water use between Fitzroy Falls Reservoir and Lake Yarrunga per generation cycle, ensuring the volume of water in Bendeela Pondage does not exceed 880 ML, and divert water to Lake Yarrunga for the purposes of electricity generation when Fitzroy Falls Reservoir is spilling into Yarrunga Creek. The WAL also includes conditions that limit its application to the use of the existing Kangaroo Valley Power Station and Bendeela Power Station. Origin intends to rely on Water Access Licence No. WAL17432 (WAL) issued for the Existing Scheme, for the purposes of the Project. As the concurrent operation of the Project and the Existing Scheme will result in the existing water allocation being drawn and returned over shorter cycles, but no change to the overall volume of water being drawn during a generation cycle, no change is required to the Extraction Component or Share Component of the WAL. However, as the WAL currently only permits water to be interchanged under the WAL utilising the Existing Scheme, Origin proposes to seek an amendment pursuant to Division 3 of Part 2 of the WM Act to the conditions of the WAL to allow for the interchange of water under the WAL utilising both the Existing Scheme and the Project. Additional WALs would be required for construction and operation as follows: ▪ For surface water take from existing reservoirs for construction make-up water under the Shoalhaven River Water Source of the Water Sharing Plan for the *Greater Metropolitan Region Unregulated and Alluvial Water Sources* 2011 ▪ For groundwater take from the Sydney Basin South Groundwater Source of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 Appendix J identifies the predicted water take for the project.
Dams Safety Act 2015	Tallowa Dam (Lake Yarrunga), Fitzroy Falls Dam and Bendeela Pondage are all declared dams under the *Dam Safety Act 2015*. No changes are proposed to the form or function of these prescribed dams associated with the Project.
Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)	A referral has been submitted to the Department of Climate Change, Environment, Energy and Water (DEECCW) to confirm whether the Project requires assessment and approval under the EPBC Act. On 28 September 2022, the Project was determined to be a controlled action, requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on the following Matters of National Environmental Significance (MNES): ▪ Listed threatened species and communities (sections 18 & 18A). The Project would be assessed under the bilateral agreement between the Commonwealth and NSW Governments and DEECCW has issued its assessment requirements which have been incorporated into the SEARs for the Project (refer to **Appendix A**).
Native Title Act 1993	The *Native Title Act 1993* seeks to recognise and protect native title. A successful native title determination results in the recognition of the rights, interests or uses claimed by the registered party, and any actions by Government on that land must be consistent with the claim. The South Coast People Native Title claimant group have an existing, undetermined native title claim registered on 21 January 2018 which encompasses the Project area.
Pre-conditions to exercising the power to grant approval	
Section 5.19	Section 5.19 of the EP&A Act provides the Minister with the powers to grant consent to CSSI where an application has been made and the minister has been provided with the Planning Secretary's report. Section
Section 5.15	The application required under Section 5.19 is to be lodged with the Planning Secretary, describe the infrastructure and contain any other matters required by the Planning Secretary.
Section 5.16	When an application is made under Section 5.15, the Planning Secretary is to prepare and notify the proponent of environmental assessment requirements that require the preparation of an EIS in the form prescribed by the EP&A Regulations. Environmental assessment requirements for the Project were last notified on 12 July 2021 and consideration of where in this EIS they are addressed is provided in **Appendix A**.
Section 5.17	The proponent is to submit the EIS to the Planning Secretary and may require the proponent to submit a response to any issues raised in submissions and a preferred infrastructure report.

Category	Requirement
Section 5.18	Under Section 5.18, the Planning Secretary's report for the Ministers consideration is to include the EIS and any preferred infrastructure report, and advice provided by public authorities, any report or advice of the Independent Planning Commission and any environmental assessment undertaken by the Planning Secretary or any other matter the Planning Secretary considers appropriate.
Biodiversity Conservation Act 2018 (BC Act)	Under Section 7.9 of the BC Act, an application under Division 5.2 of the EP&A Act is to be accompanied by a BDAR unless the Planning Agency Head and the Environment Agency Head determine that the proposed development is not likely to have any significant impact on biodiversity values. A BDAR is provided as **Appendix F**.
WNSW Act	Under Section 50 of the WNSW Act, the Minister for Planning may not exercise their functions in relation to land within a special area unless notice is first given to the Minister for Lands and Water or their delegate. The forwarding of the application is understood to be taken to be notification for the purposes of this Section.
Mandatory matters for consideration	
EP&A Regulation 2021	Section 190 of the EP&A Regulations establish mandatory matters for consideration for SSI as including the form and content requirements of and EIS. The statutory compliance table in Appendix C identifies where in the EIS these are addressed. Section 191 of the EP&A Regulation requires the EIS to comply with the SEARs. How the EIS addresses the SEARs is identified in **Appendix A**.
Other considerations (not applicable under Section 5.22 of the EP&A Act)	
State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP)	The Resilience and Hazards SEPP assesses the potential hazards associated with the proposed development by providing definitions and guidelines for hazardous industry, offensive industry, hazardous storage establishments, and offensive storage establishments. Under Section 3.7 of the Resilience and Hazards SEPP, consideration is required of current circulars or guidelines published by the DPE relating to hazardous or offensive development, including: ▪ Hazardous Industry Planning Advisory Paper No 3 – Risk Assessment ▪ Hazardous Industry Planning Advisory Paper No 12 – Hazards A Preliminary Risk Assessment is provided in Appendix P. Under Section 4.6 of the Resilience and Hazards SEPP, a consent authority is required to consider whether a proposed development site is affected by soil or other contaminants before granting consent. The potential for contamination to be present or be caused by the Project is considered in **Section 6.4**.
State Environmental Planning Policy (Biodiversity and Conservation) 2021	Chapter 3 (Koala habitat protection 2020) and Chapter 4 (Koala habitat protection 2021) of the *State Environmental Planning Policy (Biodiversity and Conservation) 2021* aim to encourage conservation and management of areas of natural vegetation that form koala habitats. Chapter 3 and 4 apply to LGAs across NSW as listed in Schedule 2, which includes the Wingecarribee LGA and the Shoalhaven LGA. The BDAR in **Appendix F** has considered potential koala habitat impacts.
Shoalhaven Local Environmental Plan 2014	The Project is predominantly within the application area of the Shoalhaven Local Environment Plan 2014. Were it to apply, the all surface works would be permissible with consent and consistent with the objectives of the land use zoning being located within the SP2. Underground Works would also pass under land zoned RU2 Primary Production, C2 Conservation and C1 National Park where the Project purpose would be prohibited. The Project intersects a very small area mapped as habitat corridor and land within 40 m of the bank of a natural water course and as such would otherwise require consideration under clause 7.5 Terrestrial Biodiversity of the Shoalhaven LEP including that the consent authority be satisfied that significant adverse environmental impacts can be avoided, or, where not reasonable to do so, minimised or mitigated. No other mandatory considerations are identified as otherwise required in were the Shoalhaven LEP to be applicable.

Category	Requirement
Wingecarribee Local Environmental Plan 2010	The Promised Land Trail access upgrade and initial 600 meter section of the trail are within land subject to the Wingecarribee Local Environmental Plan 2010. Were it to apply, these works would be permissible with consent where located within the SP2 zoning with the exception of works immediately adjacent to Nowra Road which are within the C1 National Park zone. The Project is within 10 m of a watercourse mapped as Category 3 on the Natural Resources Sensitivity map which would otherwise require consideration of Clause 7.5 of the *Wingecarribee Local Environmental Plan 2010 including that the consent authority consider impacts to the water body and be satisfied that significant adverse environmental impacts can be avoided, minimised or mitigated.* No other mandatory considerations are identified as otherwise required in were the Shoalhaven LEP to be applicable.

5. Engagement

This chapter provides a summary of consultation undertaken by Origin with the relevant local, State or Commonwealth Government authorities and other stakeholders. It provides a summary of consultation undertaken, issues raised and where or how they are addressed. Further detail is also provided in Appendix D.

SEARs for the Project required that:

- During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners.
- The EIS must describe the consultation that was carried out, identify the issues raised during this consultation, and explain how these have been considered and addressed.

5.1 Engagement approach

Origin is committed to engaging with stakeholders across the development of new projects, expansions of existing infrastructure, and ongoing operations. During engagement, Origin:

- Conducts consultation with identified stakeholders including local community, local and state government agencies
- Establishes constructive working relationships and communication channels with stakeholders
- Considers Aboriginal cultural heritage issues in the consultation process
- Seeks community feedback
- Provides regular updates to interested communities on the progress of projects.

Stakeholder engagement for the project has been guided by the values of Origin and with reference to the SEARs for the Project, NSW Government *Undertaking Engagement: Guidelines for State Significant Projects* (DPIE 2021), the International Association for Public Participation (IAP2) public participation framework.

5.1.1 Engagement program

Community and stakeholder engagement commenced in October 2018 with the public announcement of the Project and continued through to October 2022. A summary of the engagement program, including purpose and key activities, is provided in **Table 5-1**. Further details about consultation activities undertaken is provided in **Appendix D**.

Table 5-1. Engagement program

Timing	Consultation purpose	Key communication and engagement activities
October 2018 – October 2019	Public announcement of the project and declaration of the project as CSSI	▪ Establishment of project specific website ▪ Meetings with Councils and government agencies (e.g., presentation to councillors, meetings with Council staff) ▪ Face-to-face and telephone meetings with near neighbours ▪ Meetings with community groups ▪ Letters to near neighbours about noise monitoring ▪ Project feedback channels (e.g., dedicated phone number and email address)
2019-2021	Keeping community updated on an as needs basis	▪ Response to requests for information from community members ▪ Project feedback channels (e.g., dedicated phone number and email address)
November 2021 – October 2022	Re-engage with community to advise of ongoing work to seek approval for the Project and intention to submit EIS for the full project	▪ Letters to near neighbours to provide a Project update ▪ Face to face and telephone meetings with near neighbours, landholders, business and Councils to provide Project updates and intention to submit EIS ▪ Letters to near neighbours, landholders, businesses and community groups providing project and EIS submission information ▪ Website update with information about the Project and EIS ▪ Project fact sheet ▪ Project feedback channels (e.g., dedicated phone number and email address)

Timing	Consultation purpose	Key communication and engagement activities
Late 2022	Exhibition of the EIS	▪ Website updates, including information about the EIS and frequently asked questions ▪ Letters to neighbours, landholders, businesses, and community groups with information about the EIS ▪ Advertisements in local papers ▪ Community information sessions ▪ One-on-one stakeholder meetings and briefings ▪ Project feedback channels (e.g, dedicated phone number and email address).

5.1.2 Engagement tools

Targeted activities were undertaken to engage with community members and stakeholders about the project, as outlined in **Table 5-2**.

Table 5-2. Overview of communication and engagement activities

Activities	Description	Example tools
Communication	Communication activities were undertaken to inform people about the Project	▪ Project website ▪ Project updates ▪ Fact sheet ▪ Letters to near neighbours with information about the Project and the EIS
Stakeholder engagement	Stakeholder meetings and briefings provide a channel for sharing information and identifying stakeholder issues and concerns.	▪ Briefings to local Councils and government agencies ▪ One-on-one meetings with Council staff and government agencies
Community consultation	Community engagement activities provided an opportunity for residents to learn more about the Project, ask questions and provide feedback.	▪ Face-to-face and virtual meetings with individuals and groups near the project (e.g., residents, property owners, business owners, community facility managers, community organisations)
Feedback and reporting	A variety of opportunities and mechanisms allowed community members and stakeholders to provide their feedback about the Project.	▪ Correspondence (email and letters) ▪ Establishment of feedback channels to allow community members and stakeholders to ask questions, including: - Dedicated phone number (1800 677 315) - Dedicated email address (shoalhavenexpansion@originenergy.com.au).

5.1.3 Stakeholders

Throughout engagement for the project, key stakeholder groups were targeted using tailored communication and engagement activities. Stakeholder groups are outlined in **Table 5-3**.

Table 5-3. Stakeholder groups

Stakeholder group	Description	Stakeholders
Community stakeholders, including community groups and organisations, and business representatives	Groups and individuals with a direct stake in the area surrounding the Project and an interest in construction and operational impacts, including property owners, residents, business owners, community facility managers, and visitors.	▪ Adjacent residents and landowners ▪ Adjacent businesses ▪ Tourism operators ▪ Businesses in Kangaroo Valley ▪ Local schools (e.g., Scots College, Avoca Public School, Kangaroo Valley Public School) ▪ Local environmental groups ▪ Sport and recreation clubs (e.g., Southern Highlands Sailing Club)
NSW Government stakeholders	A range of NSW Government stakeholders have an interest in the project, including agencies that own or manage land accommodating Project infrastructure, that operate in the area surrounding the Project, or with a regulatory role.	▪ Water NSW ▪ National Parks and Wildlife Service ▪ EPA ▪ Heritage NSW ▪ Biodiversity Conservation Service (BCS) ▪ Department of Primary Industries – Land and Water ▪ TransGrid ▪ NSW Rural Fire Service (RFS) ▪ Transport for NSW
Council stakeholders	Local government areas within which the Project is located or that are located in the wider region and have an interest in the Project (e.g., construction traffic impacts, economic opportunities).	▪ Shoalhaven City Council ▪ Wingecarribee Shire Council ▪ Kiama Council
Australian Government stakeholders	Australian Government stakeholders have a regulatory interest in the project.	▪ Department of Climate Change, Environment, Energy and Water (DCCEEW)
Aboriginal stakeholders	Traditional Owners and Aboriginal parties with an interest in the project	▪ South Coast People Native Title claimant group ▪ Registered Aboriginal Parties (RAPs)

5.2 Outcomes of consultation

The following provides an overview of engagement activities for various stakeholder groups and outcomes of consultation.

5.2.1 Agency consultation

As part of the preparation of SEARs, DPE and Origin hosted an agency briefing and Project area tour with various agencies to introduce the Project and familiarise agencies with the Project environmental context. At this meeting, agencies identified preliminary expectations for the assessment of the Project which were formalised through review of the Project Scoping Report as inputs to the SEARs.

Origin and Jacobs has subsequently engaged with some agencies where necessary to clarify expectations and provide Project updates.

Table 5-4. Summary of agency consultation

Agency	Issue / request	How / where addressed
Department of Industry – Water and Natural Resources Access Regulator	Recommended SEARs include: ▪ The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply ▪ A detailed and consolidated site water balance ▪ Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts ▪ Proposed surface and groundwater monitoring activities and methodologies ▪ Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans.	The Operation of the Project would utilise existing water allocations linked to the Existing Scheme while construction water may need to be sourced either from existing reservoirs. A detailed water balance is provided in **Appendix J** and forecasts a net surplus of water during construction resulting from groundwater take associated with tunnelling. Discharge of surplus water to the local catchment following appropriate treatment is proposed. Addressed in **Appendix I** and **Appendix J**. Origin will separately engage with appropriate regulators to establish appropriate authorisations for reliable supply.
DPI Fisheries	Fisheries requested that the Biodiversity Assessment for this Project needs to include a clearly separate aquatic habitat and FM Act threatened species assessment with particular attention to critically endangered Fitzroy Falls Spiny Crayfish.	The BDAR in **Appendix F** considers the potential for impacts to confirmed Fitzroy Falls Spiny Crayfish. No further consultation with DPI Fisheries has been undertaken to date.
DPI Agriculture	A land use conflict risk assessment (LUCRA) should be prepared to identify potential conflict during construction and operation. The LUCRA is to be prepared in accordance with the DPI Land Use Conflict Risk Assessment Guide.	Consideration of land use conflicts is provided in **Section 6.4.4.2**.
Division Of Resources & Geoscience NSW (GSNSW)	As the study area does not preclude access to known resources or exploration for future resource discovery and extraction, GSNSW had no concerns or issues to raise in relation to resource sterilisation at this stage. Should biodiversity offsets be considered GSNSW requests to be consulted in relation to the proposed location of any biodiversity offset areas or any supplementary biodiversity offset measures to ensure there is no consequent reduction in access to prospective land for mineral exploration, or potential for sterilisation of mineral resources.	Biodiversity offsetting would be progressed in accordance with the Biodiversity Offset Scheme. No further consultation has been undertaken to date.
EPA	The EPA identified one additional environmental assessment regarding waste management which was adopted in the SEARs.	Waste management is addressed in **Section 6.11.**

Agency	Issue / request	How / where addressed
Office of Environment and Heritage (Now Biodiversity Conservation Service and Heritage NSW)	Key concerns flagged as Biodiversity and Aboriginal Cultural Heritage. Noted draft SEARs included appropriate mechanisms for assessment.	A BDAR in accordance with the Biodiversity Assessment Method (BAM) is provided in Appendix F. An Aboriginal Cultural Heritage Assessment Report (ACHAR) is provided in **Appendix G**. BCS was consulted in the preparation of the BDAR including in relation to survey methods, flowering of reference populations and application of Biodiversity Offsets Credit Calculator in relation to multi-subregion Project footprint. Heritage NSW was consulted in preparation of the ACHAR through the process of identifying potential RAPs and provision of the test excavation methodology.
NSW RFS	RFS noted the Project has potential to increase the level of bush fire risk within the landscape and required a bushfire assessment report be prepared for the Project by a suitably qualified person. RFS were subsequently consulted in August 2022 to provide a briefing in relation to the design status of the Project and implications for approach to the assessment based on this and nature of the Project. RFS identified that confidence in the ongoing maintenance of Asset Protection Zones (APZs) was a key concern and recommended consideration of higher levels of construction to mitigate risk where APZs are relied on.	A bushfire assessment is provided in **Appendix O**. Given the limited infrastructure identified as vulnerable to bushfires and the uncertainty in location of potentially vulnerable assets, the Bushfire Assessment commits to construction standards achieving necessary protections for calculated bushfire attack levels as part of detailed design.
Roads and Maritime Services (now Transport for NSW (TfNSW)	TfNSW required a detailed traffic study be prepared as part of the EIS. Origin has sought to engage with TfNSW to outline the findings of the Traffic Impact Assessment and seek to commence consultation focussed on identifying most appropriate means of providing safe access noting this would be subject to ongoing consultation during detailed design.	A detailed traffic study has been prepared and is provided in **Appendix L**. TfNSW acknowledged the need for ongoing consultation regarding the provision of safe access and will respond formally through the EIS exhibition process or earlier and informally if advanced review of TIA is possible.
Shoalhaven Council	Council's SEARs inputs requested that it be appropriately accessed against all relevant legislation, any environmental impact is minimised and managed and any damage/disturbance avoided or appropriately rehabilitated/restored. Council requests that it be kept advised of the progress of this significant project within our LGA. Council is also happy to be involved as needed as the project moves forward and will review and comment on the EIS when available.	The EIS considers relevant legislation as summarised in **Section 4,** identifies mitigation measures in **Appendix E** and includes a rehabilitation strategy in **Section 3.4.9**. Council has been further briefed through 2022. Specific issued raised by Council in follow-up consultation is included in issues summary table below.
Shoalhaven Water (via Council)	Council would like to see a specific mention of the Bendeela Water Treatment Plan (WTP), owned by Shoalhaven City Council (SW) as a stakeholder. We have concerns in respect to the potential for higher than current algal and toxin counts as result of water movements/transfers.	The Bendeela WTP is identified in **Section 2.4** as a key feature of the Project surrounds. Water quality impacts to the Bendeela Pondage are considered in **Appendix I** including algal and toxin management.

Agency	Issue / request	How / where addressed
WaterNSW	WaterNSW has a key interest in the Project as the landowner of most of the Project area, proximity to existing water supply assets, potential for significant impacts to WaterNSW land and infrastructure and location with the declared Sydney catchment for which WaterNSW has legislative objectives and functions. Key issues identified for consideration include: ▪ Likely interactions with the Existing Scheme ▪ Likely impacts on WaterNSW land and assets and mitigation measures proposed to address them ▪ Consideration of Water NSW Act and Regulation ▪ An assessment of the risk of soil and water contamination based on the predicted geochemistry of excavated rock ▪ An assessment of whether the project would have a neutral or beneficial effect on water quality. Origin has subsequently established a working group with WaterNSW to address the various commercial, construction and operational interfaces and is providing draft impact assessment documentation for review and consideration of amendments. Origin requested information from WaterNSW about public use of campground at Bendeela Recreation Area.	The Existing Scheme is identified as a key feature of the surrounding area in **Section 2.4** and has been a key consideration in the Project development to date. The likely impacts to WaterNSW are described in various sections of the EIS with consideration of land use conflict provided in **Section 6.4.4.2**. The risks to soil and waters from geochemistry of excavated rock is discussed in **Section 6.4.4.3**, **Appendix I** and **Appendix J**. These risks would be managed through to implementation of a spoil management plan based on the spoil management strategy provided in **Appendix K**. A neutral or beneficial impact assessment is provided in **Appendix I**. Details on the use of the campground at Bendeela Recreation Area are provided in **Appendix Q**.

Agency	Issue / request	How / where addressed
NPWS	In commenting on the separate application to undertake geotechnical investigations, NPWS raised the following concerns: ▪ No access to or works on park are to occur as part of this modification unless authorisation is granted by NPWS under the NPW Act or the National Parks and Wildlife Regulation 2019. ▪ The *Developments adjacent to National Parks and Wildlife Service lands* (NPWS 2020) resource provides general guidance on the priority environmental considerations for impact assessments adjacent park. ▪ Potential for conflicts between construction vehicles and walkers and cyclists on weekends on the Promised Land Trail. Appropriate conditions should be applied to ensure monitoring of any impacts to adjacent lands (including the national park) occur at the applicant's expense during and following completion of works, and that any required rectification works to adjacent lands are undertaken. Works undertaken as part of the overall Shoalhaven Hydro project (CSSI 10033) would have to consider the tenure of any land on which the project is proposed. It is anticipated that any subsequent EIA for the overall Shoalhaven Hydro project would clearly outline the tenure of lands on which the proposal was proposed to be sited and would establish access/permissibility of the project under the NPW Act and the Morton National Park, Budawang National Park Plan of Management (NPWS 2001) if any such components were proposed on NPWS estate. Origin has subsequently discussed the Project and avenues to secure tenure including undertaking a site inspection with NPWS representative. Issues discussed included: ▪ Agreement/ approval from NPWS for project tunnels under National Parks (subject to depth of tunnel) ▪ Need for access approval to use the Promised Land Trail and agreement to close the trail to public access during construction ▪ Reinstatement of the Promised Land Trail post-construction ▪ Access for operations and maintenance.	Origin has commenced a process to establish the legal means of securing necessary approvals in consultation with NPWS. The *Developments adjacent to National Parks and Wildlife Service lands* guidelines have been considered in the development of the EIS as identified in **Section 2.4.2**. Public access along the Promised Land Trail may need to be limited during construction for safety management purposes. The trail would be reinstated and opened to public access following construction. A rehabilitation strategy is provided in **Section 3.4.9** and mitigation measures including monitoring are documented in **Appendix E**. The tenure of lands as they relate to the Morton National Park are discussed in **Section 4**.

Agency	Issue / request	How / where addressed
Department of Climate Change, Environment, Energy and Water (DCCEEW)	Origin provided DCCEEW with a briefing to introduce the Project in 2019 at which time biodiversity assessments were commencing and it was uncertain if a significant impact was likely. Origin subsequently re-introduced the Project to DCCEEEW in 2022 and then submitted a Referral under the EPBC Act on 29 June 2022. DCCEEW accepted and published the referral on 30 August 2022. Origin facilitated a site visit with DCCEEW assessment team on 13 September 2022 and provided clarification on questions raised. On 28 September 2022, the Project was determined to be a controlled action under the Environment Protection and Biodiversity Conservation Act 1999 and will be assessed under the bilateral agreement between the NSW and Commonwealth Governments. DCCEEW has identified a list of species of concern requiring assessment as Part of the EIS.	The BDAR provided in **Appendix F** assesses the Project's impacts on relevant matters of National environmental significance. Consideration of how the EIS addresses the EPBC Act is provided in **Appendix A**.

5.2.2 Community consultation

Since the initial announcement of the Project, Origin has consulted with local communities, including residents, property owners, and community organisations to provide information about the Project and gather feedback on concerns or issues for consideration in the project development and EIS. **Table 5-5** provides a summary of the key issues raised, along with information about how issues have been addressed.

Table 5-5. Summary of issues raised through community consultation

Theme	Summary of feedback	How / where addressed
Property and land use	▪ Possible for property values to be adversely affected ▪ Concerns about potential impacts on property from site investigations and construction activities (e.g., noise, vibration, damage from vehicle movements during wet weather) ▪ Proximity of cavern and underground works to properties.	▪ Land use risks are assessed in **Section 6.4.4.2** ▪ Refinements have been made to the tunnel alignment in response to geotechnical investigations and community feedback ▪ Potential property impacts are described in **Section 6.13** and **Appendix Q**.
Business impacts and opportunities	▪ Noise and vibration impact to businesses near the Project during construction ▪ Amenity impacts on businesses due to the location of laydown areas ▪ Accommodation impacts for their employees during construction ▪ Business and visitor impact during construction (i.e., Impacts during construction on visitor economy and workforce accommodation) ▪ Potential impacts on business that operates out of Bendeela recreation area and Lake Yarrunga.	▪ Potential impacts for local businesses, including on tourism uses, are described in **Section 6.13** and **Appendix Q** of the EIS.
Noise and vibration	▪ Noise and vibration impact during construction, including from tunnelling under properties and houses ▪ Concerns about road traffic noise from movement of trucks during the day and night ▪ Vibration during operations.	▪ Noise and vibration impacts of the Project's construction and operation, including measures for managing potential impacts, are described in **Section 6.8** and **Appendix M**.
Traffic and access	▪ Concerns about construction access and potential construction traffic impacts ▪ Impacts to roads and road maintenance (i.e., concerns that some roads are already in a bad condition and will need to be fixed if increasing traffic) ▪ Potential for speeding trucks and concerns about road safety for children ▪ Student safety from increased construction traffic ▪ Concerned about the use of Old Bendeela Road for emergency access for Scots College Campus.	▪ Potential construction traffic impacts are described in **Section 6.7.4** and **Appendix L**.
Potential hazard and risks	▪ Fire hazard safety procedures ▪ Mitigation measures of bushfires in close proximity to residents	▪ Potential risks and impacts on public safety such as bushfire risk, and measures for managing potential risks, are described in **Section 6.12**.

Theme	Summary of feedback	How / where addressed
Biodiversity	▪ Potential for speeding trucks and concerns about impacts on wildlife ▪ Impacts to wombats ▪ Mitigation measures to minimise flora and fauna impacts and other biodiversity considerations	▪ Potential impacts, including measures for managing potential impacts, on flora and fauna are discussed in **Section 6.1**. ▪ The design of the Project has sought to prioritise the use of existing disturbed areas, limit works within Morton National Park, narrow site access to the Promised Land Trail to reduce impact on habitat, use underground infrastructure to avoid or minimise surface impacts.
Amenity impacts	▪ Impacts relating to noise, traffic movement and disposal of spoil ▪ Whether ventilation shafts will emit emissions and noise under normal circumstances or in an emergency ▪ Noise and vibration during operations due to proximity to cavern location ▪ Operational impacts on rural and scenic character of the area as a result of additional above ground infrastructure	▪ Amenity related impacts of the project's construction and operation are described in the noise and vibration assessment (**Section 6.8**), air quality (**Section 6.9**), visual amenity (**Section 6.14**), and socio-economic assessment (**Section 6.13**). ▪ The revised design no longer includes a ventilation shaft with ventilation to be provided through the access and ventilation tunnel.
Community uses	▪ Concerns about operational impacts on recreational use (e.g., sailing) of Fitzroy Falls Reservoir and Lake Yarrunga ▪ Kangaroo River is used as a drinking water source for Scots College campus and concerns about potential for construction to increase turbidity of water, water level or flow changes in the Kangaroo River.	▪ Potential changes to water levels and impacts on surface water, including proposed management measures, are described in **Section 6.5**.
Housing and accommodation	▪ Size of the construction workforce and where they will be accommodated ▪ Issues about existing challenges in finding local accommodation for staff.	▪ Potential impacts for housing and accommodation are described in **Section 6.13** and **Appendix Q** of the EIS.

5.2.3 Aboriginal stakeholder consultation

Aboriginal stakeholder engagement and involvement is important for the identification of Aboriginal cultural values relevant to the Project. This section summarises the consultation process relating to the organisation and conduct of the ACHAR. Details of consultation, including examples of letters sent to the RAPs and knowledge holders, conversations undertaken during archaeological survey, native title search results, records of cultural heritage values interviews and a detailed consultation log are included in Chapter 3 and Appendix A of the ACHAR (refer to **Appendix G**). **Table 5-6** outlines the stages of Aboriginal stakeholder consultation undertaken for the Project.

Table 5-6. Summary of Aboriginal stakeholder consultation undertaken for the Project

Task name	Date
Stage 1 – Agency letters	12 November 2021
Stage 1 – Newspaper advertisements	Advertised in the South Coast Register and the Koori Mail on 1 December 2021
Stage 1 – Project notification and invitation to register supplied to potential Aboriginal stakeholders	1 December 2021 to 15 December 2021
Stage 1 – Supply the list of RAPs to Heritage NSW, Nowra Local Aboriginal Land Council (LALC) and Illawarra LALC	21 December 2021
Stages 2 and 3 – RAP review of Project information and methodology and request for information about cultural significance	20 December 2021
Stage 4 – Carry out archaeological survey and prepare a draft ACHAR	27 June 2022 to 22 August 2022
Stage 4 – Present the draft ACHAR to RAPs for review and comment	23 August to 21 September 2022

Stage 1 of the consultation process is to identify, notify and register any Aboriginal people or groups who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the Project area. Notification was initiated on 12 November 2021 to all relevant organisations listed under Section 4.1.2 in the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (ACHCRP) (DECCW, 2010a)

In accordance with Section 4.1.3 of the ACHCRP a notice in the local newspaper circulating in the general location of the proposed Project was completed, with information explaining the Project and its exact location.

Notices were placed in the South Coast Register and Koori Mail on 1 December 2021. These advertisements provided additional opportunity for Aboriginal people who are interested in the Project to register.

Project notifications were sent to all groups and individuals identified in the above consultation process. Fifteen RAPs were established as follows:

- Nowra LALC
- Illawarra LALC
- South Coast People
- DNC
- Freeman & Marx Pty Ltd
- Murra Bidgee Mullangari Aboriginal Corporation
- Yurrandaali Pty Ltd
- Barraby Cultural Services
- Woronora Plateau Gundangara Elders Council
- Duncan Falk Consultancy
- Goobah Development PTY LTD (Murrin Clan/Peoples)
- Warragil Cultural Services
- Three individuals (names withheld).

Following Section 4.1.6 of Stage 1 of the ACHCRP, a list of RAPs for the Project and copies of the notifications from Section 4.1.3 of the ACHCRP were submitted to Heritage NSW, Nowra LALC and Illawarra LALC.

Stage 2 of the consultation process provides RAPs with information about the scope of the proposed Project and the proposed cultural heritage assessment process. The RAPs were provided with a copy of the draft test excavation methodology on 20 December 2021 with a 28-day period for review and comment. By the end of the review period two groups had provided comment (Goobah Development PTY LTD and Murra Bidgee Mullangari Aboriginal Corporation), both in support of the methodology. The methodology was finalised following the receipt of comments and the end of the 28-day consultation period.

All RAPs were invited to participate in the completion of an archaeological survey and test excavation program. Six RAPs participated in archaeological investigations between 27 and 30 June 2022.

Stage 3 of the consultation process is to facilitate a process whereby RAPs can contribute to culturally appropriate information gathering and the research methodology, provide information that will enable the cultural significance of Aboriginal objects and/or places on the Project area to be determined, and have input into the development of any cultural heritage management options.

RAPs were invited to submit information relevant to the cultural significance of the Project area and any areas and objects within it, at all stages of the consultation process.

Stage 4 of the consultation process involves the RAPs review and feedback on the draft ACHAR. The draft ACHAR was sent to all RAPs on 23 August date, so that they could review the document and supply comments and provide feedback. Feedback was received from RAPs has been incorporated and the ACHAR has been finalised. The Final ACHAR has been sent to RAPs to coincide with public exhibition of the EIS.

5.3 Ongoing community feedback strategy

Consultation for the Project is ongoing and will include:

- Increased contact and communication on EIS exhibition and opportunities to ask questions, submit comments and raise issues to be responded to post exhibition and in ongoing detailed design
- Future engagement to keep stakeholders informed on process and timing of construction if approved.

5.3.1 Public exhibition of the EIS

During the public exhibition period, the community and other stakeholders will have the opportunity to review the EIS and make written submissions to DPE regarding the Project. The EIS will be available for review by the community and stakeholders on the DPE Major Projects website (www.planningportal.nsw.gov.au/majorprojects).

A range of communication and engagement activities would be undertaken by Origin to allow community members and stakeholders to find out more about the Project, its construction and operation, potential environmental impacts and management measures. These are outlined in **Table 5-7**.

Table 5-7. EIS exhibition communication and engagement activities

Activity	Description
Communication	▪ Publish and distribute fact sheet on project website and at local venues ▪ Updated the project website with information about the EIS and frequently asked questions ▪ Letters to neighbours, landholders, businesses, and community groups with information about the EIS ▪ Advertisements in local papers
Stakeholder engagement	▪ Hold one-on-one stakeholder meetings and briefings
Community consultation	▪ Hold community information sessions at locations near the Project to allow community members to speak to a member of the Project team about the Project, environmental impacts and management measures
Feedback and reporting	▪ Maintain public feedback channels to allow community members and stakeholders to ask questions, including: - Dedicated phone number (1800 677 315) - Dedicated email address (powerdevelopmentprojects@originenergy.com.au).

Engagement carried out after exhibition of the EIS will most likely focus on responding to any key and substantive issues raised in submissions. A submissions report would then be prepared by Origin for submission to DPE which would be available to the public via the DPE Major Projects website (https://www.planningportal.nsw.gov.au/major-projects).

5.3.2 Future engagement activities

Should the EIS be approved, and a decision made by Origin to proceed with the Project, engagement with the community and stakeholders will continue during the Project's detailed design and construction phases. During these phases, communication and engagement will see to ensure that residents, landowners, local communities, and other key stakeholders are informed about the project and construction activities. Key issues to be addressed include the timing, duration, and likely impact of construction activities, opportunities for community members to participate through business, employment and training opportunities, and measures to mitigate or manage potential construction impacts. The process for engaging with the community and stakeholders would be outlined in a Stakeholder and Community Engagement Plan (SCEP).

6. Assessment of impacts

This chapter provides an assessment of the predicted and potential impacts associated with the Project. For each key issue the assessment methodology is detailed, existing environment is described, potential impacts of the Project during construction and operation are assessed, and the proposed mitigation measures are described.

Appendix E provides a consolidated summary of all the proposed environmental management and monitoring measures, and how these mitigation measures would be integrated with the existing environmental management, monitoring and reporting regime for the Existing Scheme where relevant.

The assessment of key issues is supported by detailed investigations that are documented in the technical assessment reports in provided in the Appendices.

6.1 Biodiversity

This section provides an assessment of the potential biodiversity impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix F** (BDAR).

The assessment addresses the following SEARs:

Biodiversity – including:

- An assessment of the biodiversity values and the likely biodiversity impacts of the project (including consideration of the Morton National Park in accordance with the NSW *Biodiversity Conservation Act 2016*, the BAM, and documented in a BDAR;
    - the BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM; and-
    - an assessment of the impacts of the project on aquatic ecology, key fish habitat and threatened aquatic species, and measures to rehabilitate or offset (if required) aquatic biodiversity values
    - if an offset is required, details of the measures proposed to address the offset obligation

6.1.1 Legislative and policy context

The BDAR has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- EPBC Act
- EP&A Act
- BC Act
- FM Act
- NPWS Act
- *Biodiversity Offsets Scheme*
- *BAM (DPIE, 2020a)*
- *Biodiversity Assessment Method Calculator (Office of Environment and Heritage (OEH), 2020) (BAM-C)*
- *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (Department of the Environment, 2013)
- *Atlas of Groundwater Dependent Ecosystems* (Bureau of Meteorology, 2020)
- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov et al., 2012).

6.1.2 Methodology

The methodology for the biodiversity assessment included:

- Desktop review of available databases, regional mapping, assessment reports and other relevant environmental and strategic planning documents, to identify threatened species requiring further assessment and consideration
- A habitat and likelihood of occurrence assessment to determine the likelihood of a particular species occurring within the study area. A likelihood ranking was assigned to each species, including 'recorded', 'high', 'moderate', 'low' and 'none'. The likelihood of occurrence assessment was used to guide and inform the field surveys carried out for the Project

- Field surveys to identify the biodiversity values within the study area, including:
  - Identification and mapping of PCTs and stratification of native vegetation into survey units (vegetation zones) and plot-based full floristic survey and vegetation integrity assessment
- Targeted survey for threatened species surveys between 2019 and 2022, including;
  - Parallel transects undertaken across suitable habitats within the Project area for threatened flora species within the required survey periods (seasons)
  - Targeted fauna survey methods were employed including live trapping, baited remote sensor camera traps, call broadcasting, ultrasonic call recording (bats), spotlighting, timed area searches, nest tree survey and stag watching
- Targeted survey of potential nest tress and breeding activity for the Gon-gong Cockatoo and Glossy Black-Cockatoo
- Search to identifying large stick nests that may be used by White-bellied Sea-Eagle, Little Eagle and Square-tailed Kite.
- Identification and assessment of potential impacts on biodiversity arising from the Project
- Mitigation measures for avoiding, managing or reducing impacts on biodiversity values during detailed design, construction and operation
- Identification of any residual impacts that cannot be avoided, minimised or mitigated which must be offset.

The BDAR has been undertaken in accordance with Stage 1 and Stage 2 of the BAM (DPIE, 2020). The BDAR addresses potential impacts to biodiversity listed under the BC Act, FM Act and MNES identified in the EPBC Act.

Further detail about the assessment methodology, including field surveys undertaken is provided in the **Appendix F.**

The biodiversity study area comprises of a 50 m buffer around the Project area. To identify the landscape features a 500 m buffer was also placed around the Project area.

6.1.3 Existing environment

The Project area occupies a landscape that was previously disturbed and modified for construction of the original Shoalhaven hydro scheme in 1974. Since this time considerable regeneration has occurred and the locality is known to retain biodiversity values including a number of threatened species and ecological communities listed both state and commonwealth legislation.

6.1.3.1 Landscape features

The landscape features of the Project area were determined in accordance with the requirements of the BAM. **Table 6-1** summarises the biodiversity landscape features found in and around the Project area.

Table 6-1. Biodiversity landscape features of the study area

Landscape feature	Description
Interim Biogeographic Rationalisation for Australia (IBRA).	The Project is located within the Sydney basin IBRA and traverses three IBRA subregions; ▪ Ettrema subregion occurs at the southern end of the Project and encompasses land occupied by the Bendeela pondage, Kangaroo Valley and Kangaroo River ▪ Illawarra subregion occupies the slopes and cliff faces below the existing surge tank ▪ Moss Vale subregion occupies the plateau.
NSW Landscape Regions (Mitchell landscapes)	The Project crosses three NSW landscapes: ▪ Fitzroy Falls Plateau ▪ Fitzroy Falls Escarpment ▪ Kangaroo Valley landscapes.

Landscape feature	Description
Rivers and streams	The Project is located within the Shoalhaven River catchment (Kangaroo River sub-catchment). Key waterways around the Project include Fitzroy Falls Reservoir and Fitzroy Falls Upper Canal, Trimbles Creek and several tributaries of Trimbles Creek, Yarrunga Creek and several tributaries of Yarrunga Creek, Bendeela Pondage, Kings Creek, Kangaroo River) and several tributaries of Kangaroo River, as well as Lake Yarrunga. These are discussed further in **Section 6.5**.
Wetlands	There are no naturally occurring wetlands in the Project area.
Connectivity of habitat	Vegetation connectivity within the Project area is very high, particularly from the plateau in a west and southwest direction and associated the expansive Morton National Park that is connected to the south to other national parks and state conservation areas including Bugong National Park and Colymea State Conservation Area. From the Fitzroy Canal to the east there are extensive cleared lands associated with rural land, however connectivity remains high and continues to Budderoo National Park around 12 km to the east. In the plateau portions of the Project area there are no major barriers that break apart vegetation (apart from the infrastructure associated with Existing Scheme). The vegetation in the plateau is largely contiguous and much of this is preserved within Morton National Park. In contrast the Kangaroo Valley portions of the Project area in the south and more fragmented and associated with clearing for the power station areas, dams, public roads and paddocks (private rural properties). However, Kangaroo Valley still contains contiguous forest patches which are within close proximity to vegetation in the Project area, particularly on the south side of the Kangaroo River.
Areas of geological significance	Areas of geological significance generally include karst, caves, crevices and cliffs. Cliffs are a common feature of the Morton National Park landscape and within the Project area occur predominately in a broad rim encircling below the southern end of the existing pipeline and surge tank. In steep locations between the Promised Land track and the existing pipeline there are exposed rocky habitats that contain many crevices and shallow overhangs. The Project area follows an existing engineered cutting in the plateau areas (containing the existing pipeline). This cutting was investigated thoroughly and does not contain suitable habitat crevices or caves as it is a shaped wall of sandstone.
Human made structures and non-native vegetation	There are no human-made structures of concern in terms of providing known or potential habitat for threatened species and there are no areas of non-native vegetation associated with this Project that would potentially provide habitat for threatened species.
Areas of outstanding biodiversity value	The Project area does not contain any areas of outstanding biodiversity value listed on the register of declared areas of outstanding biodiversity value.
Native vegetation extent	The current percentage of native vegetation cover was calculated in the BDAR from regional vegetation mapping and aerial imagery within the 500 m landscape buffer. The 500 m landscape buffer is approximately 1,046 ha in size and contains approximately 911 ha of native vegetation. The current percentage of native vegetation cover in the landscape is approximately 87 %.
Patch size	The main barrier that breaks apart vegetation within the Project area is the infrastructure associated with the Existing Scheme and clearing from power station areas, dams, public roads and paddocks in Kangaroo valley. As such, the vegetation zones used in the BAM-C are all contiguous with a maximum patch size class of greater than 100 ha.
Weeds	High threat weeds including *Lantana camara* (Lantana), *Ligutrum sinense* (Chinese Privet), *Ageratina Adenophora* (Crofton Weed), *Bidens Pilosa* (Cobbler's Pegs), *Araujia sericifera* (Moth Vine) and *Ageratina riparia* (Mist Flower) were observed in the Project area during the biodiversity surveys.
Bushfire 2019/2020	A large bushfire affected parts of the Kangaroo Valley and Morton National Park to the west of the Project area in January 2020. The biodiversity surveys between October 2021 to May 2022 confirm that the Project area was not affected by the fire

6.1.3.2 Native vegetation

There is approximately 29.5 ha of vegetation within the Project area which is comprised of approximately 22.2 ha of regrowth and 7.3 ha of potentially remnant native vegetation.

6.1.3.2.1 Plant community types

Following desktop review and ground truthing, seven PCTs in varied condition were identified within the Project area as shown on **Figure 6-1**. These PCT are:

- PCT 1254: Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin Bioregion
- PCT 1156: Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateau, southern Sydney Basin Bioregion
- PCT 1082: Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion
- PCT 1283: Turpentine - Red Bloodwood - Sydney Peppermint shrubby open forest on the foothills, southern Sydney Basin Bioregion and northern Southeast Corner Bioregion
- PCT 1245: Illawarra Escarpment Blue Gum Wet Forest
- PCT 1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateau of the Sydney Basin Bioregion
- PCT 1108: River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin Bioregion and Southeast Corner Bioregion.

PCT 1245 corresponds with a threatened ecological community (TEC) listed as endangered under the BC Act referred to 'Southern Highland Shale Woodland of the Sydney Basin Bioregion' which is also listed as critically endangered under the EPBC Act referred to as 'Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion'.

6.1.3.2.2 Groundwater dependent ecosystems (GDEs)

The level of groundwater dependence of vegetation communities in the Project area has been identified using the *Atlas of Groundwater Dependent Ecosystems* (Bureau of Meteorology, 2020) and the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov et al., 2012).

There are four potential terrestrial GDEs in the Project area which include:

- Shoalhaven Sandstone Forest – Low potential GDE (PCT 1156, PCT 1082, PCT 1083)
- Turpentine forest – Low potential GDE (PCT 1238)
- Escarpment foothills wet forest – Moderate potential GDE (PCT 1245)
- Riverbank forest – High potential GDE (PCT1108).

The PCTs identified in the Project area that correspond with terrestrial GDE mapping are shown in **Figure 6-1**.

6.1.3.3 Habitat suitability for threatened species

The PCTs listed in Section **6.1.3.2.1** correspond with six broad habitat types, including:

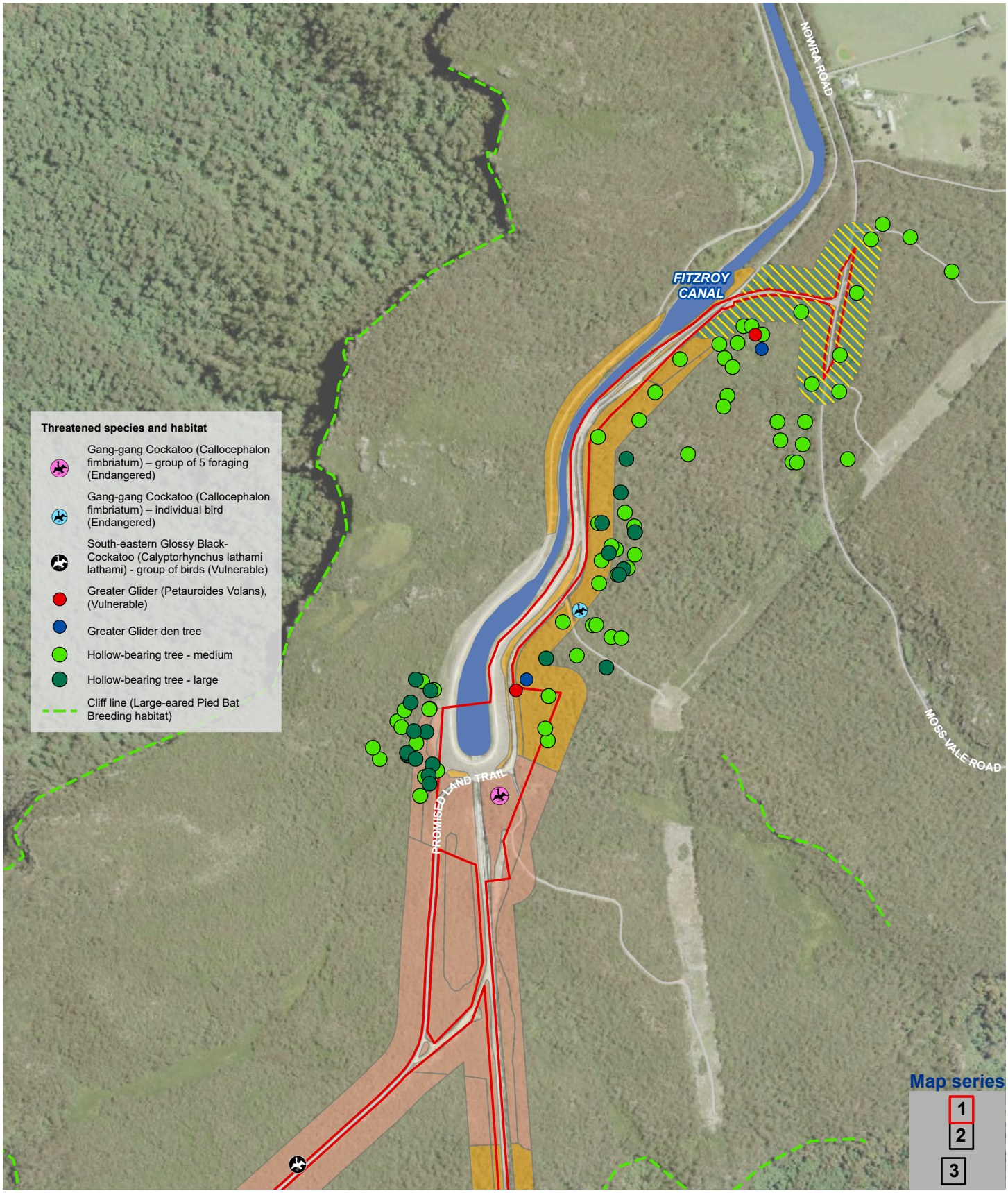
- Southern escarpment wet sclerophyll forests
- Sydney Coastal Dry Sclerophyll Forests
- South-East Dry Sclerophyll Forests
- Southern Lowland Wet Sclerophyll Forests
- North Coast Wet Sclerophyll Forests
- Eastern Riverine Forests.

Much of the vegetation within the Project area has been previously cleared or disturbed and no longer meets the structural or floristic condition of the broad habitat type. As such, the habitat quality for threatened species varies greatly between condition classes (and vegetation zones).

All habitats are well represented in the surrounding forest areas and the locality and particularly widespread in Morton National Park.

There are a several large eucalypts trees in and around the Project area which contain occasional large tree hollows, as shown on **Figure 2-5**. These tree hollows would provide opportunities for sheltering and breeding for hollow-dependent fauna, including threatened species such as Gang-gang Cockatoo, Glossy Black-cockatoo and Greater Glider (*Petauroides Volans)*. The forest floor contains hollow logs, wood debris as well as intact groundcover and midstorey stratums.

A large number of hollow-bearing trees have been mapped in buffer areas surrounding the Project.



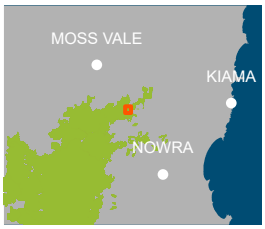
Legend

- Disturbance area
- Road
- Waterbody
- Southern Highlands Shale Woodlands in the Sydney Basin Bioregion (Endangered Ecological Community)
- PCT 1082 - Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion
- PCT 1156 - Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateaux, southern Sydney Basin Bioregion
- PCT 1254 - Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

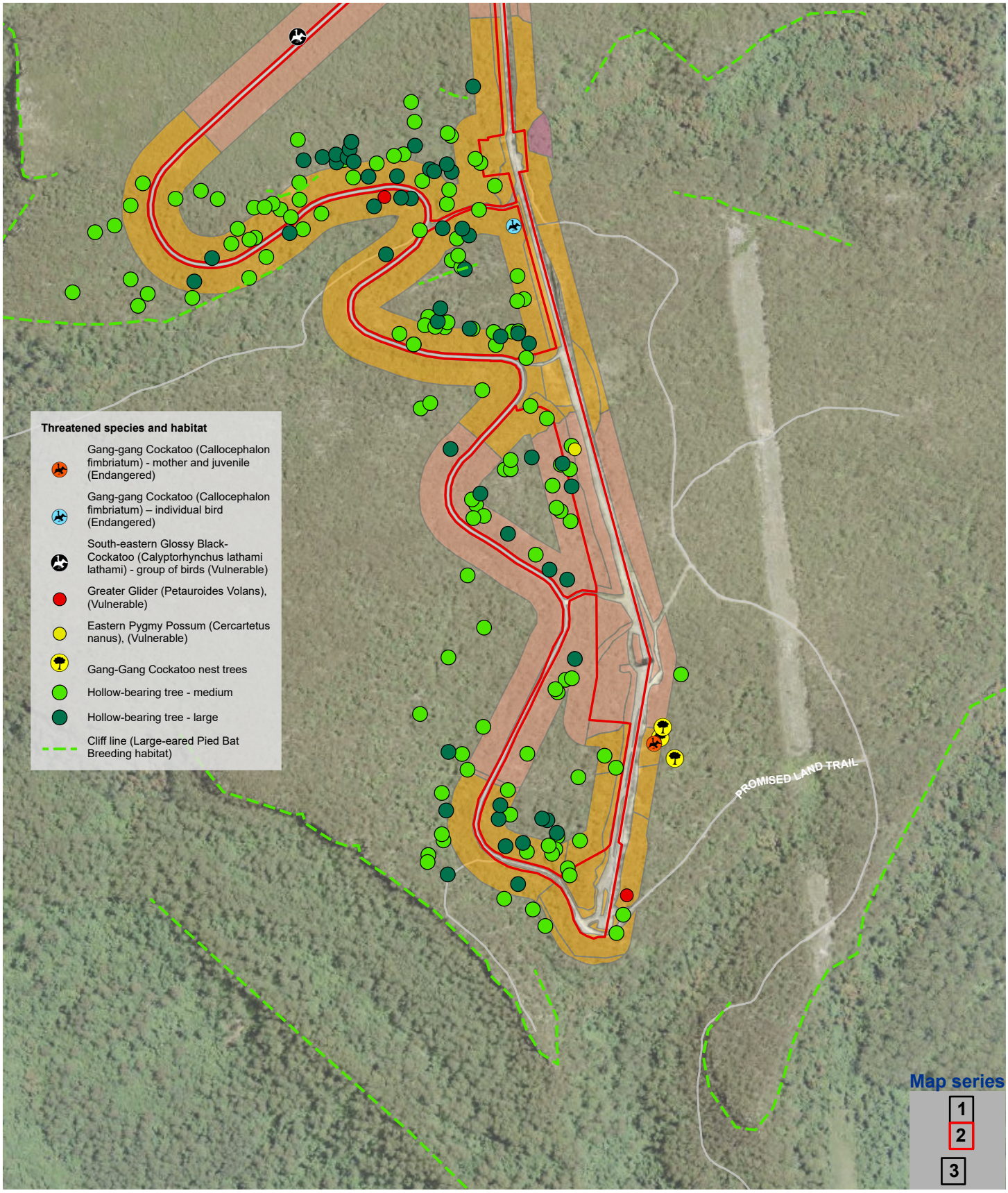


Data sources1

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-1 Native vegetation, threatened species and habitat

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC



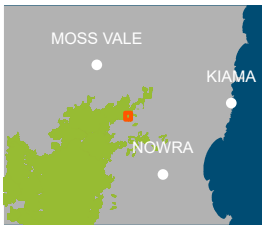
Legend

- Disturbance area
- Road
- PCT 769 - Coachwood - Lilly Pilly warm temperate rainforest in moist sandstone gullies, Sydney Basin Bioregion
- PCT 1082 - Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion
- PCT 1156 - Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateaux, southern Sydney Basin Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

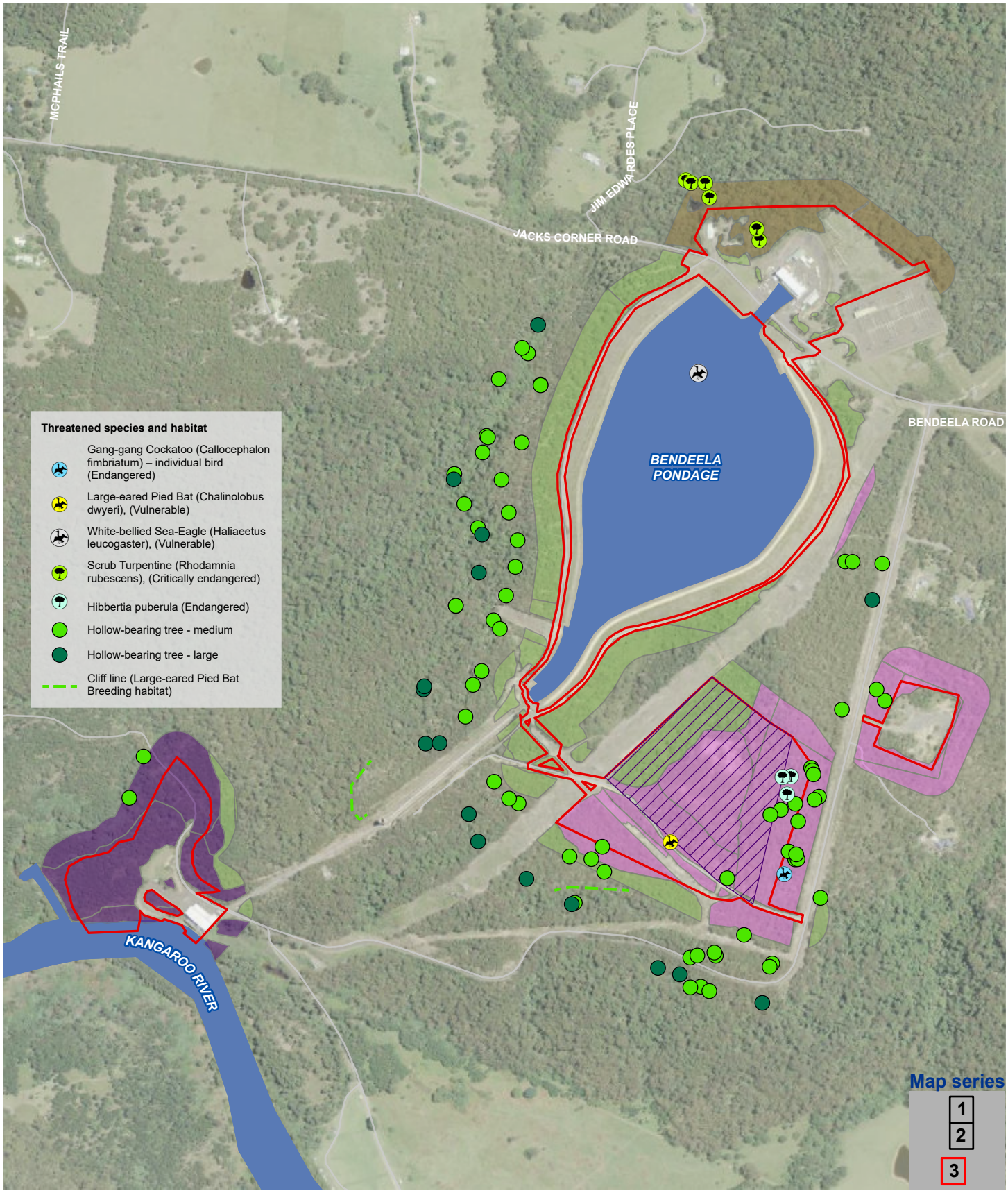


Data sources2

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-1 Native vegetation, threatened species and habitat

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC



Legend

- Disturbance area
- Spoil site
- Road
- Waterway
- Waterbody

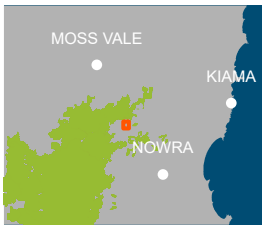
- PCT 1083 - Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion
- PCT 1108 - River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion
- PCT 1245 - Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion
- PCT 1283 - Turpentine - Red Bloodwood - Sydney Peppermint shrubby open forest on the foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion

0 200 400 metres

1:10,000 at A4

GDA2020 MGA Zone 56

N



Data sources3

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-1 Native vegetation, threatened species and habitat

Date: 10/31/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_EIS.aprx
Created by : JB | QA by : CC

6.1.3.4 Threatened species

6.1.3.4.1 Threatened flora

Two threatened plant species, *Rhodamnia rubescens* (Scrub Turpentine) and *Hibbertia puberula* were identified from targeted surveys and one additional threatened flora plant species was assumed to be present, *Genoplesium baueri* (Bauer's Midge Orchid).

6.1.3.4.2 Threatened fauna

Due to the large extent, variability and generally high quality of the habitats present across the broader locality, many listed threatened plant species are known to occur in the locality. The threatened fauna species likely to occur in the Project area and targeted during surveys are summarised in **Table 6-2**. This list was primarily determined by the BAM-C based on the habitats present within the Project area.

The fauna surveys identified the following threatened species:

- Birds: Gang-gang Cockatoo (*Callocephalon fimbriatum*), and Glossy Black-cockatoo (*Calyptorhynchus lathami*)
- Non-flying mammals: Greater Glider (*Petauroides volans*) and Eastern Pygmy Possum (*Cercartetus nanus*)
- Flying mammals: Large-eared Pied Bat (*Chalinolobus dwyeri*) and Southern Myotis (*Myotis macropus*).

Giant Burrowing Frog (*Heleioporus australiacus*), and Littlejohn's Tree Frog (*Litoria littlejohni*) were assumed to occur in the Project area.

Table 6-2. Threatened fauna likely to occur in the Project area and targeted during surveys

Species	Common name	BC Act	EPBC Act	Likelihood of Occurrence
Birds				
Artamus cyanopterus	Dusky Woodswallow	V	-	Moderate
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Present
Callocephalon fimbriatum	Gang-gang Cockatoo	V	E	Present
Tyto novaehollandiae	Masked Owl	V	-	High
Tyto tenebricosa	Sooty Owl	V	-	High
Petroica boodang	Scarlet Robin	V	-	Moderate
Pycnoptilus Floccosus	Pilotbird	-	V	Moderate
Daphoenositta chrysoptera	Varied Sittella	V	-	Moderate
Glossopsitta pusilla	Little Lorikeet	V	-	High
Neophema pulchella	Turquoise Parrot	V	-	Moderate
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	High
Numenius madagascariensis	Eastern Curlew	V	-	High
Bats				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	High
Miniopterus australis	Little Bentwing-bat	V	-	High
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	High
Micronomus norfolkensis	Eastern Coastal Freetail-bat	V	-	High
Myotis macropus	Southern Myotis	V		High

Species	Common name	BC Act	EPBC Act	Likelihood of Occurrence
Phoniscus papuensis	Golden-tipped Bat	V	-	Moderate
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	High
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V	-	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Present
Mammals				
Dasyurus maculatus	Spotted-tail Quoll	V	E	Moderate
Petauroides volans	Greater Glider	-	V	Present
Cercartetus nanus	Eastern Pygmy-possum	V	-	High
Amphibians				
Heleioporus australiacus	Giant Burrowing Frog	V	V	Moderate
Litoria littlejohni	Littlejohn's Tree Frog	V	E	Moderate

6.1.3.4.3 Threatened aquatic species

No Fitzroy Falls Spiny Crayfish (*Euastacus dharawalus*) were caught during the aquatic survey program for these species. This is consistent with findings presented in the desktop review and therefore it is reasonable to suggest that the Fitzroy Falls Crayfish is unlikely to inhabit the Project area.

No other threatened aquatic species are likely to inhabit the Project area.

6.1.3.4.4 Migratory species

Five migratory species listed under the EPBC Act are likely to occur within the Project area. The White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and two migratory species Black-faced Monarch (*Monarcha melanopsis*), Rufous Fantail (*Rhipidura rufifrons*) were the only migratory species observed during the field surveys. However, the Satin Flycatcher (*Myiagra cyanoleuca*) and Spectacled Monarch (*Monarcha trivirgatus*) are considered likely to occur based on favourable habitats.

While some migratory species of bird are likely to use the Project area and locality, the Project area would not be classed as an 'important habitat' as defined by the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (Department of the Environment, 2013). A nationally significant proportion of a population would not be supported by the Project area.

6.1.3.5 Aquatic habitats

The Project area contains four main waterbodies, Kangaroo River and Bendeela Pondage in the valley and Fitzroy Canal and Trimbles Creek on the plateau. Additionally, the Project is located within the catchment of Kings Creek which flows to Kangaroo River.

The NSW Department of Primary Industries Key Fish Habitat (KFH) mapping indicates that Fitzroy Canal, Bendeela Pondage and Kangaroo River are categorized as KFH – of the southern rivers. Kings Creek and Lake Yarrunga to the south of the Project is also mapped as KFH.

Some mapped drainage lines to the east of Bendeela pondage in Kangaroo Valley no longer exist and were likely removed during construction of the balancing storage and nearby earthworks/ spoil placement.

Most of the aquatic habitats in the Project area are already affected by the Existing Scheme to some degree either as a result of inundation by the Existing Scheme reservoirs, landform modifications associated with prior construction and spoil emplacement and ongoing water transfers.

6.1.4 Construction impacts

As discussed in **Section 1.2**, the majority of the Project area occupies a landscape that was previously disturbed and modified for construction of the Existing Scheme in the 1970's.

The Project infrastructure has been intentionally placed adjacent to the Existing Scheme and access would be along previously cleared tracks, within minimal clearing of regrowth required to upgrade. Additionally, previously cleared land (with current regrowth) would be used for spoil stockpile, and a substantial portion of the Project will be placed underground and involve tunnelling. As such, the Project will result in minimal clearing of native vegetation.

The Project area has been frequently adjusted since the preliminary design stages in 2018 to account for biodiversity values identified during the survey program. Importantly, the impacts to Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion critically endangered ecological community (CEEC) have been significantly reduced at the intersection of the Promised Lands Trail and Nowra/Moss Vale Rd (in the north of the Project site). The original design for major clearing and lane-widening at this location (for truck access and laydowns) has been refined to only 0.23 ha of vegetation impacts (along road edges).

6.1.4.1 Impacts on native vegetation and habitat

6.1.4.1.1 Direct impacts

The Project would result in the direct removal of about 29.5 ha of native vegetation which includes approximately 0.23 ha of the TEC listed under both the BC Act and EPBC Act as summarised in **Table 6-3**. Approximately 25 % of the vegetation that is required to be removed is regrowth vegetation that has been previously disturbed.

The removal of this vegetation would also have direct impacts on threatened species habitat as outlined in **Table 6-4**.

Table 6-3. Summary of direct impacts to vegetation within the Project area

PCT	Description	Impacted area (ha)
1254	Sydney Peppermint - White Stringybark moist shrubby forest on elevated ridges, Sydney Basin Bioregion which also make up the TEC listed under both the BC Act and EPBC Act.	0.23 ha
1156	Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateau, southern Sydney Basin Bioregion	5.55 ha
1082	Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion	6.55 ha
1283	Turpentine - Red Bloodwood - Sydney Peppermint shrubby open forest on the foothills, southern Sydney Basin Bioregion and northern Southeast Corner Bioregion	2.63 ha
1245	Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion	1.41 ha
1083	Red Bloodwood - scribbly gum heathy woodland on sandstone plateau of the Sydney Basin Bioregion	9.39 ha
1108	River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin Bioregion and Southeast Corner Bioregion	3.68 ha
Total		**29.44 ha**

Table 6-4. Summary of direct impacts on threatened species habitat (species credit species)

Threatened species	BC Act	EPBC Act s	Extent of direct impact (ha, number of individuals)
Rhodamnia rubescens (Scrub Turpentine)	CE	CE	2 individuals
Genoplesium baueri (Baueri Midge Orchid)	E	E	Assumed present over 9.39 ha
*Hibbertia puberula (*Hibbertia puberula*)*	E	Not listed	0.55 ha
Greater Glider (*Petauroides volans*)	Not listed	V	12.33 ha
Eastern Pygmy Possum (*Cercartetus nanus*)	V	Not listed	25.79 ha
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	0.87 ha
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	25.79 ha
Littlejohn's Tree Frog (*Litoria littlejohni*)	V	V	12.10 ha
Southern Myotis (*Myotis macropus*)	V	Not listed	9.69 ha
Gang-Gang Cockatoo (breeding)	V	E	1.01 ha

Key: CE= Critically endangered E = endangered, EP = endangered population, V = vulnerable

6.1.4.1.2 Indirect impacts

Indirect impacts are changes to the structure and function of retained vegetation in association with factors such as increased light intensity and duration, increased exposure to wind and weed and pathogen invasion resulting from the creation of a new edge (i.e. edge effects), removal or bush rock and the potential increase in predators or pest animal species. These impacts are discussed further below.

In general, vegetation clearing will occur along edges of existing cleared areas (as a result of widening such areas). Widening of clearings and canopy gaps can push edge effects further into surrounding vegetation areas, however much of this vegetation has already been exposed to similar effects during previous construction phases. Some vegetation areas will be subject to new clearing, such as the proposed laydown areas in the lower scheme area and the underground access area adjacent the existing power station. Importantly, stockpile areas will be located in previously disturbed or cleared areas containing regrowth vegetation (and in these locations new edges will not be created.

Clearing works along the pipeline would only be undertaken to facilitate placement of machinery and construction laydown areas, and would not result in total removal of vegetation. Following construction these areas will be rehabilitated and returned to native vegetation. The access roads are existing tracks to be that would be upgraded, and vegetation along these roads is already impacted by edge affects. Therefore, the conditions following the clearing of native vegetation for the Project is unlikely to dramatically change the abiotic conditions (temperature, light and moisture).

While the Project would not directly or indirectly impact on cliff lines, and exposed rock platforms, there is likely to be disturbance of surface rocks in construction areas. This would involve tramping of rocks by machinery and physical disturbance to surface rock. The impact would be on smaller rock sheltering fauna such as reptiles and frogs and would be temporary, and only during construction.

The activities associated with clearing vegetation and increased human presence including ongoing movements of large machinery during construction have potential to introduce weeds and plant and animal diseases into adjacent vegetation outside the Project area. As described in **Section 6.1.3**, the Project area contains high threat weeds which need to be managed to prevent the spread.

Predator species and pest animal species can potentially be attracted to the Project area during construction and associated with increased human presence and activity. The potential risk in increased where there is accumulation of domestic rubbish and waste around construction compounds and the Project itself. This is particularly important given the Project is adjacent to Morton National Park. Appropriate disposal and handling of domestic waste will be managed on site during all periods of construction to reduce this risk.

Noise and vibration from construction activities would potentially disrupt the roosting and foraging behaviour of fauna species and reduce the occupancy of areas of suitable habitat. The noise and vibration impact maybe also potentially to push fauna further away from the Project or disrupt breeding activities through interruption of mate calling, or excessive activity near an important habitat tree.

During winter and out of hours work, lighting may potentially be required in the early mornings and late afternoons. This could potentially affect nocturnal fauna.

Air quality impacts, particularly dust have the potential to adversely impact native species during ground disturbance works. Potential impacts include dust covering vegetation thereby potentially reducing vegetation health and growth.

Indirect impacts can be minimised and avoided through the implementation of the mitigation measures detailed **Section 6.1.8.**

6.1.4.2 Groundwater dependent ecosystems

The Project is not likely to interrupt the hydrological connection between a GDE and the aquifer it depends on, nor is it likely to impact groundwater quality or recharge. This is because the Project would have a limited interaction with groundwater, as discussed in **Section 6.6**. However, the Project would require the removal of potential GDEs during construction (PCT 1156, PCT 1082, PCT 1083, PCT 1238, PCT 1245 and PCT1108).

6.1.4.3 Prescribed biodiversity impacts

Prescribed biodiversity impacts (as defined by the BAM) are in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat.

There are no major open cliff faces with crevices or caves that may be suitable as shelter or roosting sites threatened species within the Project. Therefore, the Project would not impact on the adjacent steep sandstone exposures which may contact Karst, caves, crevices, cliffs, rocks or other geological features of significance.

The Project has been planned to position all the new surface infrastructure adjacent to existing infrastructure within already cleared areas and the use of the existing access track. As such that the Project will not create any new barriers to fauna movement, nor will it result in substantial breaking up of a continuous vegetated landscape or creating new barriers to fauna movement. The impacts to current movement opportunities would be considered low.

The Project however does have the potential to result in some prescribed biodiversity impacts, namely impacts to waterbodies, water quality and hydrological processes and potential fauna vehicles strikes. These are discussed below.

6.1.4.3.1 Waterbodies, water quality and hydrological processes

Due to the nature of the Project being associated with construction activities near waterways and waterbodies, there is potential for mobilised sediments to enter the waterways, particularly during and after and vegetation clearing and in the event of heavy rainfall occurring during construction. This indirect impact has potential to cause negative short-term impacts to aquatic habitat in these waterways, that are potentially used by fish, amphibians, birds and mammals (including threatened species).

In addition to potential displacement of sediment, there is a risk of localised release of contaminants (i.e. hydraulic fluids, oils, drilling fluids, etc.) into the receiving waterways, in the event of an accidental spill or incident. A contamination event has the potential to cause direct physical trauma to aquatic fauna that come into contact with the contaminants. Accidental release of contaminants is considered low risk, and if it did occur would be limited primarily to the construction phase and would likely to be localised and able to be contained. The mitigation measures are discussed further in **Section 6.1.8.**

Most of the aquatic habitats in the Project are already affected by the Existing Scheme to some degree. The Project will require a range of mitigation measures to prevent or minimise further impacts or habitat degradation.

No clearing or direct impacts to KFH are likely due to the nature of the works proposed and mitigation measures to be employed.

6.1.4.3.2 Vehicle strikes

Construction of the Project will involve regular vehicle movements on existing roads, fire trails and tracks for routine access by workers, transportation of spoil from excavation tunnels and site works to stockpile sites, and transportation to and from laydown areas. These increased vehicle movements during construction of the Project have the potential to increase the risk of fauna injury and mortality given the roads used traverse large areas of forest, including Morton National Park. Threatened species most at risk of vehicle strike include Pygmy Possum *(Cercartetus nanus)*, Greater Glider *(Petauroides Volans)*, and a diversity of common fauna species, including Common Wombats. Vehicle strike is an impact that can reduce local population numbers, although any impacts would be short-term and during construction only. Construction activities will occur during the day, therefore there is little risk of collision at night from construction vehicles.

Fauna injury or death has the greatest potential to occur during the construction phase when excavation and vegetation clearing would take place. The extent of this impact would be proportionate to the extent of vegetation that is cleared. Less mobile species (ground dwelling mammals, amphibians and reptiles), or those that are nocturnal and nest or roost in trees during the day (arboreal mammals and microbat species), may find it difficult to rapidly move away from the clearing activities when disturbed. In addition to this, entrapment of fauna in any excavated trenches or pits may potentially occur if the trenches or pits are deep and steep sided. Fauna may also become trapped in or may choose to shelter in construction vehicles, infrastructure, machinery and equipment and/or during relocation of stored construction materials that is stored in the Project area overnight. This may result in injury or death of fauna if not thoroughly checked prior to construction activities and equipment use.

These potential impacts can be avoided and managed and will be addressed in the CEMP, and include measures such as on-site education, identifying and reporting hazards as they occur during construction, and setting vehicle speed limits.

6.1.5 Operational impacts

Minimal impacts on biodiversity (either direct or indirect) are anticipated during operation of the Project. Risks to fauna from vehicle strikes and impacts to waterways by pollution (spills or sediment movement) still remain but at a much-reduced level.

Over the long-term operational phase of the Project, the recovery of ground layer vegetation at the site would be expected to prevent further movement of sediment and as construction ends there is a lower risk of spillage of contaminants.

During operation, portions of the Project around tunnel entry will require security lighting at all hours of the night. While the external lighting would be installed in a manner that aims to minimise light spill to areas beyond the Kangaroo Valley Power Station boundary fence, there is likely to be some small amount of light pollution into the surrounding vegetation. The amount of light spill is expected to be very low and the area around the existing power station and associated infrastructure is already exposed to some level of disturbance.

The ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle, such as the Greater Glider *(Petauroides Volans)*, and Eastern Pygmy Possum *(Cercartetus nanus)*. It is likely that any nocturnal animals present will habituate over the long-term. Some species such as light tolerant microchiropteran bats may benefit from the lighting due to increased food availability (e.g. insects attracted to lights) around these areas.

Assuming that lighting is designed and installed to limit light spill, the impact of the residual light spill is unlikely to significantly affect any nocturnal species in the area.

6.1.6 Serious and irreversible impacts

Four species-credit species predicted by the BAM calculator for the proposed development are also listed as SAII entities in the Guidance to Assist a Decision-Maker to Determine a SAII (OEH, 2017c), including:

- Southern Highlands Shale Woodland in the Sydney Basin Bioregion TEC
- *Rhodamnia rubescens* (Scrub Turpentine)
- *Genoplesium baueri* (Bauer's Midge Orchid)
- Large-eared Pied Bat (*Chalinolobus dwyeri*).

The BDAR provides additional impact assessment for each of these entities for which the Minister must take into consideration and determine whether there are any additional and appropriate measures that will minimise those impacts if consent or approval is granted.

6.1.7 Matters of National Environmental Significance

For threatened biodiversity listed under the EPBC Act that have been positively identified within the Project area or considered as high or moderately likely to occur, significance assessments have been completed in accordance with the EPBC Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of Environment, 2013). The EPBC Act listed species subject to this assessment included:

- Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion – CEEC under EPBC Act
- *Rhodamnia rubescens* (Scrub Turpentine)
- *Genoplesium baueri* (Bauer's Midge Orchid)
- Greater Glider (*Petauroides* Volans)
- Gang-gang Cockatoo (Callocephalon fimbriatum)
- Glossy Black-cockatoo (Calyptorhynchus lathami lathami)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)
- Giant Burrowing Frog (Heleioporus australiacus)
- Littlejohn's Tree Frog (Litoria littlejohni) (also Litoria watsoni)
- Pilotbird (Pycnoptilus floccosus).

The significance assessments found that the Project is unlikely to result in a significant impact to any threatened community or species. Nor would the Project substantially modify, destroy or isolate an area of important habitat for migratory species, and it would not seriously disrupt the lifecycle of an ecologically significant proportion of a population of migratory birds.

6.1.8 Mitigation measures

Mitigation measures to address the biodiversity impacts of the Project are listed in **Table 6-5**. Mitigation measures for erosion and sediment control and water quality are provided in **Section 6.5.7.**

Table 6-5. Biodiversity mitigation measures

Ref	Impact	Biodiversity mitigation action	Timing
BIO1	Impacts to biodiversity	A Biodiversity Management Plan (BMP) will be prepared and-implemented. The BMP will be prepared by a qualified ecologist and include a plan for implementing, evaluating and reporting on the effectiveness of all mitigation measures outlined in this BDAR, but not be limited to these measures. The overarching framework of the BMP will be based on SMART principals (Specific, Measurable, Achievable, Realistic, Timebound) and will focus on monitoring the performance of measures and informing any adaptive management required based on performance triggers for remedial action or additional offsets where further impacts are identified. The BMP will detail required mitigation actions for the Project for all biodiversity, including indirect, and prescribed impacts.	Construction

Ref	Impact	Biodiversity mitigation action	Timing
BIO2	Removal of native vegetation and habitat	Mitigation measures for avoiding harm to animals and threatened hollow dependent fauna during pre-clearing survey and any translocation activities include: ▪ Pre-clearing surveys to be conducted with a suitably qualified and licenced wildlife handler to rescue and re-locate fauna ▪ Protocol for the removal of hollow bearing trees - hollow inspection /lowering limbs to the ground ▪ Protocol to mitigate harm to hollow dependent threatened fauna known or with potential to be utilising breeding habitat in the Project area and disturbance footprint, e.g. Gang-gang Cockatoo (*Callocephalon fimbriatum*), Glossy Black-cockatoo (*Calyptorhynchus lathami*), Eastern Pygmy-possum (*Cercartetus nanus*), and Greater Glider (*Petauroides volans*).	Pre-clearing
BIO3	Pre-clearance surveys	Pre-clearance surveys will be undertaken prior to tree felling works by suitably qualified and experienced persons/personnel and will include: ▪ Scheduling the clearing works for a time of year to avoid the breeding seasons of identified potential threatened species and other threatened fauna that may breed on site, where practicable. In the event that works cannot be scheduled outside of breeding times, additional controls will be implemented prior to clearing to further manage the risk. This could include, but is not limited to, additional pre-clearance surveillance of potential den tree (stagwatching or cameras) and sectional removal of suspected habitat trees ▪ Comparative habitat assessments conducted on clearing sites and proposed release sites to ensure that habitat features are available in the released sites ▪ Release sites identified and mapped prior to clearing and all appropriate approvals granted by the landholders ▪ The demarcation of areas approved for clearing to reduce risk of accidental clearing ▪ Habitat resources and habitat trees will be identified and marked. Other habitat features to be identified include fallen timber/hollow logs, burrows, and boulder piles ▪ The identification of potential presence of threatened flora and fauna species, endangered populations and TECs ▪ The identification of threatened species or habitat features that are suitable for translocation or salvage ▪ Disturbance activities will be targeted to specific times of the year to minimise impacts to threatened species' usage of habitat features for breeding and roosting, where practicable.	Pre-clearing

Ref	Impact	Biodiversity mitigation action	Timing
BIO4	Habitat clearing	Tree felling will be completed as close to the completion of pre-clearance surveys as practicable to limit the potential for new issues to arise (such as new active nests being built). Tree felling supervision will be undertaken by an appropriately qualified and experienced person after pre-clearance surveys have identified potential habitat features. The tree-felling process will include the following: ▪ Prior to Felling Habitat Trees: - Completion of actions recommended from the pre-clearing surveys, including (but not limited to) salvage of identified habitat features, additional surveys to determine threatened fauna usage of the area (if required), identification of active dens or burrows, any actions required to discourage fauna occupation and weed or feral fauna management requirements - Removal of non-habitat trees/vegetation as close to the habitat tree felling date as possible in order to create disturbance to discourage fauna usage of the habitat trees - Shaking of habitat trees (with heavy machinery) as appropriate to encourage fauna to abandon trees. ▪ On the Day of Felling Habitat Trees: - Tree clearing should not be conducted above 35°C for the interests of animal welfare - Communication with rescue agencies and local veterinarians prior to the commencement of clearing to confirm the availability of resources for any captured/injured fauna that is unable to be released - Clearing should be conducted sequentially and directionally towards areas of refuge to prevent the creation of vegetation islands - All habitat trees will be subject to a visual inspection to survey for threatened species - Trees previously identified as containing fauna will be shaken and then felled, providing no threatened species are identified - The lowering of hollow-bearing trees will be done as gently as possible with heavy machinery - If a threatened species is identified in a habitat tree on the day of felling, the supervising person is to advise the most appropriate method to minimise potential harm. This may include leaving the tree overnight, further shaking to encourage the animal to vacate the tree, gradual removal of branches to discourage ongoing use, soft felling of the tree with the animal in the tree, or measures to capture and relocate the animal to secure habitat - Uninjured animals should be released on the day of capture into nearby suitable secure habitat and should not be held for extended periods of time - Injured animals will be taken to the nearest veterinary clinic or wildlife carer as soon as possible for assessment and treatment - Felled trees are to be rolled where appropriate so that the number of hollows blocked against the ground is minimised - All felled habitat trees should remain in place for a least one night to allow any remaining fauna to escape - Ensure that trees felled are positioned so that hollows are facing upwards and out to allow fauna to escape overnight - Habitat features identified for translocation or salvage operations should be extracted and stored appropriately.	Pre-clearing

Ref	Impact	Biodiversity mitigation action	Timing
BIO5	Gang-gang and Glossy Black-cockatoos	Specific measures to mitigate the impact to individual breeding pairs of Gang-gang cockatoo (*Callocephalon fimbriatum*) and Glossy Black-cockatoo (*Calyptorhynchus lathami*) (adults, chicks and eggs) will be confirmed. The pre-clearing protocol of breeding habitat for cockatoos needs to comprise: ▪ Hollow-bearing potential nest tree(s) is to be clearly identified on construction planning maps ▪ Hollow bearing tree(s) are to be removed outside the breeding season where practicable (April to August and Oct to Jan). ▪ A pre-clearing protocol will include inspection of the tree to determine if live cockatoos are present and potentially nesting. If nesting cockatoos are present, additional mitigation is to be implemented and could include clearing of identified potential habitat trees outside the breeding season and installation of nest boxes by a suitably qualified and experienced ecologist. Where nesting is identified as occurring at the proposed time of clearing, the subject trees are to be clearly marked as no-go zones and removal delayed until the chicks have fledged. There is to be no disturbance within 100 m of the tree, and disturbance between 100 -200 m is to be minimised. The removal of the tree must allow time for fauna to vacate the habitat.	Pre-clearing
BIO6	Greater Glider	The boundary of the clearing limits for each disturbance zone will be clearly marked on site by a surveyor before vegetation clearing commences: ▪ Exclusion zones, or 'No-Go' zones, will be clearly marked at the edge of the clearing zones to protect the vegetation to be retained outside the project from inadvertent direct impacts. These will be in place for pre-clearing, construction and remain in place until post-construction rehabilitation objectives have been met.	Pre-clearing, construction and early operation
BIO7	Exclusion Zones	A staged habitat removal process will be required for removal of habitat (hollow-bearing trees, habitat trees, and bushrock) Staged habitat removal minimises direct impacts on fauna by providing them with an opportunity to vacate hollows and relocate naturally. The process includes: ▪ Avoiding clearing during times when hollow-dependent fauna is breeding ▪ Contact vets and wildlife carers before works commence ▪ Ensure that licensed wildlife carers and/or ecologists are on site during habitat removal ▪ Adopt two staged removal clearing non-habitat first (e.g. shrubs, regrowth, ground cover and non-habitat trees). Allow at least 24 hours for fauna to vacate habitat before removing habitat trees ▪ Ensure wildlife carers and/or ecologists are present during removal of habitat trees, and that habitat trees are felled carefully, using equipment that allows habitat trees to be lowered to the ground with minimal impact ▪ A procedure for the ethical handling of injured or displaced fauna ▪ Record the effort and outcomes of the habitat removal process ▪ Save and reuse cleared habitat material ▪ Preparation of an 'Unexpected threatened species finds procedure' to be implemented during construction and operation. Applies to all activities that have potential to impact upon threatened flora and fauna species which have not already been assessed and approved. Any threatened entities found in a location previously unknown during construction or operation must be immediately notified to NPWS ▪ Preparation of a Fauna handling and rescue procedure to be implemented during construction.	Construction
BIO8	Staged Habitat Removal	▪ Erosion and sedimentation will be managed through implementation of effective sediment control measures ▪ Disturbed areas will be stabilised to reduce erosion potential ▪ Only native indigenous species will be used for landscaping of disturbed surfaces Soil loss will be minimised by immediate stabilisation of exposed surfaces (e.g. use of Jute mesh and/or soil binder).	Pre-construction, construction

Ref	Impact	Biodiversity mitigation action	Timing
BIO9	Impacts on water quality and hydrological processes	A Weed monitoring and control program(s) will include the following: ▪ Identify, map, and remove all weeds before clearing for construction, and record location of weed and sprayed area for use in ongoing weed monitoring and management programs. ▪ Prepare a vehicle and machinery hygiene strategy and implement during construction. The strategy will include specific locations, timing and methods for removing soil and plant matter from vehicles and machinery. Ensure vehicle and machinery hygiene measures in the strategy are applied during construction. ▪ During the clearing works, weeds will be disposed and managed appropriately to stop the spread of weed species Wash down stations will be constructed at suitable locations to wash down vehicles and employee shoes to stop the spread of weeds, pathogens (including amphibian chytrid fungus, Phytophthora cinnamomi and exotic rust fungi) and the introduction of new species	Pre-construction, and construction
BIO10	Increase in weeds and disease pathogens	▪ Personal waste / refuse generated during construction will be stored appropriately in accessible bins and disposed at appropriate waste disposal facilities off-site. Any personal waste generated during operation will be removed from the site (including power station) and disposed in an appropriate waste facility A feral animal monitoring program will be developed and implemented based on performance triggers for adaptive management. Data will be shared with NPWS. Increased predator activity will trigger the need for predator control based on performance measures. Control will be implemented in consultation with NPWS.	During construction
BIO11	Increase in predatory and pest species	▪ Directional lighting will be used for any permanent lighting required as part of the permanent infrastructure to minimise light spill as much as possible Artificial lighting required during construction in the early morning and late afternoon in winter or night periods will be minimised consistent with the requirements of Australian Standard 4282-1997 Control of the obtrusive effects of outdoor lighting.	During construction and operation
BIO12	Light impacts	Minimise noise from equipment through measures such as: ▪ Selecting equipment with the lowest noise rating that meets task requirements and minimise operating loud machinery simultaneously in close proximity. For example, operating a jackhammer and concrete saw ▪ Keeping both stationary and mobile plant and equipment in good working condition (including mufflers, enclosures etc.) Avoid leaving engines running on standby when machinery is not being used.	During construction
BIO13	Noise impacts	Dust management and standards to control air quality will be implemented.	During construction
BIO14	Dust pollution	Vehicle movements on internal access tracks will be limited to 20km/h speed limit implemented to reduce the risk of vehicle strike to fauna.	Construction and operation
BIO15	Wildlife impacts from vehicle strike	Vehicle movements on internal access tracks will be limited to 20km/h speed limit implemented to reduce the risk of vehicle strike to fauna.	Construction and operation

6.1.9 Biodiversity offset strategy

The Biodiversity Offsets Scheme applies to SSI projects unless the Secretary of DPE and the Executive of Environment, Energy and Science Group determine that the Project is not likely to have a significant impact.

Offsets would be required for the residual impacts to native vegetation and species-credit species present within the Project area. The Project impacts and offset obligations have been calculated using the BAM-C based on the concept design, as is normal for a major project at this stage of the process. The Project impacts

and offset obligations would be revised in response to submissions and detailed design and would include consideration of areas where total clearing and permanent infrastructure may be avoided.

The credit requirement for the Project that has generated by the BAM-C for the three subregions assessed, includes 596 ecosystem credits and 2,644 species credits. The full Biodiversity Credit Report is included in Appendix D of the BDAR (**Appendix F**).

Fulfilling offset requirements under the BC Act can be undertaken using one or a combination of the following offset strategies:

- In-perpetuity conservation through the establishment of a Stewardship site and the retirement of credits
- Securing required credits through the open credit market and/or
- Payments to the Biodiversity Conservation Fund.

As Origin does not own land in the vicinity of the Project area where all required credits are likely to be available, the establishment of a Stewardship site has not been investigated to date. As such, Origin currently proposes to secure credits through the open market where available or otherwise make payment through the Biodiversity Conservation Fund. Should an opportunity arise to establish a suitable Stewardship site in time, Origin would consider this further in negotiation with relevant landowners. Otherwise, Origin intends to commence consultation with the Biodiversity Conservation Trust including initiating an expression of interest for identified credit requirements.

6.2 Aboriginal heritage

This section provides an assessment of the potential Aboriginal heritage impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix G** (Aboriginal cultural heritage assessment report) (ACHAR).

The assessment addresses the following SEARs:

Heritage – including:

- An assessment of the Aboriginal cultural heritage items (cultural and archaeological) in accordance with the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011) and the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010c);
- Archival and oral history recording for any items with significant heritage values likely to be disturbed or impacted by the project; and
- Evidence of adequate consultation with the local Aboriginal community in determining and assessing impacts, developing options and selecting options and mitigation measures (including the final proposed measures), having regard to the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (OEH, 2010a).

6.2.1 Legislative and policy context

The ACHAR has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Native Title Act* 1993
- *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act* 1984
- NPW Act
- *Native Title Act* 1994 (NSW)
- *Aboriginal Land Rights Act* 1983
- *Aboriginal cultural heritage consultation requirements for proponents* 2010a (DECCW 2010a) (the Consultation Requirements).
- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (Department of Environment Climate Change and Water [DECCW] 2010b)* (the Due Diligence Code)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW 2010c)* (the Code of Practice).
- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011)* (the Guide).

6.2.2 Methodology

The methodology for the ACHAR included:

- A desktop review of archaeological literature and data including an Aboriginal Heritage Information Management System (AHIMS) search
- An archaeological preliminary site inspection of the Project area carried out on 27 and 28 June 2022 with RAP representatives
- A test archaeological field excavation at the Bendeela Power Station Potential Archaeological Deposits (PADs) carried out on 39 and 30 June 2022 with RAP representatives
- Consultation with the Aboriginal community representatives as described in Section 5.2.3
- Assessment to determine the cultural significance of identified items
- Assessment of the potential impacts on Aboriginal sites, places and objects
- Identification of appropriate mitigation measures.

6.2.3 Existing environment

Shoalhaven, and specifically the Shoalhaven River, is of high cultural significance and likely to contain varying densities of archaeological deposits. Previous archaeological investigations within the region, indicate that archaeological deposits occur within the Project area, including isolated sites, artefact scatters and PADs. Where sites have not previously been identified, this may be due to the low number of archaeological assessments which have happened in the region. As a result, an examination of the local environment and the various cultural factors in the region will add to this existing knowledge and enable the creations of a predictive model that will assist in locating more Aboriginal sites.

The South Coast People Native Title claimant group have an existing, undetermined native title claim registered on 21 January 2018 which encompasses the Project area.

6.2.3.1 Ethno-historical background

The closest water sources include Fitzroy Falls Reservoir to the North of the Project area, Bendeela Pondage and Lake Yarrunga to the South of the Project area, Yarrunga Creek to the West and Miller Creek to the East. Fitzroy Falls Reservoir, Bendeela Pondage and Lake Yarrunga were formed as part of the Existing Scheme with the later inundating the lower reaches of the Kangaroo River.

Within the Illawarra region, key resources included water, stone, clay, plant, and animals. Resources would have been both marine and terrestrial. Marine resources would have included a range of fish and shellfish (evident from shell middens on the eastern coast). Terrestrial resources would have been utilised not only for food but also for medicine and raw materials to aid in making cultural objects such as baskets. Implements created from wood would have made up a large part of the material culture present within the Shoalhaven area. Artefacts such as spears (karmai), woomeras (womra), boomerangs (bumarin), shields (hilamin), and canoes (maduri) would have been made from timbers, gums and resins.

A dominant material which remains preserved in the archaeological record is stone such as silcrete, chert, indurated mudstone, quartz, and quartzite. In archaeological sites these raw materials were used to craft stone artefacts. These stone technologies are present within assemblages and demonstrate its use or certain tools for hunting and gathering, as well as for crafting weaponry such as spears and woomeras.

Aerial imagery indicates the Project area surrounds currently encompasses National Parkland with some residential and agricultural properties. The Project area has largely avoided the National Parklands (except for access and underground works) and follows targets areas of prior disturbance, cleared land or their fringes. The original landscape within Project area has changed since the arrival of Europeans. Though patches of original vegetation remain, such as Eucalypt woodland, much of the original vegetation has been cleared to make room for pastural practices and in some cases regrown. Dairy farming is the primary industry in the region which has meant, areas of land are fenced off and ploughed. The Project area has been further impacted by considerable earthworks associated with the construction of the Existing Scheme as evident in **Figure 2-6**.

6.2.3.2 Database search results

A search of the AHIMS database was undertaken on 11 February 2022 for an area of land at Geocentric Datum of Australia, zone 56, eastings 264974 – 273849, northings 6150178 – 6162300 without. The search area extends 2km beyond the Project area in all directions to gain information on the archaeological context of the local area.

A total of nine previously recorded Aboriginal sites were identified within the AHIMS search area as shown in **Figure 6-2**. The majority of the registered AHIMS sites are located to the south, southwest and southeast of the Project area and were likely identified during the heritage assessments prepared for the development of the land on the Kangaroo Valley floor. Therefore, additional archaeological resources may be present but have not been identified due to lack of previous archaeological investigations, particularly on the sandstone escarpment. The closest previously registered site to the Project area is Lake Yarrunga 4 (#52-4-0118), located approximately 1 km west of the Bendeela Power Station.

No registered AHIMS sites were identified as located within the study area. No previously identified Aboriginal sites would be impacted by the Project.

6.2.3.3 Predictive model

The desktop assessment indicates that certain landscape contexts within the Project area have a higher likelihood to contain archaeological sites and deposits than others. Predictive modelling was used to determine the archaeological sensitivity for Aboriginal cultural heritage of particular landforms within the proposed Project area. Within the Project area differing degrees of ground disturbance and development has resulted in fluctuations of disturbed archaeological integrity, mainly as an effect of alluvial, colluvial, agricultural and decreased preservation processes.

Based on the search of the AHIMS and Australian Heritage database and review of previous archaeological reports pertaining to the broader Project area, the following site types, characteristics and potential location of Aboriginal places within the Project area are potentially located within the Project area:

- Artefact scatters, grinding grooves, areas of PAD, scarred trees and rock shelters are likely to be associated with primary resources zones along major rivers and also evident along higher order creek flats, slopes and terraces
- Grinding grooves and rock shelters are a likely site type to occur in the broader area. Rock shelters are likely to occur in steep drainage depressions or spur crest units or sloping terrain. Grinding grooves are likely to occur on homogenous stone outcrops such as sandstone close to water sources
- Artefacts scatters and isolated artefacts are a likely to occur. These are likely to be located along alluvial floodplains and are likely to include surface and subsurface deposits
- Areas of PAD are likely to occur where intact deposits are retained. Surface scatters may likely indicate potential for sub-surface deposit
- Scarred trees are a less likely site type to encounter in the valley. These are less abundant and are likely to occur on mature vegetation and in the vicinity of or in association with other cultural and archaeological material. If scarred trees are located within or in proximity to the Project area, it is likely they will be encountered within vegetation on the escarpment at Promised Land Trail and Morton National Park.

6.2.3.4 Preliminary site inspection

The archaeological preliminary site inspection was conducted on the 27 and 28 June 2022 in order to gauge where impacts would occur, and to identify whether or not Aboriginal objects are, or are likely to be, present, and whether or not the proposal is likely to harm Aboriginal objects. The archaeological survey was undertaken in consultation with the RAPs to confirm areas of PAD to be subject to archaeological test excavation.

Survey effectiveness was generally low across the study area due to low surface visibility and exposure. The archaeological survey resulted in the identification of one scarred tree, Promised Land Trail ST01, located at the intersection of McPhails Firetrail and Promised Land Trail. A PAD, the Bendeela Power Station PAD, was also identified west of the Bendeela Power Station in the area proposed for the Lower intake structure having been first identified in 2019.

6.2.3.5 Test excavation

Test excavation was undertaken on 29 and 30June 2022 at the Bendeela Power Station PAD, shown in **Figure 6-3**, which was previously identified during 2019 excavations as containing three sub-surface Aboriginal objects. The test excavation was undertaken in consultation with the RAPs to identify if Aboriginal objects are present and would be harmed as a result of the Project.

The test excavation identified one artefact scatter, Bendeela Hydro AS01 (AHIMS ID 52-4-0729), from which 49 Aboriginal objects were recovered. The results of the test excavation are further described in Chapter 5 of Appendix B of **Appendix G**.

6.2.4 Cultural heritage values identified during assessment

Discussions with Aboriginal people and knowledge holders have identified various key elements that makeup cultural heritage values within the landscape of the Project area. Two specific locations within the Project area, being the Promised Land Trail ST01 (AHIMS ID 52-4-0730) and Bendeela AS01 (AHIMS ID 52-4-0729) are known to have Aboriginal cultural values. However, the entirety of the Kangaroo Valley has cultural significance to Aboriginal people who have inhabited the region for thousands of years. The Kangaroo River is of particular significance to contemporary Aboriginal people for its connection with ancestors, and one RAP identified specific cultural knowledge of sites in the Fitzroy Falls area and has knowledge of cultural areas within and around the Project area.

The Promised Land Trail ST01 scarred tree is of cultural value to Aboriginal stakeholders. This type of site is particularly rare in areas that have been subject to urbanisation or where historic forestry practices have taken place. Aboriginal stakeholders noted that the Eucalyptus spp. is the common scarred tree type of the area. A knowledge holder noted that the scar was most likely consistent with that of a shield tree.

One Aboriginal stakeholder noted that the portions of Bendeela Hydro AS01 (AHIMS ID 52-4-0729) closest to the Kangaroo River adjacent to the south would have been a place where Aboriginal people camped. The location of this site immediately adjacent to the Kangaroo River suggests that Bendeela Hydro AS01 (AHIMS ID 52-4-0729) likely has at least moderate cultural values to the local Aboriginal community.

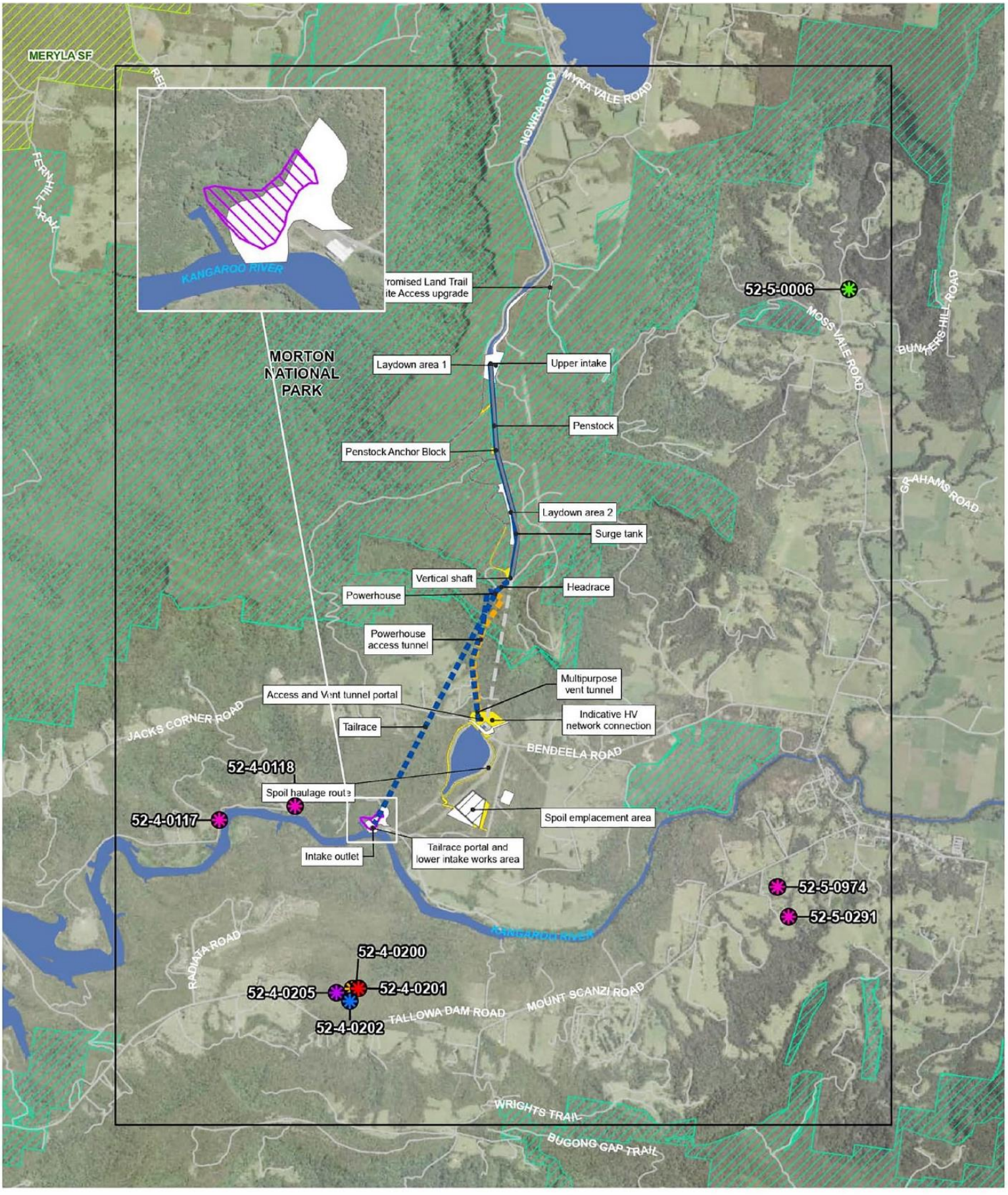
Cultural heritage values are further described in Chapter 6 of **Appendix G**.

6.2.4.1 Significant assessment

A significance assessment is made up of several significance criteria that attempt to define why a site is important. Such assessment recognises that sites may be important for different reasons to different people, and even at different times. The assessment of Aboriginal cultural heritage in this assessment is based upon the four values of The Burra Charter (Australia ICOMOS, 2013).

- Social values
- Historical values
- Scientific values
- Aesthetic values.

Based on the aesthetic, historic and social context of the identified Aboriginal objects; the Project area is considered to be of moderate cultural heritage significance. The Aboriginal objects present within the Project area are tangible expressions of Aboriginal life prior to contact and have potential to connect the contemporary community with traditional practices that have been disrupted by colonial activity.



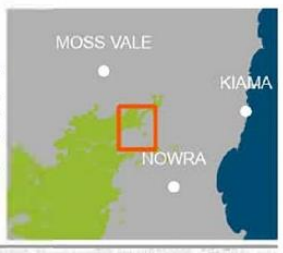
Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Disturbance area
- Spoil site
- Additional areas since 2019
- Art (Pigment or Engraved), Artefact, Potential Archaeological Deposit (PAD)
- Art (Pigment or Engraved), Artefact, Potential Archaeological Deposit (PAD), Grinding Groove
- Art (Pigment or Engraved), Grinding Groove, Potential Archaeological Deposit (PAD)
- Art (Pigment or Engraved), Ochre Quarry, Water Hole
- Artefact
- Grinding Groove
- Potential archaeological sensitivity
- AHIMS search extent
- State Forest
- NPWS Reserve
- Road
- Waterway
- Waterbody

0 1 2 km

1:60,000 at A4

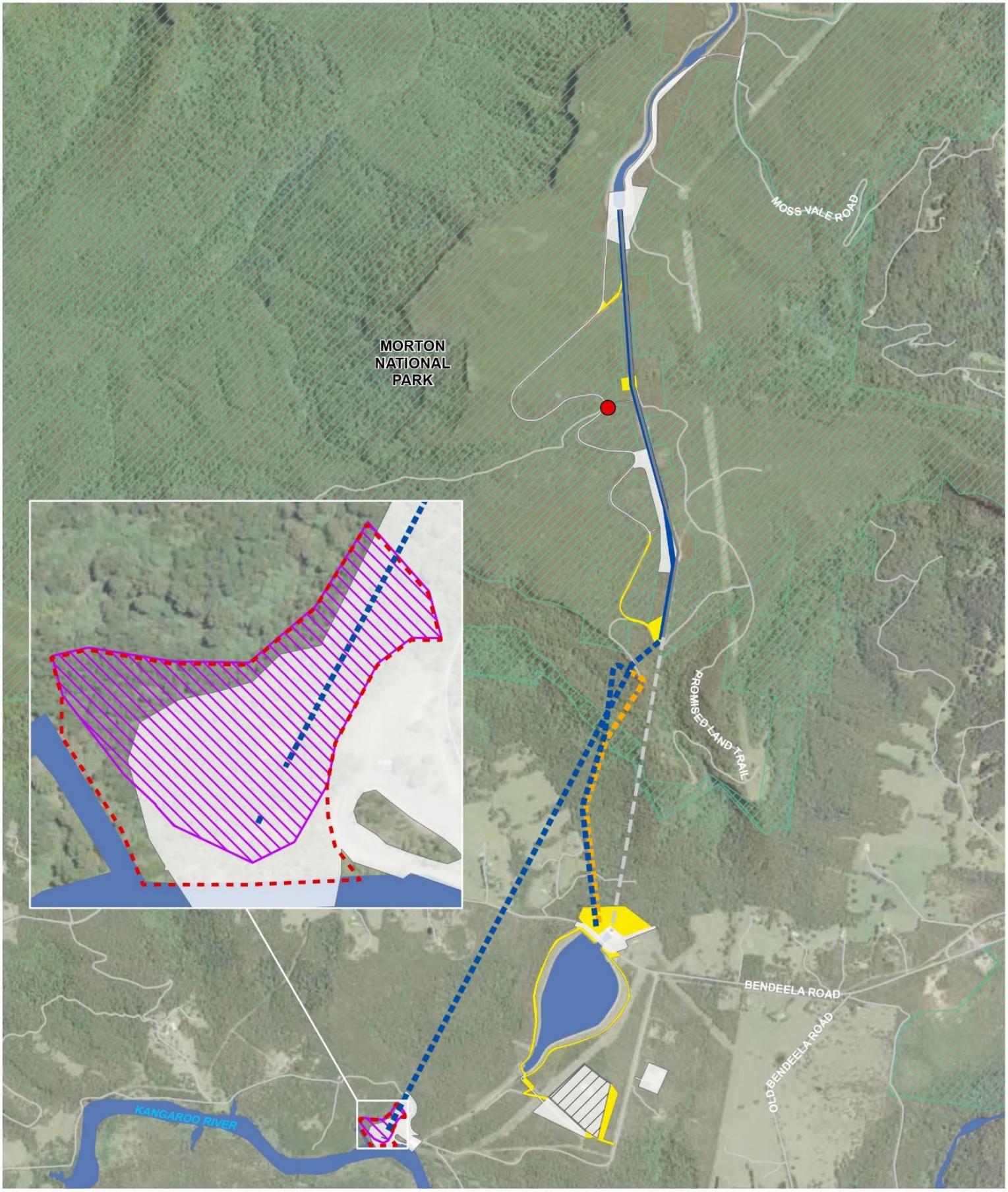
GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-2 AHIMS search results



Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Disturbance area
- Spoil site
- Additional areas since 2019
- Potential archaeological sensitivity
- Promised Land Trail ST01
- Bendeela Hydro AS01
- NPWS Reserve
- Road
- Waterway
- Waterbody

0 1 2 km

1:30,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-3 Locations of newly identified sites

Date: 15/07/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Heritage.aprx
Created by: JB | QA by: CC

6.2.5 Construction impacts

Based on the current design plans, Promised Land Trail ST01 will not be impacted by any works and will not be harmed. Ground disturbing works are planned to take place within the extent of Bendeela Hydro AS01 (AHIMS ID 52-4-0729) that will result in partial harm and a partial loss of value. Mitigation measures will be implemented as described in **Section 6.2.7** to manage potential Aboriginal heritage impacts.

Salvage excavations will take place prior to any impacts to Bendeela Hydro AS01 (AHIMS ID 52-4-0729) in accordance with the salvage methodology provided in Chapter 11 of **Appendix G**.

An exclusion zone and fence will be established surrounding the Promised Land Trail ST01 (AHIMS ID 52-4-0730) to protect the site from accidental damage.

A summary of the assessed impacts in accordance with the Code of Practice is included in **Table 6-6**.

Table 6-6. Summary of potential impacts

Site name (AHIMS ID)	Type of harm	Degree of harm	Consequence of harm
Promised Land Trail ST01 (#)	None	None	None
Bendeela Hydro AS01 (AHIMS ID 52-4-0729)	Direct	Partial	Partial loss of value

6.2.6 Operational impacts

Operation of the Project is not anticipated to result in any impacts to Aboriginal heritage.

6.2.7 Mitigation measures

Mitigation measures to address the potential Aboriginal heritage impacts of the Project are listed in **Table 6-7**.

Table 6-7. Aboriginal heritage mitigation measures

Ref	Impact	Mitigation measure	Timing
AH1	Potential impact to Promised Land Trail ST01 (AHIMS ID 52-4-0730)	An exclusion zone and fencing with a 10m buffer will be established around AHIMS ID 52-4-0730.	Prior to construction
AH2	Harm to Bendeela Hydro AS01 (AHIMS ID 52-4-0729)	Salvage excavations will take place prior to any impacts to Bendeela Hydro AS01 (AHIMS ID 52-4-0729). The salvage excavation will be carried out as described in the ACHAR (**Appendix G**) to record the full extent of the intact artefact concentration.	Prior to construction
AH3	Impacts on Aboriginal heritage during construction	A Cultural Heritage Management Plan (CHMP) will be developed and implemented to management Aboriginal objects recovered through the testing and the salvage excavation program. The long-term storage of any recovered Aboriginal objects will be developed during the completion of the CHMP, in consultation with the RAPs and other stakeholders including WaterNSW, but is likely to include (in preferential order): ▪ Re-burial on site, in an appropriate location in the vicinity of the Project ▪ Lodged with a RAP under a Care and Control Agreement ▪ Deposition with the Australian Museum. The CHMP will be provided to WaterNSW for review and to consult and negotiate on potential locations to rebury Aboriginal objects on WaterNSW land.	Construction

Ref	Impact	Mitigation measure	Timing
AH4	Unexpected finds	The unexpected finds procedure in the ACHAR will be followed for any unidentified Aboriginal heritage objects found during the works. If suspected human remains are located during any stage of the project, work should stop immediately, and the NSW Police will be notified. Heritage NSW will be notified if the remains are found to be Ancestral Aboriginal remains.	Construction and operation
AH5	Changes to the Project area	If changes are made to the Project to include impacts outside the disturbance area as delineated in ACHAR, further archaeological investigation will need to be conducted.	Construction

6.3 Historical heritage

This section provides an assessment of the potential historical heritage impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix H** (Historical heritage impact assessment).

The assessment addresses the following SEARs:

Heritage – including:

- Assessment of the impacts to historic heritage having regard to the NSW Heritage Manual.

6.3.1 Legislative and policy context

The land assessment has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- Heritage Act
- *Archaeological Assessments: Archaeological Assessment Guidelines* (NSW Heritage Office 1996a)
- *NSW Heritage Manual* (NSW Heritage Office 1996b).

6.3.2 Methodology

The Project area with a buffer of 50 m was established as the historical heritage study area. While the Hampden Bridge lies outside of this study area, it was also assessed given that vehicles complying with existing restrictions would use the bridge as part of the Project.

The methodology for the historical heritage assessment included:

- A search of relevant heritage databases on 25 July 2022 to identify previously recorded historical heritage items in the study area, including:
  - NSW State Heritage Register (SHR)
  - NSW State Heritage Inventory
  - Section 170 Registers (s170)
  - World Heritage List
  - National Heritage List
  - Commonwealth Heritage List
  - Register of National Estate (RNE)
  - Shoalhaven LEP 2014
  - Wingecarribee LEP 2010
  - Regional Environmental Plan
- A desktop review of historical resources, including:
  - Existing heritage studies, historical records and historical mapping
  - Historical and modern aerial imagery
  - Secondary sources, including books and publications from local historical societies.
- A targeted site inspection of the former Bendeela Public School undertaken on 17 April 2019.

6.3.3 Existing environment

There are no listed World, National, Commonwealth, State or locally listed heritage items within the historical heritage study area. The closest listed historical heritage item to the Project is Kangaroo Valley (RNE 1589), situated approximately 230 m to the east of the study area, which comprises the valley in which settlement occurred in the 19th century, including Hampden Bridge.

One potential archaeological site, the former Bendeela Public School (Portion 216) is partially located within the historical heritage study area as shown within **Figure 6-4**.

Non-OSOM vehicles would access the Project area via the heritage-listed Hampden Bridge (SHR 02024/LEP 241/LEP C4/s170 4301059/RNE 1621), which is of State-level significance.

No other heritage items or places of archaeological potential were identified within or adjacent to the Project area.

6.3.3.1 Archaeological site inspection and assessment

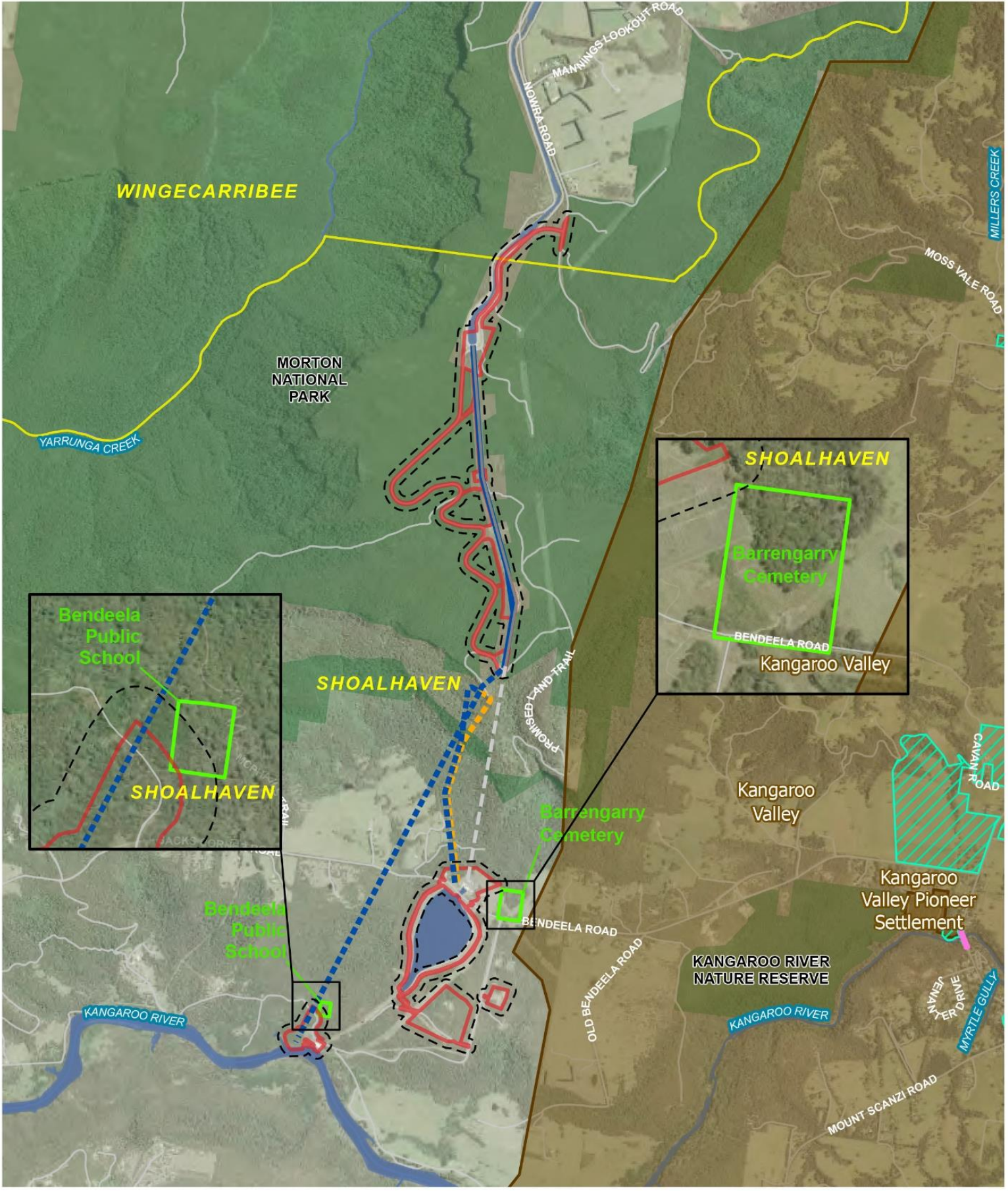
The former Bendeela Public School (Portion 216) was the subject of the targeted archaeological site inspection, which did not reveal any remains of buildings or remnant building material. While the former location of the school buildings themselves were not positively identified during the site inspection, a relatively level area which was suitable for buildings was recorded at the centre of the property boundary. It is unknown, however, whether this is a natural feature or whether the landform had been modified to accommodate the school.

Historical information suggests that the school comprised a slab hut which was constructed in 1878 by the local community using local materials. This comprised the cheapest and most convenient construction method of the time. The school building was likely built directly on the ground, with no excavation taking place. It is therefore unlikely that there will be any archaeological evidence remaining of the school building and is concluded that there is low archaeological potential within the Project area.

6.3.3.2 Significance assessment

The former Bendeela Public School (Portion 216) is not listed on any heritage register. The archaeological research potential of this site is considered to be negligible and is unlikely to demonstrate evidence of the past through archaeological methods. As such, even if archaeological remains are uncovered, the significance of those remains are likely to be of low local significance.

Hampden Bridge (SHR 02024/LEP 241/LEP C4/s170 4301059/RNE 1621) is an historical sandstone bridge situated on Moss Vale Road, over Kangaroo River, to the south of the township of Kangaroo Valley. The historical bridge is assessed under the Heritage Significance Criteria as satisfying Criterion A (Historical significance), Criterion B (Associative significance), Criterion C (Creative/technical significance), and Criterion F (Rarity). This heritage item comprises a bridge of State-level significance.



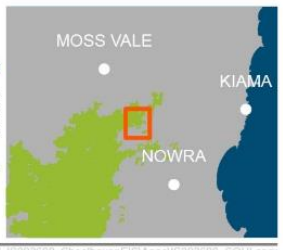
Legend

- Project area
- Study area
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- LGA
- NPWS estate
- Road
- Waterways
- Waterbody
- LEP Heritage (DPIE)
- State Heritage Register (DPIE)
- Register Of The National Estate (AUDEE)
- Potential historical heritage places

0 1 2 km

1:40,000 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-4 Location of historical heritage places near the Project

Date: 24/06/2022 Path: \\ausyd0vs01\gisproj\NSW_IS302600_ShoalhavenEIS\Apps\IS302600_SOHI.aprx
Created by : JB | QA by : CC

6.3.4 Construction impacts

As there are no listed heritage items within the historical heritage study area, there would be no impacts to World, National, Commonwealth, State or locally listed heritage as a result of the construction or operation of the Project.

Construction activities that involve ground disturbance within the maximum Project area have the potential to impact on unexpected remains associated with the former Bendeela Public School (Portion 206) site. However, this is considered unlikely as the potential archaeological assessment has concluded that there is little to no archaeological potential within the site. Detailed design and construction planning would seek to minimise the footprint within Lot 216/DP751262 (owned by WaterNSW) with the aim of avoiding any existing archaeological potential.

As there are no planned works occurring at Hampden Bridge (SHR 02024/LEP 241/LEP C4/s170 4301059/RNE 1621), there would not be any direct impacts to this heritage item. However, incidental impacts to this heritage bridge may result from the use of non-OSOM vehicles on the bridge. This may comprise physical impacts from vehicles nearing 5.4 m in height, vehicles nearing 42.5 t or multiple simultaneous vehicles. As a result, road use limits would be complied with for Hampden Bridge to avoid physical impacts to the bridge.

As there are no listed heritage items, or places of archaeological potential, situated along the tunnel alignments or within proximity of vibration-generating Project works, indirect heritage impacts are not anticipated.

6.3.5 Operational impacts

Operation of the Project is not anticipated to result in any impact to historical heritage. As the Project would to duplicate the Existing Scheme, operational visual heritage impacts to Kangaroo Valley as a result of the Project are not anticipated.

6.3.6 Mitigation measures

Mitigation measures to address the potential historical heritage impacts of the Project are listed in **Table 6-8**.

Table 6-8. Historical heritage mitigation measures

Ref	Impact	Mitigation measure	Timing
HH1	Unexpected historical archaeology	Should any unexpected historical heritage, including archaeological relics, be uncovered during the course of the works, works will stop, and the area cordoned off. If any heritage items (either on the surface or buried archaeological items) are discovered on land in the ownership of WaterNSW. WaterNSW must be notified about the discovery. A qualified archaeologist and, if necessary, Heritage NSW will be contacted to assess significance and advise on further requirements before work can recommence.	Construction
HH2	Historical heritage items	Where feasible and reasonable the design and construction planning will avoid or minimise incidental physical impacts to historical heritage. This includes the following site-specific management measures at the heritage listed Hampden Bridge: ▪ Ensure the existing heavy vehicle load limit of 42.5 t is in place. ▪ Ensure no more than one non-OSOM vehicles to be on the bridge at any one time ▪ Ensure all non-OSOM vehicles using the bridge have adequate height clearances ▪ Any accidental damage is reported to the site supervisor and advice sought from a qualified heritage specialist.	Pre-Construction and Construction

Ref	Impact	Mitigation measure	Timing
HH3	Training and awareness	All contractors and subcontractors should be made aware of the presence of a heritage item and associated elements in the vicinity of the proposed works should be communicated to all staff during toolbox talks.	Pre-Construction and Construction

6.4 Land

This section provides an assessment of the potential land and contamination impacts of the Project and measures to mitigate them, as well as an assessment the impact of the Project on landforms and geotechnical stability.

The assessment addresses the following SEARs:

Land – including:

- an assessment of impacts of the project on soils, land capability, including potential impacts associated with the use of hydrocarbons and chemicals, dealing with the spoil generated by the Project, and geotechnical stability of the site and surrounds, including completion of a Land Use Conflict Risk Assessment in accordance with DPI's Land Use Conflict Risk Assessment Guide;
- an assessment of the impacts of the project on landforms, including the short and long term geotechnical stability of any new landforms and any seismic or subsidence impacts; and
- an assessment of the risk of soil and water contamination based on the predicted geochemistry of the excavated rock and any disturbance of land associated with previous mining activities and naturally occurring asbestos in the vicinity of the site; and
- a strategy to manage the progressive rehabilitation of the land disturbed by the Project and enhance any new landforms created.

6.4.1 Legislative and policy context

The land assessment has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Contaminated Land Management Act* 1997
- POEO Act
- Resilience and Hazards SEPP (Chapter 4: Remediation of Land)
- Acid Sulfate Soils Assessment Guideline (Australian Sulfate Soil Management Advisory Committee, 1998)
- Agricultural Land Use Mapping Resources in NSW (DPI, 2017)
- *Managing Urban Stormwater, Soils and Construction, Volume 1* (Landcom, 2004) and Volume 2 (DECCW, 2008) (the Blue Book)
- Guidelines for Consultants Reporting on Contaminated Land (EPA, 2020)
- Land Use Conflict Risk Assessment Guide (DPI, 2011)
- Managing asbestos in or on soil (SafeWork NSW, 2014)
- National Environmental Protection (Assessment of Site Contamination) Measure1990 (as amended 2013) (National Environmental Protection Council, 2013)

6.4.2 Methodology

The land assessment included the following:

- A desktop assessment using publicly available databases and previous investigations specific to the Project to characterise the existing environment, including:
  - A review of the history of the Project area, including zoning, previous and present land use, historical building approvals and historical aerial photographs
  - A review of geological mapping where available mapping (Geoscience Australia, 2018)
  - A review of soil profile reports (OEH, 2018)
  - A search of the Contaminated Land Record (EPA), conducted on 10 June 2022
  - A review of contamination sources and potential environmental risks associated with hydrocarbons and chemicals
- Identification of Areas of Environmental Interest (AEIs) that may be at threat by potential contamination or other risks, based on results of the desktop assessment
- A site walkover to identify any evidence of contamination
- An assessment of short and long term geotechnical stability of Project landforms
- Identification of potential for Project conflicts to arise in relation to the Project with reference to Land Use Conflict Risk Assessment Guide (DPI, 2011)
- Identification of mitigation measures required to minimise the risks associated with contamination sources.

6.4.3 Existing environment

6.4.3.1 Geology, soils and land capability

Geotechnical investigations and desktop analysis to date has developed a local and regional understanding of geotechnical stability.

The scheme is in the southern part of the Sydney-Bowen sedimentary basin which comprises a major structural basin extending from Batemans Bay northward to central Queensland. The basin consists of a sequence of uplifted and gently deformed sedimentary rocks ranging from the Lower Permian at the base to the Triassic at the top with a combined thickness of up to several kms. In NSW the basin is bounded by the older Lachlan fold belt to the west and the New England fold belt to the east.

The Shoalhaven and Kangaroo rivers are deeply incised into a formerly more extensive table land, of which the main remnant in the Project area is the Hawkesbury Sandstone capped Robertson Plateau. The valleys are mostly steep sided with the profile slopes influenced by the resistance to weathering of the various underlying rock types. The finer grained rocks which are more prone to weathering such as the shales and siltstones usually form moderately steep slopes while the resistant rocks such as the sandstone units form terraces in the valley floors or pronounced steps and cliffs up to 150 m high along escarpment upper slopes and crestal areas. The overburden soils directly above bedrock comprise residual soils and weathered bedrock of varying depths mainly as a function of their resistance to weathering.

Colluvial soils and extensive areas of landslide debris exceeding 10m thickness cover the slopes associated with an ongoing history of erosion and deposition over millions of years. Alluvial and flood plain deposits have formed within the valley floors of the main rivers in the area including the now flooded Kangaroo River channel in the Lake Yarrunga area.

Geological mapping does not show any significant structural features such as faults and folds. Minor faulting was however encountered during the investigation and construction stage for the Existing Scheme. To assess the potential for encountering faults along the area of the new alignment a lineament analysis of aerial images was undertaken as shown in **Figure 6-5** to identify faulting or structural features that could intersect the Project alignment.

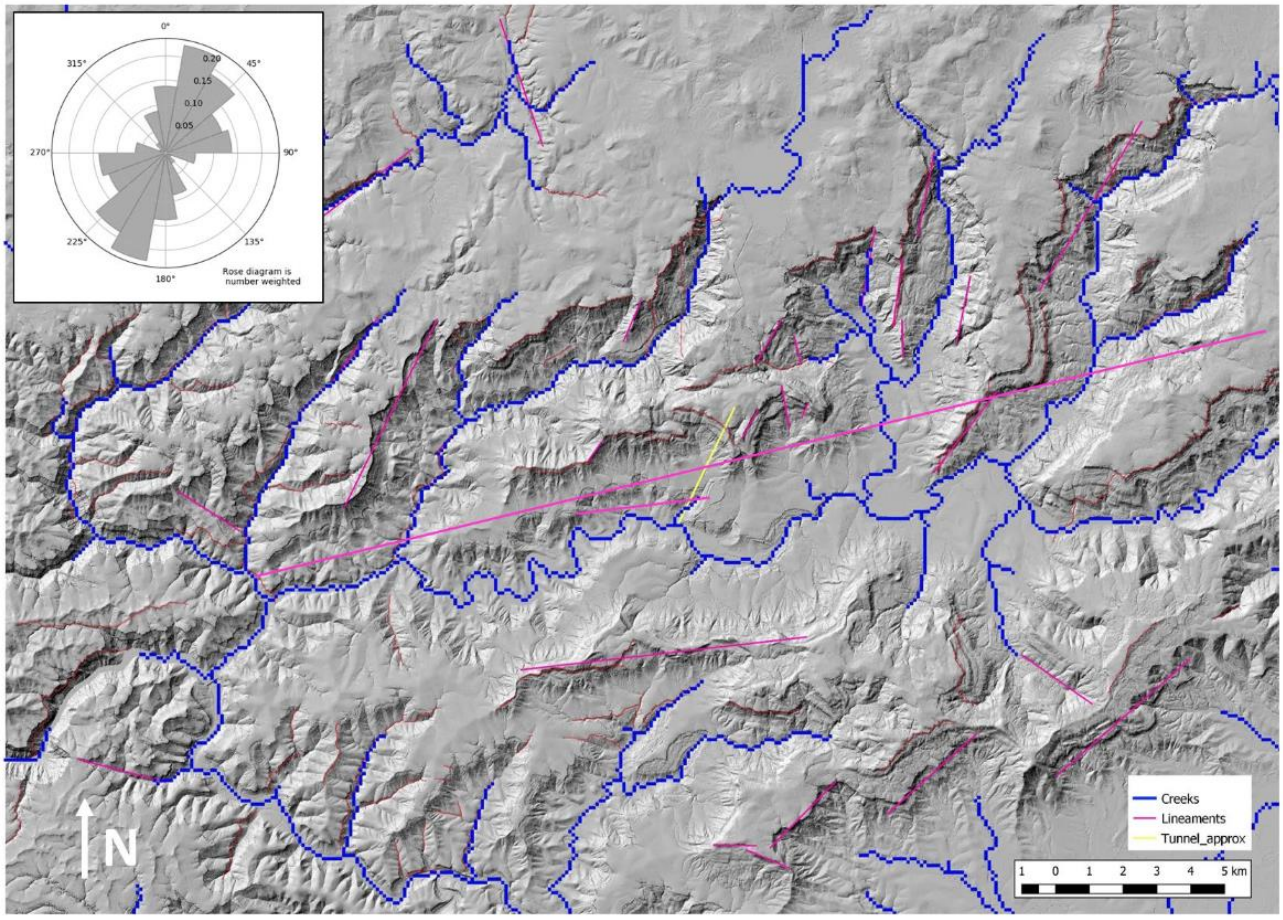


Figure 6-5. Regional Hill shade map with interpretation of lineaments

A lineament is a line on a topographical map that reflects a zone of increased differential weathering which may reflect a weakness at the surface which could suggest the presence of a fault or structural trend such as a joint swarm. Often such weaknesses are reflected in the drainage pattern but may not be detected on the ground due to cover by thick soils.

Figure 6-5 shows that the dominant lineament trend reflecting the main drainage pattern for the area. These two broad structural trends also occur in the Illawarra Plateau to the north and are considered to reflect the main structural shear trend of the region.

The landscape has been basically formed by an active (youthful) retreating escarpment face and down cutting along steep sloping drainage lines. The intervening remnant (mature) more gently sloping areas are likely to be zones of colluvial accumulation and deeper weathering because of their greater duration of exposure to weathering processes over millions of years. Based on this process it can be assumed that because the new alignment will pass through an area of mainly mature landscape compared to the existing tunnel alignment, it can be expected that the depth of weathering and potential for a more open jointed rock mass is expected to be greater at least near the surface. This is likely to be evident in areas of shallow tunnelling in the lowest lying areas of the site near the outlet structure and particularly near Kings Creek.

The geology of the Project area comprises lithologies of the Southern Coalfields region of the Sydney Basin including the Triassic Hawkesbury and varies across distance and depth. **Table 6-9** provides further details about the underlying geological units within the Project area.

Table 6-9. Geological units underlying the Project area and surrounds

Period	Geological unit		Elevation (RL m)	Thickness (m)	Description	Indicative acid generation
Triassic	Hawkesbury Sandstone		650 to 560	90	The Hawkesbury Sandstone is composed mainly of quartz-rich sandstone. Some mudstone and shale plies are present within this formation. Deposition is dominated by a braided fluvial deltaic environment.	Low
	Narrabeen Group		560 to 545	15	The Narrabeen Group is a non-coal-bearing stratigraphic unit composed mainly of quartz-rich sandstone, shale and mudstone units. Deposition was within several different fluvial environments, associated with a relatively slow period of marine transgression.	Moderate
Permian	Illawarra Coal Measures		545 to 520	25	The Illawarra Coal Measures are composed of sandstone, siltstone, claystone and coal. There are also some minor tuff and conglomerate layers, with rare basalt noted within the Southern Coalfield only. The formation of these coal measures occurred in lower delta plain to alluvial fan environments.	High
	Shoalhaven Group	Broughton Formation	520 to 440	80	The thick sand and silt units of the Shoalhaven Group were deposited during the early Permian marine transgression. These were deposited in variably low to high energy, fluvial to marine (shelf) environments and mainly comprise sandstone with interbedded shale and mudstone. The shale and mudstone units represent marine influenced deposition, whereas the sandstone units are fluvial to terrestrial in origin.	Moderate
		Budgong Sandstone	440 to 375	65		Low
		Berry Siltstone	375 to 170	205		High
		Nowra Sandstone	170 to 130	40		Low
		Wandrawandian Siltstone	130 to 30	100		High
		Snapper Point Formation	30 to -40	Inferred 70		Moderate

A number of geological units within the Project area have a moderate to high potential for generating acid rock. These include the Snapper Point Formation, Wandrawandian Siltstone and Berry Siltstone.

Soil profiles taken from the elevated plateau near the Kangaroo Pipeline indicated moist, yellowish brown soils with a loamy sand to sandy loam texture (OEH, 2018). Soil profiles measured on the slope near Bendeela Road indicated moist, black soils with a sandy loam texture (OEH, 2018).

A desktop search did not reveal any acid sulfate soils (ASS) or potential ASS within the Project area.

Land in NSW is commonly classified according to the capability of land to remain stable under particular land uses. The Land And Soil Capability Assessment Scheme (OEH, 2012) classes land in terms of inherent physical characteristics or constraints, it considers the optimum use of land rather than the maximum use and in general would not change over time.

The Project area traverses three land and soil capability classes (LSC). These include:

- Class 4 - This land has moderate to severe limitations for some land uses that need to be consciously managed to prevent soil and land degradation

- Class 6 – This land has very severe limitations for a wide range of land uses and few management practices are available to overcome these limitations. Land generally is suitable only for grazing with limitations and is not suitable for cultivation
- Class 7 - This land has extremely severe limitations for most land uses. It is unsuitable for any type of cropping or grazing because of its limitations. Use of this land for these purposes will result in severe erosion and degradation. It may be too steep, rocky, swampy or fragile for grazing. The land may be suitable for commercial timber plantations or for native timber on undeveloped land.

The earthquake hazard map and recommended structural design actions for Australia are described in Australian Standard 1170.4 (2007). In 2012 Geoscience Australia produced an updated National Seismic Hazard Map with 500-year return period Peak Ground Acceleration (PGA) contours (Burbidge, 2012). The updated Atlas of Seismic Hazard Maps (Leonard et al., 2013) shows that the Project is located between the PGA contours of 0.05g and 0.06g which correspond to peak ground acceleration of between 0.49 and 0.59 m/s2.

The large amphitheatre topographic feature drained by Kings Creek at the southern section of the Project, west of the Bendeela Power Station, is covered by a range of landslide features. The colluvial scree consists of a mixture of soil (sand, silt and clays) with gravel to massive boulder sized blocks embedded in the soil mass. Large boulder beds were observed along the Kings Creek channel in this area possibly due to mobilisation during floods but more likely due to toppling from adjacent cliffs and flood erosion scour away of colluvium. No rock outcrop areas have been identified in the region other than in the vicinity of the rock cuttings in the Bendeela Power Station area.

Almost the entire crestal perimeter of the amphitheatre is defined by a prominent cliff face of Nowra Sandstone falling into two areas as follows:

- Along the eastern faces directly adjacent to the Bendeela Pondage a steep cliff faces up to 30 m high with prominent north-east striking joint set initiating large scale toppling failures of the cliff face into the valley which then merges with thick colluvial cover
- Along the northern slopes Nowra sandstone cliff face which are defined by the complimentary east -west joint set as a release plane of weakness developing into tension cracks of varying width due to apparent lateral movement of the slope. This cliff scarp height is not as prominent and forms a “stepped” topography suggestive of a “block gliding” failure mechanism which then merges with a thick colluvial cover lower down the valley.

While the Project is located in the Southern Coalfields region of NSW the nearest operating coal mine is the Dendrobium Mine, located just west of Wollongong, about 40 km northeast of Bendeela Pondage. The Project area is not within a mine subsidence district.

6.4.3.2 Existing land uses

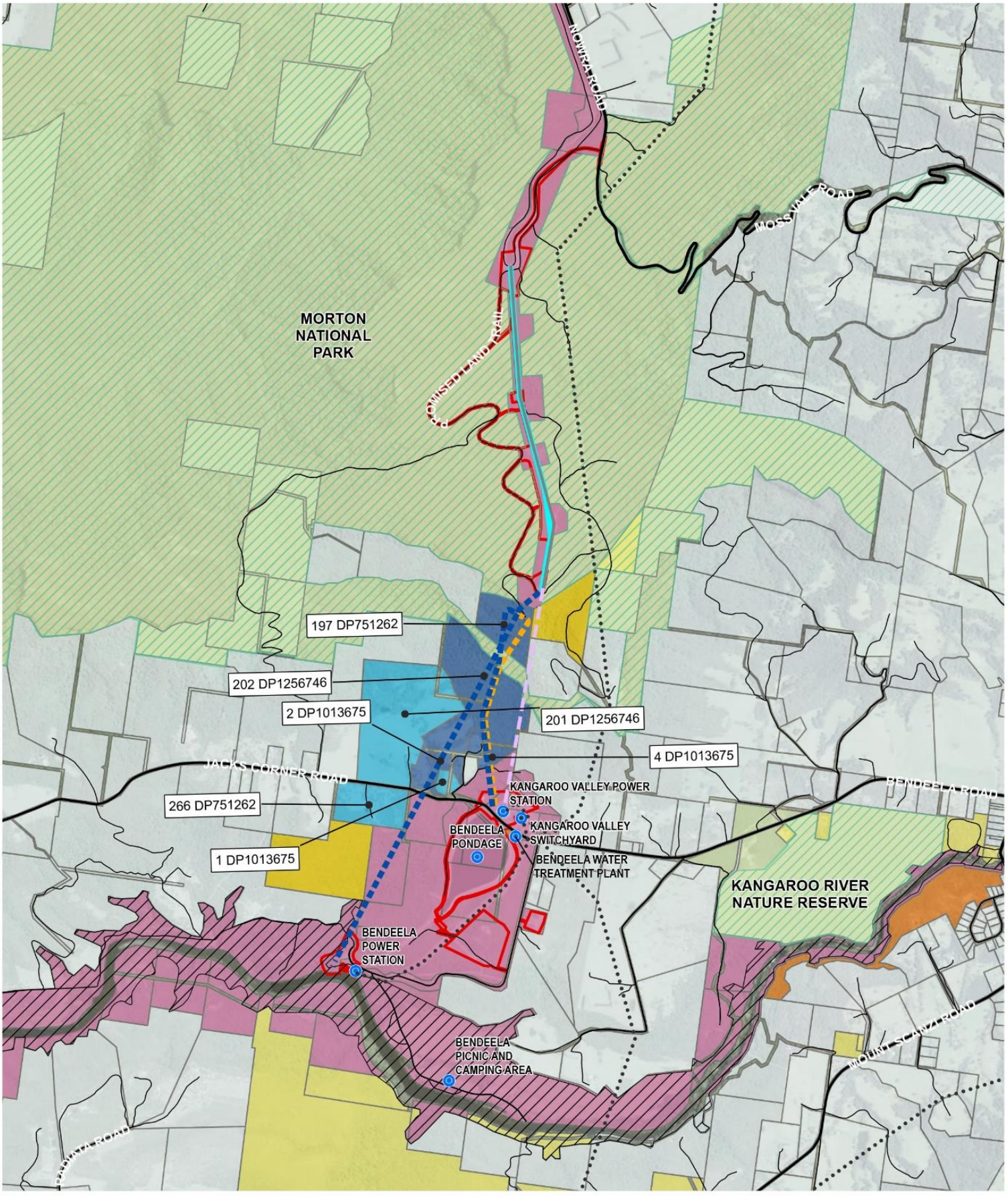
The existing environment of the Project area is described in **Section 2.4**. The Project is:

- Located adjacent to and in immediate proximity to the Existing Scheme, which was commissioned in 1977 and is currently used to generate electricity
- Surrounded by the Morton and Budawang National Parks, which comprise an area of over 190,000 ha on the eastern escarpment of the Southern Tablelands
- Partially within the Shoalhaven Special Area surrounding Lake Yarrunga
- Located west of the Bendeela Recreation Area, located on the northern bank of Lake Yarrunga directly to the east of the Existing Scheme and consisting of a popular, serviced campground operated by WaterNSW on WaterNSW land
- Surrounded by communities and townships within the zone of influence of the Project, including Barrengarry, Kangaroo Valley, Fitzroy Falls, Wildes Meadow and Avoca
- Surrounded by rural landholdings consisting of isolated dwellings to the east and west of the Project and accessed off Bendeela Road and Jacks Corner Road
- Approximately 500 m to the east of The Scots Collage Glengarry Campus.

The Project is located within the Shoalhaven and Wingecarribee LGAs, which are covered by the Shoalhaven LEP and the Wingecarribee LEP.

As described in **Section 6.2.3**, there is an undetermined native title claim which encompasses the Project area.

Land ownership is illustrated in **Figure 6-6**.



Legend

- Points of interest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Shoalhaven special area
- NPWS Reserve
- Transmission lines
- Private land intersected by indicative tunnel alignment
- Private land within 20m of tunnel alignment
- Crown land within 20m of tunnel alignment
- Crown
- Local Government
- NSW Government
- Private
- WaterNSW

0 5 10 km

1:40,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2021
NSW Spatial Services 2021

Figure 6-6 Property landownership

Date: 10/6/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_MWPEA.aprx
Created by: JN | QA by: CC

6.4.3.3 Contamination

A search of the list of contaminated land record of notices for Shoalhaven City LGA and Wingecarribee Shire LGA was undertaken on 10 June 2022. The search results are presented in **Table 6-10**. In summary, no existing notified sites are located in proximity to the Project area.

A desktop review of the site history, including zoning, previous and present land use and building approvals, was undertaken. That desktop review did not identify any previous land uses that may result in contamination impacts. No presence of potential contamination, including asbestos containing materials and areas of illegal dumping, was identified during the site walkover.

Table 6-10. Results of search of contaminated land record of notices

Address	Site	Approximate distance from Project area
Wingecarribee Shire LGA		
Merrigang Street, Bowral	Former gasworks	22 km
Joadja Road, Joadja	Former shale oil refinery	38 km
Alfred Street, Mittagong	Lots 1 and 2 Alfred St	25 km
Bowman/Berrima Road, Moss Vale	Moss Vale North Depot	19 km
Shoalhaven City LGA		
320 Princes Highway, Bomadery	Commercial land	14 km
Lamonds Lane, Nowra	Former gasworks	17 km
Lot 3 Kalandar Street, Nowra East	Mobil Service Station	18 km

Based on an understanding of local geology described in **Section 6.4.4.1** there is a low risk of encountering geological units with naturally occurring asbestos within the study area. The Project however is located more than 90 km away from the closest geological units with low potential of naturally occurring asbestos. Therefore, the likelihood of naturally occurring asbestos in the Project area has been assessed as extremely low resulting in a low risk.

As described in **Appendix K**, a geological model has predicted that potentially acid forming (PAF) rock is located within the Project area. The Wandrawandian and Berry formations show the highest PAF based on the limited test results, whereas the Nowra Sandstone results show that it is mainly non-acid forming. The Illawarra Coal Measures, Berry Siltstone and Snapper Point Formation are indicated to be overall net acid consuming. The potential volume of acid forming materials is estimated to be about 18.6 % of the overall volume of material to be excavated, with material with net acid consuming potential comprising most of the excavated material.

6.4.4 Construction impacts

6.4.4.1 Soils and land capability

The soil profiles have been considered in the development of the drainage and erosion and sediment controls structures that would be implemented for the Project. These control structures are further described in **Appendix I** and have been considered in the assessment of water contamination described in **Section 6.5.4.1**.

The Project area is not likely to contain ASS and so construction of the Project is not anticipated to disturb any ASS.

During construction, soils and land capability may be impacted by soil and water contamination, either by the disturbance of acid rock in the form of PAF spoil, or from hydrocarbons and other chemicals being used and transported during construction. These impacts are further assessed in **Section 6.4.4.3**.

Soils with an LSC class of 6–7 are already inherently poor and any further of loss of soil capability may result in limitations in establishing stabilising cover and rehabilitation, and in some cases the vegetation community originally on-site may not be able to be sustained following reinstatement. If not managed appropriately the Project has the potential to further reduce the soil capability. The rehabilitation management plan would

consider the recover and re-use topsoils for rehabilitation and methods to maintain or improve their existing capability.

6.4.4.2 Land use conflict risk assessment

Land use conflicts occur when one land user is perceived to infringe upon the rights, values or amenity of another (DPI, 2011). The process of identifying potential land use conflict is generally to identify potential risks by considering land use changes that may affect existing land uses in the area. **Table 6-11** identifies and quantifies potential construction land use conflicts based on the findings of assessment as part of the EIS process by considering land use changes that may affect existing land uses in the area.

Table 6-11. Potential construction land use conflicts

Environmental matter	Impact mechanism	Summary of conflict
Biodiversity	Vegetation clearing and has potential to impact habitat and connectivity through the Project area. During construction, clearing of up to 29.5 ha of vegetation would be required. Where practicable, clearing would avoid native vegetation and habitat to the extent feasible.	A conflict with the use of the Project area for threatened species has been identified. Impacts have been assessed in accordance with the BAM and would be mitigated as described in **Section 6.1**.
Aboriginal heritage	The construction of the Project has potential to impact Aboriginal heritage. The Project would impact one Aboriginal site within the Project area, Bendeela Hydro AS01 Where practicable, Aboriginal heritage impacts would be avoided. Unexpected finds would be managed in accordance with standard unexpected finds mitigation and management measures.	A conflict with the use of the Project area for one Aboriginal sites, the Bendeela Hydro AS01. Impacts have been assessed and would be mitigated as described in **Section 6.2**.
Historical heritage	The construction of the Project has potential to impact historical heritage. The Project would potentially impact one heritage site within the Project area, the former Bendeela Public School (Portion 216), however the archaeological research potential of this site is considered to be negligible. Where practicable, heritage impacts would be avoided. Unexpected finds would be managed in accordance with standard unexpected finds mitigation and management measures.	A conflict with the use of the Project area for one heritage site. Impacts have been assessed and would be mitigated as described in **Section 6.3**.
Surface water	Water impacts have potential to lead to land use conflicts where they affect the volume or quality of water for other users. The Project has the potential to increase erosion potential leading to sediment laden run-off. This will be managed in accordance with standard mitigation measures such that off-site water quality impacts do not eventuate.	With the implementation of recommended mitigation measures, it is considered that the Project would have a neutral outcome on existing water quality as described in **Section 6.5**.
Groundwater	Groundwater impacts have potential to lead to drawdown of groundwater sources and contamination of surrounding groundwater from acid rock drainage. During construction and operation, drawdown related to groundwater inflow is not expected to impact on any groundwater dependent ecosystems or other groundwater use. Any identified acid rock drainage would be captured and treated.	With the implementation of recommended management measures, the Project is not anticipated to result in significant groundwater impacts as described in **Section 6.6**.

Environmental matter	Impact mechanism	Summary of conflict
Transport	Traffic impacts have potential to lead to land use conflict where they unreasonably restrict access. During construction, additional worker transport shuttles, light vehicles and heavy vehicles (including OSOM vehicles) would use the existing road network in the vicinity of the Project but not to the extent that they are assessed as causing delays to other road users. The Moss Vale Road (B73) / Promised Land Trail intersection would be upgraded as part of the Project.	The construction of the Project is expected to have a negligible impact on the performance of key intersections and a negligible impact to public transport, pedestrians and cyclists, road safety and parking as described in **Section 6.7.4.5**.
Noise and vibration	Noise and vibration impacts have the potential to lead to land use conflict with sensitive receivers and also affect amenity for recreational uses. Vibration impacts and blasting impacts could result in damage to existing scheme infrastructure and buildings in proximity to underground works if not managed appropriately.	Reasonable and feasible mitigation measures are available and would be implemented to minimise noise impacts as described in **Section 6.8**. Pre and post construction dilapidation surveys would be undertaken on potentially impacted structures. Vibration generating works and blasting would be managed to prevent damage to infrastructure and any damage attributable to the Project rectified.
Air quality	Air quality impacts would be readily managed during construction using standard methods through the application of available mitigation measures. As a result, the Project is unlikely to cause adverse air quality impacts. Dust would be managed during construction to avoid offsite impacts.	Air quality impacts would be unlikely to extend off-site and would be managed so as not to infringe on amenity of surrounding land uses through the application of available mitigation measures.
Waste	During construction, up to 420,000 m^3 of bulked spoil would be generated by the Project. Spoil would be appropriately managed in accordance with standard mitigation measures such that spoil disposal does not pose an impact. Significant quantities of other wastes are not anticipated to be generated by the Project. This would not lead to land use conflicts either on or off site.	The increase in spoil and other waste generated by the Project would not cause land use conflicts with the implementation of standard mitigation measures.
Public safety	The Project would introduce public safety risks to the Project area, potentially including elevated bushfire and fires risks. However most hazards can be prevented by employing a combination of common measures, including following all applicable Standards, separation distances and setbacks, physical protection and control systems measures.	The Project is not considered likely to restrict the types of development compatible with current zoning or likely future uses due to public safety risks. The risk of off-site impacts is considered able to be mitigated to a level where off-site land uses are not restricted or affected.
Social and economic impacts	The Project would impact on local amenity (air, noise, visual and traffic), require close the Project area to the public and require the short-term road closures.	The restriction of access to Project area would restrict access to Bendeela Recreation Area and Promised Land Trail in Morton National Park potentially diminishing peoples' experience and enjoyment of the natural environment. Reasonable and feasible mitigation measures are available and would be implemented to minimise social and economic impacts as described in **Section 6.14**

As demonstrated in **Table 6-11**, while construction will introduce a number of land use conflicts these impacts are not considered to be significant provided the recommended mitigation measures in **Appendix E** are implemented.

6.4.4.3 Contamination

As described in **Section 6.4.3**, there is minimal potential to encounter localised areas of contamination associated with historical land use and naturally occurring asbestos within the Project area during construction. However, soil and water contamination may result from the disturbance of acid rock in the form of PAF spoil, or from hydrocarbons and other chemicals being used and transported during construction. These are discussed further below.

In addition, stockpiles that are not adequately stabilised or managed can result in material eroding away during high rainfall events, these impacts are discussed further in **Section 6.5.4.1**.

6.4.4.3.1 Potentially acid forming spoil

As described in **Section 3.4.4** the Project would generate about 420,00 m^3 of spoil. Some of this is anticipated to be PAF, as shown in **Table 6-12**, most spoil would be net ACM.

Table 6-12. Estimated spoil classification

Material Classification	Estimated Volume (m3)	Percentage of total excavated material (%)
Non-acid forming (NAF) material	48,481	16.4
ACM	192,464	65
Potential PAF	55,105	18.6

6.4.4.3.2 Hydrocarbons and chemicals

Construction of the Project could result in soil and contamination from accidental leaks or spills of hydrocarbons and chemicals required for construction activities. This could pollute the local environment, including waterways, if not appropriately managed.

A discussion of potential water contamination is provided in **Section 6.5.4.1**. In summary, while there is a risk of water quality degradation at the closest sensitive waterway of Lake Yarrunga, the mitigation measures are anticipated to adequately mitigate this risk and the Project is anticipated to have a neutral effect on water quality during construction.

Chemicals will be stored in accordance with their safety data sheets, and where practical, will be stored within bunded areas. Refuelling of construction plant and equipment will occur only within controlled areas. Spill kits will be maintained on site during construction, and any spill clean-up material will be placed in dedicated covered skip bin for collection for off-site disposal.

Provided the spoil management plan and the Project mitigation measures as summarised in **Appendix E** are implemented contamination impacts from PAF spoil and potential contamination impacts associated with hydrocarbons and chemicals during construction are not considered to be significant

6.4.4.4 Geotechnical stability and landform

The existing geotechnical conditions identified have the following implications that have been considered in design development:

- The large "block gliding" mechanism is expected to not have any real impact on the Project given the overall relatively shallow depth of the slide plane relative to the proposed tunnelling levels and distance to the surface works (above 500m far from the lower intake)
- The main access tunnel portal has been relocated outside of the colluvium west to the Bendeela Power Station to prevent triggering future landslides
- Target investigations to understand the depth of colluvium and the potential presence of paleochannels in the tailrace for selection of the final arrangement. Such investigations will verify the depth of colluvium below Kings Creek to confirm a suitable rock cover for tunnelling or required tunnel treatments

- Negligible stress or groundwater drawdown induced ground movement would occur given the depth of cover to most tunnelling with shallow tunnelling from portals to adopt necessary tunnelling support practices
- All underground works will be supported as necessary as they progress such that no subsidence impacts or consequences would occur.

As discussed in **Section 3.4.7**, a strategy for managing the stability of the Project landforms has been developed and would continue to be refined through detailed design.

Temporary landform changes would occur within temporary construction areas such as laydown and work areas, site offices, batching plants and warehouses. These landform changes would be temporary in nature, and where not required for Project operation, would be rehabilitated in accordance with the rehabilitation management plan that will be prepared for the Project.

The rehabilitation strategy which is outlined in **Section 3.4.9**, would form the basis of the rehabilitation management plan which would be prepared to guide the long term rehabilitation of the Project area.

The permanent landform will be designed considering geotechnical short-term stability and any potential seismic impacts. Project-specific geological, geotechnical, hydrogeological and geophysical investigations will be undertaken to inform the design.

6.4.5 Operational impacts

6.4.5.1 Soils and land capability

The operation and maintenance of the Project would not result in likely potential for any direct contact with subsurface soil during operations. The drainage control structures described in **Appendix I** would continue to be used during operation and maintenance activities where relevant. As a result, impacts to soils during operation are not considered to be significant.

A rehabilitation management plan will be prepared to determine how areas disturbed during construction that are not required for operation of the Project would be progressively rehabilitated. The rehabilitation management plan will include the rehabilitation of disturbed soils and strategies to retain and improve land capability where relevant.

As a result, impacts to land capability during operation are not considered to be significant.

During operation, soils and land capability may also be impacted by soil and water contamination from maintenance activities. These impacts are further assessed in **Section 6.4.5.3**.

6.4.5.2 Land use conflict risk assessment

The Project would introduce a new infrastructure across WaterNSW land and introduce a land use conflict issue with the Existing Scheme. This conflict is identified as arising from the Project being established along the existing excavated alignment currently used by WaterNSW for routine inspection and maintenance purposes. The use of this area would as such complicate these WaterNSW activities.

Origin and WaterNSW have established a working group to identify appropriate solutions to facilitate ongoing inspection and maintenance requirements.

No other operation land use conflicts were identified given Project will essentially duplicate of the Existing Scheme and operate such that Existing Scheme operations are not compromised.

6.4.5.3 Contamination

The operation and maintenance of the Project would not result in likely potential for any direct contact with subsurface soil during operations. During operation of the Project, soil and water contamination may result from the permanent stockpiling of PAF spoil, or from hydrocarbons and other chemicals being used for maintenance activities.

Given the implementation of the spoil management plan and the Project mitigation measures as summarised in **Appendix E**, contamination impacts from PAF spoil during operation are not considered to be significant.

Periodic maintenance of the Project during the operational phase could result in soil and contamination from accidental leaks or spills of hydrocarbons and chemicals required for maintenance activities. This could pollute the local environment, including waterways, if not appropriately managed.

Operation of the Project would result in the transfer of water from one reservoir to another, potentially carrying contamination within the reservoir system. Maintenance activities may result in the drainage of and discharge of water to surrounding waterways and waterbodies The operational water quality impacts of the Project are further described in **Section 6.5.5.1**.

Chemicals would be stored in accordance with their safety data sheets, and where practical, would be stored within bunded areas. Refuelling of maintenance plant and equipment would occur only within controlled areas. Spill kits would be maintained on site during operation of the Project, and spill clean-up material would be placed in dedicated covered skip bin for collection for off-site disposal.

With the implementation of the mitigation measures described in **Appendix E**, potential contamination impacts associated with hydrocarbons and chemicals is not considered to be significant.

6.4.5.4 Geotechnical stability and landform

As discussed in **Section 3.4.7**, permanent landform changes would be required for the Project.

These landform changes would remain following the completion of Project construction, resulting in local modifications to the existing site landform. Permanent landform changes will predominantly occur at the lower intake structure, main access tunnel portal and permanent spoil areas, where large excavations and embankments are required.

The permanent landform changes would be designed and managed as per the strategy for managing the geotechnical stability of Project. Where feasible and reasonable the final landform design will use opportunities to reinstate local landform changes to complement the surrounding topography and reduce visual impacts will be investigated.

As discussed in **Section 3.4.9**, the rehabilitation strategy would form the basis of the rehabilitation management plan which would be prepared to guide the long term rehabilitation of the Project area. The rehabilitation management plan considered the permanent landform changes based on the final land use and operational requirements.

6.4.6 Mitigation measures

Mitigation measures to address the potential land impacts of the Project are listed in **Table 6-13**.

Table 6-13. Land mitigation measures

Ref	Impact	Mitigation measure	Timing
L1	Geotechnical stability	▪ The strategy for managing the geotechnical stability of the Project landforms during construction and operation will continue to be refined through detailed design ▪ Detailed design of the Project will consider and address geotechnical stability risks in accordance with applicable design standards where feasible and reasonable ▪ The permanent landform changes based on the final land use and operational requirements will be considered in the rehabilitation management plan.	Detailed design

Ref	Impact	Mitigation measure	Timing
L2	Potential surface contamination	Potential surface contamination-related impacts associated with the Project will be managed by: ▪ An unexpected finds protocol, during the extent of the construction works. This will include guidance on identifying potential contaminated land characteristics (visual, odours, etc), steps to cease works in the affected area, further investigation to assess the extent, magnitude and type of contaminants and appropriate remedial actions ▪ Management of surface water when present to minimise the mobilisation of any potential residual soil impacts that could migrate to sensitive off-site ecological receptors.	Construction
L3	Spoil management	A spoil management plan will be prepared for the Project. The spoil management plan will outline appropriate management procedures for the generation, management of spoil. It will include, but not be limited to: ▪ Confirming spoil quantities ▪ Procedures for classification and testing of spoil, including classification of PAF and any other hazardous spoil materials based on site-specific data and testing currently available and additional data obtained during details design, to facilitate management of materials and ensure appropriate treatment and placement of materials ▪ Identification of spoil reuse measures, including segregation of soils as subsoils and topsoils ▪ Spoil stockpile management procedures, include the management of PAF spoil ▪ Spoil haulage routes ▪ Spoil disposal and reuse locations ▪ Measures for managing PAF spoil including methods to safely handle, segregate, transport and contain materials, including treatment of PAF ▪ Rehabilitation of the spoil emplacement facility with native vegetation similar to existing and to the extent it will not impact any encapsulation integrity. The plan will also include a monitoring program. The plan will follow recommendations from relevant guidelines.	Detailed design/ Construction/ Operation
L4	Hydrocarbon and chemical spills	Chemicals will be stored in accordance with their safety data sheets, and where practical, will be stored within bunded areas.	Construction/ operation
L5		Refuelling of construction plant and equipment will occur only within controlled areas.	Construction/ operation
L6		Spill kits will be maintained on site during construction, and spill clean-up material will be placed in dedicated covered skip bin for collection for off-site disposal.	Construction

Ref	Impact	Mitigation measure	Timing
L7	Rehabilitation management	A rehabilitation management plan will be prepared to guide the long term rehabilitation of the project. The rehabilitation plan will: ▪ Include a detailed plan for rehabilitation of the site including any permanent new landforms ▪ Characterise the soil types within the disturbance area ▪ Include details of soil management measures ▪ Include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the sites, and triggering any remedial action (if necessary) ▪ Describe the measures that will be implemented to: - Comply with the rehabilitation objectives and associated performance and completion criteria - Progressively rehabilitate the site. - Include a program to monitor and report the effectiveness of these measures.	Construction
L8	Landform stability	Where relevant, batter slopes will be designed by a geotechnical engineer and will consider the long-term stability of the landform, including appropriate drainage and erosion measures. Slope stability measures, including shotcrete and rock bolts, will be utilised if required. The option of backfilling excavated areas to pre-disturbed conditions will be investigated as part of the detailed design.	Detailed design
L9		Final landform design will be developed as part of the detail design where opportunities to reinstate local landform changes to complement the surrounding topography and reduce visual impacts will be investigated.	Detailed design

6.5 Surface water

This section provides an assessment of the potential surface water impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix I** (Surface water quality, hydrology and geomorphology impact assessment).

The assessment addresses the following SEARs:

Water – including:

- An assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the NSW Aquifer Interference Policy and relevant Water Sharing Plans
- A detailed site water balance for the Project, including water supply and wastewater disposal arrangements
- An assessment of whether the project would have a neutral or beneficial effect on water quality
- Where the Project involves works within 40 m of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI Guidelines for Controlled Activities on Waterfront Land (2018) and (if necessary) Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI 2003) and Policy & Guidelines for Fish Habitat Conservation & Management (DPI, 2013)
- A strategy to manage spoil.

6.5.1 Legislative and policy context

The surface water assessment has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Water Management Act 2000*
- *WaterNSW Act 2014*
- *WaterNSW Regulation 2013*
- POEO Act
- FM Act

- *Biodiversity Conservation Act 2016*
- *National Water Quality Management Strategy* (Australian Government, 2018)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environmental and Conservation Council* (ANZECC)/ *Agriculture and Resource Management Council of Australia and New Zealand* (ARMCANZ), 2000)
- *Australian Drinking Water Guidelines* (NHMRC & NRMMC 2011)
- *NSW Water Quality Objectives* (DECCW, 2006)
- *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2015)
- *Managing Urban Stormwater, Soils and Construction, Volume* 1 (Landcom, 2004) *and Volume 2* (DECCW, 2008) (the Blue Book)
- *Guidelines for Managing Risks in Recreational Water* (NHRMC, 2008)
- *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013)
- *Guidelines for Controlled Activities on Waterfront Land* (DPI, 2018).

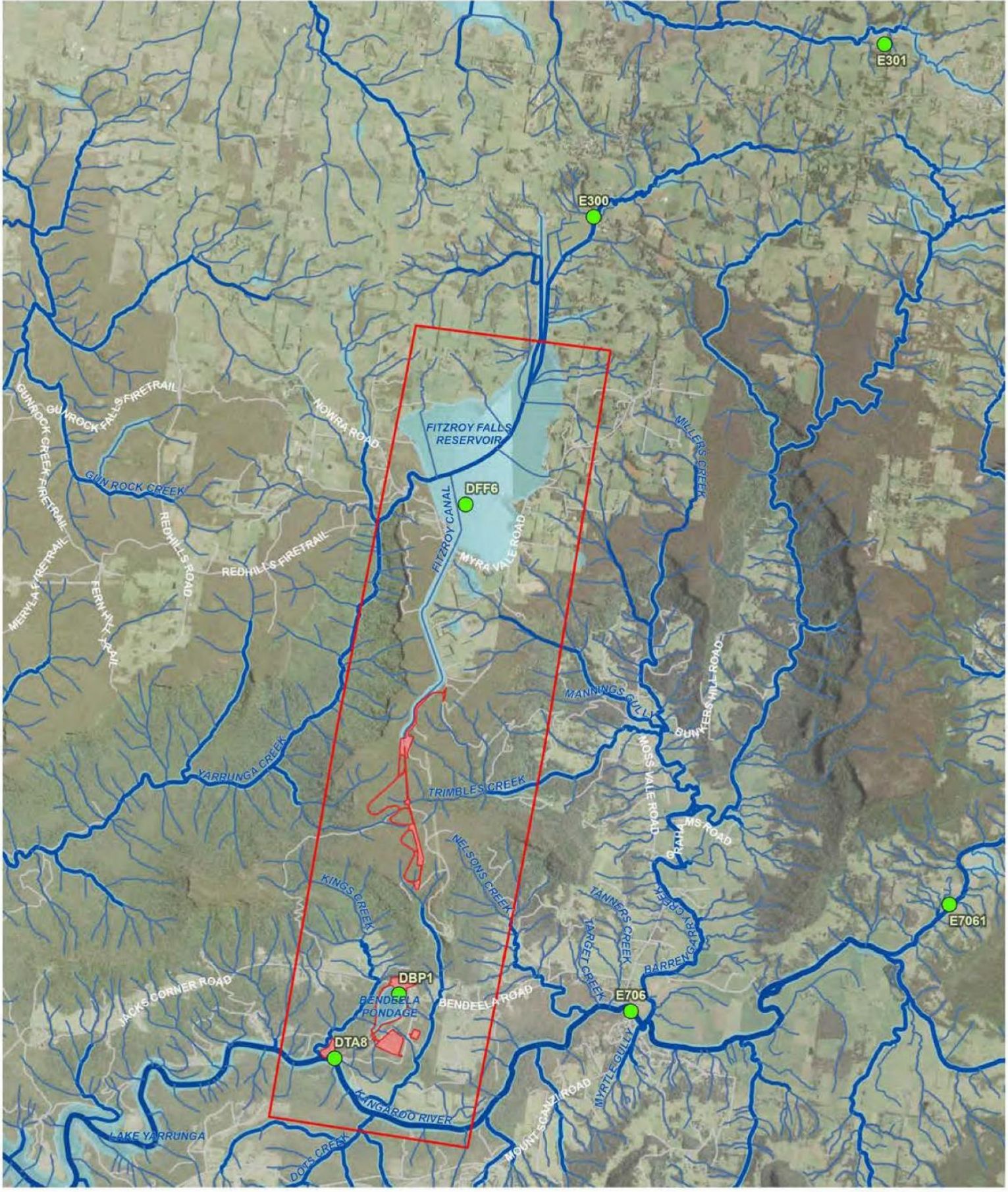
6.5.2 Methodology

The surface water assessment included:

- Desktop review and analysis of available information to understand the existing environment, including environmental values and existing water quality data, and to identify potential waterway-specific and geomorphological risks
- A field assessment undertaken on 19 and 20 February 2019 to visually assess the condition of relevant waterways and waterbodies, including the Fitzroy Falls Reservoir
- Identification of sensitive receiving environments (SREs)
- Preparation of a detailed water balance, taking into account water supply sources (including groundwater inflows) and water demands
- A qualitative assessment of the quality and quantity of pollutants that may be introduced during construction and operation, and the impact that this may have on surface water, with reference to:
  - *The Water Quality Guidelines* (ANZG, 2018)
  - The relevant water quality objectives and environmental values as identified in the *NSW Water Quality Objectives* (DECCW, 2006)
- An assessment in accordance with the Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW, 2015) to determine whether the Project will have a neutral or beneficial impact on water quality
- A qualitative assessment of changes to water level and flows that would occur during construction and the impact that this may have on river geomorphology, and hydrological regime of waterways and waterbodies within the catchment
- Recommendations for appropriate treatment measures to mitigate the impacts of construction and operation on surface water quality, hydrology, and geomorphology including water quality controls, flow controls and recommendations for a water quality monitoring program during pre-construction, construction and operation of the Project.

Additional details of the surface water assessment methodology are provided in Chapter 3 of **Appendix I**.

The surface water study area comprises the Project area and a 'zone of impact', which consists of a 500 m buffer around the proposal footprint areas, Fitzroy Falls Reservoir and Lake Yarrunga to 500 m upstream and downstream of the instream footprint, as shown in **Figure 6-7**. The surface water study area can be separated into the upper surface water study area, consisting of the consists of the Fitzroy Falls Reservoir, the plateau and its slopes on both sides, and the lower surface water study area, spanning from the Kangaroo River Valley to the base of the escarpment.



Legend

- WaterNSW Routine Monitoring Site

Strahler stream order

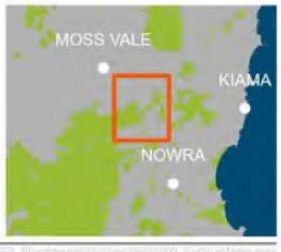
- 1
- 2
- 3
- 4
- 5
- 6

- Project Study Area
- Construction disturbance area
- Key fish habitat
- Road

0 1 2 km

1:90,000 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-7 Surface water study area

6.5.3 Existing environment

6.5.3.1 Catchment overview

The Project is situated in the Shoalhaven River Catchment in southern NSW. Key waterways and waterbodies within the surface water study area form part of the Sydney Water Drinking Catchment, as well as provide raw drinking water supply to Kangaroo Valley Water Filtration Plant for use by Kangaroo Valley township. The Project is surrounded by Morton National Park in the Upper portion of the surface water study area. Key waterways within the surface water study area include Fitzroy Falls Reservoir and Fitzroy Falls Upper Canal, Trimbles Creek and several tributaries of Trimbles Creek, Yarrunga Creek and several tributaries of Yarrunga Creek, Bendeela Pondage, Kings Creek, Kangaroo River (upstream of the FSL of Lake Yarrunga) and several tributaries of Kangaroo River, as well as Lake Yarrunga.

6.5.3.2 Climate

The surface water study area generally experiences a warm-temperate climate typical of its location in south-eastern Australia, with mild to hot summers and cool-mild winters. As the upper portion of the Project is located in the southern highlands and the lower portion of the Project falls within a valley between Berry Mountain and the Illawarra Escarpment, temperature and rainfall conditions can vary.

Rainfall trends indicate that the region experiences highest rainfall in late summer/early autumn (February and March), but also receives significant amounts in June. Rainfall in the upper portion of the Project tends to receive larger amounts of rainfall than the lower portion due to orographic lift phenomenon.

Temperature data indicates that the region is positioned within a temperate climatic region characterised by mild to warm summer and cool winters. Average minimum and maximum temperatures range from approximately 12 to 27°C (December to February) and 3 to 13°C (June to August) seasonally, with predominantly mild temperatures in the autumn and spring months. While no data was available for the lower surface water study area in Kangaroo Valley, it is expected that temperatures would be slightly warmer during summer months and colder during winter months than what is experienced in the upper portion of the Project on the plateau.

6.5.3.3 Topography, drainage and waterways and waterbodies

The surface water study area extends from low elevation areas in the southern extent at the Kangaroo River to the northern extent at the upper plateau near Fitzroy Falls. Elevations across the surface water study area range between approximately 60 m Australian Height Datum (AHD) at Kangaroo River to up to 670 m AHD on the plateau, which continues to the Fitzroy Falls Reservoir.

The upper surface water study area consists of the Fitzroy Falls Reservoir, the plateau and its slopes on both sides. There is significant topographic variation along the plateau, including a cliff-like topographic feature (the escarpment) about 50 m south of the base of the high pressure shaft. At the south-west extent of the plateau there are several drainage lines down the escarpment. The headwaters of Kings Creek rise to the west of the plateau and follow the base of the escarpment before turning south and flowing to Kangaroo River. Drainage lines also drain west toward Yarrunga Creek which flows west before turning to the south and connecting with the Kangaroo River. To the south-east of the plateau, drainage lines lead into Nelsons Creek which also flows into the Kangaroo River. To the east of the plateau, drainage lines lead into Trimbles Creek which flows east off the escarpment and connects to Millers Creek. Along the top of the escarpment the Fitzroy Canal connects the Fitzroy Falls Reservoir and the Upper Intake. The escarpment is largely flat with a gentle slope towards the edges of the escarpment and away from the canal as such minimal rainfall runoff will enter the canal.

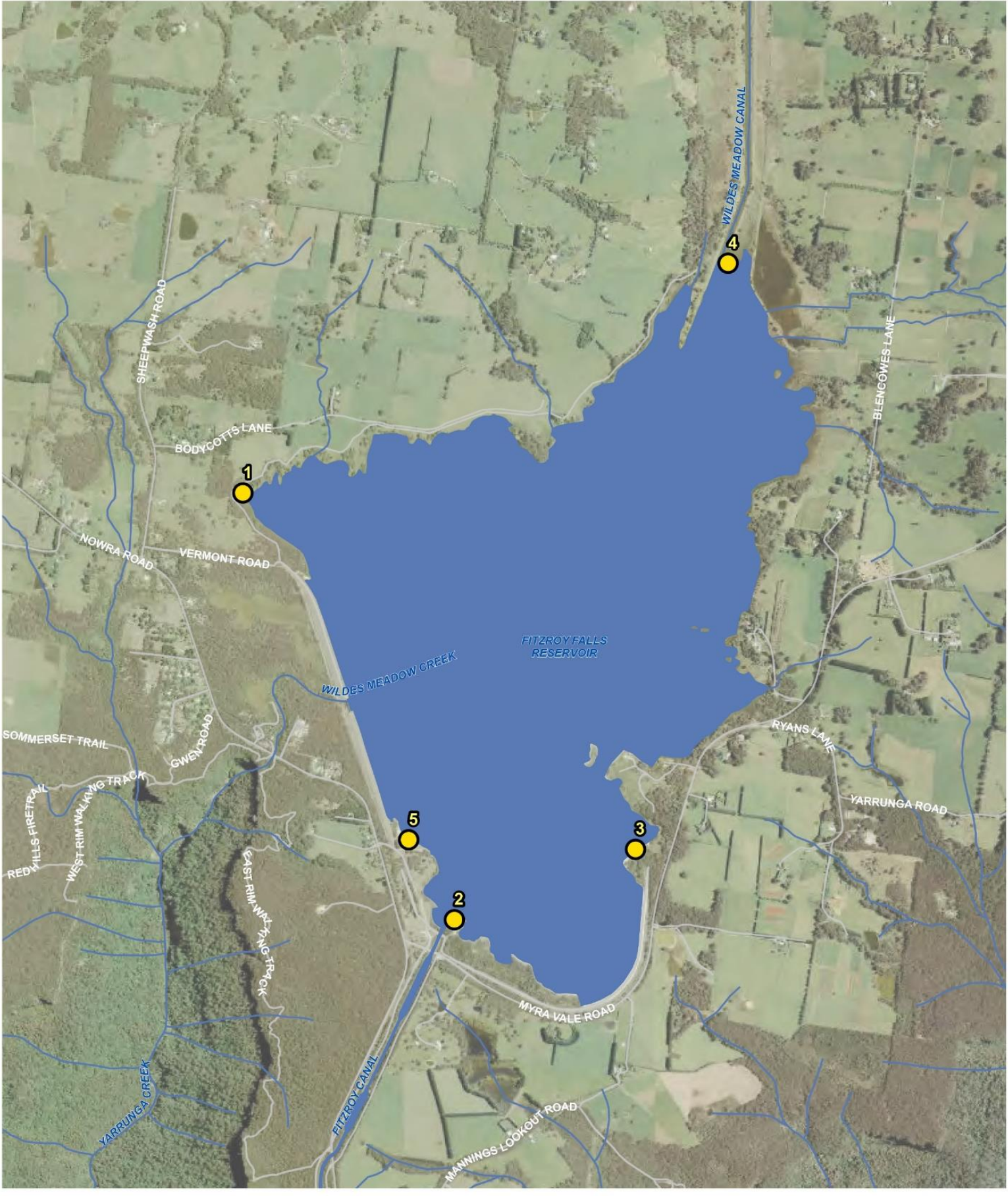
The lower surface water study area spans from the Kangaroo River Valley to the base of the escarpment. From the base of the escarpment the area gradually slopes south until an area of flat ground where several farms, the Kangaroo Valley Power Station and Bendeela Pondage are located. The area again slopes south toward Kangaroo River. There are two main drainage lines running north to south through the area connecting the escarpment with the Kangaroo River. Kings Creek flows on the western side of the Kangaroo Valley Power Station as well as a significant, but unnamed drainage line to the east of the power station.

The key waterways and waterbodies within the surface water study area, including their Strahler stream order and the presence of KFH are summarised in **Table 6-14.** The key waterways and waterbodies are shown on **Figure 6-8**. Additional information on each waterway and water body is presented in in **Appendix I**.

Table 6-14. Summary of waterways and waterbodies within the surface water study area

Waterway / waterbody	Stream order	KFH	Stream type	Relevant features
Kangaroo River (upstream) / Lake Yarrunga (downstream)	6	Yes	Perennial (upstream) Permanent waterbody (downstream)	▪ Kangaroo River (upstream) experiences low-moderate flows in a westerly direction before reaching Lake Yarrunga. The riverbanks of the Kangaroo River within the vicinity of Bendeela Pumping Station appear to be generally stable, and there are no obvious signs of current bank instability. Some sedimentation in the formation of bar development is noted in the channel of the Kangaroo River. ▪ Kangaroo River (upstream) is predicted habitat for the Macquarie Perch (DPI, 2022). ▪ Lake Yarrunga (downstream) generally has no-low flow, however experiences water level fluctuation from the existing pumped hydro scheme. At FSL, Lake Yarrunga extends approximately 2 km upstream of the Bendeela Power Station. Above this, the waterway is Kangaroo River.
Kings Creek	3	Yes	Perennial	▪ Kings Creek generally flows south toward Lake Yarrunga ▪ The lower portion of the creek (below Lower Bendeela Road crossing) becomes inundated from Lake Yarrunga regularly. The upper portion is a series of interconnected pools and riffles ▪ A cliff-like topographic feature is present approximately 0.5 km upstream of the Lower Bendeela Road crossing, creating a barrier to fish passage ▪ Based on groundwater modelling, there is potential that the lower reaches of Kings Creek, above the influence of Lake Yarrunga and below the break in slope (approximately 60 m AHD) may be subject to groundwater baseflow from the regional water table.
Unnamed tributary of Kangaroo River	3	Yes	Ephemeral	▪ The unnamed tributary flows in a southerly direction toward Kangaroo River ▪ The lower portion forms a wetland environment, and the surrounding area has been cleared of vegetation apart for a small riparian corridor ▪ The upstream section flows through a mix of cleared rural properties and densely forested area, as well as under Bendeela Road approximately 800 m east of the Kangaroo Valley Power Station ▪ Predicted habitat for the Macquarie Perch is located within the unnamed tributary of Kangaroo River.
Bendeela Pondage	-	Yes	Permanent waterbody	▪ Bendeela Pondage is an earth and rockfill embankment structure, connected by pipes to Fitzroy Falls Reservoir and Lake Yarrunga forms the central balancing storage for the existing Shoalhaven Power Station ▪ Used for water supply for Kangaroo Valley township ▪ The pondage is approximately 250 m across at its widest point and narrows to approximately 50 m.
Unnamed tributaries of Trimbles Creek	1	No	Ephemeral	▪ Multiple drainage paths which flow for over 1 km toward Trimbles Creek in a south and south-easterly direction ▪ In proximity to the eastern perimeter of Laydown / Work Area 1 ▪ Flows only occur during or after rainfall.

Waterway / waterbody	Stream order	KFH	Stream type	Relevant features
Trimbles Creek	2	No	Ephemeral	▪ Trimbles Creek flows in an easterly direction toward Barrengarry Creek ▪ The Project traverses Trimbles Creek in the existing disturbance area of the existing surface pipeline / anchor block ▪ The creek is mapped as KFH 1.4 km downstream of the Project crossing.
Unnamed tributaries to Yarrunga Creek	1	No	Ephemeral	▪ Multiple drainage paths which flow for over 3 km toward Yarrunga Creek in a westerly direction ▪ In proximity to the western perimeter of Laydown / Work Area 1 and Laydown / Work Area 2 ▪ Flows only occur during or after rainfall.
Yarrunga Creek	4	Yes	Perennial	▪ Yarrunga creek runs approximately parallel to Fitzroy Falls Upper Canal and the penstock before flowing south-west toward Lake Yarrunga ▪ The upper portion of Yarrunga Creek is disconnected from the lower portion by a large waterfall formation (Fitzroy Falls) ▪ The creek receives regulated environmental flows from Fitzroy Falls Reservoir as per the dam operational rules ▪ The creek flows through a densely forested gully entirely within the Morton National Park ▪ The lower 3.5 km of Yarrunga Creek is permanently inundated and forms part of Lake Yarrunga.
Fitzroy Falls Upper Canal	4	Yes	Permanent waterbody	▪ Fitzroy Falls Upper Canal is a large, permanent, artificial channel located in the upper portion of the surface water study area which connects the main waterbody of the Fitzroy Falls Reservoir to the Existing Scheme penstock ▪ The canal is an earth and rockfill embankment structure in the lower portion near the penstock connection and has been incised into bedrock in the upper portion closer to the reservoir ▪ The canal is approximately 65 m across at its widest point (at the inlet/outlet works) and narrows to approximately 15 m along the length of the canal.
Fitzroy Falls Reservoir	4	Yes	Permanent waterbody	▪ Fitzroy Falls Reservoir consists of four separate earth and rockfill embankments damming Yarrunga Creek, upstream of Fitzroy Falls. The reservoir has relatively gentle bank slopes. ▪ The reservoir has a catchment totalling 31 square kilometres (km^2) and has a permanent waterbody and water level fluctuates up to 14 m. The reservoir is a predicted habitat for the Fitzroy Falls Spiny Crayfish.



Legend

- Feild Assessment Site
- Waterway
- Road
- Waterbody

0 0.8 1.5 km

1:25,000 at A4

GDA2020 MGA Zone 56

Data sourcesa

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-8 Key waterways and waterbodies within the surface water study

Date: 21/07/2022 Path: \\ausyd0vs01\gisproj\NSW_IS\302600_ShoalhavenEIS\Apps\IS302600_SurfaceWater.aprx
Created by : NT | QA by : CC

6.5.3.4 Sensitive receiving environments

While all waterways within the surface water study area are considered SREs, the level of sensitivity differs for each waterway based on site-specific conditions as well as the environmental and human uses for the waterways. Waterways which were identified as highly sensitive SREs include Kangaroo River / Lake Yarrunga, Kings Creek, Unnamed tributary of Kangaroo River (Lower Scheme), Bendeela Pondage, and Fitzroy Falls Reservoir. All other waterways were considered to have low or very low sensitivity, with the exception of Fitzroy Canal which was classified as medium sensitivity due to its connection with Fitzroy Falls Reservoir.

6.5.3.5 Existing surface water quality

Analysis of existing water quality found that the water quality of the drinking water supply storages and waterways which flow to catchment storages (Kangaroo River, Yarrunga Creek, Lake Yarrunga and Fitzroy Falls Reservoir) was variable, with only around half of the indicators complying with relevant guidelines and standards. Indicators which generally did comply included pH, turbidity, dissolved oxygen and dissolved metals (dissolved iron, aluminium and manganese). Those that generally did not comply with guideline trigger values were nutrients (nitrogen and phosphorus in various forms), electrical conductivity, and total metals (total iron and aluminium). Compliance with algal and toxic cyanobacteria standards was also variable.

Waterway condition assessment identified that waterways and waterbodies within the surface water study area were in fair to good condition, and all waterways and waterbodies were identified SREs. It was noted however that the level of sensitivity varied for different waterways based on their human and aquatic ecosystem values.

With respect to geomorphology, the banks of Lake Yarrunga appeared to be generally stable. Historic photographic evidence suggested there were no obvious signs of bank instability, although some notching of the bank was evident. Some sedimentation in the formation of bar development was noted in the channel which is to be expected in the upper section of the weir pool. Fitzroy Falls Reservoir and Bendeela Pondage were considered to have low erosion potential due to the constructed nature of these storages, as well as the shallow gradient of shoreline and vegetated cover along the perimeter of Fitzroy Falls Reservoir.

6.5.4 Construction impacts

6.5.4.1 Water quality

Construction of the Project has potential to result in changes to surface water quality if not properly managed. These potential impacts are described in **Table 6-15**.

All wastewater produced during Project construction will be collected and removed from site and disposed of at a suitably licenced waste facility.

Potential water quality issues would be managed through the establishment of erosion and sediment controls as described in Chapter 5 of **Appendix I**, as well as the mitigation measures described in **Section 6.5.6**. With the implementation controls and mitigation, it was determined that risk of these impacts occurring were very low or low for waterways and waterbodies within the surface water study area.

The only waterway that was identified as having a medium risk was Lake Yarrunga. This was because construction activities are expected to occur within and in close proximity of this sensitive waterway and therefore the likelihood of impact is slightly higher. It is anticipated that identified water quality mitigation measures will adequately mitigate this risk.

As a result, the Project is anticipated to have a neutral effect on water quality during construction.

Table 6-15. Potential impacts to surface water quality during construction

Construction activity	Potential surface water quality impact
Road works at the Promised Land Trail and the intersection of the Promised Land Trail and Moss Vale Road	Soils in the road corridor and the road material (compacted in situ material and imported gravel) are at risk of being transported via stormwater runoff into the downstream aquatic environments. Once sediments enter the waterways they have the potential to temporarily reduce downstream water quality by increasing turbidity and smothering aquatic organisms.
Vegetation removal	Removal of vegetation can impact on water quality during the construction phase if runoff is allowed to mobilise exposed soils or tannin leachate. This can result in increased turbidity, suspended solids, nutrients and contaminants in downstream waterways. Clearing and trimming of vegetation will be done to avoid tannin leachate entering downstream waterways. It is anticipated that there is low risk of impacts to water quality from vegetation clearing for most areas except for in areas with steep gradient slope where runoff may transport sediment or tannin leachate if able to mobilise downstream.
Excavation and earthworks	Sedimentation can occur when rain or runoff comes into contact with these exposed areas, transporting sediment to downstream receiving waterways. Once sediments enter waterways, they can directly and indirectly impact the aquatic environment by: ▪ Increasing sediment and deposition, altering the geomorphology of waterways, increasing turbidity and reducing water clarity ▪ Containing high concentrations of nutrients, leading to algal blooms ▪ Containing elevated concentrations of metals and other contaminants, negatively impacting aquatic life and reducing the suitability of the water for drinking, irrigation and recreation. The waterways at most risk are those located in close proximity to the work areas and where more significant earthworks would be occurring, including at Trimbles Creek and Lake Yarrunga. Without management, there would be potential for Trimbles Creek, and Lake Yarrunga to receive direct runoff from work areas and major earthwork sites.
Concrete works, including use of premixed concrete and use of the onsite concrete batching plant	Alkaline concrete by-products have the potential to alter the pH of water which can be harmful to aquatic life that are sensitive to changes in water quality. The main areas at risk from potential mobilisation of concrete waste are waterways which are in close proximity to concrete works including Trimbles Creek, Bendeela Pondage, Kings Creek and its ephemeral tributary which are located in close proximity to Laydown / Work Areas and some unnamed ephemeral drainage lines which are located in the vicinity of Project components requiring concrete works.
Site facilities and laydown areas	Potential pollution pathways to surface water quality could arise from the establishment and use of site facilities and laydowns areas, including: ▪ Potential for litter and debris to be transported off the laydown area by wind, runoff and/or floods ▪ Sewage and wastewater spills entering a downstream receiver ▪ Spills and leaks from construction plant and equipment ▪ Transportation of soils and sediment associated with vegetation clearing and vehicle movements across exposed earth. The subsequent impact to surface water quality could therefore include elevated turbidity, nutrients, toxicants and elevated levels of enterococci or bacteria.

Construction activity	Potential surface water quality impact
Spoil movement and stockpiling	Spoil movement and temporary stockpiles can result in sedimentation of downstream waterways if high rainfall events and high winds result in exposed materials and soils being mobilised downstream from temporary stockpiles or loss of excavated materials from vehicles moving between sites if not appropriately secured. Material/spoil transport poses the highest risk to waterways adjacent to haulage routes and waterways in proximity to ancillary facilities or construction sites, in particular Kings Creek and Bendeela Pondage. The location of the main spoil emplacement facility presents a risk to the water quality due to its location near the unnamed tributary of Kangaroo River. Materials identified as PAF present the greatest risk to water quality once exposed to oxygen and water which without appropriate management can result in acid drainage and contamination of downstream surface and groundwater. Stockpiles that are not adequately stabilised or managed can result in material eroding away during high rainfall events. This can introduce sediments, nutrients, acid leachate, hydrocarbons, metals, contaminants and gross pollutants into downstream waterways. Sedimentation can result in increased turbidity which could lead to fish kills and can also reduce light penetration which can limit the growth of aquatic vegetation.
Tunnel process water	The construction of the vertical shaft, tunnels and other underground works would generate tunnel process water constituting a mix of collected groundwater and water used in the tunnelling process. Tunnel process water would be captured within underground workings and require dewatering with excess water that needs to be discharged if it cannot be reused. Tunnel process water is likely to contain elevated levels of suspended solids, potential acid rock drainage and hydrocarbons, plus any known contaminants associated with groundwater in the area which may include elevated salinity and some heavy metals. If water is discharged untreated or poorly treated there is potential to impact the receiving waterways by introducing contaminants into downstream waterways. Waterways at risk are those where discharge is proposed or downgradient areas where tunnel process water is stored and treated. To minimise the amount of groundwater seepage and potential for oxidation of materials leading to acid rock drainage the tunnels will be lined as soon as practical behind tunnel advancement. it is proposed to treat tunnel process water via a water treatment plant so that it meets the background water quality of the discharge location and the water quality targets set out in the Kangaroo Valley Raw Water Supply Agreement and the ANZG (2018) guidelines. It is also recommended to undertake further groundwater monitoring to gain a greater appreciation of other key contaminants (i.e. metals and nutrients) that may be present in groundwater in elevated concentrations. Additional detail regarding groundwater quality is presented in Section 6.1.8 of **Appendix I** and throughout **Appendix J**.
Controlled sediment basin discharges	Project construction would result in the controlled discharge of water from temporary sediment basins. By capturing sediments (and subsequently nutrients and toxicants) via temporary sediment basins, the risk to downstream water quality would be reduced. Controlled discharge of basins would occur following treatment, in accordance with the Blue Book (within 5 days of a rainfall event), when turbidity and pH concentration in the discharge are similar to existing water quality of the receiving waterways. If after all reasonable and practicable measures have been implemented to avoid the discharge of water (including re-use options) unsuitably high levels of sediment remain in the runoff collected in the basin, the use of fine gypsum naturally occurring or flocculation to improve the settlement of dispersible soil particles in the sediment basins will be considered. Application of gypsum will be in accordance with relevant guidelines and the pH and electrical conductivity will be monitored to achieve compliance with ANZG (2018) and/or the water quality of downstream receivers prior to discharge to minimise any impact to aquatic ecosystems.

Construction activity	Potential surface water quality impact
Uncontrolled sediment basin discharges	There is a risk to water quality of downstream receivers is during and following a significant rainfall event when the design capacity of the basin is exceeded, resulting in an uncontrolled discharge. Uncontrolled discharges are likely to result in high turbidity and subsequently elevated levels of nutrients and/or heavy metals which are bound to the sediment. Waterways at risk of sediment basin discharges are Trimbles Creek, the unnamed tributary of Yarrunga Creek 2, unnamed tributary of Kangaroo River (Lower Scheme) and Kings Creek as they are located downstream of likely sediment basin locations. Basins that discharge directly or very close to a waterway present a greater risk to downstream water quality compared to those that discharge via overland flow. Two potential basins would discharge into Trimbles Creek with minimal overland flow path which, if not treated appropriately, could impact the water quality of Trimbles Creek. Given the proximity to Trimbles Creek, its ephemeral nature and there being only a small catchment area above the Project area, Trimbles Creek is unlikely to provide any dilution or assimilation of basin discharges that have elevated TSS. Any water that flows via uncontrolled discharges to this waterway is unlikely to mobilise any significant distance to downstream. Given that Trimbles Creek is not considered to be a highly sensitive SRE, the consequence of an uncontrolled discharge mobilising to Trimbles Creek would be minor Higher sediment concentrations in uncontrolled discharges are expected to assimilate into the water within Trimbles Creek within a reasonable distance of the discharge point and would not impact on the environmental values of the water way. In addition, large rainfall events which would result in an uncontrolled discharge would be rare, therefore the risk is considered low. Trimbles Creek has been identified as a priority area for erosion and sediment control development as part of detailed design.
Rock blasting	Rock blasting would require the use of chemicals that can be harmful to aquatic ecosystems should they enter nearby waterways. Kings Creek and Lake Yarrunga are the surface water bodies at most risk of being impacted from rock blasting. The key risk to water quality is from leakage or spills of petroleum, oils, and other chemical contaminants from construction machinery, plant equipment, refuelling and vehicles traveling to and from site. This may result in the release of heavy metals, potentially hazardous substances such as ammonia and nitrate, and hydrocarbons which can be toxic to aquatic species. Additionally, blasted rockpiles that are not appropriately managed prior to being transported off site have the potential to contaminate surface water during rainfall events. Appropriate controls will be adopted to ensure no contaminants are released off-site or into Lake Yarrunga.
Steelworks	Steel cuttings may be mobilised to downstream waterways during steelworks which can result in increased toxicity of the waterway from leaching of heavy metal constituents (i.e. Iron, aluminium or chromium).
Instream works	Instream works may result in the disturbance of sediment during excavation activities (including vegetation clearing) which may in turn increase sedimentation to the downstream receiver. Vegetation clearing within and near waterways may result in mobilisation of instream sediments, destabilisation of riverbanks and/or erosion of exposed topsoils via wind or runoff. Mobilised sediment may result in increased turbidity that can be detrimental to aquatic life, result in algal blooms and can reduce visual amenity. Installation of a sediment curtain, coffer dam or alternate measure to manage water quality in Lake Yarrunga would be required at the inlet/outlet structure to minimise impacts to water quality from the rock blasting at the earthen block bank. While a cofferdam is a water quality control to minimise movement of sediment and other contaminants downstream, construction of the cofferdam would require dewatering around the construction area and surface water that seeps into the cofferdam would require extraction. If a coffer dam were adopted, dewatering from within the temporary coffer dam would be discharged into a sediment basin for treatment prior to be discharge back into Lake Yarrunga.

Construction activity	Potential surface water quality impact
Tunnelling and underground works	Excavated material from tunnelling would require stockpiling and transport off site. Excavation of the shafts would also require a considerable work area which may require clearing of vegetation and topsoil. The disturbance of soil could increase the potential for soil erosion causing sediments, nutrients and other contaminants bound to the soil being transported to downstream waterways resulting in increased turbidity, lower dissolved oxygen and increased concentrations of nutrients due to increased sediment. This may lead to algal blooms, aquatic weed growth and reduced visual amenity. Additionally during tunnelling there is risk of acid formation and subsequent acid leachate should excavation occur through acid forming rock. To minimise the risk to the quality of water during dewatering, rapid application of tunnel lining will occur.

6.5.4.2 Hydrology

Water extraction from surface waters is not proposed during construction of the Project with the exception of water captured in sediment basins that may be re-used. As such, the only potential impacts to hydrology may result from groundwater drawdown from tunnelling and underground excavation works, as well as increased impervious surfaces from site works and surface hardening from the use of heavy machinery. Any changes to hydrology would be temporary and sites would be progressively stabilised and rehabilitated to their original states as far as practicable as works are completed.

6.5.4.3 Geomorphology

The proposed instream works have the potential to impact on the geomorphological condition of Lake Yarrunga and Trimbles Creek from erosion and sedimentation. In particular, the key risk to geomorphology of these waterways from temporary instream works is downstream deposition of sediment within the channel, potentially leading to alteration of flow and subsequent changes in the channel bed and banks.

While there is potential for minor geomorphological impacts to occur, they are considered unlikely with the implementation of erosion and sediment control measures outlined in Chapter 5 of **Appendix I** and the mitigation measures described in **Section 6.5.6**. As such, the risk of changes to geomorphology are considered very low.

6.5.4.4 Construction water balance

A construction water balance, consisting of total Project water demands and sources, is provided in **Table 6-16**. For the purposes of this water balance it is assumed that groundwater inflows will either be of suitable quality for Project use or can be treated to suitable quality. A detailed water balance for the Upper and Lower Scheme is provided in Chapter 8 of **Appendix I**.

Overall, the Project is estimated to require a total of approximately 141.9 ML of make-up water, with approximately 5.4 ML to be sourced from Bendeela Pondage and 136.5 ML to be sourced from Fitzroy Canal.

Approximately 251.9ML of controlled discharge is anticipated, averaging approximately 4.9 ML/month over the period of construction. This is surplus water that will be treated to suitable quality prior to being discharged to either Bendeela Pondage or Lake Yarrunga. A peak surplus requiring discharge of up to approximately 12ML/month is anticipated midway during construction.

Table 6-16. Project construction water balance

Water Demand / Source	Volume (ML)
Inputs	
Groundwater Inflow	426.7
Recycled water	45.3
Make-up Water	141.9
Total Inputs	**613.9**

Water Demand / Source	Volume (ML)
Outputs	
Concrete Batching	8.4
Dust Suppression	251.6
Tunnelling	79.7
Washdown	10.9
Amenities	11.4
Controlled Discharge	251.9
Total Outputs	**613.9**

6.5.4.5 Construction spoil management

The spoil management strategy is presented as **Appendix K**. In summary, spoil would be treated and disposed of on-site, with PAF spoil being identified and managed to neutralise the risk of acidic water from the stockpile area to the surrounding surface water, refer to **Section 3.4.4.**

Given the implementation of the spoil management strategy, the risk of impacts to surface water from spoil are not considered to be significant.

6.5.5 Operational impacts

6.5.5.1 Water quality

During the operational phase of the Project, all construction access roads for the various Project components would be maintained, cleared areas would be stabilised and rehabilitated as required and scour protection would be installed at any outlets along the pipeline alignment. All Project components would be constructed and commissioned, and construction work sites would be progressively decommissioned following the completion of the works. All wastewater produced during Project operation will be removed from site and disposed of at a suitable waste facility.

The potential impacts to surface water quality of waterways and waterbodies associated with operation is shown in **Table 6-17.**

Potential water quality issues would be managed through the establishment of erosion and sediment controls as described in Chapter 5 of **Appendix I**, as well as the mitigation measures described in **Section 6.5.6**. With the implementation of controls and mitigation, it is determined that risk of these impacts occurring are low for waterways and waterbodies within the surface water study area. The only waterway that is identified as having a medium risk was Lake Yarrunga due to possibility of increased bank erosion. Despite this slightly higher risk, it is expected that the Project would be designed and operated to reduce this risk. As such, the Project is expected to have a neutral effect on water quality during operation.

Table 6-17. Potential impacts to surface water quality during construction

Operational activity	Potential surface water quality impact
Instream structures and maintenance	Following construction, recently disturbed soils would be susceptible to scour and erosion from stormwater runoff. This results in sedimentation, which can have: ▪ Direct impacts of large volumes of sediments mobilising to downstream receivers include reducing light penetration (limiting the growth of macrophytes), clogging fish gills, smothering of benthic organisms and reduced visibility for fish. ▪ Indirect impacts of sedimentation occur over the longer term and include accumulation of sediments instream, altering stream geomorphology and release of pollutants such as heavy metals and nutrients which may contribute to algal blooms. There is potential for contamination of downstream waterways from accidental spill of vehicle oils, lubricants and hydraulic fluids and other accidental spill from maintenance vehicles. Spills and leakages can impact water quality by: ▪ Increasing toxicant concentrations into downstream watercourses which may be toxic to aquatic biota and fish ▪ Creating oily surface films which can reduce the visual amenity of the watercourse.
Discharge of tunnel seepage from drained main access tunnels and caverns.	Water would be collected via a drainage and sump system at the lowest level in the underground power station. While the quality of groundwater of the area is generally unknown, captured groundwater may have elevated conductivity and may contain traces or small concentrations of hydrocarbons. During operation, natural groundwater that is collected will be mixed with water collected from the operation of the underground power station. This groundwater and runoff from operation is likely to be of poorer quality than the water quality of the receiving environment which is proposed to be Lake Yarrunga. Following treatment and dilution via the tailrace tunnel, water quality of the groundwater seepage that reaches Lake Yarrunga or Fitzroy Canal is expected to be indistinguishable from the water quality of the intake water and as the Project would operate in accordance with the WAL that authorises water transfers between the two reservoirs is considered a neutral water quality outcome.
System maintenance requiring drainage of the pipeline between the Canal and the surge tanks, necessitating	When required, drainage would occur via the discharge control structure at the Penstock low point to Trimbles Creek. The risk to water quality of the downstream environment is dependent on the quality within the pipeline at the time of discharge. As water in the pipe will frequently move between the two reservoirs, it is expected that the water quality within the system would be reflective of Lake Yarrunga SSTVs and in accordance with scheme operating rules and as such acceptable for release downstream. Scour of the channel would be all but prevented by the design of the outlet and by limiting the discharge rate.
Transfer of water between reservoirs	There is a risk of transfer of algae between reservoirs, and subsequently on the effectiveness of the Kangaroo Valley WTP to adequately treat water. Measured algal biovolume and counts show that: ▪ Algal counts in Fitzroy Falls Reservoir are eight times higher and almost three times higher than counts in Lake Yarrunga and Bendeela Pondage respectively. ▪ Toxic cyanobacteria counts in Fitzroy Falls are 13 times higher than counts in Lake Yarrunga and eight times higher than counts in Bendeela Pondage. ▪ Fitzroy Falls Reservoir had higher cyanobacteria and toxic algal biovolume compared with the other reservoirs most notable was median toxic algal cyanobacteria which was 20 to 25 times higher than Lake Yarrunga and Bendeela Pondage respectively. Existing algal transfers occur under the Existing Scheme and the increased rate of transfer within the new scheme under operation is not expected to increase the risk of this occurring as the volume transferred would not change. Further, the Project does not involve additional transfers of water to Bendeela Pondage from which the Kangaroo Valley WTP draws water.

6.5.5.2 Hydrology

Extraction from catchment streams is not proposed for the operational stage of the Project, however, water transfers between Fitzroy Falls Reservoir and Lake Yarrunga will continue to be undertaken under the water allocation for the existing pumped hydro scheme and in accordance with the WAL. Where the Project is operated at the same time as the Existing Scheme, the rate at which water will be exchanged between the reservoirs will approximately double. While this is not expected to result in any significant hydrological

changes within the catchment, water level in the reservoirs will fluctuate more rapidly, potentially resulting in changes to channel bank geomorphology (see **Section 6.5.5.3**) and increased turbidity.

The increase in flow rate will result in an increase in water velocities in the Fitzroy Canal both during pumping and generation. This change is not expected to have any effect on sediment movement or other water quality parameters.

The Project would not alter the minimum or maximum water levels in either the Fitzroy Falls Reservoir or Lake Yarrunga. With appropriate design, discharge velocities at Lake Yarrunga would be managed such that scour at the discharge point is avoided.

While there is possibility of groundwater drawdown from seepage in the access tunnels and caverns, based on groundwater hydrological modelling, significant changes to baseflows in creeks within the catchment are not expected from groundwater seepage during operation. As such, impacts to surface environmental water availability and flows are not expected.

6.5.5.3 Geomorphology

The Project would increase the rate of rise and fall of water levels when the Project is operated concurrently with the Existing Scheme, increasing the variability in water levels at Fitzroy Falls and Lake Yarrunga. This could result in bank erosion at Lake Yarrunga from repeated wetting and drying of the same section of the riverbank from the increased rate of water fluctuation in the reservoirs.

The transfers of water between the reservoirs would not impact on sedimentation and bar development in Lake Yarrunga. However, the transfer of water between the reservoirs would increase fluxes of water through Fitzroy Canal and connecting inlet/outlet to Fitzroy Falls Reservoir. This has the potential to cause increased scour along the canal and also localised scour in the area where water flows into and out of the reservoir. With the Fitzroy Canal design flow limits not being exceeded by the Project in combined operation with the Existing Scheme, the risk is considered limited.

At any such time that the system requires maintenance during operation, drainage of the pipeline via the outlet at the Penstock Anchor Block discharge point to Trimbles Creek would occur. Discharge rates would be adopted to reduce geomorphological impacts of this discharge.

6.5.5.4 Operational water balance

During operation, water transfers would be undertaken within the Existing Scheme WAL allowance. As a result, a detailed water balance is not necessary for operation. Ongoing seepage of groundwater to permanently drained structures is estimated to be approximately 2.78 ML/month (91.26 kL/day or 1.06 L/s). This water will be treated to suitable quality and discharged to the Tailrace.

Water required from ongoing operation of site amenities will be sourced from Project scheme water at the Lower Schemes as required consistent with Existing Scheme arrangements.

6.5.5.5 Operational spoil management

A spoil management strategy is presented as **Appendix K**. In summary, spoil would be treated and disposed of on-site, with PAF spoil being identified and managed to neutralise the risk of acidic water from the stockpile area to the surrounding surface water.

Given the implementation of the spoil management strategy, the risk of impacts to surface water from spoil are not considered to be significant.

6.5.6 Neutral or beneficial effect assessment

A neutral or beneficial affect assessment has been carried out to determine whether the Project would have a neutral or beneficial effect on water quality. That assessment is presented in full as Chapter 9 of **Appendix I**.

In summary, both the construction and operation of the Project have the potential to impact on surface water quality. With the implementation of the mitigation measures described in **Section 6.5.7** and the erosion and

sediment controls developed for the Project as described in Chapter 5 of **Appendix I**, it is considered that the Project is likely to have a neutral effect on water quality as the risks have been adequately mitigated.

6.5.7 Mitigation measures

Mitigation measures to address the potential surface water impacts of the Project are listed in **Table 6-18.**

Table 6-18. Surface water mitigation measures

Ref	Impact	Mitigation measure	Timing
SW01	General	A Construction Soil and Water Management Plan (CSWMP) will be prepared and implemented for the project. The plan will outline measures to manage soil and water impacts associated with the construction works. The CSWMP will include but not be limited to: ▪ Measures to minimise/manage erosion and sediment transport within the construction footprint and offsite including requirements for the preparation of ESCPs for all stages of construction ▪ Measures to manage stockpiles, sediment controls and stabilisation ▪ Measures to manage accidental spills in accordance with WaterNSW incident management protocols, including the requirement to maintain materials such as spill kits ▪ Measures to manage potential tannin leachate where stockpiling of mulch is undertaken ▪ Details of surface water quality monitoring to be undertaken ▪ Measures to treat water collected in sediment basins for reuse on-site or discharge to downstream waterways ▪ Measures to manage tunnel process water (including dewatering), groundwater ingress into vertical shafts and tunnels, drilling fluids, grout and cement contaminated water from construction, including water collection protocols, water quality standards to be achieved for-release to downstream receiving environment. The Construction Contractor will be required to obtain and comply with an EPL and any other approvals to discharge treated water off site. The EPL will specify: ▪ Discharge locations to be identified in detailed design, ▪ Water quality concentration limits to be met prior to discharge.	Construction

Ref	Impact	Mitigation measure	Timing
SW02	Erosion and sedimentation	ESCPs will be developed progressively as set out in the CSWMP and will detail the erosion and sediment control measures to be implemented at all work sites in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2D* (NSW department of Environment, Climate Change and Water, 2008), commonly referred to as the "Blue Book". The Construction ESCP will include but not be limited to: ▪ Plans for temporary drainage, scour protection and control measures to reduce erosion and water quality impacts from increased sediment loads from construction sites, ancillary sites and access tracks. These water quality controls will likely consist of sediment fencing, sediment sumps and sediment basins. ▪ The locations of construction sediment basins, sediment sumps, sediment fences, diversion drains etc considering detailed design and selected construction methods.	Pre-construction/ Construction
SW03	Spills and leakages	Site specific controls and procedures will be developed and implemented to reduce the risk of the release of potentially harmful chemicals from spills entering downstream watercourses and include the following measures: ▪ All fuels, chemicals and liquids will be stored on level ground at least 20 m away from waterways and will be stored in a sealed bunded areas within works areas ▪ Spill response kits will be kept at all sites in the event of a spill, and site personnel will be appropriately trained in the use of spill response equipment ▪ An emergency spill response procedure will be prepared to minimise the impact of accidental spillages of fuels, chemicals and fluids during construction. The procedure will have regard to notification and reporting of incident to relevant authorities, e.g. WaterNSW and EPA ▪ Regular visual water quality checks (for hydrocarbon spills/slicks, turbid plumes and other water quality issues) will be carried out when working near waterways.	Pre-construction/ Construction
SW04	Impacts of Stockpiles	Stockpiles, spoil loading, processing, transport and emplacement activities will be managed to minimise the potential for mobilisation and transport of dust, sediment, contamination and leachate in runoff. This will include: ▪ Minimising the number of stockpiles, the area used for stockpiles and time that they are left exposed ▪ Locating temporary stockpiles away from drainage lines and waterways and managing stockpile areas (including during inclement weather events) ▪ Establishing appropriate sediment controls and suppressing dust as required.	Pre-construction/ Construction
SW05	Concrete works	To avoid ingress of concrete waste material into downstream waterways, the CSWMP will outline procedures to capture, contain and appropriately dispose of any concrete wastes from concrete works associated with foundations, lining of vertical shaft and tunnels and for installation of the anchor block at the Penstock. Concrete structures will be pre-fabricated prior to installation instream, where practicable.	Pre-construction/ Construction

Ref	Impact	Mitigation measure	Timing
SW06	Construction discharge	▪ Prior to disposal of construction water collected in sediment basins, water will be treated to the appropriate standard specified in the CSWMP and reused on site wherever possible. For instance, for dust suppression activities ▪ A construction discharge water treatment plant will be designed to treat tunnel process water including groundwater seepage ▪ Site specific trigger values will be developed during construction planning to set the discharge water treatment plant and sediment basin discharge criteria to minimise pollution of water.	Pre-construction/ Construction
SW07	Water quality monitoring - construction	A construction surface water monitoring Program will be developed and included in the CSWMP to establish baseline conditions, to observe any changes in surface water quality and condition in watercourses withing 500 m of the Project footprint that maybe be attributable to construction of the Project and inform management responses. Monitoring during pre-construction and construction will occur at representative locations. Monitoring sites will be located upstream and downstream of the construction footprint areas and will include sampling for key indicators of concern. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts adaptive, corrective management would be undertaken to resolve the exceedances.	Pre-construction/ Construction
SW08	Instream works	All works in the bed of bank of Lake Yarrunga would occur within a sediment curtain, coffer dam or alternate measure to manage water quality.	Construction
SW09	Water quality monitoring - operation	The operational surface water quality monitoring program will be based on the construction monitoring program but refined to target issues relating to the operation of the Project Erosion and sediment controls during operation will be outlined in the Operational Management Plan and will detail procedures and protocols for maintaining scour protection measures at the outlets, groundwater seepage, and ongoing rehabilitation of disturbed areas and spoil emplacement facility.	Operation
SW10	Water discharges	A permanent water treatment facility will be designed to treat ground water seepage generated from groundwater ingress in the main access tunnel and caverns and runoff from operation in the caverns. The collected water will be separated via an oily water separator and treated to an acceptable standard (where required) prior to being injected into the tailrace tunnel where it will further dilute to the water quality of inside the tailrace tunnel, which will flow out to Lake Yarrunga during generation. The level of treatment provided will consider the characteristics of the receiving environment. Following treatment and dilution via the tailrace tunnel, water quality of the groundwater seepage that reaches Lake Yarrunga or Fitzroy Canal is expected to be indistinguishable from the water quality of the intake water and as the project will operate in accordance with the WAL that authorises water transfers between the two reservoirs.	Operation

6.6 Groundwater

This section provides an assessment of the potential groundwater impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix J** (Groundwater impact assessment).

The assessment addresses the following SEARs:

Water – including:

- An assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the NSW Aquifer Interference Policy and relevant Water Sharing Plans
- An assessment of whether the Project would have a neutral or beneficial effect on water quality.

6.6.1 Legislative and policy context

The groundwater assessment has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Water Management Act 2000*
- *Sydney Basin South Groundwater Source of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (Department of Industry, 2019) (the Water Sharing Plan)*
- *NSW Aquifer Interference Policy*
- *NSW Groundwater Quality Protection Policy (Department of Land and Water Conservation, 1998)*
- *NSW State Groundwater Dependent Ecosystems (GDE) Policy (Department of Land and Water Conservation, 2002)*
- *Guidelines for the Assessment and Management of Groundwater Contamination (DEC, 2007).*

6.6.2 Methodology

The groundwater assessment included:

- Desktop review and analysis of prior investigations undertaken for the Existing Scheme and the Kangaroo Valley Power Station, as well as the result of preliminary Project geotechnical investigations
- A search of the WaterNSW-registered groundwater bores, with additional bore data sourced from the Australian Groundwater Explorer, to identify groundwater works within five km of the Project
- A search of the Groundwater Dependent Ecosystems Atlas (GDE Atlas) to identify groundwater dependent ecosystems located within five km of the Project.
- Characterisation of the existing hydrogeological environment to facilitate the assessment of potential groundwater seepage to excavations during Project construction, and the long-term response of groundwater to drained underground structures
- Calculation of groundwater inflow rates and seepage to excavations and tunnels, and associated groundwater depressurisation and drawdown via a number of methodologies including:
    - Goodman et al. (1965) equation for inflows into tunnels
    - Theim and Dupuit-Theim equations for radial flow to a large diameter well (shaft) under confined and unconfined conditions
    - Analytic Element Modelling – AnAqSim (Fitts Geosolutions, 2022) for assessment of potential inflows to the inlet / outlet structure excavation, associated groundwater drawdown and potential baseflow reduction to Kings Creek, and for the assessment of groundwater seepage to power station cavern excavations and associated drawdown propagation
    - Two-dimensional finite element modelling – Seep/W (Geoslope, 2012) for assessment of potential depressurisation surrounding tunnels and caverns
- A comparison of the potential groundwater level and quality impacts of the Project against the NSW Aquifer Interference Policy and with regard to Neutral or Beneficial Effects of water quality
- Identification of mitigation measures required to minimise the risks to groundwater.

Additional details of the groundwater assessment methodology are provided in Chapter 3 of **Appendix J**.

The groundwater study area comprises a five km radius surround the key Project components relative to groundwater, including all underground works, the tailrace inlet/outlet structure and the waste rock emplacement area.

6.6.3 Existing environment

Details of existing climate and topography and drainage described in **Section 6.5.3**, and details of the surrounding geological environment are described in **Section 6.4.3**.

Two main groundwater systems have been identified associated with the Project, these being an upper stratified groundwater system with limited vertical connectivity, and a deeper regional groundwater system. The upper stratified groundwater system is present beneath the elevated plateaus and generally discharges to the escarpments. The regional groundwater system is present beneath the lower study area and is also inferred to extend, at depth, beneath the upper stratified groundwater system.

Groundwater quality is expected to range from relatively fresh at shallow depth and in the vicinity of Lake Yarrunga, to more brackish at depth in the vicinity of the main power station cavern.

Groundwater elevations are anticipated to be between approximately 530 m AHD and 630 m AHD beneath the plateau, around approximately 175 m AHD in the vicinity of the Bendeela Pondage, reducing to 75 m AHD in areas adjacent to Lake Yarrunga.

6.6.3.1 Registered groundwater works

A search of the WaterNSW-registered groundwater bored identified that there are approximately 53 groundwater works within five km of the Project (works classified as abandoned or non-functional are excluded). Of these works:

- 26 bores are recorded as being for water supply
- Four bores are recorded as being for irrigation
- One bore is recorded as "other"
- 22 bores are recorded as being for monitoring, and are associated with the Kangaroo Valley power station.

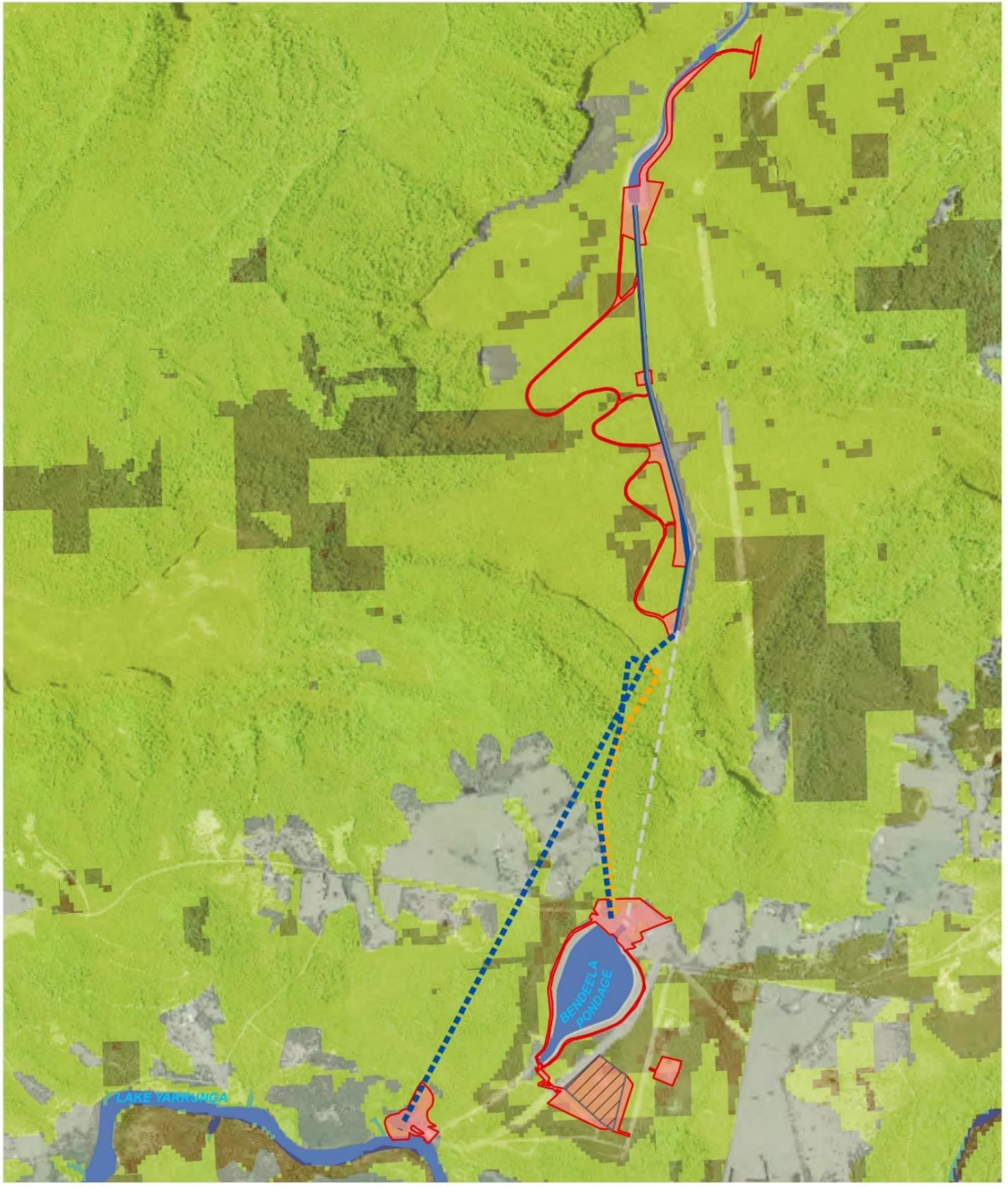
One bore, located to the south of Lake Yarrunga, would be located within 2 km of the proposed excavations and tunnelling.

6.6.3.2 Groundwater dependent ecosystems

Groundwater Dependent Ecosystems (GDEs) are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater. While the Water Sharing Plan does not identify any high priority GDE in the vicinity of the Project, the following terrestrial (vegetation) ecosystems that potentially rely on groundwater in the vicinity of the Project area:

- Shoalhaven Hanging Swamps of high potential reliance and Shoalhaven Sandstone Forest of low and moderate potential on the upper slopes and plateau
- Escarpment Foothills Wet Forest low potential reliance on the mid-slopes and escarpment
- Coastal Warm Temperate Rainforest of low to moderate potential reliance on the mid-slopes and escarpment
- Warm Temperate Layered Forest of low to high potential reliance, and Southern and Turpentine Forest of moderate potential on the lower slopes, in the vicinity of Bendeela Pondage and the lower reaches of Kings Creek
- Southern Turpentine Forest of moderate potential reliance in the vicinity of Lake Yarrunga and Bendeela Pondage
- Riverbank Forest of moderate potential reliance in the vicinity of Kangaroo River and the lower reaches of Kings Creek.

The GDE Atlas also identifies Lake Yarrunga, located immediately downstream of the Project area, as an aquatic GDE with moderate potential reliance on groundwater. These GDE are shown in **Figure 6-9**.



Legend

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterbody

0 1 2 km

1:30,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
BOM 2022
© Department of Customer Service 2020

Figure 6-9 GDEs in the vicinity of the Project area

Date: 12/06/2022 Path: \\aurvydlvs01\gisproj\NSW_BS\87600_ShoalhavenEIS\Apps\ts\387600_GroundWater.aprx
Created by: JB | QA by: HK

6.6.3.3 Groundwater inflows and dewatering

The total estimated groundwater take during construction from the individual Project components is described in Chapter 8 of **Appendix J**. In summary, groundwater inflows are predicted to increase steadily, peaking at 15,131 m^3/month (15.13 ML/month) after two years of construction. The total predicted groundwater take is estimated at 426.7 ML, averaging approximately 106.7 ML per annum or 3.6 L/s.

Overall, the predicted groundwater inflows are considered to be conservative with consideration for the larger scale of the Project. It is possible that short term inflows may exceed predictions where fractured ground or more permeable formations are encountered. Where inflow volumes are problematic remedial measures such as grouting would be employed.

Inflows to underground tunnels and excavations during construction will be collected in dewatering sumps and pumped to construction drainage water holding ponds located near the access and tailrace drive portals, where collected groundwater would be treated and prioritised for re-use in either dust suppression, underground tunnelling and excavations, or concrete batching as required. Where discharge of groundwater to the surrounding environment is required, water will be treated to the appropriate discharge criteria.

Management and monitoring of dewatering and associated potential impacts will be managed via the implementation of a dewatering management plan which would be developed as part of detailed design and construction planning.

6.6.3.4 Groundwater drawdown

Figure 6-10 shows the predicted groundwater drawdown during construction. There are no known groundwater users within the predicted areas of groundwater drawdown and depressurisation during construction. As such, the Project construction will not result in impacts to other groundwater users.

While there are no high priority GDEs in the vicinity of the Project and no high potential GDEs mapped within the predicted areas of groundwater drawdown, groundwater drawdown at the water table is predicted beneath areas mapped as low potential GDE, as shown in

Figure 6-10.

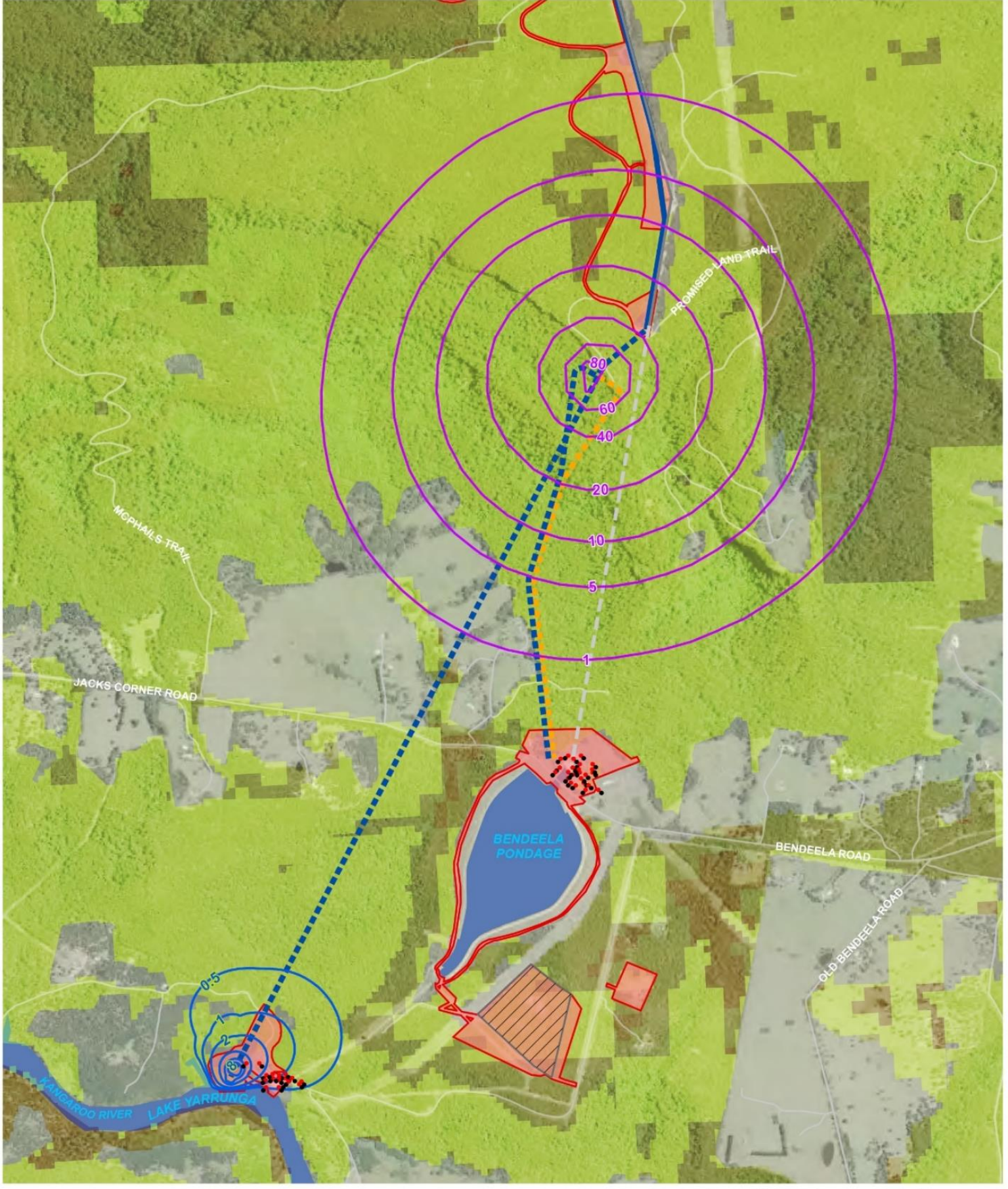
Drawdown is also anticipated beneath an area mapped as medium potential GDE, however this drawdown would be located sufficiently below the potential GDE. As a result, construction of the Project is not anticipated to result in any significant impacts to GDEs.

6.6.3.5 Water quality

The Project is not expected to result in any detrimental change to groundwater quality.

Potential acid drainage in vicinity of spoil emplacement and outlet structure excavation will be monitored and managed in accordance with the CEMP and spoil management plan that would be prepared for the Project. Potential impacts associated with PAF spoil, and how they would be managed, are further described in **Chapter 6.4**.

With respect to potential groundwater discharges, the Project is not anticipated to result in any detrimental changes to catchment water quality. All controlled groundwater discharges will be treated to suitable quality prior to being discharged. As such, Project construction is considered to meet with the requirement for Neutral or Beneficial Effect on catchment water quality with regards to groundwater.



Legend

Bore

- Monitoring
- Water table drawdown contours (m)
- Confined drawdown contours (m)
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterbody

0 0.4 0.8 km

1:20,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
BOM 2022
© Department of Customer Service 2020

Figure 6-10 Predicted groundwater drawdown during construction

Date: 14/07/2022 Path: \\ausyd0vs01\gisproj\NSW_IS\302600_ShoalhavenLTS\Apps\IS302600_GroundWater.aprx
Created by : JD | QA by : HK

6.6.4 Operational impacts

6.6.4.1 Groundwater inflows and dewatering

During operation, ongoing groundwater take would be limited to seepage through drained operational structures, including the access tunnel and ventilation, the egress tunnel and the power station cavern

The total estimated groundwater take during operation from these elements is described in Chapter 8 of **Appendix J**. The total operational groundwater seepage is predicted to be about 91.5 m^3/day (1.06 L/s), equivalent to about 33.4 ML per annum.

Ongoing seepage to drained structures during operation will be collected in a dewatering sump located at the lowest level in the underground power station. Seepage water will be treated before being discharged to the tailrace.

6.6.4.2 Groundwater drawdown

Figure 6-11 shows the predicted groundwater drawdown during operation, 100 years following construction.

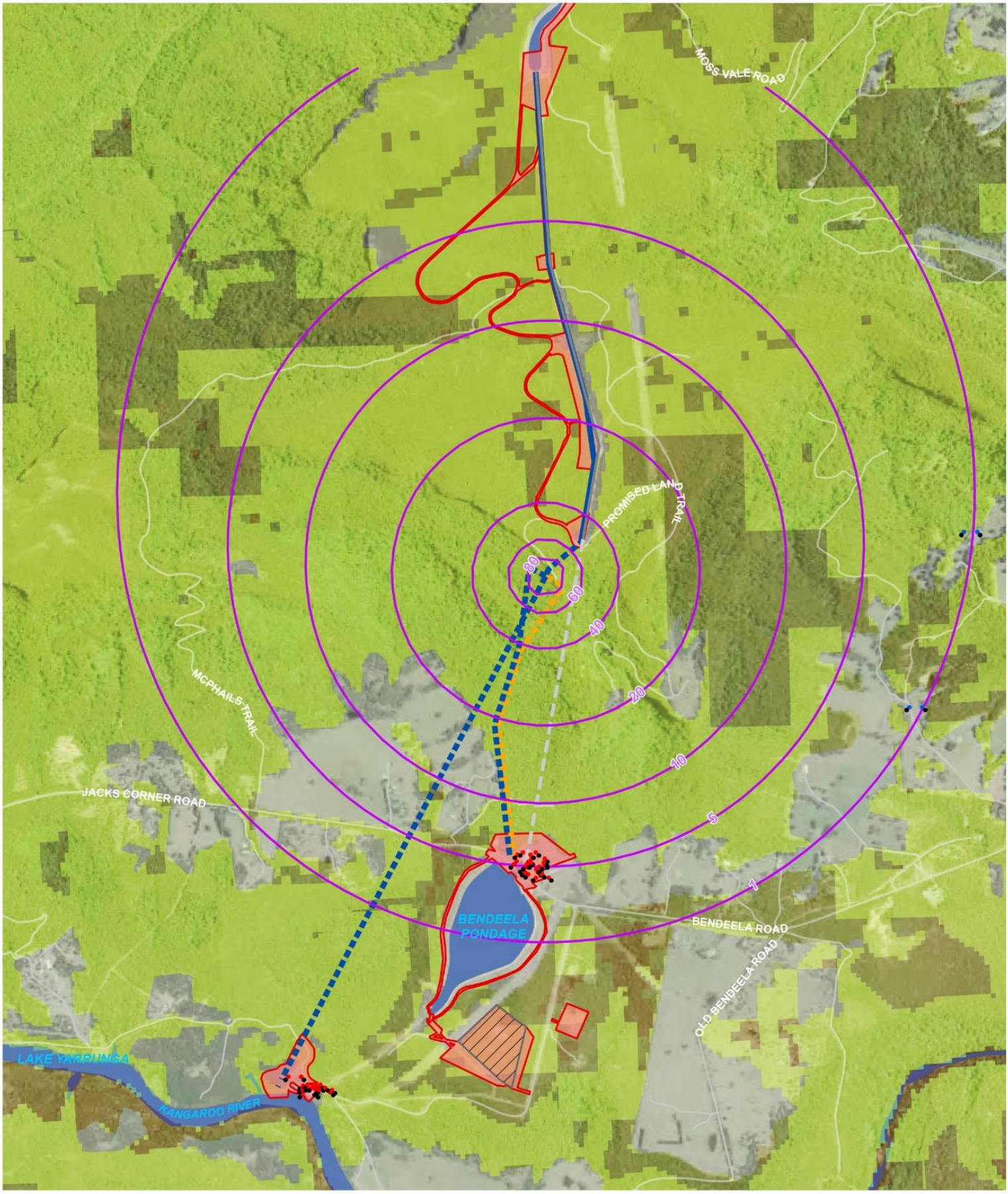
Drawdown propagation from the drained caverns is predicted to encroach beneath two registered groundwater bores as shown in **Table 6-19.**

Table 6-19. Drawdown beneath registered bores

Bore name	Recorded purpose	Recorded bore depth	Predicted drawdown beneath bore	Assessment of impacts
GW101249	Water supply	1 m	1.12 m	The bore is inferred to be installed at the location of a natural seepage resulting from the stratified groundwater system or in an alluvial channel and is unlikely to be detrimentally affected by the predicted drawdown.
GW101591	Water supply	60 m	1.3 m	Some drawdown may be experienced at the bore. However, the magnitude of the predicted drawdown is unlikely to detrimentally impact on the supply capacity of the bore.

There are no high priority GDEs in the vicinity of the Project and no high potential GDEs mapped within the predicted areas of groundwater drawdown.

Drawdown is also anticipated beneath an area mapped as medium potential GDE, however this drawdown would be located sufficiently below the potential GDE. As a result, operation of the Project is not anticipated to result in any significant impacts to GDEs.



Legend

Bore

- Monitoring
- Water Supply
- Confined drawdown contours (m)
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterbody

0 0.6 1.1 km

1:27,500 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
BOM 2022
© Department of Customer Service 2020

Figure 6-11 Predicted groundwater drawdown after 100 years

Date: 14/07/2022 Path: \\ausyd0vs01\gispro\NSW_IS392600_Shoalhaven\EIS\Apps\IS392600_GroundWater.aprx
Created by: JB | QA by: HK

6.6.4.3 Water quality

Operation of the Project is not expected to result in any significant change to groundwater quality.

Potential acid drainage in the vicinity of spoil emplacement and outlet structure excavation during operation will be monitored and managed in accordance with the Operational Environmental Management Plan and spoil management plan that would be prepared for the Project. Potential impacts associated with PAF spoil, and how they would be managed, are further described in **Section 6.4**.

With respect to potential groundwater discharges, the Project is not anticipated to result in any detrimental changes to catchment water quality. All controlled groundwater discharges will be treated to suitable quality prior to discharge. As such, Project construction is considered to meet with the requirement for Neutral or Beneficial Effect on catchment water quality with respect to groundwater.

6.6.4.4 NSW Aquifer Interference Policy

Assessment of the Project against the NSW Aquifer Interference Policy – Minimal Impact Considerations indicates that the Project meets with the Level 1 - Minimal Impact Considerations and, as such, has an acceptable (negligible) level of impact.

6.6.5 Mitigation measures

Mitigation measures to address the potential groundwater water impacts of the Project are listed in **Table 6-20**.

Table 6-20. Groundwater water mitigation measures

Ref	Impact	Mitigation measure	Timing
GW01	Groundwater monitoring	Groundwater monitoring, including the installation of additional monitoring locations, will be undertaken to collect additional baseline information and to assess and monitor for potential impacts during construction.	Pre-construction/ Construction/
GW02	PAF forming materials	The spoil management strategy will be developed to a spoil management plan as part of detailed design and construction planning and identify mitigating and remedial measures in the event that actual acid rock drainage is identified.	Pre-construction/ Construction
GW03	Dewatering	A dewatering management plan will be prepared and implemented. The dewatering management plan will outline responsibilities, controls and procedures to mitigate potential environmental impacts associated with temporary construction dewatering and ongoing operational dewatering.	Construction/ Operation
GW04	Groundwater discharge	In conjunction with the DWMP, discharge of groundwater will be managed in accordance with CSWMP.	Pre-construction/ Construction/ Operation

6.7 Traffic and transport

This section provides an assessment of the potential traffic and transport impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix L** (Traffic and Transport impact assessment).

The assessment addresses the following SEARs:

Transport – including:

- an assessment of the transport impacts of the project on the capacity, condition, safety and efficiency of the local road network (including Moss Vale Road, Jacks Corner Road, Lower Bendeela Road and Promised Lands Trail);

6.7.1 Legislative and policy context

The traffic and transport assessment has been prepared in accordance with the following relevant legislation, policy and guidelines:

- *Roads Act 1993*
- *Future Transport Strategy 2056 (TfNSW, 2020)*
- *Guide to Traffic Generating Developments (Version 2.2) (Roads and Traffic Authority, 2002)*
- *EIS Guidelines – Roads and Related Facilities (Department of Urban Affairs and Planning, 1996)*
- *Guide to Traffic Management Part 3: Traffic Studies and Analysis (Austroads, 2017)*
- *Guide to Traffic Management Part 12: Integrated Transport Assessments for Developments (Austroads, 2020)*
- *Supplements to Austroads Guides (Roads and Maritime Services, 2013)*
- *2026 Road Safety Action Plan (TfNSW, 2021).*

6.7.2 Methodology

6.7.2.1 Study area

The traffic and transport study area is shown in **Figure 6-12** and comprises the transport network servicing the Project. It includes the roads which form part of the proposed access routes for construction and operational vehicles. These roads include Moss Vale Road (B73), Nowra Road (B73), Promised Land Trail, Bendeela Road, Jacks Corner Road and Lower Bendeela Road.

Additionally, the OSOM route study considers impacts to roads located outside of the study area that form part of the proposed OSOM haulage route between the Port Kembla and the Project. These roads are shown in **Figure 6-13**.

Traffic scenarios modelled in the traffic and transport assessment includes a baseline existing traffic scenario, 2027 with and without Project, 2028 with and without Project and 2038 with and without Project, as shown in **Table 6-22.**

Table 6-21. Modelled traffic scenarios for the Project

Scenario name	Year	With or without the Project	Description
Existing traffic	2022	Without	The traffic conditions as it was in 2019, scaled to 2022 traffic volumes
2027 without Project	2027	Without	The traffic conditions in 2027 without the construction of the Project
2028 without Project	2028	Without	The traffic conditions in 2028 without the construction of the Project
2038 without Project	2038	Without	The traffic conditions in 2038 without the construction of the Project
2027 with Project	2027	With	The traffic conditions in 2027 during the anticipated peak construction year of the Project

Scenario name	Year	With or without the Project	Description
2028 with Project	2028	With	The traffic conditions in 2028 during the anticipated first year of operation of the Project
2038 with Project	2038	With	The traffic conditions in 2038, after the anticipated first ten years of operation of the Project

Traffic scenarios modelled in the traffic and transport assessment includes a baseline existing traffic scenario, 2027 with and without Project, 2028 with and without Project and 2038 with and without Project, as shown in **Table 6-22.**

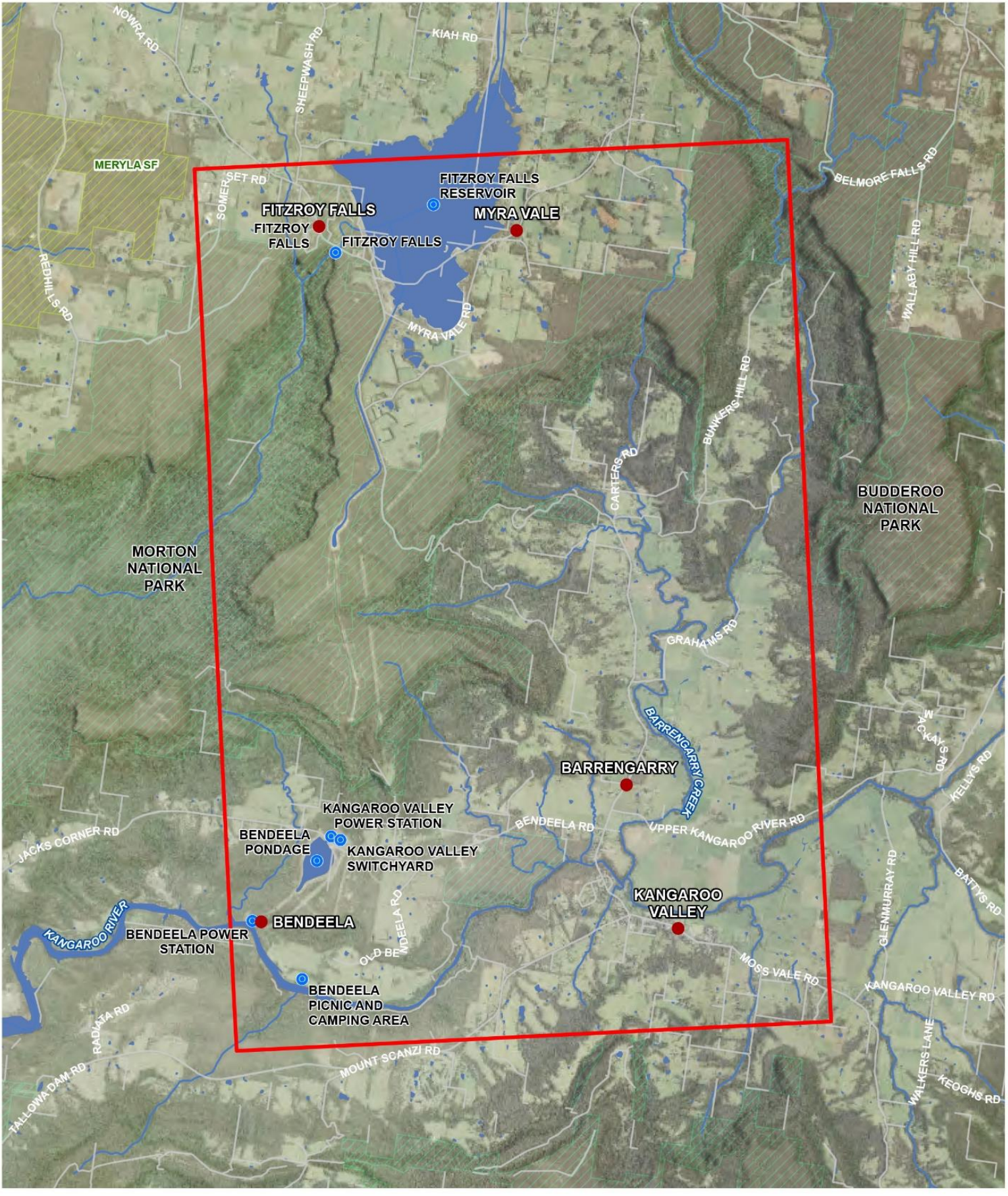
Table 6-22. Modelled traffic scenarios for the Project

Scenario name	Year	With or without the Project	Description
Existing traffic	2022	Without	The traffic conditions as it was in 2019, scaled to 2022 traffic volumes
2027 without Project	2027	Without	The traffic conditions in 2027 without the construction of the Project
2028 without Project	2028	Without	The traffic conditions in 2028 without the construction of the Project
2038 without Project	2038	Without	The traffic conditions in 2038 without the construction of the Project
2027 with Project	2027	With	The traffic conditions in 2027 during the anticipated peak construction year of the Project
2028 with Project	2028	With	The traffic conditions in 2028 during the anticipated first year of operation of the Project
2038 with Project	2038	With	The traffic conditions in 2038, after the anticipated first ten years of operation of the Project

The criteria for evaluating the operational performance of intersections using LoS ratings is shown in **Table 6-23.** The LoS assessment modelled for different year periods are summarised in **Section 6.7.4.5** and **Section 6.7.5.2**.

Table 6-23. LoS definitions

LoS	Average delay (seconds/vehicle)	Give way and stop signs
A	Less than 15	Good operation
B	15 to 28	Acceptable delays and spare capacity
C	29 to 42	Satisfactory, but accident study required
D	43 to 56	Near capacity and accident study required
E	57 to 70	At capacity, requires other control mode
F	Over 70	Extreme delay, traffic signal or other major treatment required



Legend

- Points of interest
- Study area
- Road
- Waterways
- Waterbody
- NPWS Reserve
- State Forest

0 1 2 km

1:75,000 at A4

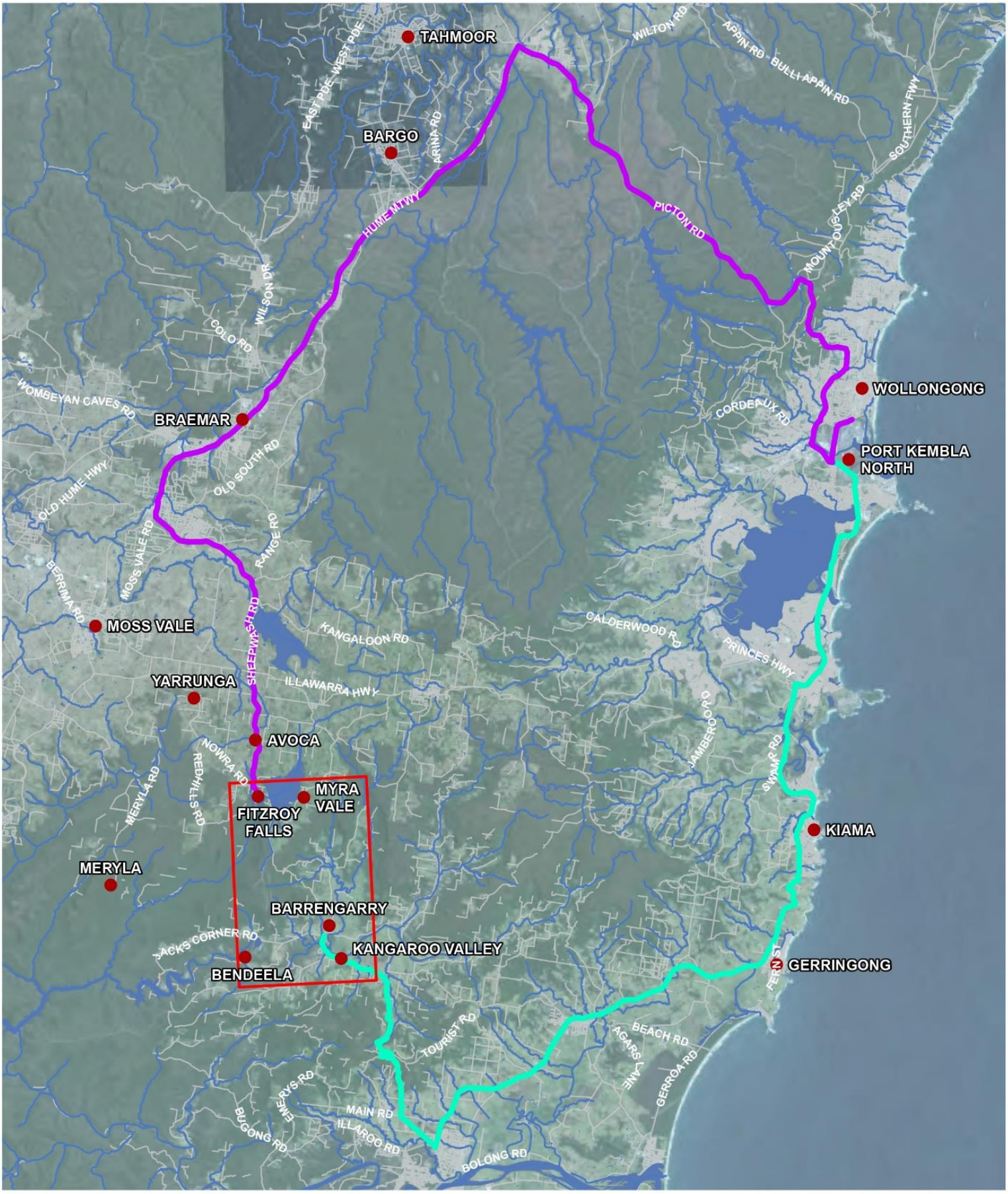
GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022

Figure 6-12 Traffic and transport study area

Date: 4/08/2022 Path: \\ausyd0vs01\gisproj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Transport.aprx
Created by : JB | QA by : HK



Legend

- Proposed southern route
- Proposed northern route
- Study area
- Road
- Waterways
- Waterbody

0 5 10 km

1:325,000 at A4

GDA2020 MGA Zone 56

N

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-13 Proposed OSOM Routes from Port Kembla to the Project

Date: 4/08/2022 Path: \\ausyd0vs01\gsproj\NSW_IS302600_Shoalhaven\E\S\Apps\IS302600_Transport.aprx
Created by : JB | QA by : CC

6.7.2.2 Existing environment methodology

To determine existing traffic volumes and patterns, tube counts were undertaken on Moss Vale Road (B73) and Bendeela Road over a one-week period between Monday 4 February 2019 to Sunday 10 February 2019. In addition, intersection turn movement counts were conducted on Friday 8 February 2019 at the following intersections:

- Nowra Road (B73) / Myra Vale Road
- Moss Vale Road (B73) / Bendeela Road
- Bendeela Road / Jacks Corner Road / Lower Bendeela Road.

To account for traffic growth from 2019 to the current year (2022), the traffic counts were scaled using a 3.0 % annual growth rate factor. This approach is anticipated to provide a conservative traffic volume assessment for the study area given there have been no major developments that have occurred within the vicinity of the Project since 2019, and given that the traffic counts were undertaken prior to the COVID-19 public health orders.

6.7.2.3 Construction impacts on road network methodology

Traffic modelling using SIDRA Intersection 9 was undertaken to assess the construction traffic impacts of the Project on road capacity and performance. The traffic modelling was performed for the following weekday peak periods:

- Weekday AM peak - 6:30am to 7:30am
- Weekday heavy vehicle (HV peak) - 2:00pm to 3:00pm
- Weekday PM peak - 6:00pm to 7:00pm.

Due to the relatively high Saturday traffic volumes experienced by the local road network, traffic modelling was also performed for the following Saturday peak periods:

- Saturday AM peak - 7:30am to 8:30am
- Saturday HV peak - 11:45pm to 12:45pm
- Saturday PM peak - 1:00pm to 2:00pm.

The AM and PM peak periods represent the hours when the traffic generated by the construction of the Project is greatest (due to the transportation of the workforce to and from the Project).

The HV peak period represents the peak hour of heavy vehicle deliveries and has been modelled to occur concurrently to the peak hour of background traffic volumes within the proposed delivery window (10:00am to 3:00pm on weekdays and 10:00am to 1:00pm on Saturdays). As such, this scenario represents a worst-case scenario as the available spare capacity of the road network is at its most limited.

It is noted that construction activity associated with the upper scheme of the Project may occur up until the year 2027, and the Lower Scheme may occur up until 2028. For the traffic and transport assessment, it has been assumed that peak construction would occur in 2027. To account for potential traffic growth in the area, the background traffic volumes have been scaled using a 3.0 % annual growth rate.

Intersection performance results under a 'without Project' (without vehicles associated with construction of the Project) and a 'with Project' (with vehicles associated with construction of the Project) scenarios are used in the traffic modelling, and are detailed in **Appendix L**.

6.7.2.4 Operational impacts on road network methodology

Traffic modelling was undertaken using SIDRA Intersection 9 to assess the operational traffic impacts of the Project on road capacity and performance. The traffic modelling was performed for the following weekday peak periods:

- Weekday AM peak – 6:30 am to 7:30 am
- Weekday PM peak – 4:00 pm to 5:00 pm.

The Project would be operational by 2028 and is expected to have a lifespan of approximately 100 years. The years 2028 and 2038 have therefore been selected as the assessment years in order to assess the impacts of the Project on the performance of the road network over the first 10 years of operation.

6.7.3 Existing environment

6.7.3.1 Road network

Access to the Project would be via a network of local council and state managed roads. These roads are described **Appendix L** and include:

- Moss Vale Road (B73): A sealed State road that extends between Promised Land Trail to the north and the township of Bombaderry to the south
- Nowra Road: A sealed State road that extends between Sheepwash Road to the north and Promised Land Trail to the south
- Promised Land Trail: The road traverses both WaterNSW land and the Morton National Park, and features a secured gated entrance
- Bendeela Road: A 3.8 km sealed local road that extends in the east-west direction between Moss Vale Road (B73) and Jacks Corner Road
- Lower Bendeela Road: A local sealed road that provides access to the Bendeela Hydroelectric Pumping Station and Bendeela Recreation Area
- Jacks Corner Road: A local sealed road that provides access to the Kangaroo Valley Hydro Plant and associated infrastructure.

6.7.3.2 Existing traffic conditions

The existing traffic conditions for the study area are summarised in **Table 6-24**.

Table 6-24. Traffic conditions for roads near the Project

Road	Description
Moss Vale Road (B73)	North of Bendeela Road, Moss Vale Road (B73) experiences a peak of approximately 645 vehicles per hour between 11:45am and 12:45pm on a Sunday. Traffic volumes are also relatively high on Moss Vale Road (B73) during the Friday evening period (440 vehicle per hour) and Saturday midday period (430 vehicles per hour). Heavy vehicles account for approximately 12.6 % of the total traffic travelling on Moss Vale Road (B73).
Nowra Road (B73)	Intersection counts undertaken at the Nowra Road (B73) / Myra Vale Road intersection indicate peak hour volumes on Jacks Corner Road typically range up to 495 vehicles per hour. Heavy vehicles comprise approximately 9.7 % of the total traffic travelling on Nowra Road (B73).
Promised Land Trail	Promised Land Trail provides vehicular access to the Morton National Park and WaterNSW land via a secure gated entrance. As such, traffic volumes on Promised Land Trail are typically negligible on an average weekday or weekend.
Bendeela Road	Bendeela Road experiences a peak of 145 vehicles per hour on Sunday between 12:00 pm and 1:00pm. Similar to Moss Vale Road (B73), Bendeela Road also experiences relatively high traffic volumes during the Saturday midday period (110 vehicles per hour). Heavy vehicles account for approximately 15.3 % of the total traffic travelling on Moss Vale Road (B73).
Lower Bendeela Road	Intersection counts undertaken at the Bendeela Road / Jacks Corner Road / Lower Bendeela Road intersection indicate peak hour volumes on Lower Bendeela Road typically range up to 40 vehicles per hour. Heavy vehicles comprise approximately 4.4 % of the total traffic travelling on Lower Bendeela Road.
Jacks Corner Road	Intersection counts undertaken at the Bendeela Road / Jacks Corner Road / Lower Bendeela Road intersection indicate peak hour volumes on Jacks Corner Road typically range up to 100 vehicles per hour. Heavy vehicles comprise approximately 5.5 % of the total traffic travelling on Jacks Corner Road.

6.7.3.3 Heavy vehicle haulage routes

Moss Vale Road (B73), Nowra Road (B73), Promised Land Trail, Bendeela Road, Jacks Corner Road and Lower Bendeela Road all form part of the NSW approved network for general access vehicles. Roads in the study area that form part of the NSW approved network for 4.6-metre-high vehicles includes Moss Vale Road (B73) and Nowra Road (B73), as shown in **Figure 6-14**.

6.7.3.4 Road safety

A review of crash data was undertaken to provide an assessment of safety issues and trends associated with the proposed access routes to the Project. In the five-year period from 2016 to 2020, a total of 41 crashes were reported on roads in the study area. The distribution of crashes in the study area is shown **in Figure 6-15**. Approximately 87.8 % of crashes (36 crashes) occurred on Moss Vale Road (B73), 9.8 % of crashes (four crashes) occurred on the Nowra Road (B73) and 2.4 % of crashes (one crash) occurred on Jacks Corner Road. No crashes were reported on Bendeela Road or Lower Bendeela Road.

The majority of crashes that occurred in the study area (34.1 %) resulted in a towaway with no casualty. The most common crash type involved vehicles travelling off the road on a curved section (41.3 % of all crashes), followed by vehicles travelling off the road on a straight section (19.5 % of all crashes).

About 27 % of crashes in the area involved speeding and 5 % involved fatigue as a contributing factor. In addition, 29 % of crashes in the area occurred under wet pavement conditions and 46 % occurred on the section of Moss Vale Road (B73) within Barrengarry Mountain (TfNSW Centre for Road Safety, 2022).

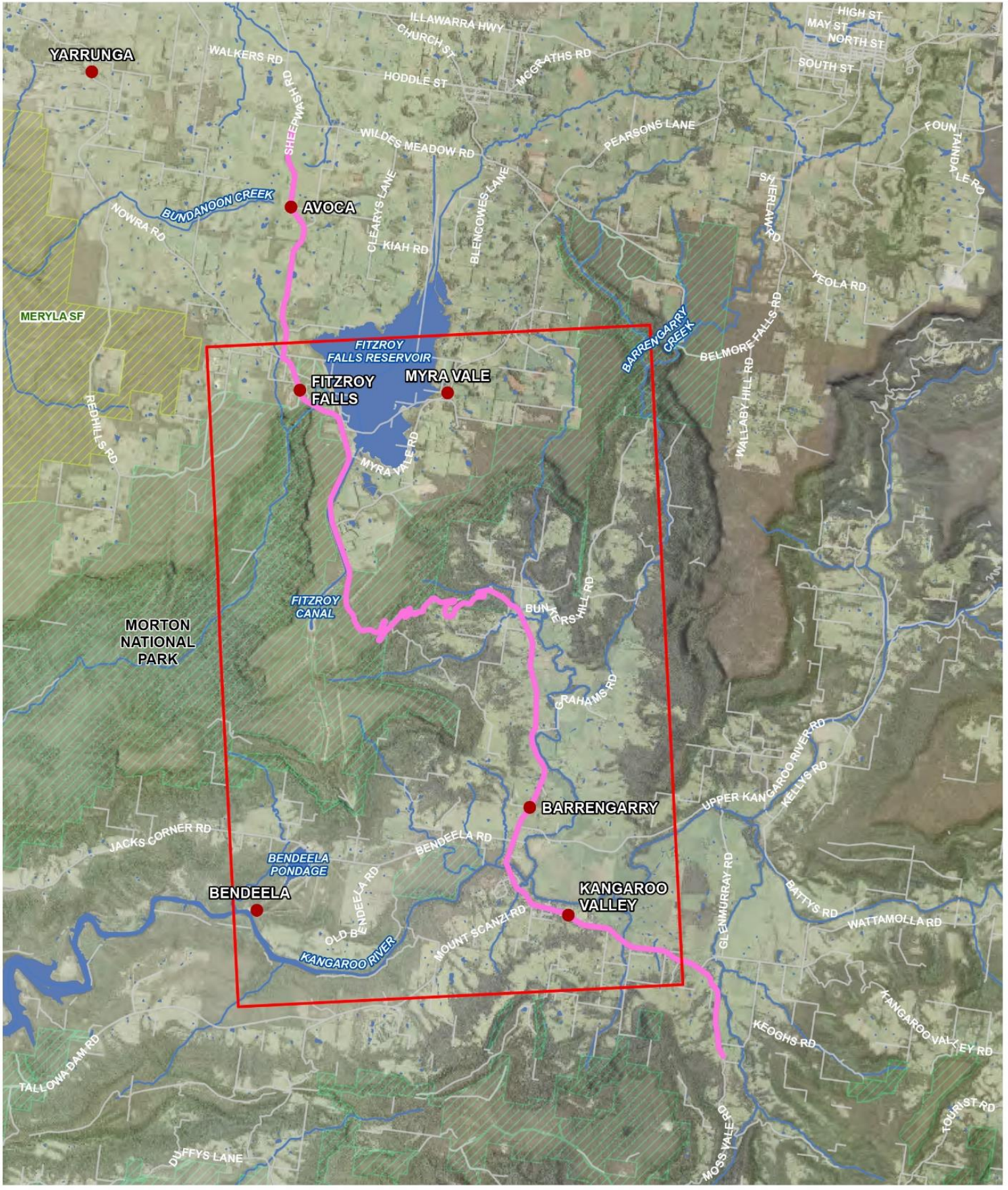
6.7.3.5 Public transport and active transport

There are two public bus routes that operate in the traffic and transport study area. Bus route 810 runs once daily between Moss Vale, Fitzroy Falls, Kangaroo Valley and Nowra on school days only. Bus route 112 runs from Nowra to Kangaroo Valley via Cambewarra and Bomaderry, with up to four buses on weekdays and Saturdays.

Three privately run school bus services also operate for the Kangaroo Valley Public School, which routes in the vicinity of the Project including along Jacks Corner Road and Moss Vale Road. These services are infrequent, and run in the morning and afternoon periods on school days.

Facilities for pedestrians and cyclists are limited in the study area. A concrete footpath 4.2 km in length is provided on the eastern side of Moss Vale Road (B73) between Canvan Road to the north and Nugents Creek Road to the south. A concrete footpath 500 m in length is also provided on the western side of Moss Vale Road (B73) within the township of Kangaroo Valley.

The Hampden Bride is lane-marked to provide two narrow pedestrian walkways on each side of the one-way bridge lane.



Legend

- 4.6m-high vehicle route
- Study area
- Road
- Waterways
- Waterbody
- State Forest
- NPWS Reserve

0 1 2 km

1:100,000 at A4

GDA2020 MGA Zone 56

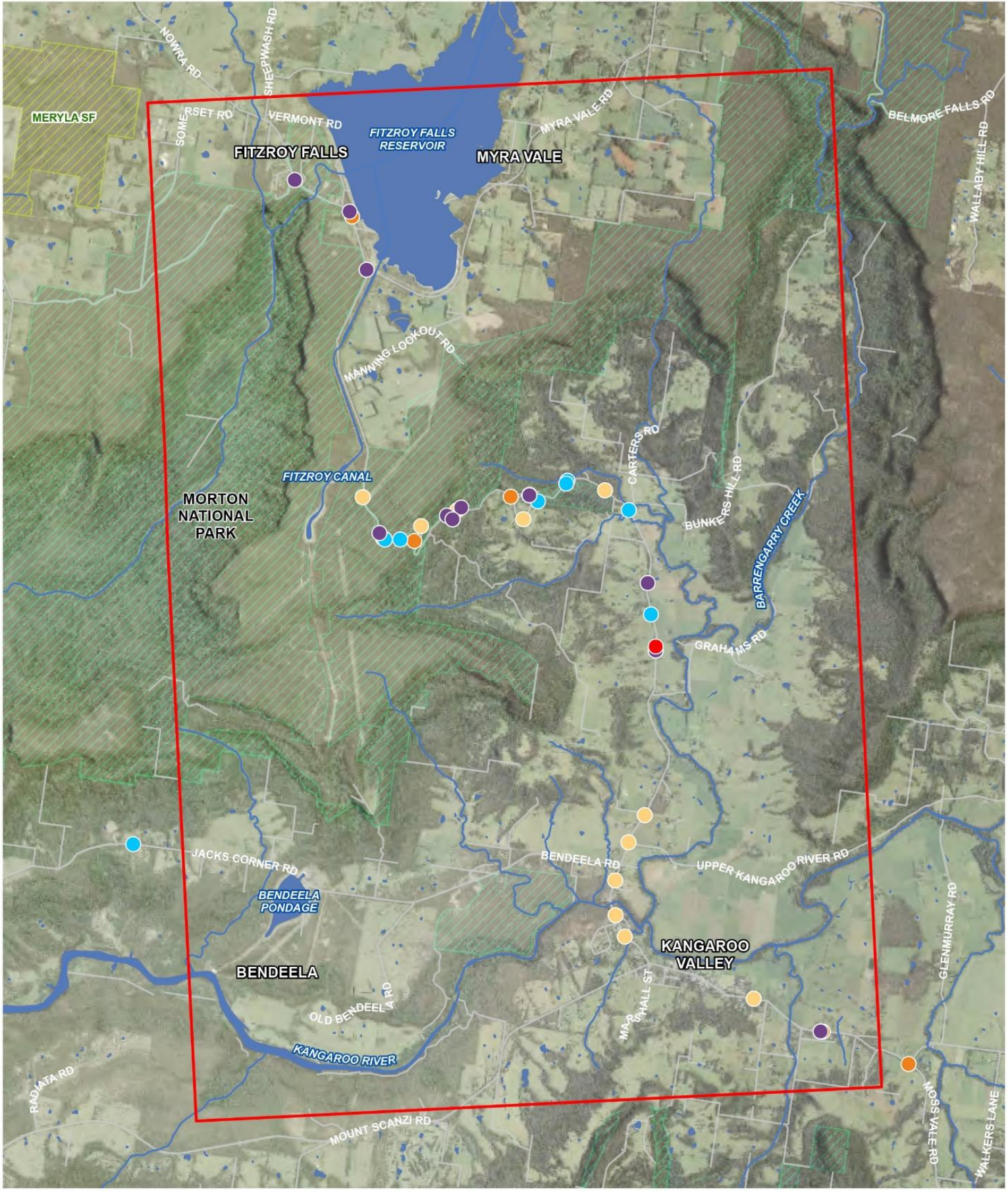
Data sources

Jacobs 2022

Department of Planning and Environment 2022

Figure 6-14 TfNSW approved road network for 4.6-metre-high vehicles

Date: 4/08/2022 Path: \\ausyd0vs01\gsproj\NSW_IS362600_Shoalhaven\4-IS\Apps\IS362600_TransportMap.aprx
Created by : JB | QA by : CC



Legend

Degree of crash reported

- Fatal
- Serious Injury
- Moderate Injury
- Minor/Other Injury
- Non-casualty (towaway)
- Study area

- Road
- Waterways
- Waterbody
- State Forest
- NPWS Reserve

0 1 2 km

1:65,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022

Figure 6-15 Location of crashes reported in the study area

Date: 4/08/2022 Path: \\ausyd0vs01\gisproj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_Transport.aprx
Created by : NT | QA by : CC

6.7.4 Construction impacts

6.7.4.1 Construction workforce

All temporary work facilities associated with the construction of the Project would be limited to areas of previous disturbance to the extent possible. As such, limited parking would be made available to construction workers due to space constraints. Shuttle buses tare therefore proposed to transport the majority of construction workers to and from the Project. The shuttle buses would likely service local townships with reasonable availability of rental accommodation including Moss Vale, Nowra and Bomaderry. A small number of construction personnel (e.g. site supervisors and Project managers) are anticipated to travel to and from the Project using a mix of light vehicles including sedans, four-wheel drives, light utility trucks and vans.

The morning peak hour of traffic generation associated with the transport of construction workers would be 6:30am to 7:30am on weekdays and 7:00am to 8:00am on Saturdays. Shuttle buses are expected to arrive within the 30-minute period prior to shift commencement to allow adequate time for construction workers to egress the bus and prepare for the shift (e.g. check-in and change clothing), as well as transfer between the Upper and Lower Schemes, if required. The shuttle buses would remain on site to transport the departing workers from the overnight shift concluding at 7:00am.

The afternoon peak hour of traffic generation associated with the transport of construction workers would be 6:00pm to 7:00pm on weekdays and 1:00pm to 2:00pm on Saturdays. During this peak period, shuttle buses would arrive to pick up construction workers concluding their shift at 6:00pm (weekdays) or 1:00pm (Saturdays). During the weekday afternoon period, buses would also be arriving during this period to drop off the overnight shift workers commencing at 7:00pm.

About 15 shuttle buses and 20 light vehicles are expected to facilitate the transportation of a peak workforce of 370 personnel to the Project during each morning and afternoon peak. Shuttle buses are assumed to have a capacity of 28 passengers and would be evenly distributed between the Upper and Lower Schemes of the Project. A small number of shuttle buses may transport construction workers between the Upper and Lower Schemes of the Project.

6.7.4.2 Spoil haulage

As described in **Section 3.4.4**, bulk of spoil generated by the Lower Scheme construction works is proposed to be transported out of the underground tunnels via haul trucks and transported to a dedicated spoil disposal location adjacent to Bendeela Pondage via public access roads. Up to 160 maximum daily heavy vehicle movements (i.e. 80 movements to the spoil disposal area and 80 return movements) during the peak construction stage may be generated by this transportation. The daily average over the spoil haulage period (about 36 months) is expected to be less than 30 spoil truck movements. It is expected that about 10 trucks would be required to accommodate expected peak spoil haulage. It is assumed that site arrival of these trucks would be dispersed outside of peak traffic periods around the commencement of the excavation works and therefore are included in forecast peak hour construction traffic volumes. It is assumed that the haulage trucks would remain on site during the works period and demobilised at the end of their requirement.

Minimal spoil is proposed to be generated during the Upper Scheme construction works on the plateau. Up to 40 daily heavy vehicles movements (i.e. 20 movements trips to the spoil disposal area and 20 return movements to the plateau) may be generated by the transportation of the surplus spoil from the plateau to the spoil disposal area adjacent to the Bendeela Pondage. These heavy vehicle movements would be for a period of up to four months.

These heavy vehicle movements for spoil transport for both the Upper and Lower Scheme would be scheduled to not coincide with construction staff shift movements or peak delivery periods and would be evenly distributed throughout standard working hours.

The spoil haulage route would generate increase in traffic activity on Promised Land Trail and Nowra Road which could impact road users, pedestrians/ cyclists, WaterNSW/ NPWS personnel and contractors. The spoil truck haulage movements and route will be finalised post approval in concurrence with WaterNSW and other relevant stakeholders. These roads would become a controlled environment during the construction period and management measures would be implemented in consultation with WaterNSW and NPWS.

6.7.4.3 Concrete truck movements

As the concrete batching plant would be located within the Laydown / Works Area 5, the movement of the concrete agitator trucks to the tunnels and caverns are not counted in traffic movements as they are within the site. There will be an average of four daily heavy vehicle movements (four inbound and four outbound) of aggregate or cement for the period of 18 months to feed the concrete batching plant. During peak times there may be up to ten hourly heavy vehicle movements (10 inbound and 10 outbound). It is expected that that this material concrete bath would come from Nowra. Should the batching plant not be able to be located at the main access tunnel portal then further heavy vehicle movements would be generated between the batching plant and the main access tunnel portal.

For the Upper Scheme, during peak times there may be up to ten hourly heavy vehicle movements (10 inbound and 10 outbound) to the Promise Land Trail for concrete agitator trucks coming from Moss Vale.

6.7.4.4 Delivery of materials and equipment

Principal materials and components required to construct the Project are expected to originate from Port Kembla and would be transported to the Project via the Princes Highway (A1) and Moss Vale Road (B73). General construction equipment (e.g. mobile cranes and pumps) would be transported from Sydney via major roads including the Hume Motorway (M31). Premixed concrete is likely to be sourced locally from Moss Vale and concrete subcomponents including sand, gravel and cement would likely be sourced from Nowra.

The following heavy vehicle movements would be generated during construction:

- Semi-trailer (2 and 3-axle): delivery of structural, mechanical, electrical equipment (other than those requiring oversize transport) and other miscellaneous equipment (e.g. prefabricated site offices, gates, fencing, portaloos and tanks)
- Heavy rigid: transport of raw construction materials including gravel, premixed concrete (or alternatively subcomponents including sand, gravel and cement), fuel for onsite machinery, water
- Heavy machinery (e.g. earthmoving equipment and cranes): sourced from Sydney and transported via low-loader. Assumed to remain onsite for the duration of the construction works (e.g. earthmoving equipment and cranes)
- OSOM: delivery of major loads, transformers, penstock pipe, etc.

A single vehicle movement is assumed to consist of two trips (one inbound trip and one outbound trip). During peak construction periods, an hourly peak of 15 heavy vehicle movements (i.e. 15 inbound trips and 15 outbound trips) are expected to occur at the upper scheme and a peak of 10 heavy vehicle movements (i.e. 10 inbound trips and 10 outbound trips) are expected at the Lower Scheme. The majority of heavy vehicle movements are expected to occur between 10:00am and 3:00pm on weekdays or between 10:00am to 1:00pm on Saturdays and would be scheduled to not coincide with peak periods of construction staff shift movements or peak periods of background traffic.

In addition to the 15 shuttle buses and 20 light vehicles associated with the transportation of the workforce to and from the Project, the following additional movements have been assumed during the morning and afternoon peak period in order to provide a conservative assessment:

- Up to two light vehicle and two heavy vehicle movements in each direction between the Upper and Lower Schemes of the Project
- Up to four miscellaneous heavy vehicle arrivals and four miscellaneous departures at each of the Upper and Lower Schemes of the Project
- Up to three light vehicle and seven heavy vehicles movements in each direction between the Kangaroo Valley Power Station and Bendeela Power Station
- Up to four bus trips from the Kangaroo Valley Power Station to Bendeela Power Station and two returning bus trips from Bendeela Power Station to Kangaroo Valley Power Station.

6.7.4.5 Impacts on road network capacity and performance

Traffic modelling using SIDRA Intersection 9 has found the following:

- Under the 'without Project' scenario, modelled intersection performance indicates that all intersections in the study area would operate satisfactorily at a LoS A in 2027. Minimal queue lengths are observed for all

intersections and the results show the maximum average delay any intersection would experience is approximately 10 seconds or less.
- Under the 'with Project' scenario (with vehicles associated with construction of the Project), all intersections in the study area are expected to continue to perform at a LoS A. The maximum increase in average delay as a result of the Project is anticipated to be approximately four seconds or less.

As such, the Project is expected to have a negligible impact on the performance of local intersections.

The WaterNSW bridge across the outfall of the Kangaroo Vally Power Station would be used in the spoil haulage route as well as a transport route for deliveries of materials and equipment. The detailed assessment of the capacity of this bridge will be completed as part of the contractor's traffic management planning. The most likely mitigation measure if the capacity of the bridge was found to not support the 25 t rigid body truck would be for the contractor to select a multi axle truck of a similar size or to use smaller trucks. In the event that the heaviest loads exceed the capacity of the bridge, an alternative may be to transport those loads through the Kangaroo Valley Power Station. This alternative would be assessed as part of the contractor's traffic management planning.

6.7.4.6 Impacts of OSOM vehicles

OSOM vehicles would be required to transport certain oversized equipment to the Project area during the construction of the Project. OSOM equipment is expected to originate from the Port Kembla and would generate up to 450 one-way OSOM vehicle trips on the proposed OSOM routes shown on **Figure 6-13**.

Depending on the outcome of the Transport Management Plans for very large loads it may be necessary to close Moss Vale Road in both directions Barfield Road Cambewarra to Fitzroy Falls. These disruptions are expected to occur in the order of 20 times throughout the construction.

An access permit will be sought from the National Heavy Vehicle Regulator prior to any OSOM movements on the road network. As part of the permit, a subcontractor will develop a Transport Management Plan and determine the suitable route based on the required OSOM vehicle dimensions and mass in consultation with the relevant stakeholders.

All OSOM movements associated with the construction of the Project would be performed outside of peak traffic periods and in accordance with any OSOM permit conditions to minimise any adverse impacts to the road network.

The increase in heavy vehicle and OSOM movements has the potential to impact the condition of roads forming part of the proposed haulage routes. Measures to minimise road damage and deterioration during the construction of the Project are provided in **Section 6.7.6** and would include the preparation of a dilapidation report, during the detailed design stage of the Project.

6.7.4.7 Impacts on road safety

With school buses and cyclist utilising the local road network, potential for conflict with Project construction vehicles will be managed through appropriate control measures developed during detailed design stage.

6.7.4.7.1 Sight distance assessment

A preliminary sight distance assessment was undertaken to evaluate whether adequate sight distances are available at the Moss Vale Road (B73) / Nowra Road (B73) / Promised Land Trail intersection to enable road users to safety perceive and react to turning Project traffic. Based on the preliminary assessment, the Safe Intersection Sight Distance (SISD) for vehicles travelling northbound and southbound on Moss Vale Road are currently inadequate for a speed of 100 km per hour due to horizontal curves and roadside vegetation.

A 3D sight distance check and other key sight distance checks would be required prior to the construction of the Project to confirm that the SISD for vehicles comply with road design requirements, and ensure the sight lines are not obstructed. The indicative SISD requirements and preliminary SISD results are outlined in Section 5.5.1 of **Appendix L**.

6.7.4.7.2 Turn warrant assessment

A series of turn warrant assessments were also undertaken to determine whether peak periods of construction traffic generation would require the adoption of a higher-order turn treatment at key intersections in comparison to the forecast 2027 background traffic volumes. The results of the turn warrant assessments are summarised in Table 6-25, with details provided in Section 5.5.2 of **Appendix L**.

Table 6-25. Turn warrant assessment findings for key intersections

Key intersection	Turn warrant results
Moss Vale Road (B73) / Nowra Road (B73) / Promised Land Trail	The existing basic left-turn treatment is expected to remain appropriate at this intersection under both the 'without Project' and 'with Project' scenarios. A higher-order (channelised) right-turn treatment would be warranted with the HV peak and PM peak construction volumes at some peak times. Higher-order right-turn treatment would not be required if the speed limit for Moss Vale Road (B73) is under 70 km/hour, or if the frequency of right-turn vehicle movements are managed.
Moss Vale Road (B73) / Bendeela Road	The existing basic left-turn treatment is expected to remain appropriate at this intersection under the 'without Project' and 'with Project' scenarios. A higher-order (channelised) right-turn would be required under both the 'without Project' and 'with Project' scenarios.
Bendeela Road / Jacks Corner Road / Lower Bendeela Road	The existing basic left-turn and basic right-turn treatments are both expected to remain appropriate at this intersection under the 'without Project' and 'with Project' scenarios.

6.7.4.7.3 Crash rates

The high frequency of crash occurrences on Moss Vale Road could potentially be further impacted by the increased traffic resulting from the Project. Typically, a higher level of traffic and congestion results in a reduction in road safety, and therefore the additional traffic volumes may increase the risks to road users.

To minimise the risks of speeding and fatigue, as well as other road safety risks and contributing factors, appropriate driver induction, training, safety measures and protocols would be detailed in a Construction Traffic Management Plan (CTMP) and Driver Code of Conduct. All Project personnel, including shuttle bus drivers, would be required to adhere to the CTMP and Driver Code of Conduct. In addition, speed reductions, use of fog lights during periods of low visibility, stopping works and site shutdowns will be implemented as required during periods of adverse weather.

Provided that road safety risks and contributing factors would be adequately managed, construction of the Project is not expected to have a major impact on road safety.

6.7.4.8 Impacts on public transport, pedestrians, cyclist and parking

Impacts to public or school bus services are expected to be negligible given the available spare capacity of the road network. The construction of the Project would have a negligible impact on the operation of bus stops.

Impacts to pedestrians and cyclists would also be limited to minor amenity impacts at town centres due to the addition of light and heavy construction vehicles on the road network.

Impacts to parking are expected to be minimal as parking for construction vehicles would be provided within the Project, away from public roads, and construction workforce shuttle buses would be parked on-site within the Project area during workers' shifts. It is expected that the hardstand area in front of KV Power Station may see an increase in usage by vehicles waiting to access site.

6.7.5 Operational impacts

6.7.5.1 Operational workforce

Operation of the Project would occur 24 hours per day, 365 days per year. The operational workforce is anticipated to comprise up to five FTE, generating up to five movements per day (five arrivals to the Project and five departures from the Project per day), as shown in Table 6-26.

Operational staff are expected to arrive at the Project at 7:20am and depart at 4:00pm on weekdays in line with the existing shift pattern at the Kangaroo Valley Power Station. Operational staff would likely commute to the Project daily from local townships using a mix of light vehicles.

Heavy vehicle traffic generation resulting from operation of the Project would be limited to a small number of movements associated with specialist maintenance and facility upkeep activities. During these activities, up to five heavy vehicles are expected, generating up to five movements per day (five arrivals to the Project and five departures from the Project per day).

Approximately 50 % of operational vehicles are expected to access the Project via Bendeela Road from the north and 50 % are expected to access the Project via Bendeela Road from the south.

Table 6-26. Indicative operational traffic generation

Vehicle class	Daily trips	Peak hour trips
Light	10	5
Heavy	10	5
OSOM	0	0

6.7.5.2 Impacts on road network capacity and performance

Traffic modelling using SIDRA Intersection 9 has found the following:

- Under the 'without Project' scenario, all roads would operate satisfactorily at a LoS A in 2028 and 2038.
- Under the 'with Project' scenario, all roads in the study area are expected to continue to perform at a LoS A in 2028 and 2038.

Therefore, no impacts to road performance are anticipated and the road network is expected to have sufficient capacity to accommodate the future traffic demand during the operation of the Project.

6.7.5.3 Impacts on road safety

A series of turn warrant assessments were undertaken to determine whether peak periods of operational traffic generation would require the adoption of a higher-order turn treatment at key intersections in comparison to the forecast 2028 and 2038 background traffic volumes.

The turn warrant assessment indicates that the current basic left-turn and basic right-turn treatments are appropriate for the following intersections:

- Moss Vale Road (B73) / Promised Land Trail
- Moss Vale Road (B73) / Bendeela Road
- Bendeela Road / Jacks Corner Road / Lower Bendeela Road.

Operation of the Project is anticipated to have negligible impacts on road safety due to the low operational traffic volumes expected.

6.7.5.4 Impacts on public transport and parking

Impacts to local bus services during the operation of the Project would be negligible due to the low operational traffic volumes anticipated.

In addition, the Project would have no impact on pedestrians or cyclists. Amenity impacts at town centres due to the addition of operational vehicles on the road network would be negligible given the low operational traffic volumes anticipated.

No impacts to parking are expected as parking for operational vehicles would be provided within or next to the permanent operational and maintenance facility, away from public roads.

6.7.6 Mitigation measures

The following mitigation measures detailed in **Table 6-27** have been developed to specifically manage potential traffic and transport impacts which have been predicted during construction and operation of the Project.

Table 6-27. Traffic and transport mitigation measures

Ref	Impact	Mitigation measure	Timing
TT1	Impacts to the local road network	A CTMP will be prepared in consultation with WaterNSW and implemented by the construction contractor. The CTMP will include: ▪ Confirmation of haulage routes ▪ Access to construction site including entry and exit locations ▪ Times of transporting to minimise impacts on the road network ▪ Measures to minimise the number of workers using private vehicles ▪ Management of oversized vehicles and OSOM movements ▪ Confirm maximum vehicle movements during peak periods ▪ Site specific traffic control measures (including signage) to manage and regulate traffic movement ▪ Relevant traffic safety measures including driver induction, training, safety measures and protocols ▪ Identify requirements for, and placement of, traffic barriers. ▪ Requirements and methods to inform the local community of impacts on the local road network due to the development-related activities ▪ Consultation with Transport for NSW, National Heavy Vehicle Regular and Council ▪ Consultation with the emergency services to ensure that procedures are in place to maintain safe, priority access for emergency vehicles ▪ A response plan for any construction related traffic incident ▪ Monitoring, review and amendment mechanisms ▪ Individual traffic management requirements at each phase of construction.	Construction
TT2		Heavy vehicle movements to and from the Project area will be scheduled to minimise traffic disruption to the surrounding road network. This may include, but is not limited to: ▪ Scheduling the movement of construction material, equipment and waste to occur outside of peak periods where practical ▪ Scheduling heavy vehicle deliveries to be evenly dispersed as far as practical to minimise convoying or platoons and queuing outside the Project or on the road network.	Construction
TT3		The loading and unloading of trucks will be planned to ensure each individual truck haulage capacity is fully utilised to reduce the total number of truck movements.	Construction

Ref	Impact	Mitigation measure	Timing
TT4	OSOM vehicles	An oversized vehicle permit will be sought for all OSOM vehicle movements where required. The OSOM movements will be in accordance with the permit requirements and be outside of peak traffic periods where possible. In addition, a separate OSOM transport management plan will be prepared and will include: ▪ Identification of routes ▪ Potential impacts to the road network including road condition ▪ Measures to provide an escort for the loads ▪ Times of transporting to minimise impacts on the road network ▪ Location of rest areas and require rest stops along the route ▪ Identification of the maximum parameters of the OSOM vehicle ▪ Notification strategy and liaising with emergency services and police ▪ Any minor temporary civil infrastructure works may be required to accommodate OSOM movements.	Construction
TT5	Road safety	A Driver Code of Conduct will be prepared as part of the CTMP and be used to outline the rules and behaviours which drivers associated with the Project will be required to adhere to. The Driver Code of Conduct will outline arrangements for light and heavy vehicle drivers including: ▪ General requirements including site induction requirements ▪ Travelling speeds and safe driving practices, particularly through residential areas and school zones ▪ Fatigue management ▪ Adherence to designated transport routes and heavy vehicle noise ▪ Public complaint resolution.	Prior to construction, construction and, operation
TT6		A detailed intersection design will be developed for the upgrade of the Moss Vale Road (B73) / Promised Land Trail intersection. This design will be developed in consultation with and to the satisfaction of TfNSW and Council as appropriate under Section 138 of the *NSW Roads Act 1993*. As the Austroads warrants for turn treatments provides guidance on the preferred minimum turn treatments for major roads based on traffic flows only, the intersection design will also consider geometric minimal (e.g. limited sight distance, steep grade). This may result in the adoption of a turn treatment of a higher order than that indicated by the warrants.	Prior to construction
TT7		Vehicles will be required to enter and leave the Project area in a forward direction where possible, to minimise collision and safety risks.	Construction And operation
TT8		Public roads and Crown roads will not be obstructed by any materials, vehicles, skip bins or the like, under any circumstances.	Construction and operation
TT9		'Trucks Turning' warning signs will be installed on both approaches to the intersection of Moss Vale Road (B73) / Promised Land Trail and Moss Vale Road (B73) / Bendeela Road to advise existing road users of the increased heavy vehicle volumes. The signs will be removed upon the completion of the construction works.	Construction
TT10		Project vehicle speed reductions, use of fog lights during periods of low visibility and limitation of works will be implemented as required during periods of adverse weather.	Construction and operation
T11	Access	Affected parties including emergency services will be notified in advance of any disruptions to traffic and restriction of access impacted by Project activities.	Prior to construction / Construction.

Ref	Impact	Mitigation measure	Timing
TT12	Road condition	All vehicles transporting loose materials will have the entire load covered and/or secured to prevent any large items, excess dust or dirt particles depositing onto the roadway during travel to and from the Project area. Contamination with weeds and mud tracking from trucks leaving the Promised Land Trail, will be managed using standard controls detailed in **Appendix F**(BDAR), **Appendix I** (Surface Water Quality, Hydrology and Geomorphology impact assessment)	Construction
TT13		All vehicles leaving the site would be cleaned of materials that may fall on the roadway before they are allowed to leave the site.	Construction
TT14		No tracked vehicles will be permitted on any paved roads.	Construction
TT15		A Road Dilapidation Report will be prepared prior to and following construction of the Project. Any impacts identified as caused by the Project will be rectified.	Prior to construction, following construction

6.8 Noise and vibration

This section provides an assessment of the potential noise and vibration impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix M** (Noise and vibration impact assessment).

The assessment addresses the following SEARs:

- Noise – including an assessment of the construction noise, road noise and vibration impacts of the project.

6.8.1 Legislative and policy context

The noise and vibration assessment has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *ICNG* (DECC, 2009)
- *Noise Policy for Industry* (NPI) (EPA, 2017)
- *Assessing Vibration: a technical guideline* (Department of Environment and Conservation, 2006)
- *NSW Road Noise Policy* (Department of Environment, Climate Change and Water NSW, 2011)
- *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990)
- *Construction Noise and Vibration Guideline* (NSW Roads and Maritime Service, 2016).

6.8.2 Methodology

The EPA sets guidance and criteria for major development proposals in terms of the different types of noise and vibration likely to be generated during construction and operation of a proposal. These guidelines and criteria form the basis of impact assessments, based on an understanding of existing background noise levels which are measured and recorded. For this Project the noise and vibration methodology included:

- Identification of noise sensitive receivers by review of aerial imagery
- Continuous unattended noise monitoring, carried out between 26 March and 8 April 2019 using Type 1 Ngara noise loggers, to identify background noise levels at noise catchment areas (NCAs)
- Identification of meteorological conditions, including prevailing winds, that may enhance the propagation of noise.
- Identification of existing traffic conditions as described in **Section 6.7.3**
- Identification of assessment criteria, including NMLs for the identified surrounding residential receivers in accordance with the ICNG and relevant standards and guidelines
- Construction and operational noise and vibration assessment predictions based on detailed noise and vibration modelling of construction and operational activities to predict noise and vibration levels that may be generated by the Project in accordance with current guidelines

- Assessment of noise and vibration impacts, summarising the modelled predictions at sensitive receivers
- Identification of mitigation measures required to minimise impacts.

The methodology of the noise and vibration assessment, including modelling parameters, is further described in Chapter 5 of **Appendix M**.

6.8.3 Existing environment

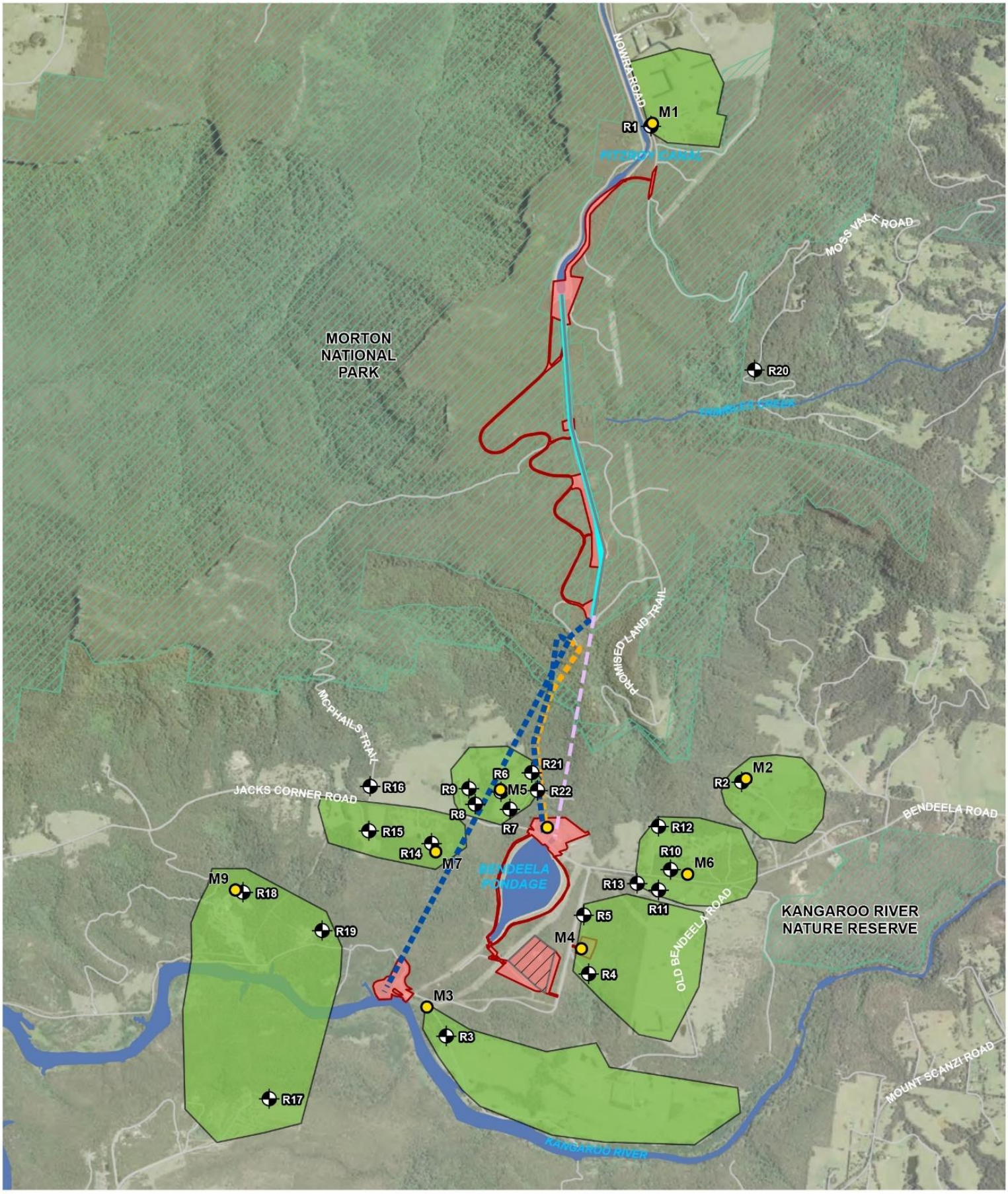
6.8.3.1 Sensitive receivers

A noise sensitive receiver is considered to be any location where inhabitants or users may be impacted by noise generated by the Project. Twenty two sensitive receivers were identified within approximately 5 km of the Project. More populated areas were noted with the closest being Kangaroo Valley set approximately three kms away. The sensitive receivers surrounding the Project are shown in **Figure 6-16** and summarised in **Table 6-28**.

There are no precision (including medical) industries or listed heritage items, or places of archaeological potential, situated within the Project area or near the Project that that would be susceptible to vibration impacts.

Table 6-28. Surrounding sensitive receivers

ID	Address	Type	Distance from Project	Disturbance
R1	1671 Nowra Road Fitzroy Falls	Residential	440 m	Road Upgrades
R2	198 Bendeela Road Kangaroo Valley	Residential	1480 m	Kangaroo Portal
R3	407C Bendeela Road (Camp) Kangaroo Valley	Passive recreation	500 m	Tail Race Portal
R4	407D Bendeela Road Kangaroo Valley	Residential	100 m	J-Storage
R5	407A Bendeela Road Kangaroo Valley	Residential	160 m	J-Storage
R6	35 Jim Edwardes Place Kangaroo Valley	Residential	370 m	Kangaroo Portal
R7	13 Jim Edwardes Place Kangaroo Valley	Residential	240 m	Kangaroo Portal
R8	94 Jacks Corner Road Kangaroo Valley	Residential	500 m	Kangaroo Portal
R9	110 Jacks Corner Road Kangaroo Valley	Residential	590 m	Kangaroo Portal
R10	340 Bendeela Road Kangaroo Valley	Residential	780 m	Haulage (non-road)
R11	353 Bendeela Road Kangaroo Valley	Residential	610 m	J-Storage
R12	360 Bendeela Road Kangaroo Valley	Residential	800 m	Kangaroo Portal
R13	369 Bendeela Road Kangaroo Valley	Residential	520 m	Haulage (non-road)
R14	145 Jacks Corner Road Kangaroo Valley	Residential	790 m	Kangaroo Portal
R15	199 Jacks Corner Road Kangaroo Valley	Residential	1130 m	Tail Race Portal
R16	180 Jacks Corner Road Kangaroo Valley	Residential	1310 m	Kangaroo Portal
R17	114 Radiata Road (Cottages) Kangaroo Valley	Residential	1160 m	Tail Race Portal
R18	369 Jacks Corner Road (Campus) Kangaroo Valley	Educational	1,270 m	Tail Race Portal
R19	369 Jacks Corner Road (Dorms) Kangaroo Valley	Residential	610 m	Tail Race Portal
R20	2999 Moss Vale Road Barrengarry	Residential	1630 m	Road Upgrades
R21	40 Jim Edwardes Place (North) Kangaroo Valley	Residential	390 m	Kangaroo Portal
R22	40 Jim Edwardes Place (South) Kangaroo Valley	Residential	260 m	Kangaroo Portal



Legend

- Monitoring location
- Sensitive receptors
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Noise catchment area
- Project area
- Spoil site
- NPWS Reserve
- Road
- Waterway
- Waterbody

0 1 2 km

1:40,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-16 Surrounding sensitive receivers, monitoring locations and noise catchment areas

Date: 9/27/2022 Path: \\ausyd0vs01\GIS\Proj\NSW_IS\302600_ShoalhavenLIS\Apps\IS302600_Acoustic.aprx
Created by : JB | QA by : AA

6.8.3.2 Background noise levels

To understand and quantify levels of existing background noise around the Project, continuous unattended noise monitoring was completed at eight locations in 2019. Although this data was collected in 2019, they are still considered appropriate. The environment around each monitoring location has remained unchanged, with the predominant sources contributing to the measured background levels similarly expected as remaining generally the same. Additionally, most were measured at or below the minimum rating background noise levels (RBLs) from the NPI.

Based on the results of the background noise monitoring, NCAs were established to describe locations with similar background noise levels. The background noise monitoring locations and the NCAs established are shown in **Figure 6-16**, with the adopted background noise levels established for each noise catchment area detailed in **Table 6-29**.

The term 'L_{90}' is a statistical descriptor which refers to the noise level exceeded 90 % of the time during the monitoring period. It is commonly used to define the background noise level. 'L_{Aeq}' is the equivalent continuous sound level or energy-time average for the period of monitoring.

Table 6-29. Measured background noise levels

NCA	Characterised by results from the following noise monitor	Adopted background (L_{A90}) noise levels A-weighted decibel (dB(A))		
		Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
NCA01	NM1	35	35	32
NCA02	NM2	35	35	33
NCA03	NM3	35	30	30
NCA04	NM4	35	34	30
NCA05	NM5	35	31	30
NCA06	NM6	35	31	30
NCA07	NM7	35	30	30
NCA08	NM8	35	30	30

6.8.4 Assessment criteria

6.8.4.1 Construction airborne noise

6.8.4.1.1 Noise management levels

Construction noise criteria have been established for the Project in accordance with the ICNG, in the form of construction NML. Considering the adopted background noise presented in **Table 6-29** and the guidance from the ICNG, the NMLs listed in **Table 6-30** were established to assess potential construction noise impacts at the identified sensitive receiver locations.

The ICNG also provides construction NMLs for non-residential sensitive land uses, these are presented in **Table 6-31**.

Table 6-30. Construction NMLs (residential receivers)

NCA	NML $L_{eq\ 15\ min}$ dB(A) (RBL->NML)			
	Day	Outside standard hours (Day)	Outside standard hours (Evening)	Outside standard hours (Night)
NCA 1	45	40	40	37
NCA 2	45	40	40	38
NCA 3	45	40	35	35
NCA 4	45	40	39	35

NCA	NML $L_{eq\ 15\ min}$ dB(A) (RBL->NML)			
	Day	Outside standard hours (Day)	Outside standard hours (Evening)	Outside standard hours (Night)
NCA 5	45	40	36	35
NCA 6	45	40	36	35
NCA 7	45	40	35	35
NCA 8	45	40	35	35

Where:

Day (during standard hours) is 7am – 6pm Weekdays and 8am – 1pm Saturdays

Outside standard hours (Day) is 1pm – 6pm Saturday

Outside standard hours (Evening) is 6pm-10pm Weekdays and 6pm – 10pm Saturdays

Outside standard hours (Night) is 10pm-7am Weekdays, 10pm – 8am Saturdays and 6pm – 7am Sundays and Public Holidays

Table 6-31. NMLs for non-residential receivers

Non-residential receiver type	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Educational facilities	Internal Noise Level – 45 dB(A)
Passive Recreation	External Noise Level – 60 dB(A)
Active Recreation	External Noise Level – 65 dB(A)

6.8.4.1.2 Sleep disturbance

For premises where night construction (and operations) occurs, the potential for noise levels to lead to sleep disturbance has been considered. As such a sleep disturbance screening criterion of 65 L_{AFMax} dB(A) external has been adopted for residential receivers within the NCAs surrounding the Project.

6.8.4.1.3 Construction traffic noise

The construction road traffic noise assessment criteria are presented in **Table 6-32**.

Table 6-32. Road traffic noise assessment criteria

Road	Road category	Day (7am to 10pm) $L_{AEq\ 15\text{-}hour}$ dB(A)	Night (10pm to 7am) $L_{AEq\ 9\text{-}hour}$ dB(A)
Moss Vale Road	Freeway / arterial / sub-arterial road	60	55
Bendeela Road	Local road	55	50

6.8.4.2 Construction ground-borne noise

Vibration from construction activities can induce vibration within receiver structures, wherein some of the vibration of building elements such as the floors, walls and ceilings can be converted into sound. The sound that is thereby induced by re-radiation of the structural vibration into the air within the receiving building is called structure-borne noise.

Assessment values for ground-borne noise are provided in the ICNG (DECC, 2009), shown in Table 6-33. The ground-borne noise levels are provided as guidance for when management actions should be implemented.

Table 6-33. Ground-borne noise assessment levels

Receiver type	Time Period	Ground-borne noise level $L_{Aeq(15\ minutes)}$
Residential only (Internal; within the most affected habitable room)	Evening (6pm to 10 pm)	40 dB(A)
	Night (10 pm to 7 am)	35 dB(A)

6.8.4.3 Construction vibration and blasting

6.8.4.3.1 Vibration sources other than blasting

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.

The recommended safe working distances for the most vibration intensive plant and equipment during surface construction activities is presented in **Table 6-34**.

Table 6-34. Vibration risks from surface vibration-generating construction activities

Plant	Rating / description	Safe working distance (m)	
		Cosmetic damage (BS7385-2: 1993)	Human response (DEC, 2006)
Vibratory pile driver	Sheet piles	2 to 20	20
Large hydraulic hammer	(1600 kilograms – 18t to 34t excavator)	22	73
Jackhammer	Hand-held	1	2

6.8.4.3.2 Blasting

Overpressure and vibration from blasting are assessed against the levels provided in the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Council (ANZEC), 1990).

As the construction program includes limited surface blast for construction purposes , a criterion of 133 dB(L) has been adopted as a safe level for this blast.

For blasting activities underground, air blast overpressure is not relevant however ground vibration impacts will still need to be considered. Due to the semi-regular nature of the underground blasting during excavation of the cavern, it would be appropriate for the applicable vibration criteria to be based on human comfort, rather than structural damage. The ICNG/ANZEC guidelines would recommend a criteria of peak particle velocity (PPV) of 5 millimetres per second (mm/s) for all blasts. However, the guidance in Australian Standard AS2187.2-2006 would recommend a PPV criterion of 10 mm/s for all blasts if the construction period is less than 12 months. Consequently, if the construction period of the power station cavern is less than 12 months, the vibration criteria for the underground drill and blasting is PPV 10 mm/s. If the drill & blast construction period is more than 12 months, the recommended vibration criteria for the underground drill & blasting is PPV 5 mm/s.

6.8.4.4 Operational noise

Operational noise objectives for the Project were determined in accordance with the NPI which seeks to regulate noise impact from 'industrial activity' pertaining to noise from fixed industry and mechanical plant rather than from road, rail or construction sources. To achieve this, the NPI applies two separate noise criteria:

- Limiting the intrusiveness of the Project's noise against the prevailing background noise
- Achieving suitable acoustic amenity for the surrounding land uses from industry.

The more stringent of these is used to define the operational noise limit for a Project. Considering the intrusive and amenity criteria established in the NIA, Table 6 22 presents the Project Noise Trigger Levels (PNTLs) adopted for the various NCAs related to the Project. Considering the intrusive and amenity criteria, **Table 6-35** presents the operational noise criteria adopted for the various NCAs related to the Project. The NPI also provides amenity noise levels for non-residential receivers. **Table 6-36** presents these levels for non-residential land usage.

Table 6-35. Project operational noise criteria

NCA	Time of day	Noise intrusiveness level dB(A)	Project amenity $L_{eq\ 15\text{-}minute}$ Noise Level dB(A)	Recommended L_{Aeq} Noise Level dB(A)
NCA 1	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	40	43	40
	Night (10 pm to 7 am)	37	38	37
NCA 2	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	40	43	40
	Night (10 pm to 7 am)	38	38	38
NCA 3	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	35	43	35
	Night (10 pm to 7 am)	35	38	35
NCA 4	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	39	42	39
	Night (10 pm to 7 am)	35	38	35
NCA 5	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	36	43	36
	Night (10 pm to 7 am)	35	38	35
NCA 6	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	36	43	36
	Night (10 pm to 7 am)	35	38	35
NCA 7	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	35	43	35
	Night (10 pm to 7 am)	35	38	35
NCA 8	Day (7 am to 6 pm)	40	48	40
	Evening (6 pm to 10 pm)	35	43	35
	Night (10 pm to 7 am)	35	38	35

Table 6-36. NPI amenity noise criteria for non-residential receivers

Receiver type	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{eq\ 15\text{-}minute}$ Noise Level dB(A)
Commercial	When in use	65	63
Industrial	When in use	70	68
Educational / Childcare	Noisiest 1-hour period when in use	35 (internal) 45 (external)	33 (internal) 43 (external)
Hospital / Medical	Noisiest 1-hour period	35 (internal) 50 (external)	33 (internal) 48 (external)
Place of Worship	When in use	40 (internal) 50 (external)	38 (internal) 48 (external)
Passive Recreation	When in use	50	48
Active Recreation	When in use	55	53

The criteria for assessing construction traffic noise impacts (refer to **Table 6-32**) would continue to be applied for the operation of the Project

6.8.5 Construction impacts

6.8.5.1 Airborne noise

Noise modelling was used to predict likely exceedances of noise management levels for the following construction scenarios:

- Upper Scheme construction
- Lower Scheme construction comprising intensive surface works associated with tunnel portal and spoil emplacement facility establishment with and without spoil haulage
- Tunnelling works comprising continuous underground works and associated surface support activities with typical day time surface construction and with continuous or day time only spoil haulage
- Short term OSOM deliveries occurring at night.

Predicted impacts are considered conservative with all associated equipment in each scenario operating concurrently at the nearest point to the receptor with limited mitigation.

In summary, a small number of receivers were predicted to experience noise levels above applicable NMLs. These exceedances are generally expected to be noticeable or clearly audible although over longer durations, rather than being highly intrusive.

The Lower Scheme and Lower Scheme surface construction works and tunnelling works are predicted to remain below the revised 'Highly noise-affected level' of 65 dB(A). The only location where levels exceeding the 65 dB(A) Highly noise-affected level and sleep disturbance criterion are predicted is R5 during the short term bulk deliveries.

Detailed design and actual construction methods would be used to refine impact predictions and reasonable and feasible mitigation measures. Mitigation measures to address this impact are presented in **Section 6.8.7**.

6.8.5.1.1 Upper Scheme

Results of noise modelling during construction of the Upper Scheme are provided in Table 6-37. Exceedances of NMLs are highlighted orange.

As **Table 6-37**, shows noise levels from construction of the Upper Scheme were generally predicted to remain below the NMLs established for standard hours and outside standard hours (day) periods. The only exception was at R1 (approximately 1.5 dB(A)). This exceedance is related to anticipated works to upgrade the access point to the Promised Land Trail and as such the duration of exceedance would be limited to an estimated three month period.

Some works may be required outside standard construction hours including shaft excavation, support and lining activities and concrete pours for anchor blocks and surge tank foundation. Based on noise modelling undertaken, once the intersection upgrade is complete and in the absence of haulage, upper scheme construction is predicted to be inaudible at receivers and out of hours works as such acceptable subject to management in accordance with the requirements of an EPL.

Table 6-37. Predicted airborne noise levels during construction of the Upper Scheme

Receiver ID	Noise level $L_{Aeq\ 15\text{-}minute}$ dB(A)		
	Construction	NML Standard hours	NML Outside standard hours (day)
R1	46.5	45	40
R2	<20	45	40
R3		60	60
R4		45	40
R5		45	40
R6		45	40
R7		45	40
R8		45	40
R9		45	40

Receiver ID	Noise level $L_{Aeq\ 15\text{-}minute}$ dB(A)		
	Construction	NML Standard hours	NML Outside standard hours (day)
R10		45	40
R11		45	40
R12		45	40
R13		45	40
R14		45	40
R15		45	40
R16		45	40
R17		45	40
R18		55	55
R19		45	40
R20		45	40
R21		45	40
R22		45	40

6.8.5.1.2 Lower Scheme

Results of noise modelling during construction of the Lower Scheme are provided in **Table 6-38**. Exceedances of Standard Construction Hours NMLs are highlighted orange while the exceedances of outside standard hours (day) NMLs are highlighted grey. As shown in **Table 6-38,** noise levels from construction of the Lower Scheme were generally predicted to remain below the NMLs established for standard hours and outside standard hours (day) periods. Exceedances of the NMLs for standard hours and outside standard hours, daytime were predicted at R4, R5, R6, R7, R8, R9 and R22. All exceedances were approximately 9 dB(A) or less above the standard hours NML and 14 dB(A) or less above the NML for outside standard hours(day). Exceedances of the outside standard hours(day) NML were also predicted at R14 and R21, although noise levels at both locations was predicted to comply with the standard hours NML. With the inclusion of peak spoil haulage, exceedances of standard hours NMLs are also predicted at R14 and R21 while exceedances of outside standard hours (day) NMLs were also predicted at R10, R11 and 13.

Predicted exceedances at R4 and R5 are associated with activities at works Area 7 and spoil emplacement facility. The remaining predicted exceedances are associated with activities at the access and multipurpose tunnel surface works. These predictions are based on most intensive use of these area comprising spoil emplacement towards completion and open cut and cover activities at the portal site and without mitigation measures applied. Detailed design and actual construction methods would be used to refine impact predictions and reasonable and feasible mitigation measures.

These exceedances are related to intensive surface works associated with the establishment of tunnel portals and the spoil emplacement facility and as such have an expected duration of approximately six months and during day time periods only after which predicted impacts would revert to those identified under tunnelling scenario's below.

Table 6-38. Predicted airborne noise levels during construction of the Lower Scheme

Receiver ID	Noise level $L_{Aeq\ 15\text{-}minute}$ dB(A)			
	Predicted Sound Pressure Level (SPL)	Construction w. Peak Daytime only Haulage	NML Standard hours	NML Outside standard hours (day)
R1	<20	<20	45	40
R2	<20	<20	45	40
R3	42.1	45.9	60	60
R4	53.8	55.3	45	40
R5	50.2	58.7	45	40

Receiver ID	Noise level $L_{Aeq\ 15\text{-}minute}$ dB(A)			
R6	45.2	46.9	45	40
R7	53.8	54.6	45	40
R8	47.7	49.0	45	40
R9	45.2	46.8	45	40
R10	37.1	40.5	45	40
R11	39.7	42.7	45	40
R12	35.0	39.1	45	40
R13	39.9	44.4	45	40
R14	43.0	46.2	45	40
R15	35.3	38.0	45	40
R16	32.4	35.8	45	40
R17	35.6	37.0	45	40
R18	27.1	28.2	55	55
R19	36.9	37.8	45	40
R20	<20	<20	45	40
R21	44.3	46.0	45	40
R22	47.6	49.3	45	40

6.8.5.1.3 Tunnelling works

Results of noise modelling from underground works are provided in Table 6-39 for peak spoil movement periods. Exceedances applicable NMLs for the relevant period are highlighted orange. As identified in **Table 6-39**, for tunnelling works with spoil haulage spread over 24/7 avoiding localised stockpiling, exceedances of standard construction hours NMLs were predicted at receivers R4, R5 and R7. Exceedances were predicted to be below standard daytime NMLs at all other receivers. Exceedances of the standard hours NML were all less than 3 dB(A). With 24/7 haulage, tunnelling works were predicted to exceed out of hours NMLs at R4, R5, R6, R7,R8 ,R9, R11 , R12, R13,R14, R17, R21 and R22. Exceedances of night NML was predicted at 9.4 dB(A) at R5, under 7 dB(A) at R7, R8 and R14 and under 5 dB(A) at other receivers.

For tunnelling works with spoil haulage limited to standard construction hours, necessitating higher haulage rates and loading at portal sites, additional exceedances of standard construction hours NMLs were predicted at R8, R14 and R22 that were not predicted under 24/7 haulage scenario. The predicted exceedance of standard construction hours NMLs increases to 13.2 dB(A) at R5 and 5.6 dB(A) at R4 with all other exceedances limited to under 3 dB(A). Without 24/7 haulage, exceedances of night NMLs were predicted to reduce with exceedances no longer predicted at R4, R11, R12 and R13. Where exceedances remain, they would be reduced.

Predicted exceedances at R4 and R5 are related to night-time spoil haulage and spoil unloading. Other predicted exceedances are related to essential night-time underground works support activities at the portals with limited mitigation. Detailed design and actual construction methods would be used to refine impact predictions and reasonable and feasible mitigation measures.

While underground works may extend over the full project duration, the more intensive tunnelling and associated spoil handling works would occur over a shorter three-year period. As such, while the lower intensity exceedances may persist throughout the Project, the higher intensity exceedances of out-side standard hours could occur over a two to three year period.

Table 6-39. Predicted peak noise levels, underground works with haulage condition (24-7 or Day-time)

Receiver ID	Noise level $L_{Aeq\ 15\text{-}minute}$ dB(A)				Noise Management Level			
	24/7 Haulage		Day only haulage		Standard	Outside Std Hours		
	Std	Out-Std	Std	Out-Std	Hours	Day	Eve	Night
R1 (NCA 01)	<20	<20	<20	<20	45	40	40	37
R2 (NCA 02)	<20	<20	<20	<20	45	40	40	38
R3 (NCA 03)	42.5	40.1	45.2	34.3	60	60	60	60
R4 (NCA 04)	46.0	40.9	50.6	30.3	45	40	39	35
R5 (NCA 04)	47.6	44.4	58.2	35.7	45	40	39	35
R6 (NCA 05)	39.9	37.1	42.5	36.2	45	40	36	35
R7 (NCA 05)	45.3	41.8	47.6	41.2	45	40	36	35
R8 (NCA 05)	43.2	40.1	45.1	39.6	45	40	36	35
R9 (NCA 05)	40.8	38.4	42.8	37.8	45	40	36	35
R10 (NCA 06)	37.9	34.9	40.1	27.8	45	40	36	35
R11 (NCA 06)	38.2	36.1	41.3	28.6	45	40	36	35
R12 (NCA 06)	38.2	36.5	40.2	26.1	45	40	36	35
R13 (NCA 06)	39.4	37.2	43.6	29.2	45	40	36	35
R14 (NCA 07)	42.4	40.2	45.7	39.2	45	40	35	35
R15 (NCA 07)	35.3	33.7	37.6	32.1	45	40	35	35
R16 (NCA 07)	34.1	32.7	36.0	28.9	45	40	35	35
R17 (NCA 08)	39.3	38.7	39.8	37.9	45	40	35	35
R18 (NCA 08)	26.1	24.2	27.3	23.7	55	55	55	55
R19 (NCA 08)	35.7	33.8	36.8	33.7	45	40	35	35
R20 (NCA 02)	<20	<20	<20	<20	45	40	40	38
R21 (NCA 05)	41.4	39.1	43.5	37.3	45	40	36	35
R22 (NCA 05)	43.6	41.4	46.4	40.5	45	40	36	35

6.8.5.1.4 Short-term bulk delivery events

Noise modelling showed that short-term bulk delivery events were generally predicted to remain below the NMLs established for all periods. However, NMLs for all periods were predicted to be exceeded at R5. Exceedance of the out of hours NMLs were also predicted at R1 and R4. The highest predicted exceedance of the night-time NML was 12.1 dB(A) at R5.

The bulk deliveries scenario is centred around the arrival and where necessary unloading of OSOM equipment at Works Area 7. These are required for road safety purposes and are expected to happen infrequently but throughout the Project.

6.8.5.2 Ground-borne noise

Results of noise modelling of ground-borne noise from tunnelling are presented in **Table 6-40**. The predicted ground-borne noise levels are substantially lower than the ground-borne noise criteria for both day and night with the exception of R22. These predicted exceedances would be subject to detailed design and the duration is expected to be limited to a short period when tunnelling is occurring at the closest point to the receptor only.

Table 6-40. Predicted ground-borne noise levels

Receiver ID	Ground-borne noise level L_{Aeq} dB(A)		Ground-borne noise level criteria	
	Tailrace tunnel (both work fronts simultaneously)	Multipurpose ventilation tunnel and power station carven access tunnel (simultaneously)	Evening (6pm to 10 pm)	Night (10 pm to 7 am)
R6	16	13	40 dB(A)	35 dB(A)
R7	13	13		
R8	15	<10		
R9	12	<10		
R21	12	32		
R22	<10	**38**		

6.8.5.3 Vibration

The nearest sensitive receivers (R7 and R21) are more than 200 m beyond the highest building cosmetic damage and human response safe setback distances for the surface works. Therefore building cosmetic damage and human response vibration-related impacts for the using of plant and equipment during surface construction activities was not determined to present a risk at surrounding receivers.

The predicted ground vibration levels from construction of the tunnels using road headers are also expected to comply with the criteria for cosmetic/minor building damage at all receivers.

6.8.5.4 Blasting

Blasting rock material can potentially generate ground vibration and/or air blast overpressure that may be perceptible by occupants of receiver buildings and may also potentially result in some damage to structures including heritage structures and receiver buildings. Noting that the impact from blasting are very short-term, and momentary impact.

The surface blasting proposed for construction of the Tailrace Inlet/Outlet has the potential to result in ground vibration and/or air blast overpressure to be received at receivers and impact on existing infrastructure both within in and around the Project. Therefore detailed blast design would be required to not only achieve compliance with offsite criterion but to be protective existing infrastructure.

Underground blasting has the potential for ground vibration impacts. Based on the approximate three-dimensional slant distances between the underground construction locations and the nearest receivers, the calculated maximum instantaneous charge size for underground blasts in the cavern that complies with the criterion of 5 mm/s is approximately 2,700 kilograms of Ammonium nitrate standard explosive (ANFO). Provided the amount ANFO do not exceed 2,700 kg, the vibration levels from underground blasting activities associated with the power station cavern and tunnels construction were predicted to remain below the adopted criterion of 5 mm/s at surrounding sensitive receivers

Should blasting be used during construction in either the surface or underground works, a detailed blast management strategy will be prepared.

6.8.5.5 Road traffic noise

Construction vehicle movements have the potential to generate temporary adverse noise impacts along on the local road network and haulage routes shown on **Figure 6-14** and presented in **Table 6-41**. These impacts may be noticeable at nearby receivers along Bendeela Road and Moss Vale Road. The duration of impacts may extend over the entire Project, however is likely to be most intensive over the two to three year period of tunnelling works.

Table 6-41. Predicted changes in road traffic noise

Road	Change in noise level dB(A)		Predicted noise level	
	Day	Night	Day $L_{AEQ\ 15\text{-}hour}$ dB(A)	Night $L_{AEQ\ 9\text{-}hour}$ dB(A)
Moss Vale Road	**+2.4**	+0.8	**66.7**	58.8
Bendeela Road	**+3.7**	**+5.3**	**65.2**	**61.9**

6.8.6 Operational impacts

The noise modelling determined that the operation of the Project would not result in unacceptable impacts at the identified sensitive receiver locations. Predicted noise levels were within the adopted noise management criteria for all periods of the day (day, evening and night) at all surrounding sensitive receivers.

Any additional traffic movements from Project operation activities are not expected to result in unacceptable changes in traffic noise levels at sensitive receivers along the local road network.

6.8.7 Mitigation measures

Mitigation measures to address the potential noise and vibration impacts of the Project are listed in **Table 6-42**.

Table 6-42. Noise and vibration mitigation measures

Ref	Aspect	Control	Timing
NV01	Management of construction noise and vibration	A construction noise and vibration management plan will be prepared in consultation with WaterNSW. The construction noise and vibration management plan will include measures, processes and responsibilities to manage noise and vibration and minimise the potential for impacts during construction. The construction noise and vibration management plan will: ▪ Identify nearby sensitive receivers ▪ Include a description of the construction activities, equipment and working hours ▪ Identify relevant noise and vibration performance criteria for the Project and licence and approval requirements ▪ Describe the process(es) that will be adopted to assess actual construction methods adopted and identify reasonable and feasible controls to mitigate impacts, including assessment of cumulative impact ▪ Outline standard and additional mitigation measures to be adopted ▪ Outline requirements for the development and implementation of an Out-of-hours Work Protocol ▪ Include or provide reference to a Blast Management Strategy (where blasting is required) ▪ Outline the noise and vibration monitoring program to validate predictions and evaluate whether the mitigation measures in place are adequate or require revision ▪ Describe community consultation and complaints handling procedures in accordance with the community communication strategy to be developed for the Project. Construction.	Construction
NV02	Assess construction noise and vibration impact	Detailed noise assessments will be carried out to predict noise and vibration impact from the detailed design project is consistent with the outcomes of this EIS. The requirement for physical mitigation measures and/ or other appropriate noise management measures, is to be assessed and implemented prior to the commencement of activities which have the potential to cause noise or vibration impacts.	Pre-construction and construction

Ref	Aspect	Control	Timing
NV03	General construction noise and vibration measures	To the extent reasonable and feasible, the following measures will be adopted: ▪ Limit surface works that result in noise levels above NMLs to standard hours of construction. Where this is not feasible and reasonable, the work would be undertaken as early as possible in each work shift ▪ Select low-noise plant and equipment and ensure equipment mufflers operate in a proper and efficient manner ▪ Use quieter and less vibration emitting construction methods ▪ Only have necessary equipment on-site and turn off when not in use ▪ Concentrate noisy activities at one location and move to another as quickly as possible ▪ Vehicle movements, including deliveries outside standard hours should be minimised and avoided where possible ▪ Ensure all plant and equipment is well maintained and where possible, fitted with silencing devices ▪ Use only the necessary size and powered equipment for tasks ▪ Implement training to induct staff on Project noise and vibration sensitivities ▪ Consider the application of less intrusive alternatives to reverse beepers such as 'squawker' or 'broadband' alarms ▪ Consider the installation of temporary construction noise barriers for concentrated, noise-intensive activities ▪ Where practicable, install enclosures around noisy mobile and stationary equipment as necessary ▪ Avoid simultaneous operation of two or more noisy plant close to receivers ▪ The offset distance between noisy plant and sensitive receivers should be maximised ▪ Plan traffic flow, internal haulage routes, parking and loading/unloading areas to minimise the need for reversing movements and hard braking ▪ Delivery and loading / unloading of materials should occur as far as possible from sensitive receivers ▪ Select site access points and roads as far as possible from sensitive receivers ▪ Limit speed limits along internal haulage routes to reduce associated noise emissions ▪ Consider the use of quieter spoil transport technologies (e.g., conveyors) rather than trucks as appropriate ▪ Implement consultation, respite, notification, verification and additional requirements as appropriate, as listed in Section 5 of the Draft CNG (EPA). ▪ Complete routine monitoring to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision.	Construction
NV04	Out of hours works	All out of hours works will be undertaken in accordance with an out of hours works protocol that includes the following: ▪ Justification of requirement to undertake the works out of hours ▪ Further consideration of noise impacts ▪ Identification of reasonable and feasible mitigation measures as necessary to achieve NML or otherwise mitigate impacts ▪ Communication protocols for impacted receptors.	Construction

Ref	Aspect	Control	Timing
NV05	Notification	Where exceedances of noise mitigation measures are predicted, affected residents would be notified of works and potential disruptions. The notification would detail work activities, time periods over which the works will occur, impacts and mitigation measures. Notifications should be given a minimum of five days prior to works commencing.	Construction
NV06	Verification and adaptive management	Attended noise measurements would be undertaken to verify the noise levels predicted in this noise assessment are accurate and whether mitigation measures are appropriate. Attended noise measurements would also be undertaken to address any noise complaints raised as a result of the proposed works.	Construction
NV06	Ground-borne noise and vibration	Detailed design and construction planning should consider final tunnel alignment and construction methodology and develop necessary mitigation measures to address any remaining predicted exceedances. Where likely to be perceptible, affected receivers would be consulted on impacts to be expected and how they are to be avoided or otherwise effectively managed.	Pre-construction
NV07	Blasting	Blasting would be subject to stringent processes in accordance with the legislative and project requirements. The Interim Construction Noise Guideline recommends blasting on the surface occur between Monday to Friday (9am to 5pm) and Saturday (9am to 1pm) with no blasting on Sundays or public holidays unless otherwise agreed by the NSW Environment Protection Authority. Blasting on the surface would be planned during hours that would cause the least disruption and disturbance to the nearest receivers. Notification protocols prior to blasting for the nearest sensitive receivers would be established. Blasting underground may occur 24/7 where there is no material impact to sensitive receivers. Should the contractor undertake blasting to construct the project, a Blast Management Strategy would be prepared to address: ▪ Details of blasting to be performed ▪ Identification of all potentially affected sensitive sites including heritage buildings and utilities ▪ Establishment of appropriate criteria for blast overpressure and ground vibration ▪ Details of the transportation, storage and handling arrangements for explosive materials ▪ Determination of potential noise and vibration and risk impacts and appropriate best management practices, including: - A trial blast strategy - Additional pre- and post-dilapidation surveys - Community consultation and information program - Reasonable and feasible mitigation ▪ The necessary blast trials to establish conformance with the criteria. The blast management strategy will be prepared in consultation with Water NSW and endorsed by a suitably qualified and experienced person.	Prior to undertaking blasting
NV08	Changes in traffic noise during construction	The following controls would be considered in the traffic management plan for the Project: ▪ Schedule Project construction transport to avoid sensitive periods and locations to the extent reasonable and feasible ▪ Ensure drivers operate in a manner that avoids unnecessary impacts (e.g. from air braking) ▪ Ensure that vehicles are adequately silenced before allowing them access to site and consider selection of quieter vehicle types to the extent reasonable and feasible ▪ Review and update measures as necessary through construction.	Construction

Ref	Aspect	Control	Timing
NV09	Operational noise impacts	Operational noise sources for the Project should be reviewed as part of detailed design to ensure that the resulting noise levels and outcomes do not exceed predictions or are otherwise managed to achieve Project noise trigger levels during all relevant meteorological conditions.	Detailed design and operation

6.9 Air quality

This section provides an assessment of the potential air quality impacts of the Project and measures to mitigate them. Further detail is provided in **Appendix N** (Air Quality impact assessment).

The assessment addresses the following SEARs:

Air – including:

- An assessment of the air quality impacts of the project, including particulate matter and greenhouse gas emissions.

6.9.1 Legislative and policy context

The air quality assessment has been prepared to evaluate the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *POEO Act*
- *Protection of the Environment Operations (Clean Air) Regulation 2010*
- *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA, 2022) (the Approved Methods)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2022)
- *National Environment Protection (Ambient Air Quality) Measure* (National Environmental Protection Council, 2021).

6.9.2 Methodology

The air quality assessment:

- Used meteorological modelling to derive conditions near the Project as there are no known meteorological stations in the Kangaroo Valley.
- Examined meteorological information and modelled subsequent data from a five year period (2017 – 2021 inclusive) at Nowra station, using 2020 as representative average year
- Assessed data from four monitoring stations (Albion Park South, Bargo, Kembla Grange and Wollongong) to review key air quality indicators (PM10, PM2.5, total suspended particulates (TSP) and deposited dust) within the existing environment
- Examined data using quantified computer-based air dispersion modelling to assess the potential construction impacts, including use of the APZ
- model to predict ground-level particulate matter concentrations and deposition levels due to the Project and other sources (consistent with the Approved Methods)
- Followed the EPA's assessment criterion which establishes a national standard for air quality conditions. Particulate matter concentrations were examined against the standards to determine potential cumulative impacts
- Identified and evaluated mitigation measures relating to the construction phase of the Project
- Identified other Projects that could be considered for cumulative impacts and assessed them against a screening criterion to objectively determine the cumulative impact of the Project.

6.9.3 Existing environment

This section examines the recent and historical air quality conditions in the Shoalhaven region and establishes the appropriate background levels to be considered for assessment of the Project, as outlined in the Approved Methods.

The surrounding land use relevant to air quality impacts are described in **Section 2.4.**

6.9.3.1 Meteorology

The annual data statistics of five recent years (2017-2021 inclusive) were analysed and a representative year (2020) was selected. The results show that wind patterns appear to be consistent and do not change significantly from year-to-year in this region. Average and maximum wind speeds exhibited similar ranges across the annual data. As an hourly average, maximum wind speeds reached around 15-20 m per second, which was not isolated to a particular time of year.

6.9.3.2 Air quality

Air quality conditions are strongly correlated to climatic conditions. Key indicators such as PM_{10} and $PM_{2.5}$ are strongly influenced by seasonal variations. PM_{10} concentrations are generally higher in warmer months, whilst $PM_{2.5}$ occurs in higher concentrations during cooler months, due to combustion-related sources such as bushfires, motor vehicles and wood smoke from domestic heating. **Table 6-43** shows the expected background levels and the EPA's assessment criterion of key indicators that may apply to sensitive receptors. Potential cumulative impacts are determined by adding the Projects contributions of key indicators to the assumed background levels.

During the period of 2017 to 2020, PM_{10} and $PM_{2.5}$ concentrations increased which coincided with increased drought conditions and dust storms. At the same time there were significant increases in concentrations during 2019-2020 due to large scale bushfires. These conditions led to increases in the annual average and number of days that PM_{10} exceeded 50 µg/m^3, while $PM_{2.5}$ exceeded 25 µg/m^3 which are concentrations above the EPA's assessment criterion. The annual average of TSP is estimated to be much lower than the EPA assessment criterion of 90 µg/m^3. Deposited Dust is estimated to be lower than the EPA's assessment criterion of 4g/m^2/month annual average.

Concentrations of all key air quality indicators are expected to be lower near the Project than in areas of higher population densities.

Table 6-43. Assumed background levels that apply to sensitive receptors

Air Quality Indicator	Averaging Time	Assumed background level that applies at sensitive receptors	EPA Assessment Criterion
Particulate matter (PM_{10})	24-hour	Variable by day	50 µg/m^3
	Annual	17 µg/m^3	25 µg/m^3
Particulate matter ($PM_{2.5}$)	24-hour	Variable by day	25 µg/m^3
	Annual	6.8 µg/m^3	8 µg/m^3
Particulate matter (TSP)	Annual	43 µg/m^3	90 µg/m^3
Deposited dust	Annual	2.0 g/m^2/month	2.0 g/m^2/month (incremental) 4.0 g/m^2/month (cumulative)

6.9.4 Construction impacts

The highest potential for emissions and adverse air quality impacts associated with this Project would most likely occur during the construction phase of the Project. Emissions are expected to arise from dust (PM_{10}, $PM_{2.5}$, TSP and deposited dust) generated by construction related activities like spoil haulage, unloading and loading of spoil, wind erosion from emplacement areas. There would also be exhaust emissions from machinery and equipment used during the construction. Dust emissions are typical of standard construction projects and can be managed using the mitigation measures proposed in **Section 6.9.6.**

Activities related to construction are anticipated to contribute little emissions from key indicators and are unlikely to cause concern to the nearest sensitive receptors. The highest concentrations are expected to occur on site near the emplacement area and ventilation shaft, away from sensitive receptors. Results show key indicators would not exceed the EPA's assessment criterion and are unlikely to cause adverse air quality impacts.

6.9.4.1 Particulate matter (as PM_{10})

Figure 6-17 shows the cumulative modelled annual average PM_{10} concentrations during construction of the Project. In summary:

- The highest concentrations of PM10 are expected to occur near the emplacement area and ventilation shaft
- Construction of the Project is anticipated to contribute up to approximately 10 µg/m3 of PM10 at the nearest sensitive receptors
- Construction of the Project would not cause any additional days above the 50 µg/m3 24-hour average criterion of PM10 at sensitive receptors
- Construction of the Project would not result in an exceedance of the 25 µg/m3 annual average PM10 at sensitive receptors.

As a result, it is anticipated that construction of the Project is unlikely to cause adverse air quality impacts with respect to PM_{10}.

6.9.4.2 Particulate matter (as $PM_{2.5}$)

In summary:

- The highest concentrations of PM2.5 are expected to occur near the emplacement area and ventilation shaft
- Construction of the Project is anticipated to contribute up to approximately 2 µg/ m3 of PM2.5 at the nearest sensitive receptors
- Construction of the Project would not cause any additional days above the 25 µg/m3 24-hour average criterion of PM2.5 at sensitive receptors
- Construction of the Project would not result in an exceedance of the 8 µg/m3 annual average PM2.5 at sensitive receptors.

As a result, it is anticipated that construction of the Project is unlikely to cause adverse air quality impacts with respect to $PM_{2.5}$.

6.9.4.3 Particulate Matter (as TSP)

In summary:

- Construction of the Project is anticipated to contribute up to approximately 47 µg/m^3 of TSP at the nearest sensitive receptors
- Construction of the Project would not result in the exceedance of 90 µg/m^3 annual average TSP at sensitive receptors.

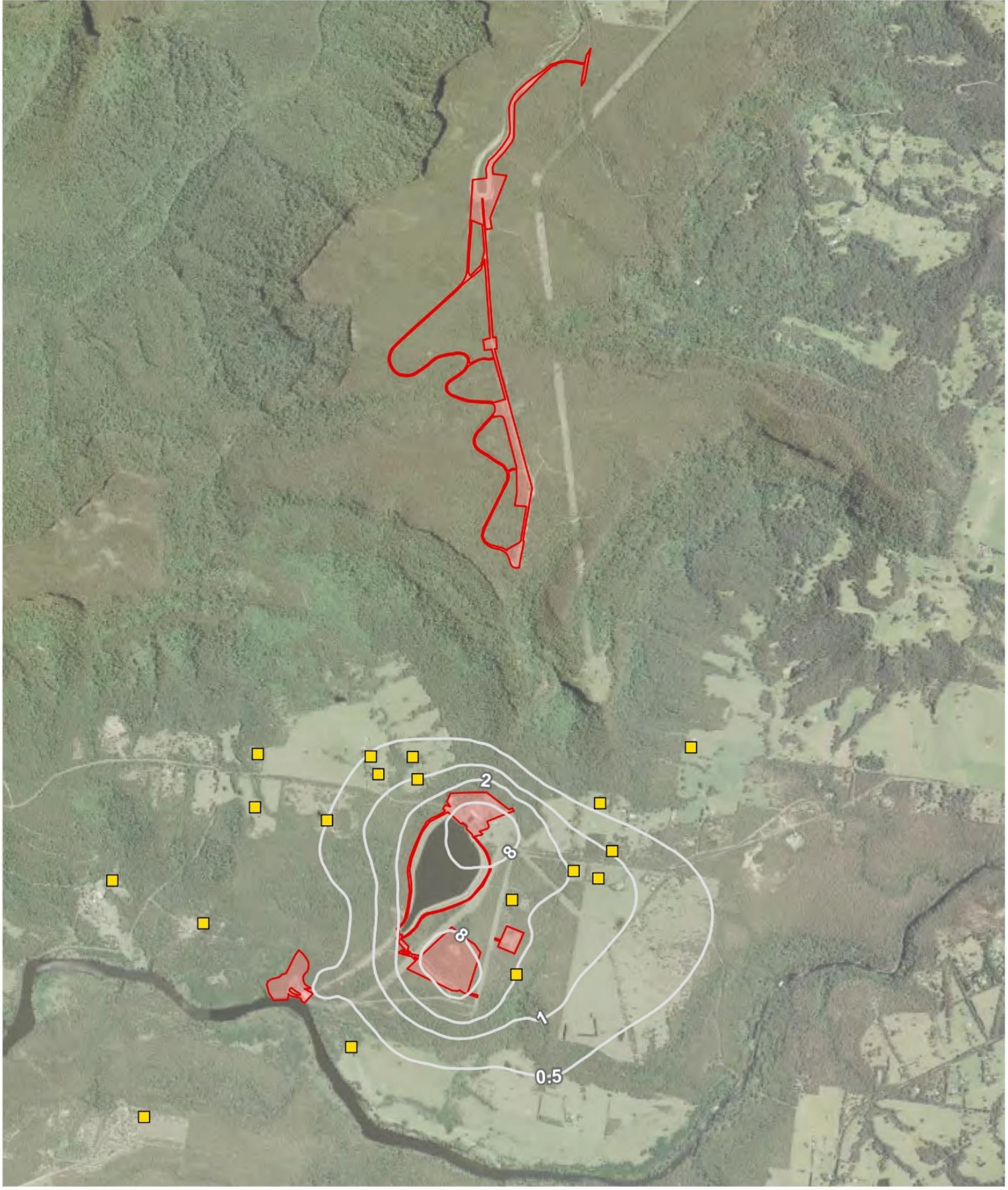
As a result, it is anticipated that construction of the Project is unlikely to cause adverse air quality impacts with respect to TSP.

6.9.4.4 Deposited Dust

In summary:

- Construction of the Project is anticipated to contribute up to approximately 2g/m^2/month of deposited dust at the nearest sensitive receptors
- Construction of the Project would not result in the exceedance of 2g/m^2/month (incremental) 4g/m^2/month (cumulative) annual average deposited dust criteria at sensitive receptors.

As a result, it is anticipated that construction of the Project is unlikely to cause adverse air quality impacts with respect to deposited dust.



Legend

- Sensitive Receptors
- Contour representing extent of PM_{10} ($\mu g/m^3$)
- Project area

0 1 2 km

1:35,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-17 Cumulative modelled annual average PM_{10} concentrations during construction of the Project ($\mu g/m^3$)

Date: 27/07/2022 Path: \\ausyd0vs01\gisproj\NSW_IS\302600_Shoalhaven\IS\Apps\IS302600_Air Quality.aprx
Created by: JB | QA by: HK

6.9.5 Operational impacts

As there would be no significant air emissions sources during operation of the Project, operation of the Project is not anticipated to cause any adverse air quality impacts.

6.9.6 Mitigation measures

Mitigation measures to address the potential air quality impacts of the Project are listed in **Table 6-44**.

Table 6-44. Air Quality mitigation measures

Ref	Impact	Mitigation Measure	Timing
AQ01	Dust due to spoil haulage	Measures will be included in the CEMP and spoil management plan to reduce dust due to spoil haulage, including: ▪ Watering of haul routes ▪ Maintenance of haul routes ▪ Restricting vehicle speeds ▪ Clearly marked haul routes ▪ Prompt cleanup of any material spillage	During construction
AQ02	Wind erosion from emplacement areas	The extent of exposed areas will be minimised where practicable to reduce wind erosion. In addition, wind fences and dust suppression using water sprays and water carts would also be used where practicable.	During construction

6.10 Greenhouse gas

This section provides an assessment of the potential greenhouse gas impacts of the Project and measures to mitigate them. The Project, like all electricity generation projects, would generate GHG emissions associated with construction and operation. It is considered that these emissions are more than offset by the Project's critical contribution to overall reduction of the average emissions intensity of the NEM.

Additionally, while the Project does generate greenhouse gas emissions, a key component is energy storage. The Project and other storage projects are recognised in energy and climate change policies at all levels of government as essential to facilitating the rapid transition to a net zero NEM through the provision of dispatchable generation required to supplement intermittent renewable sources such as wind and solar.

The assessment addresses the following SEARs:

Air – including:

- An assessment of the air quality impacts of the project, including particulate matter and greenhouse gas emissions.

6.10.1 Legislative and policy context

The GHG assessment has been prepared to evaluate the potential impacts of the Project in accordance with the legislation, policy and guidelines in **Section 2.2**, as well as the following:

- *The Greenhouse Gas Protocol (GHG Protocol) by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)*
- *International Standardisation Organisation (ISO)14064-1:2018 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.*

6.10.2 Methodology

A greenhouse gas inventory (sometimes referred to as a carbon footprint) is an assessment of the life cycle GHG emissions associated with a product, service or event. All GHGs (such as methane and nitrous oxide, as well as carbon dioxide) are aggregated and reported as a single number of 'carbon dioxide equivalents' (CO_2-e). As increasing concentrations of GHGs in the atmosphere are known to contribute to global warming, being

able to reduce these emissions across the life cycle will reduce the potential impact of the Project on global warming.

GHG emissions can be attributed to a number of sources, both direct and indirect, and can be split into three categories, known as 'Scopes'. Scopes 1, 2 and 3 are defined by the GHG Protocol and can be summarised as:

- Scope 1 – Direct emissions of GHGs from sources that are owned or operated by a reporting organisation (examples – combustion of diesel in company owned vehicles or used in on-site generators)
- Scope 2 – Indirect Emissions associated with the import of energy from another source (examples – import of electricity from the grid, or heat)
- Scope 3 – Other indirect emissions – other than energy imports (above) which are a direct result of the operations of the organisation, but from sources not owned or operated by them (examples include offsite third-party haulage of wastes and manufacture of construction materials).

For the purposes of this EIS, Scope 1, Scope 2 and material Scope 3 emissions have been determined for all operating and construction scenarios. Selected Scope 3 emissions have been included as they represent a material contribution to the overall GHG construction footprint. The sources of likely GHG emissions have been determined based on based on previous experience of similar hydro-electric projects, noting that:

- No emissions were estimated for emission sources during the design phase (e.g., consumption of electricity in offices, fuel consumption of plant / equipment used in investigative work). The exclusion of these emissions would not materially impact on the assessment as they are likely to represent less than 1 % of the total emissions for the Project.
- No emissions were estimated for the operation of the onsite concrete batch plants, as the emissions factor to calculate the embodied emissions of concrete for the Project includes the operation of batch plants.

6.10.3 Construction impacts

Table 6-45 outlines the scope 1, 2 and 3 emissions for activities and sources from the construction of the Project, including:

- Fuel consumption and transport
- Electricity construction
- Vegetation clearing
- Construction materials
- Waste.

In summary, the total emissions related to construction of the Project would be about 97,500 tCO_2-e, of which the majority is related to the embodied emissions of materials. This is shown more clearly in **Figure 6-18**, where 61 % of emissions come from the materials through embodied emissions. The next major contributors are electricity consumption and vegetation clearing at 15 % and 13 % respectively. The emissions related to transportation of spoil, materials and employees can be considered negligible when compared to the main contributors.

Table 6-45. Summary of emissions relating to construction activities

Activity/source	GHG emissions (tCO_2-e)				
	Scope 1	Scope 2	Scope 3	Total	Percentage (%)
Construction fuel	9,307		477	9,784	10 %
Electricity consumption		13,731	1,232	14,963	15 %
Vegetation clearing			12,414	12,414	13 %
Materials (Embodied)			58,986	58,986	61 %
Transport of materials			304	304	<1 %
Employee commute			818	818	1 %
Transport of spoil			184	184	<1 %
Waste degradation				0	0 %
Transport of waste				0	0 %
Total	**9,307**	**13,731**	**74,415**	**97,454**	**100 %**

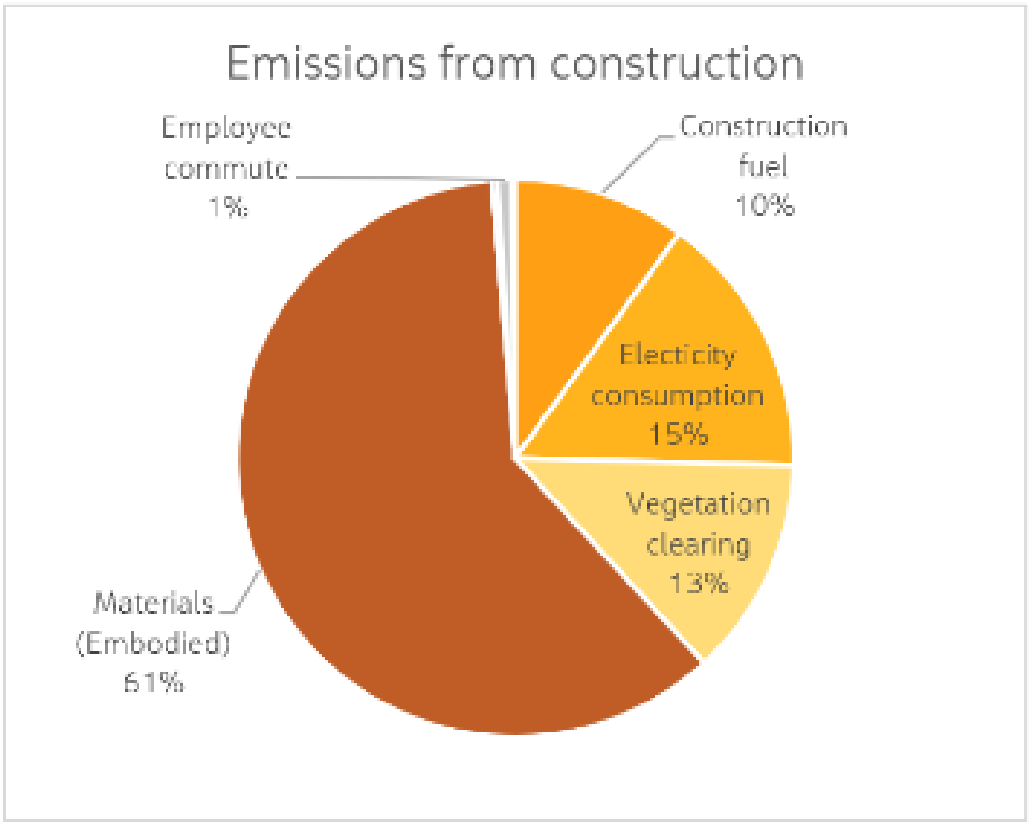


Figure 6-18. Percentage breakdown of emissions related to Project construction

6.10.4 Operational impacts

Operation of the Project is expected to export 1880 MWh of electricity into the energy grid per full cycle of electricity generation. To maintain operation, water is required to be pumped up hill back into the reservoir. This is expected to require 2400 MWh. This gives one generation cycle with an energy efficiency of 78 %.

For the purposes of GHG assessment, a scenario has been considered in which the additional energy per cycle is sourced and purchased directly from the NEM. While this would result in net positive emissions, releasing more GHG emissions into the atmosphere per MWh of energy consumed by customers, this is considered to be a worst-case scenario and it is anticipated that the carbon intensity of the NEM will likely decrease over the design life of the Project, due to the increase of renewable energy, and the reduction in fossil fuel based generated electricity. Based on the ISP (AEMO, 2022), net zero is fast approached by 2035. This would avoid operational emissions related to pumping and would act as a way to store excess renewable energy during times of over production. This would be more relevant as the amount of renewable energy in the NEM increases, as Australia reaches the net zero targets, and energy storage techniques become increasingly sought after.

Assuming the projected NEM emission intensity factors, based on a net-zero by 2050 scenario, the combined GHG intensity of the Project over the estimated 100 year life of the asset would be about 49 metric tons of carbon dioxide equivalent (tCO2-e), per gigawatt hour (GWh) generated. This metric considers the difference between the energy used to pump water up the hill and the energy generated by the asset over the lifetime.

Given that the NEM GHG intensity at the time of writing is 1,000 tCO_2e/GWh, the Project is anticipated to represent a significant saving in GHG emissions compared to the existing energy market. With the long-term reduction in fossil fuel based generated electricity, this saving is anticipated to become more efficient over time, which will support Origin's commitment to be net zero emissions by 2050.

6.10.5 Mitigation measures

Mitigation measures to address the potential air quality impacts of the Project are listed in **Table 6-46**.

Table 6-46. GHG mitigation measures

Ref	Impact	Mitigation measure	Timing
GH1	General	Detailed design and construction planning will be undertaken to consider opportunities for less carbon intensive methods and materials to the extent reasonable and feasible.	Pre-construction
GH2	Vehicle and plant emissions	Management practices will be implemented during construction, including: ▪ Operation and maintenance of construction plant and equipment to maximise efficiency and reduce emissions ▪ Lower emission plant and vehicles and alternative fuels will be used where feasible and reasonable ▪ Construction planning to minimise vehicle wait times and idling onsite ▪ Where feasible and reasonable earthwork balances will be managed to ensure that transport of material is minimised.	Pre-construction/ Construction
GH3	Electricity consumption	Where feasible and reasonable, electricity consumption will be sourced from renewable sources.	Pre-construction/ Construction
GH4	Material emissions	The use of materials with recycled and low-carbon content, including recycled steel and low carbon cement, will be investigated and incorporated to the extent reasonable and feasible.	Pre-construction/ Construction
GH5	Fuel use	Where feasible and reasonable electric vehicles would be used for operational inspection vehicles and maintenance equipment.	Operation
GH6	Operational electricity use	The potential to purchase operational electricity from renewable sources or offset GHG emissions would be further investigated and considered in accordance with Origin's net zero commitments.	Operation

6.11 Waste

This section provides an assessment of the potential waste impacts of the Project and measures to mitigate them.

The assessment addresses the following SEARS:

Waste and spoil management – including:

- identify, quantify, and classify the likely waste streams to be generated (including spoil) during construction and operation, and describe the measures to be implemented to manage, re-use, recycle and safely dispose of this waste.

6.11.1 Legislative and policy context

- *POEO Act*
- *Waste Avoidance and Recovery Act 2001*
- *Protection of the Environment Operations (Waste) Regulation 2014*
- *NSW Waste Avoidance and Resource Recovery Strategy 2014-21* (EPA, 2014a)
- *Waste Classification Guidelines* (EPA, 2014b).

6.11.2 Methodology

The waste assessment methodology has included the following:

- Quantification of spoil that would be produced by construction of the Project
- Development of a spoil management strategy to identify the volumes and classification of spoil that would be produced, and how spoil would be managed
- Identification of potential waste generating activities and likely waste streams

- Identification of opportunities for the avoidance, minimisation, and reuse of waste
- Identification of the environmental impacts associated with the generation (and subsequent disposal) of residual waste materials.

Resource use and waste generation for the Project has been identified and assessed based on proposed activities during construction and operation, the associated materials and resources required during each phase, their likely sources, and associated types of wastes that would be generated.

6.11.3 Construction impacts

6.11.3.1 Construction waste

Potential waste generated during Project construction would be managed using the waste hierarchy approach; whereby avoiding the generation of waste and reusing materials are prioritised over waste disposal. All waste would be managed in accordance with the waste provisions contained within the POEO Act and the Waste Regulation. Where waste would be reused offsite, relevant EPA Resource Recovery Orders and Exemptions would be followed. All material that is suitable for reuse would be used for construction.

The waste hierarchy prioritises waste management and ranges from most preferable to least preferable, as follows:

- Waste avoidance
- Waste reuse, recycling, reprocessing
- Waste disposal.

Should waste be found to be unsuitable for reuse, recycling or reprocessing, the disposal method would be selected based on the classification of the waste material in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (NSW EPA, 2014b). The Waste Classification Guidelines provide direction on the classification of waste, specifying requirements for management, transportation, and disposal of each waste category.

The management of construction waste would be in accordance with the statutory requirements presented in **Section 6.11.1**, and the management measures presented in **Section 6.11.5**. If waste is not appropriately managed there would be the potential to pollute the local environment including waterways.

A waste management plan would be prepared and implemented as part of the CEMP for the Project. As a result, the overall impact of construction waste is considered to be manageable and acceptable.

Table 6-47 outlines the construction waste streams, their classification and estimated quantity where possible and proposed management.

Table 6-47. Construction waste streams

Waste identification	Waste description	Likely Classification	Estimated quantity	Proposed management
Construction waste	Timber, packaging, metal, asphalt, concrete, glass, plastic, rubber, plasterboard, ceramics, bricks from the installation of foundations and underground services and above ground civil, mechanical and electrical plant and equipment.	General	Unknown	Segregated for recycling to the extent practical in accordance with current site practices. Material unable to be recycled or reused on site would be classified for lawful disposal
Grit, sediment in erosion controls	Collected in, and removed from, stormwater treatment devices and/or stormwater management systems	General	As generated	Clean sediment would be incorporated into rehabilitation.

Waste identification	Waste description	Likely Classification	Estimated quantity	Proposed management
Green waste	Clearing of vegetation	General	Subject to detailed design	Reuse in rehabilitation on site unless identified as weed infested in which case disposal at green waste facility.
Fuel contaminated soils	Spills from construction plant and refuelling	Hazardous	Minimal	Refuelling only in controlled areas. Spill clean-up material would be placed in dedicated covered skip bin for collection for off-site disposal at an appropriately licensed facility.
Maintenance fluids (fuels, lubricants, solvents, and other chemicals	Containers that previously contained Class 1, 3, 4, 5 or 8 substances used for construction plant. Used oil from construction plant.	Hazardous	Unknown volume, waste associated with minor maintenance of generators and earthmoving equipment.	Fuels and oils drained from plant for maintenance would be decanted for re-use. Where unsuitable they would be taken off-site for recycling.
Sewerage and grey water	Portable ablutions facilities pump-out	Liquid	As required	The works may require pump out for off-site disposal and/ or disposal through the Existing Scheme's treatment systems.
Wastewater	Water generated from concrete batching, dust suppression, tunnel process water, washdown water, amenities and controlled discharge	Liquid	Up to 613.9 ML over the life of the Project	Water would be reused where practicable. Any water returned back to the environment will be treated so that it meets the nominated background water quality for the receiving waterway
Site office waste	Paper/cardboard	General	As generated	Recycled as per existing site practices
Food waste	Generated from workers lunches	Putrescible	As generated	Off-site as per existing practices

6.11.3.2 Spoil and topsoil

The construction planning for this Project aims to avoid or minimise potential spoil and resource use impacts. This included the selection of tunnel boring machines for excavation practices which would minimise spoil generation by cutting a circular profile.

The Project would generate about 420,00 m^3 of bulk spoil that would need to be managed. The spoil will be managed in accordance with the spoil management strategy, refer to **Appendix K** and **Section 3.4.4** with the bulk transported to an onsite permanent spoil emplacement area. Machinery such as an extendable conveyor or trucks would be used to transport the spoil to the stockpiles.

6.11.4 Operational impacts

Waste generated by the operation of the Project would be limited. Waste would be generated from maintenance activities (including vegetation removal and minor repair works) as well as general waste from maintenance personnel such as litter and sewage. Waste generated during operation would either be

immediately removed from site and disposed of appropriately, or suitability stored onsite for pick up by a licenced contractor as required.

6.11.5 Mitigation measures

Mitigation measures to address the potential waste impacts of the Project are listed in **Table 6-48**.

Table 6-48. Waste environmental mitigation measures

Ref	Impact	Mitigation Measure	Timing
W1	Construction	A waste management plan will be developed for the Project with the following criteria: ▪ A hierarchical waste management approach will be used, from the most preferable (reduce, reuse or recycle wastes) to the least preferable (disposal) to prioritise waste management strategies to avoid waste generation ▪ The plans will promote the use of materials with minimal packaging requirements, removal of packaging off-site by suppliers and fabrication of parts off-site ▪ Where waste cannot be avoided, waste materials will be segregated by type for collection and removal (for processing or disposal) by licensed contractors ▪ All waste types will be separated at source for recycling ▪ A licensed service provider will be appointed to collect waste during construction and operation ▪ Each waste type will be classified for transport to ensure correct handling ▪ Any waste that cannot be recovered or recycled will be disposed of to a suitably authorised or licensed treatment or disposal facility where it will be treated and disposed of according to its classification.	Detailed design
W2	Spoil and topsoil	Spoil and topsoil will be reused onsite where practicable. Where spoil and topsoil cannot be used on site, it will be used for other environmental or development projects, land restoration or landfill management.	Construction
W3	Vegetation	Cleared vegetation will be either mulched for on-site reuse or used to create habitat piles where practicable, noting that any weeds and pathogens will be managed according to requirements under the NSW *Biosecurity Act 2015*.	Construction

6.12 Public safety

This section provides an assessment of the potential risks to public safety from the Project and measures or processes to mitigate them.

The potential hazards and risks have been informed by **Appendix P (**Preliminary risk assessment) and **Appendix O (**Bushfire assessment).

The assessment addresses the following SEARS:

Public safety – including:

- an assessment of the risks to public safety, paying particular attention to bushfire and flooding risks, emergency egress and evacuation, and the handling of any dangerous goods.

6.12.1 Legislative and policy context

The public safety assessment has been prepared to evaluate the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Rural Fires Act 1997*
- *Work Health and Safety Act 2011 (WHS Act) and Work Health and Safety Regulation 2017*
- *Planning for Bushfire Protection* (NSW RFS, 2019) *(PBP)*
- *Morton National Park Fire Management Strategy (2006b) and the Shoalhaven Bushfire Management Committee's Bushfire Risk Management Plan (2018)*

- *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) *and relevant Australian Standards*
- *State Environmental Planning Policy (Resilience and Hazards 2021) and Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive.*

6.12.2 Methodology

Public safety risks include risks present in the construction workplace and environmental hazards that may present risks to surrounding communities and members of the public. The methodology for the assessment of public safety included:

- The preparation of a risk assessment (refer to **Appendix P**) that consider the possible hazard scenarios that could result from Project construction and operation events, including abnormal events and the consequences of these to people, property and the biophysical environment. The Project is essentially a duplication of the Existing Scheme as such the risk assessment considers whether the new activities or components would alter the current level of hazards or risk.
- The preparation of a bush fire assessment (refer to **Appendix O**) that identifies bushfire risk factors and bush fire impacts, as well as identifies bushfire protection measures
- An assessment of other public safety risks associated with hazardous goods and dangerous materials, traffic and transport and emergency response.

This public safety assessment does not take into account potential health and safety risks to on-site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the WHS Act) and are not relevant to approval of the Project under Division 5.2, Part 5 of the EP&A Act.

6.12.3 Existing environment

6.12.3.1 Overview

In relation public safety, the Project would be located:

- Within areas mapped as bushfire prone land. Bush fire is discussed further in **Section 6.12.3.2** and **Section 6.12.4.2**
- About 100 m from the nearest sensitive receiver and about 3 km from the Kangaroo Valley township
- Close by various sensitive receivers such as water bodies and rivers
- Within close proximity to energy generation and distribution infrastructure associated with Kangaroo Valley Power Station and Bendeela Power Station and network connections to NSW which generate Electric and magnetic fields (EMF). EMF is part of the natural environment and electric fields are present in the atmosphere and static magnetic fields are created by the earth's core. EMF is also produced wherever electricity or electrical equipment is in use. EMF are strongest closest to the wires and electrical equipment and their level reduces with distance. The higher the voltage, the stronger the field
- In an area with minimal potential to encounter contamination and naturally occurring asbestos but within area of PAF soils, refer to **Section 6.5.3**
- Not within areas mapped as flood prone areas or as mine subsidence district. As such not further assessment of these risks has carried out
- Not near any coastal hazards and there are no landslide or land movement risks
- In areas where access to parts of the Project area will be closed to the public for the duration of construction works to ensure public safety

As the Project essentially duplicates the Existing Scheme, the Project would not result in any new water storages or connections between waterbodies that have not already been utilised for the Existing Scheme. In addition, no transmission line augmentations are required to receive or distribute electricity from the existing Kangaroo Valley Power Station substation.

6.12.3.2 Bushfire

6.12.3.2.1 Bush fire conditions and bush fire history

The Project would be carried out within a heavily vegetated area that is classified as bushfire prone land. Most of the vegetation surrounding the Project area is Category 1 high bush fire risk vegetation under the PBP mapping. There are some lower risk areas associated with rainforest (Category 2) and cleared areas (Category 3).

The bushfire season generally runs between October and March. The Project area is identified as having a 1:50 year Forest Fire Danger Index.

The landscape around the Project has the potential to support extreme bushfire behaviour, as evidenced previous bushfires in 2019 and 2020. The topography is complex, mountainous and steep with gorges and valleys that can funnel wind and fire. Fuel loads associated with wet and dry sclerophyll forests and rainforest are contiguous over large areas.

High bushfire risk weather conditions are most frequently associated with hot dry north-westerly winds. These conditions can be followed by a strong south-westerly change, turning the north-east flank of the fire into a long head fire

Bushfires occur frequently in the landscape surrounding the Project area. Sixty bushfires are recorded to have occurred within 10 km of the Project area since 1975. Five of these fires have impacted the Project area.

6.12.3.2.2 Fire management arrangements

Bushfire management arrangements for the Project region are described in the Morton National Park Fire Management Strategy (2006) and the Shoalhaven Bushfire Management Committee's Bushfire Risk Management Plan (2018).

These documents identify the Kangaroo Valley Power Station as well as the Bendeela pondage area and associated infrastructure as Strategic Fire Advantage Zones. These zones are strategically placed and managed to provide an advantage for fire fighters in containing and suppressing wildfires.

Prescribed burning is used to manage ecological values and the bush fire fuel hazard in forested areas in the landscape.

6.12.4 Assessment of impacts

6.12.4.1 Preliminary risk assessment

A risk assessment was carried out that considers hazards, associated risks and mitigation measures identified through various review processes. The risk assessment is provided in **Appendix P** and summarised below.

The final design details will not be known until the preferred tenderer is selected and their detailed design process is completed. As such the risk assessment focussed on known hazards associated with development aspects related to the Project and the Project area as a qualitative assessment based on industry experience and judgement.

The risk assessment identified 38 causes for hazard incidents with a potential to impact people, property and/or the biophysical environment if appropriate mitigation measures are not put in place. These are summarised in Table 6-49.

Table 6-49. Identified risks and risk level

Risk	Stage	Risk level
Power station flooding due to plant failure	Construction and operation	Medium
Underground works flooding	Construction	Medium
Fire in power station cavern or access tunnel	Operation	Medium
Fire in power station cavern or access tunnel	Construction	Medium

Risk	Stage	Risk level
Unhealthy atmosphere in underground locations	Operation	Medium
Unhealthy atmosphere in underground locations	Construction	Medium
Exit route blockage for underground works	Construction and operation	Medium
Loss of electrical power to underground structures/facilities	Construction and operation	Medium
Contamination of waterbodies	Operation	Medium
Contamination of waterbodies	Construction	Medium
Electrical hazards	Construction and operation	Medium
Mechanical Failure / Interaction with mechanical plant	Construction and operation	Medium
Injury or incident occurs due to falling objects or people	Construction and operation	Medium
High temperature environment is formed	Operation	Medium
High or low pressure could result in plant or equipment failure	Operation	Medium
Civil / Structural Failure	Construction and operation	Medium
Poor design of operating interfaces	Operation	Low
Odour	Construction and operation	Low
Maintenance hazard	Operation	Low
Incident occurs due to poor product quality	Construction and operation	Low
Emission	Construction and operation	Low
Process hazards	Construction and operation	Low
Noise	Construction and operation	Medium
Chemical and dangerous goods storage	Construction and operation	Low
Seismic events	Construction and operation	Low
Transport of equipment or materials to the site causes an unfavourable outcome	Construction and operation	Low
Vibration	Construction and operation	Medium
Dust	Construction and operation	Low
Threat that wildlife cause hazards to personnel	Construction and operation	Medium
There is a threat that security breaches occur resulting in an incident	Construction and operation	Medium
Loss of control signals	Operation	Low
Cyber security	Operation	Low
Materials and methods	Construction and operation	Low
EMF	Operation	Low
Workforce management and public safety hazards	Construction	Medium

As shown in Table 6-49 the highest identified Project risk relates to fire occurring in the power station cavern or tunnels during construction. However, this is not an unusual risk for tunnelling works and is routinely managed by experienced tunnelling contractors. While the hazards with medium level risk predominantly relate to either plant/mechanical failure, or underground elements of the Project including flooding, fire (during operation) due to the inherent risks associated with working in confined spaces.

The Project is in sensitive environments which require specific and carefully considered controls; however, they are not considered any more complex than similar pumped hydro storage or underground works Projects and well within the capability of an experienced construction contractor and operator to control.

The assessment concludes that at the current stage of development there are no hazards causing unacceptably high risks that could result in significant offsite public safety effects that are not manageable through application of inherent safety in design principles and mitigation measures.

More quantitative assessment of hazards and risk will be undertaken as the Project advances and detailed design is undertaken.

6.12.4.2 Bushfire

The bushfire assessment identified two bushfire scenarios that may affect the Project, these are:

- Scenario 1: Off-site ignition: A fire ignites in or burns into the vegetation surrounding the Project on a day of elevated fire danger. Under such conditions, embers and smoke carry towards/into the Project area and infrastructure and any personnel present would potentially be exposed to flames and radiant heat
- Scenario 2: On-site ignition: Electrical equipment failure or hot works associated with the Project results in fire ignition. Fire escapes into surrounding vegetation. This fire may be contained and remain small or spread under high risk conditions in the following days.

The potential bush fire related impacts considered in association with the Project include:

- Fire ignition
- Landscape fire
- Presence of Project infrastructure could affect suppression efforts for landscape fires
- Presence of Project infrastructure may affect bushfire fuel management.

Construction activities may present a different risk profile to those during Project operation due to the larger number of personnel and activities taking place on site. While the operation of the Project also has the potential to increase the bush fire risk through maintenance works such as hot works causing ignition within the Project area potentially enabling fire to spread from the Project area into the surround vegetation.

During this time risks of landscape fire to construction personnel and of on-site ignitions escaping from the site into the surrounding landscape may be elevated. Therefore site and emergency management planning is required to manage the risk of a fire to personnel, infrastructure and the risk of infrastructure exacerbating fire behaviour or making conditions unsafe and also manage the risk of operations creating an ignition source that could lead to a potential bush fire. The mitigation measure which includes emergency planning are outline in **Section 6.12.5**.

Should vegetation in the vicinity of the Project be ignited in a bushfire, it would potentially expose Project infrastructure to flames, radiant heat and embers. The level of exposure to bushfire (bushfire attack level (BAL)) is calculated using the method outlined in the PBP. This method was undertaken to demonstrate the potential exposure that may occur and to consider potential setbacks for infrastructure within this area.

The setbacks for different BALs were calculated from the edge of the Project area surrounding the Kangaroo Valley Power Station as this is the only area where new infrastructure is proposed that is considered necessary to manage the radiant heat exposure. The setback distances for each BAL rating are provide in **Table 6-50** and depicted in **Figure 6-19**.

Table 6-50. Bushfire attack level assessment for Kangaroo Valley Power Station Project area

Aspect	Kangaroo Valley Power Station set back distances						
Footprint perimeter aspect	**Northern perimeter**		**Western perimeter**	**South-western perimeter**	**North-eastern perimeter**		**South-eastern perimeter**
Distance to vegetation (m)	0		0	0	0		60
BAL40 setback (m)	18	28	28	46	18	28	22
BAL29 setback (m)	24	36	36	56	24	36	29
BAL19 setback (m)	33	49	49	73	33	49	40
BAL12.5 setback (m)	45	65	65	92	45	65	54

Where:

1) BAL-40: There is a much increased risk of ember attack and burning debris ignited by windborne embers. A likelihood of exposure to a high level of radiant heat and some likelihood of direct exposure to flames from the fire front.
2) BAL-29: There is an increased risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to a high level of radiant heat.
3) BAL-19: There is a risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to radiant heat.
4) BAL-12.5: There is a risk of ember attack.

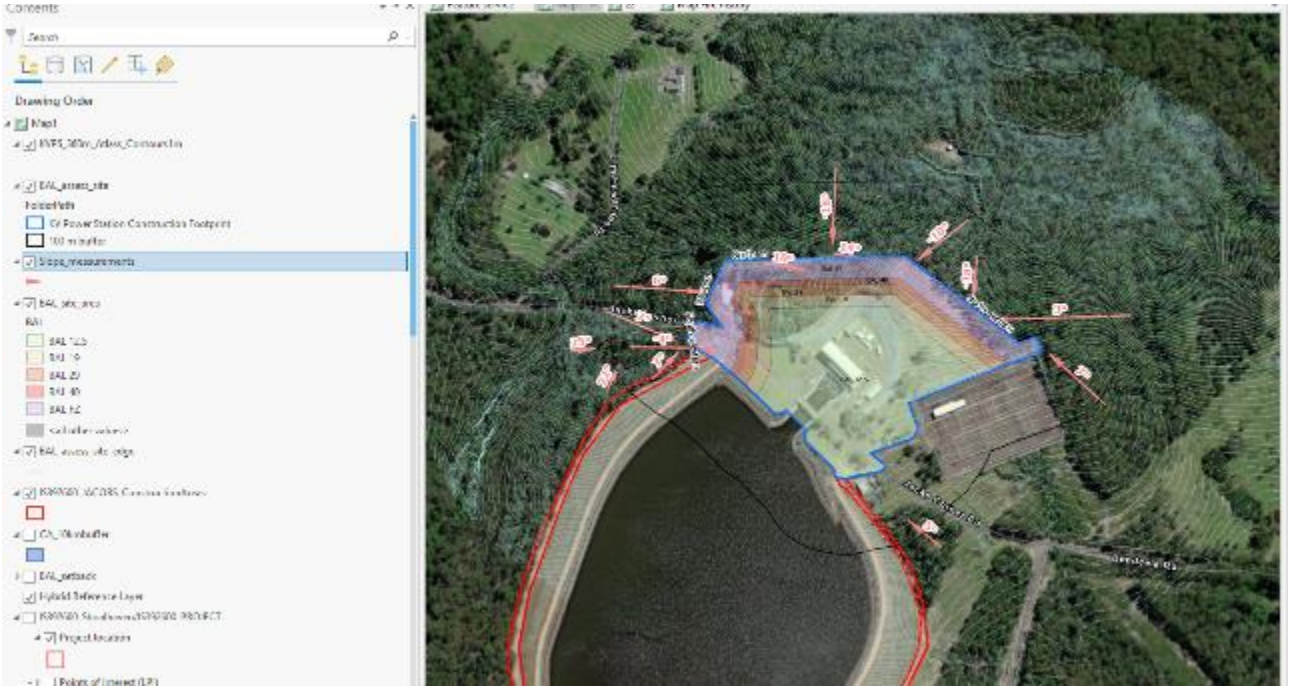


Figure 6-19. Bushfire attack level assessment for Kangaroo Valley Power Station Project area

6.12.4.3 Emergency egress and evacuation

One of the keys challenges for the Project is that the Project is remote and existing access is constrained by topography and limited existing road infrastructure. The Project area is large distance from the nearest residential or commercial land uses and publicly accessible areas. Access to parts of the Project area will be closed to the public for the duration of construction works to ensure public safety.

The power station access tunnel that would be constructed as part of the Project is anticipated to have an internal diameter of up to 8. The access tunnel would be configured to allow delivery vehicles to turn-around below ground, and the Promised Land Trail/ McPhails Firetrail would be upgraded upgrades to facilitate site access during construction.

In addition, the underground facilities would include a multipurpose ventilation and egress tunnel separate from access tunnel.

These upgrades along with the existing access network would enable safe egress for Project personnel in case of a bushfire or other emergency.

6.12.4.4 Dangerous goods

The transport and storage of dangerous goods (which includes flammables, explosives, or other chemicals) could pose a significant risk to health and safety and surrounding environment if not appropriately managed.

The types of dangerous goods and hazardous substances that would be transported to the Project area and used on site during construction may include, but are not limited to:

- Diesel fuels
- Oils, greases and lubricants
- Explosives (Class 1)
- Gases (oxy-Acetylene) (Class 2.1)
- Paints and epoxies (Class 3 PGII and Class 3 PGIII)
- Herbicides (class 6.1 PGII)
- Transformer insulation oils.

The types of dangerous goods and hazardous substances that would be stored and used during construction would be confirmed by the construction contractor and addressed in the CEMP for the Project.

It is expected that small amounts of dangerous goods and hazardous substances would be held or stored on site during operation to be used during operation and maintenance.

The storage, handling and use of dangerous goods and hazardous substances during construction and operation would be carried out in accordance with the WHS Act and associated regulations, the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and relevant Australian Standards

6.12.5 Mitigation measures

Mitigation measures to address the public safety risks of the Project are listed in **Table 6-51**.

Table 6-51. Waste environmental mitigation measures

Ref	Impact	Mitigation Measure	Timing
PS1	Hazards and risks	▪ Undertake Safety in design workshops with specific attention on construction and operation of underground elements, as well as operational control processes ▪ Specify requirements for designers and contractors to demonstrate robust designs that include redundancy to prevent, monitor and (where unable to eliminate the possibility) control hazards including through: - Underground works flood assessment and design controls - Underground works fire risk assessment and design controls - Implementing robust safety in design process - Occupational noise assessment. ▪ Specification of industry standards and requirements that are most relevant and applicable to the Project and for the hazards and risks which require management ▪ Develop and implement suitable management plans for the construction of the project, including CEMP, Construction Safety Plan and Emergency Response Plan ▪ Engage reputable and experienced design consultants and construction contractors who are knowledgeable in good industry standards to design and construct the facility.	Detail design and construction
PS2	Bushfire	The following bushfire risk mitigation measures will be applied during construction and operation: - Asset Protection Zones (APZ): provide a buffer zone between a bushfire hazard and buildings or other structures. APZ will be managed to minimise fuel loads and reduce radiant heat levels, flame, ember, and smoke attack - Siting and construction of sensitive infrastructure: buildings and other infrastructure and any hazardous material storage areas with sensitivity to radiant heat exposure will generally be provided with an APZ and where possible constructed in accordance with the relevant Bushfire Attack Level as per the National Construction Code and Planning for Bushfire Protection (NSW RFS, 2019). Where such construction is not possible due to conflicts with infrastructure function, design will aim to maximise the resilience of the infrastructure to bushfire where practicable - Access roads: which provide safe operational access to and within the Project area for emergency services personnel. Access roads will also provide safe egress for site personnel in case of a bushfire or other emergency - Fire water supply: access to water for fire suppression and/or protection of structures or equipment located on site will be provided - Emergency and evacuation planning will be addressed with other hazards as part of the contractor's and operator's site emergency management planning - The APZs will be implemented to mitigate fire sensitive infrastructure. The final location of infrastructure will be determined during the detailed design process. The design will aim to maximise the resilience of all infrastructure to bushfire where practicable.	Construction and operation

Ref	Impact	Mitigation Measure	Timing
PS3	Bushfire	A Bush Fire Emergency Management and Evacuation Plan will be prepared consistent with the NSW RFS publication: A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan, and the AS 3745:2010; and includes: ▪ Daily readiness and preparation for bushfire: including awareness of forecast fire weather conditions, monitoring fire incidence and bushfire warnings in the landscape ▪ The effective management or shutdown of the f worksites during a bushfire to reduce the risk of exacerbating fire behaviour or increasing risk to fire fighters. The risk of ignition and fire spread from operations is managed to an acceptable level including considering: ▪ Infrastructure ▪ Hazardous materials ▪ Use of a flame ▪ Hot works (activities that generate sparks, heat or hot material) ▪ Vehicles and plant (e.g. ignition from exhaust systems) ▪ On-site fire response capability: water supply, hand tools, etc ▪ Vegetation management at construction sites and laydown areas.	Pre construction
PS4	Dangerous goods and hazardous substances	▪ All chemicals or other hazardous substances will be stored in a bunded area and away from any natural drainage lines. The capacity of the bunded area will be at least 110% of the largest chemical volume contained within the bunded area. The location of the bunded enclosure/s will be shown on Site Plans ▪ The storage, handling and use of dangerous goods and hazardous substances will be carried out in accordance with the WHS Act and Regulations, the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005) and relevant Australian Standards. ▪ Safety plans including Safe Working Method Statements (SWSM) will be prepared by the contractor to identify risk and mitigation measures during constructions. The SWSM will be developed as per guidelines from Safe Work Australia.	Construction and operation

6.13 Social and economic impacts

This section provides an assessment of the potential social and economic impacts of the Project and measures or processes to mitigate them.

The potential hazards and risks have been informed by the Socio-economic impact assessment (SEIA) presented as **Appendix Q**.

The assessment addresses the following SEARS:

Social & Economic – including:

- An assessment of the social and economic impacts in accordance with Social Impact Assessment Guideline (DPIE, July 2021) (application subject to transitional arrangements) and benefits of the project for the region and the State as a whole, including consideration of any increase in demand for community infrastructure and services.

6.13.1 Legislative and policy context

The SEIA has been prepared to assess the potential impacts of the Project in accordance with the following relevant legislation, policy and guidelines:

- *Social Impact Assessment Guideline for State Significant Projects* (DPIE, 2021a) (the SIA Guideline)
- *Illawarra-Shoalhaven Regional Plan 2041* (DPIE, 2021b)
- *Shoalhaven 2032 Community Strategic Plan* (Shoalhaven City Council, 2022)
- *Wingecarribee Shire Community Strategic Plan* (Wingecarribee Shire Council, 2017).

A detailed description of the legislative and policy context for the socio-economic assessment is provided in Chapter 2 of **Appendix Q**.

6.13.2 Methodology

The methodology for the SEIA included:

- Scoping of likely social impacts and identification of the social locality
- Describing the social baseline, including social characteristics, values and conditions
- Assessing and evaluating social impacts of the Project's construction, operation and decommissioning
- Identifying social mitigation and enhancement measures.

The description of the existing socio-economic environment principally draws on data and information from the from Australian and NSW government, Council and NSW government policies and strategies, review of existing literature relevant to the Project and the socio-economic environment of the study areas, consultation outcomes, and other studies undertaken for the EIS. Key data sources include:

- Population and demographic data and information, including from the Australian Bureau of Statistics (ABS) Census of Population and Housing 2021 and 2016, other ABS publications
- Economic data, including employment data from the Australian government National Skills Commission
- Data on housing and accommodation from NSW Communities and Justice and Real Estate Institute of NSW and STR Global and Destination NSW
- Website and literature reviews
- Wingecarribee Shire Council and City of Shoalhaven strategies, reports, publications, and websites
- Feedback from community and stakeholder consultation undertaken for the Project by Origin
- Interviews with stakeholders and community representatives carried out as part of the SEIA
- Other relevant Project-related technical studies undertaken for the EIS.

A matrix was used to evaluate the significance of socio-economic impacts based on the approach presented in the SIA Guidelines. The matrix is presented in the SEIA provided in (**Appendix Q**) and includes consideration of:

- The magnitude of the change, considering the extent, duration, intensity or scale, sensitivity or importance, and level of concern/ interest
- Likelihood of the change occurring.

Previous and ongoing community and stakeholder engagement carried out by Origin has been detailed in **Chapter 5**.

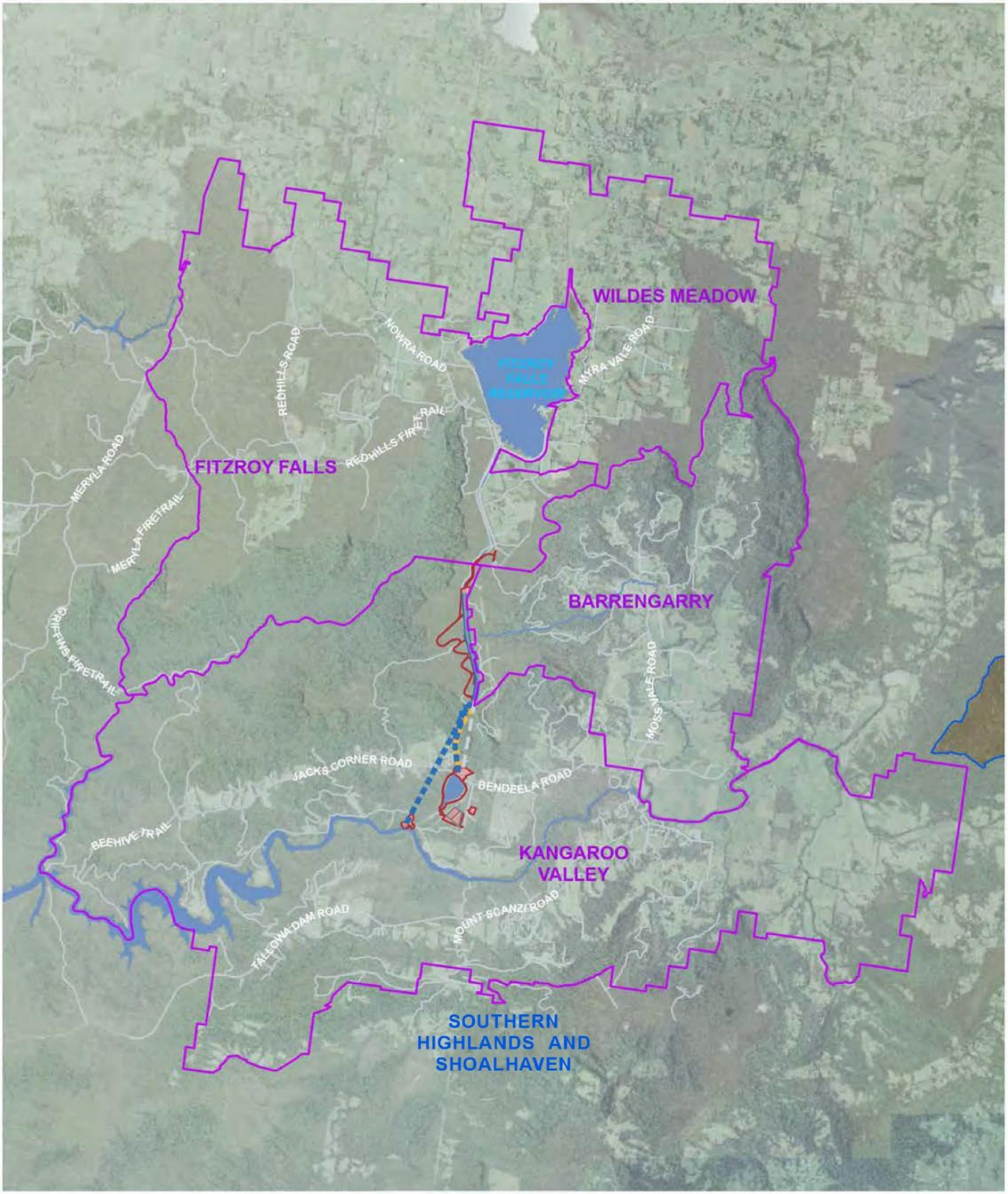
6.13.2.1 Study area

The primary socio-economic study area is shown on **Figure 6-20**. The primary study area comprises the 2021 ABS defined 'Suburbs and Localities' (SAL) geographies of:

- Wildes Meadow (SAL14309)
- Fitzroy Falls (SAL11532)
- Barrengarry (SAL10214)
- Kangaroo Valley (SAL12069).

People in the primary study area, including residents, workers and visitors, are likely to interact more frequently with the Project's construction and operational activities due to the proximity of their properties to the Project, or as they move around the area.

The Project's benefits and impacts may also be experienced by communities in the wider area. As such, a secondary study area comprises the ABS Southern Highlands and Shoalhaven Statistical Area 4 (SA4) was also considered in the SEIA, where relevant.



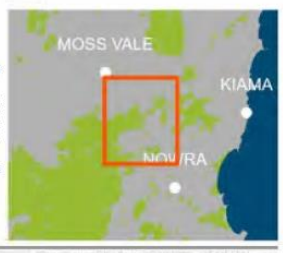
Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Disturbance area
- Spoil site
- Primary study area
- Secondary study area
- Waterbody

0 2 4 km

1:120,000 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-20 Socio-economic study area

6.13.3 Existing environment

6.13.3.1 Regional context

The Project is located within the Shoalhaven and Wingecarribee LGAs, approximately 50 km south-west of Wollongong and 20 km north-west of Nowra.

Shoalhaven LGA is characterised by mountains, coastal plains and beaches, farmland, and bushland as well as many towns and villages. The LGA contains a range of towns and villages, including the regional centre of Nowra-Bomaderry, historic towns of Kangaroo Valley and Berry, and smaller towns, villages, and settlements. The area's natural features, environmental amenity, and proximity to Sydney and Canberra make the region a popular destination for tourists and visitors, with tourism a significant contributor to the region's economy. Other key industries include defence, manufacturing, health, and social services.

The Wingecarribee LGA, also known as the Southern Highlands, is mostly rural in character, with nature reserves and agricultural lands separating the towns and villages. Key urban centres servicing the LGA include Moss Vale, Bowral, and Mittagong with these offering a range of government administration, education, health, and retail needs of the area.

The Project falls within the Shoalhaven drinking water catchment, which includes Tallowa Dam, Fitzroy Falls Reservoir and Bendeela Pondage.

6.13.3.2 Socio-economic profile

The primary study area had a total population of 1,539 people at the 2021 Census, of which more than half (856 people of 55.6 %) lived in Kangaroo Valley. Communities in the primary study area generally had an older age profile with higher median ages, lower proportions of children and working aged people (i.e., 15 years to 64 years), and higher proportions of older people aged 65 years or over.

The population of the secondary study area was 161,006 people (ABS, 2021). The secondary study area had a younger population compared to the primary study area, although this was population was still older than the population of NSW.

The primary study area had a high proportion of couple only families, with this group comprising nearly 60 % of family households compared to nearly 38 % in NSW. The family profile is consistent with many rural communities across NSW and Australia, which see older children (i.e., over 15 years) generally moving away for education or employment opportunities.

At the 2016 Census, labour force participation within the study area was below the average for NSW. Within the primary study area, all suburbs apart from Wildes Meadow recorded labour force participation rates below NSW, which is likely to reflect the older age profiles of communities in the primary study area. However the unemployment rate in the secondary study area was above NSW average, with these generally trending above the NSW average since 2012.

The top industries of employment for residents in the primary study area include:

- Beef cattle farming, vegetable growing, horse farming, sheep farming, or dairy cattle farming
- Accommodation, and/or cafes and restaurants.

Other industries of employment for communities included primary and/or secondary education, hospitals, supermarket and grocery stores and coal mining and house construction

6.13.3.3 Housing and accommodation

6.13.3.3.1 Private dwellings

Analysis of the census data indicated that the occupancy rate of properties in the primary and secondary study area was below the dwelling occupancy rate for NSW and may reflect the popularity of the primary study area for short-stay holiday makers and the possible presence of hobby farms and 'weekender' homes.

The SEIA determined that there was about 1,806 rental houses in communities across the secondary study area in March 2022, although this is likely to be an underestimation of the total number of rental properties with some properties possibly vacant or rented from a family member. The rental vacancy rates in the primary and secondary area was about 1.5 % in June 2022.

Consultation for SEIA indicated a shortage of rental accommodation in the primary study area, with existing businesses experiencing challenges securing accommodation for local staff.

6.13.3.3.2 Visitor accommodation

There are a large number of visitor accommodation providers in the primary study area. These mainly cater for people taking short stay 'weekend getaways' or attending private events such as weddings and include higher-end boutique accommodation such as bed and breakfast accommodation, spa retreats, eco-resorts, farmstays, holiday houses and apartments.

There are also two caravan and holiday parks located in the town of Kangaroo Valley, with these being the Kangaroo Valley Glenmack Park, which offers a mix of villas, cabins, caravan sites, and camping sites, and Holiday Haven Kangaroo Valley, which offers a range of cabins and camping sites.

The primary and secondary study areas is covered by two tourism regions, including:

- Capital Country, which includes the major towns of Bowral, Goulburn, Yass and Young
- South Coast, which includes the major towns of Wollongong, Shellharbour, Kiama, Jervis Bay, Ulladulla, Bateman Bay, Moruya, Narooma, Bega, Merimbula, and Eden.

Between July 2002 and June 2021, the average room occupancy rate for the tourism regions covering the primary and secondary study areas was 53.3 % and 59.1 % in the Capital Country and South Coast Tourism regions respectively, with pre-COVID-19 rates in the order of 66 %. Even assuming occupancy rates return to levels similar to 2018-19, there would likely to be some capacity within the short-term accommodation in the secondary study area to accommodate the construction workforce of between 250 and 370 people, with this data excluding accommodation types such as smaller hotels, caravan sites, holiday houses (i.e., rented through Airbnb).

6.13.3.3.3 Economic profile

There are approximately 13,362 businesses in the secondary study area, of which 98 % were small businesses employing less than 20 people. Construction related businesses comprised the largest business group, comprising about 21.3 % of all businesses follow by:

- Professional, scientific and technical services (11.5 %)
- Rental, hiring and real estate services (9.4 %)
- Agriculture, forestry and fishing (7.6 %)
- Financial and insurance services (7.2 %).

The key industries of surrounding the Project include tourism and agriculture. The business types located within about one km of the Project include:

- Recreation and tourism,
- Health and wellness / accommodation
- Accommodation
- Eco-retreat, wedding, and function venues.

6.13.3.4 Social infrastructure

The primary study area accommodates a range of community services and facilities that cater for the needs of local residents, and day trippers and overnight visitors. These are mainly located in Kangaroo Valley and include sport and recreation facilities, emergency services, cultural uses, and schools.

While the major urban centres such as Moss Vale, Bomaderry, Bowral, and Nowra accommodate a range of community services and facilities that cater for the needs of communities in the local and regional study areas.

The social infrastructure near the Project is generally limited to nature-based recreation areas and facilities, (with the exception of an education facility) and includes:

- Fitzroy Falls Reservoir and Recreation Area
- Morton National Park
- Bendeela Recreation Area
- The Scots College – Glengarry Campus
- Kangaroo River.

6.13.3.5 Community values

The local amenity and character of the area surrounding the Project is dominated by natural features such as Morton National Park and Kangaroo River; WaterNSW assets including Fitzroy Falls Reservoir; and farmland and rural landscapes, that are important to communities and visitors for the conservation, ecology and biodiversity, scenic amenity, recreation, and economic values that they offer. The Shoalhaven Pumped Hydro Scheme has also been a feature of the Kangaroo Valley since the mid-1970s when it was established as part of a dual purpose water supply and hydro-electric power generation scheme.

The Kangaroo Valley is known for its scenic beauty and tranquil surroundings and is a popular destination for visitors who are attracted to the area for its rural lifestyle and amenity, historic heritage such as historic buildings in the Kangaroo Valley township and the landmark Hampden Bridge across the Kangaroo River, natural landscapes, and nature-based recreational opportunities such as bushwalking, kayaking and fishing.

Protection of the area's natural environment and flora and fauna values is important to local and regional communities. The area's biodiversity and natural environment is also important for local tourism, with tourism businesses offering eco-tourism opportunities that seek to protect and enhance the natural environment to offer guests a low impact, and eco-friendly experience.

Communities in the primary study area show evidence of strong levels of community cohesion, sense of community and pride. Communities are supportive and connected, demonstrated by communities coming together to respond to the 2020 bushfires, and throughout the COVID-19 pandemic to manage impacts to tourism and businesses, and the high levels of volunteerism relating to community organisations and groups relating to the environment and natural assets, community safety, and local business and tourism, and recreation and sporting activities (e.g., sporting clubs, bushwalking groups). The sense of community and connection was also reflected in consultation for this assessment, businesses working together to support local tourism and produce within the Kangaroo Valley.

Communities in the primary and secondary study areas are also popular locations for events and festivals that foster social connections and that offer opportunities for community participation.

6.13.3.6 Transport and access

Residents, visitors, business and industry near the Project are serviced by several major roads and local roads and bus services. These are described in **Section 6.7**.

6.13.4 Construction impacts

6.13.4.1 Property

During construction, potential impacts on property would mainly be associated with the temporary use of land to support construction activities (e.g., temporary laydown/ works areas and sites for spoil disposal) and amenity impacts for users and occupants of surrounding properties due to construction noise and vibration, dust and traffic.

Above ground construction activities for the Project would be on land accommodating the current power stations and hydro scheme, or land owned by WaterNSW. While the construction traffic access would use the Promised Land Trail within the Morton National Park managed by the NPWS. The use of land during construction owned or managed by WaterNSW and NSW NPWS would be subject to agreement with the relevant stakeholder.

The Project would also involve tunnelling beneath privately and public land. During construction, sub-surface tunnelling works would not disrupt the use of these properties at the surface.

Following construction, areas disturbed by construction activities that are not required for ongoing operation of the Project would be rehabilitated and reinstated in consultation with WaterNSW.

6.13.4.2 Population and demography

As a result of the Project, there would be a temporary influx of non-resident construction workers into nearby towns and communities. It is anticipated that workers would generally be sourced from major centres and communities within the Southern Highlands and Shoalhaven region that are within commuting distance of the Project.

Limited availability of accommodation in the primary study area would means that it is likely that any specialist workers required to relocate for the Project are also likely to stay in larger towns and centres in the secondary study area and travel to the site on a daily basis.

Overall the construction phase of the Project is not expected to change population and demography in the primary or secondary study areas.

6.13.4.3 Housing and accommodation

As indicated above, it is anticipated that the majority of the construction workforce for the Project would be sourced from existing residents of major centres and communities in the secondary study area and commute to site on a daily basis.

While the specialised non-resident workers would require housing and accommodation in towns and centres near the Project. It is anticipated that the majority of these workers would seek housing and accommodation in larger towns and centres in the secondary study area that are within commuting distance of the Project (e.g., Bowral, Moss Vale, Mittagong, Nowra or Bomaderry).

At a worst case, assuming each of the construction workers occupies a separate dwelling, the demand for housing from the average construction workforce of 250 people, would represent about 14 % of rental houses, with this increasing to about 20 % during the three-month peak construction period. While this is likely to be a conservative estimate, it represents a significant proportion of rental houses and is well above the number of houses generally available each quarter.

This increased demand by construction workers for rental housing has potential to impact on the availability of rental housing for existing residents. This in turn may put pressure on rental prices to increase, reducing the supply of affordable rental housing and resulting in increased levels of housing stress for vulnerable households such as those on low or fixed incomes. Reduced housing affordability and increased housing stress may require some households to forego spending on other items in order to cover higher rental prices, or force some households to move from the area in search of more affordable rental housing elsewhere.

Maximising the use of short-term visitor accommodation such as motels, cabins, caravans, and other 'guest' accommodation would help to ease demand for rental housing and subsequent pressure on rental prices. As indicated in **Section 6.13.3.3**, there is likely to be some capacity within the short-term accommodation in the secondary study area to accommodate the construction workforce.

The use of visitor accommodation for the non-resident construction workforce would have positive impacts for owners of accommodation by providing reliable and consistent business throughout the construction phase, particularly during the off-peak tourist seasons. Conversely, use of short-term visitor accommodation for construction workers also has potential to reduce the availability of some visitor accommodation types for holiday makers, particularly if the peak construction phase coincides with peak tourist periods.

However the demand for accommodation by non-resident workers has potential to reduce the availability of some accommodation types for holiday makers (e.g., cabins, caravan sites, holiday apartments, hotel rooms), affecting the ability of the tourism sector to meet demand from tourists and visitors. This may discourage some people from visiting the primary and secondary study areas during the construction phase due to challenges in securing accommodation, possibly resulting in flow on effects for other business that rely on accommodation providers to support their business (e.g., hospitality businesses, wedding venues, recreation-

based tour operators). This is likely to have the greatest impact during peak tourist seasons and regional events, particularly if these coincide with the peak construction period.

A workforce accommodation strategy would be prepared prior to construction in consultation with Wingecarribee Shire Council and Shoalhaven City Council and other relevant stakeholders that outlines strategies to manage demand for housing and accommodation during the construction phase.

6.13.4.4 Employment and training

The construction phase of the Project would have positive impacts for employment and training through the creation of direct employment and training opportunities on the Project. As the Project is expected to directly create approximately 250 FTE jobs over the five-year construction phase, with this increasing to about 370 FTE jobs during the peak construction period.

The Project is also anticipated to support additional indirect jobs during construction relating to such things as trade supplies, transportation and increased economic activity from the Project. The creation of direct employment during construction would support enhanced social and economic outcomes by supporting improved incomes, skills development, and future employment opportunities for individuals, particularly in the secondary study area.

The Project's construction phase is also expected to provide training and apprenticeship opportunities that allow people to gain skills in the construction and energy industries, helping to build local workforce capacity and supporting individuals through skills development, improved incomes, and enhanced opportunities for future employment in construction.

Employment and training opportunities for the Project have potential to deliver benefits for groups such as young people, Aboriginal people, and women, helping to increase the representation of these groups in the construction and energy industries, and enhancing future employment opportunities.

6.13.4.5 Business and industry

During construction, the Project is expected to have positive impacts for local and regional businesses through the procurement of goods and services to support construction activities (e.g., equipment hire, construction materials, technical contractors, and transport services). While it is acknowledged that specialist materials and equipment would be sourced elsewhere, maximising the regional suppliers where possible, would support improved livelihoods for business owners and employees, and opportunities for increased business growth and development.

The implementation of local and regional procurement strategies such as a register of local businesses, engagement with local and regional businesses, and communication about procurement opportunities would help to maximise socio-economic benefits of the Project.

Increased trade and spending associated with purchases by construction workers would also have positive impacts for businesses in the primary study area. Businesses most likely to benefit would include businesses that cater for the day-to-day needs of construction workers such as eateries, hospitality businesses, and fuel retailers, with potential benefits including increased business income, and opportunities for business growth.

During construction, adverse changes to business amenity may also occur for some businesses located close to construction activities or that front roads used for haulage (e.g., Moss Vale Road, Nowra Road, Sheepwash Road, Bendeela Road). Potential amenity changes (including traffic noise, dust and visual amenity) are most likely to affect businesses that rely on a quieter business environment, such as visitor accommodation, cafes and restaurants, wedding and function venues, and wellness retreats. This may result in disturbances for customers and guests and potentially diminish the experience and enjoyment of their stay. This may also influence some people's choice to look for accommodation with less potential for disruption.

Underground construction activities would be undertaken 24 hours a day, seven days a week. While there is likely to be less airborne noise associated with these works, workers coming and going from the construction worksites and general movement of vehicles around worksites have potential to impact on the night-time amenity, either actual or perceived, for occupants of residential uses near to the Project.

Other businesses near the Project that may be affected by construction activities include recreation and tourism operators that provide kayaking and bushwalking tours along the Kangaroo River and from Bendeela Recreation Area. The laydown area and intake outlet for the Project is located on the northern bank of Kangaroo River next to the existing Bendeela Power Station. While access would be maintained to the Kangaroo River for water based activities, noise and dust from construction activities may temporarily diminish the enjoyment and experience of the natural environment for customers. The short-term closures of Lower Bendeela Road and public access to the Bendeela Recreation Area, would require businesses that use this area to find alternative drop-off and pick-up locations for participants in tours.

Ongoing consultation and communication will be undertaken with affected business owners and operators during construction about the timing, duration, and impacts of construction activities and measures proposed to mitigate or manage potential impacts.

6.13.4.6 Community values

During construction, potential impacts on community values would mainly be associated with the:

- Clearing of vegetation
- Noise, dust, vibration impacts
- Construction traffic reduced amenity for users of nearby residential uses, visitor accommodation, and community uses, and impacting on community perceptions of safety
- Changes to the landscape and visual character of the local area around the Project.

As the area surrounding the Project is valued for its peacefulness and tranquillity with uses including natural areas used by the public, community uses, residential uses on rural properties, visitor accommodation and rural landscapes. The above impacts may affect some peoples' use and enjoyment of the area and is likely to be a concern for community members.

6.13.4.7 Access and connectivity

Construction of the Project would generate construction traffic associated with the haulage and delivery of construction materials and equipment, transport of construction workforce, and general site activities. These impacts are discussed in **Section 6.8.4**.

The Increased construction traffic may also impact on community perceptions of road safety, particularly in locations that have higher levels of pedestrians, such as near schools (e.g., Kangaroo Valley Public School at Moss Vale Road, and Avoca School at Sheepwash Road), Kangaroo Valley township, Fitzroy Falls in the vicinity of the recreation area, visitor centre and Fitzroy Falls Lookout. The implementation of traffic management measures would assist in minimising any traffic delays and disruptions and road safety risks along haulage routes, refer to **Section 6.8.6**.

6.13.5 Operational impacts

6.13.5.1 Property

The new above ground infrastructure for the Project would be located on land owned by WaterNSW. Use of this land for the Project would be subject to agreement between Origin and WaterNSW.

The sub-surface works would occur beneath public and private property at depths below ground such that they would not impact on the ongoing use of these properties.

Operation of the Project is also not expected to result in changes to property access or local amenity for nearby properties, with operational activities similar to those in place for the existing pumped hydro scheme.

6.13.5.2 Population and demography

As indicated in **Section 3.5.3**, operational activities for the Project would require up to three FTE workers, with these anticipated to live in the secondary study area, either currently or following employment on the Project.

As such, operation of the Project is not expected to change population and demography in the primary or secondary study areas.

6.13.5.3 Housing and accommodation

During operation, potential impacts of on housing and accommodation (e.g., decreased availability of rental housing and loss of affordable rental housing for fixed- and low- income households) associated with increased demand for housing by the operational workforce are expected to be negligible.

6.13.5.4 Employment and training

The Project would have positive impacts on employment and training through the employment of local workers to support ongoing operation and maintenance activities. While community level benefits would be minimal due to the size of the operational workforce, operational employment would provide opportunities to enhance social and economic outcomes for individuals over the long-term through ongoing income, and skills development in the energy sector.

6.13.5.5 Business and industry

Once operational, the Project would create approximately 235MW of additional capacity, resulting in long-term benefits for business and industry customers through improved security and continuity of energy supply to NSW and the NEM. This may support cost savings for businesses and reduce potential energy constraints for businesses, helping to increase business confidence and supporting business investment and growth.

Operation of the Project would be similar to the existing pumped hydro scheme. Consequently, any impacts on local business and industry in the primary study area are expected to be minimal. The existing pumped hydro scheme currently supports opportunities for businesses in the primary and secondary study area including contractors and suppliers that support ongoing operation and maintenance activities. These opportunities would continue following operation of the Project.

6.13.5.6 Social infrastructure

The Project would operate under similar conditions to the existing pumped hydro scheme and any impacts on social infrastructure near the Project are expected to be minimal.

Concerns were raised during consultation for the Project about potential for the Project to impact on water-based recreation uses at the Fitzroy Falls Reservoir such as sailing. The Project would use Origin's current water allocation and would not require any additional water allocation for the operation of the Project. The concurrent operation of the Project with the Existing Scheme would result in the current water allocation being drawn and returned over shorter cycles. While would result in an increase in the rate that the water levels change in Fitzroy Falls Reservoir and Lake Yarrunga, it would not change the maximum or minimum water levels. Consequently, any impacts on the use of Fitzroy Falls Reservoir for activities such as sailing are expected to be minimal.

Land based activities associated with Fitzroy Falls Reservoir would not be affected by the operation of the Project.

6.13.5.7 Community values

The Project would introduce new above ground infrastructure and while this new infrastructure is adjacent or near to infrastructure for the Existing Scheme, there is potential for adverse impacts on values relating to the environment or visual values. Particularly in locations where clearing of vegetation is required to support construction of the infrastructure. It is likely that the level of impact would diminish over time as vegetation within the construction areas become established and views of the infrastructure are screened.

However, the operation of the Project is not expected to result in changes to community values as the operational activities similar to those in place for the existing pumped hydro scheme.

6.13.5.8 Access and connectivity

Operational activities that would generate traffic would mainly be associated with the carrying out of operation and maintenance activities, and transport of workers to site. These activities are not expected to have any day-to-day impacts on local access and connectivity in the primary or secondary study area, including community perceptions of road safety.

6.13.6 Evaluation of significance

An evaluation of significance of the socio-economic impacts of the Project was carried out as part of SEIA provided in **Appendix Q**. The findings of this significance assessment are summarised in **Table 6-52** with and without mitigation. The positive impacts of the Project are highlighted in light green.

Table 6-52 shows that most of the negative impacts of the Project would be effectively managed with the implementation of the mitigation measures outlined in **Section 6.13.7**

Refer to the SEIA provided in **Appendix Q** for the full evaluation of signification for the Project.

Table 6-52 Evaluation of significance

Impact category	Description of impact	Significance without mitigation	Significance with Mitigation
Construction			
Property	Temporary disruptions to the use or access to land owned by WaterNSW and NPWS used for construction.	Low	Low
Population and demography	Temporary changes to population and demography due to influx of non-local construction workers in the secondary study area.	Low	Low
Housing and accommodation	Reduced rental housing affordability and increased housing stress for low and fixed income earners due to demand for housing by construction workers	Med	Low
	Reduced availability of visitor accommodation for tourists due to increased demand by construction workers	Med	Low
Employment and training	Improved incomes and skills developments for individuals employed for the Project.	High	High
	Skills development relating to training and apprenticeship opportunities on the Project	High	High
Business and industry	Direct procurement of local and regional suppliers for the Project, leading to improved business income and opportunities for business growth and development	High	High
	Increased trade and spending on purchases by the construction workforce leading to increased business income and opportunities for business growth and development	Med	Med
	Increased income for individual accommodation providers, leasing to opportunities for owners of accommodation to grow their business and invest in business improvements	Med	High
	Decline in trade for tourism related businesses due to visitors facing challenges securing accommodation in the primary and secondary study area.	High	Low
	Amenity changes for businesses immediately surrounding the Project construction, discouraging people from using local accommodation and wedding businesses	High	Med
	Reduced business amenity due to increased road traffic noise on haulage routes	Med	Low
	Disruptions to local tourism operators that use Bendeela Recreation Area due to short-term closures associated with possible closure of Lower Bendeela Road.	Med	Low
Social infrastructure	Disruptions to recreational users due to the loss of access to Promised Land Trail	High	Low
	Changes to local amenity of nature-based recreation areas, possibly deterring people from accessing these facilities	Med	Med
	Short-term closures of Bendeela Recreation Area due to construction traffic use of Lower Bendeela Road.	High	Med
	Disruption to outdoor teaching classes at Glengarry Campus	Med	Low

Impact category	Description of impact	Significance without mitigation	Significance with Mitigation
	Increased road safety risks for students of Glengarry Campus during activities that use local roads	Med	Low
	Increased construction traffic on haulage routes impacted on perceptions of safety for users of social infrastructure	Med	Low
	Increased demand for social infrastructure in the secondary study area due to influx of non-resident construction workers	Med	Low
	Increased demand for emergency services in response to possible construction related safety incidents.	Med	Low
Community values	Impact on community values relating to the environment due to clearing of native vegetation	Med	Low
	Disruption to local amenity for users of properties near to construction works due to increased construction noise, dust, and traffic.	High	Med
	Possible sleep disturbance due to 24 hour works for tunnelling, resulting in health and wellbeing impacts for individuals	Med	Med
	Temporary amenity impacts for residents and businesses along Moss Vale Road, Bendeela Road and Sheepwash Road due to increased traffic noise	Med	Low
	Possible sleep disturbance due to night-time haulage activities on local and regional road network.	Med	Low
Access and connectivity	Temporary traffic disruptions and road safety risks from use of local and regional roads by construction traffic	Med	Low
Operation			
Property	Changes to the use of Water NSW land from the siting of Project infrastructure	Low	Low
	Changes to the use of private property and public land from the siting of sub-surface infrastructure	Low	Low
	Disruptions for property owners due to changes to property access	Low	Low
Population and demography	Changes to population and demography due to relocation of non-resident workers to the primary or secondary study area	Low	Low
Housing and accommodation	Potential impacts on housing and accommodation due to operational workforce	Low	Low
Employment and training	Enhanced social and economic outcomes of individuals employed for operation (e.g., ongoing income, skills development).	Low	Low
Business and industry	Opportunities for participation of local businesses supporting improved incomes and opportunities for business development	Med	High
	Improved security and continuity of energy supply for business customers, supporting cost savings for businesses, reduce energy constraints and support business investment and growth.	High	High
	Changes to local business environment due to operation of the Project.	Low	Low

Impact category	Description of impact	Significance without mitigation	Significance with Mitigation
Social infrastructure	Effects on activities of recreational users of Fitzroy Falls Reservoir (e.g., sailing competitions, fishing) due to increased rate of change for water levels.	Med	Low
Community values	Changes to local character and amenity, community health and safety, and community cohesion from operation of the Project.	Low	Low
	Diminished community values relating to environment and visual amenity due to new above ground infrastructure.	Med	Med
Access and connectivity	Changes to local access and connectivity and community perceptions of road safety due to traffic generated by operation and maintenance activities.	Low	Low

6.13.7 Mitigation measures

Mitigation measures to address the potential social and economic impacts of the Project are listed in **Table 6-53**. Mitigation measures for biodiversity, land, traffic, noise, air quality and visual amenity are provided in **Section 6.2.6**, **Section 6.4.6**, **Section 6.7.6**, **Section 6.8.7**, **Section 6.9.6**, Section respectively.

Table 6-53. Social and economic mitigation measures

Ref	Impact	Mitigation measure	Timing
SE1	General	A Stakeholder and Community Engagement Plan (SCEP) will be prepared to guide communication and engagement activities to ensure the timely and accurate provision of information to the community and stakeholders during construction. The elements of the SCEP will be consistent with the International Association of Public Participant (IAP2) principles and outline (as a minimum): ▪ Engagement principles and objectives ▪ Project stakeholders who either have an interest in the Project or may possibly be impacted by the proposed expansion ▪ Communication and consultation tools that provide: ▪ Details and timing of proposed construction activities to local communities and affected stakeholders ▪ Policies and procedures for receiving and responding to queries and about the Project and for handling of grievances and complaints ▪ Procedures for reviewing and monitoring of the effectiveness of the SCEP, including updating the SCEP in response to outcomes of the review and monitoring process or in response to continued community and stakeholder complaints about environmental issues.	Prior to construction, and construction
SE2	Housing and accommodation	A Workforce Accommodation Strategy will be prepared for the Project, in consultation with relevant stakeholders, to manage demand for housing and accommodation from the construction workforce during the construction phase, which includes (among other things): ▪ Indication of demand for housing and accommodation by the construction workforce and available options to accommodate the construction workforce ▪ Strategies to maximise the use of short-term accommodation, while also managing potential effects on tourists and holiday makers during peak tourist periods and major regional events, and seasonal workers ▪ Processes for engaging with local accommodation providers, housing support agencies and other relevant stakeholders in accordance with the SCEP, about anticipated demand for housing and accommodation by the construction workforce, peak accommodation periods, construction timing ▪ Processes and procedures for managing potential negative effects on visitor accommodation in the primary study area due to demand by the construction workforce ▪ Encourage non-local operational workers to look at housing in towns across the study areas to minimise housing demand in one town only ▪ Measures for reviewing worker accommodation requirements and monitoring potential impacts due to demand by the construction workforce.	Prior to construction, construction

Ref	Impact	Mitigation measure	Timing
SE3	Employment and training	A Local Workforce Strategy will be prepared for the Project, in consultation with relevant stakeholders, that includes (among other things): ▪ Strategies to maximise employment opportunities for residents in the primary and secondary study areas, including strategies to communicate to local communities (prior to and during construction) opportunities and requirements for work on the Project ▪ Strategies relating to training and apprenticeships for Aboriginal people, young people, and women, including consultation with local contractors and relevant stakeholders (e.g., Aboriginal groups, youth, and women organisations) to identify and develop training and education opportunities.	Prior to construction, construction
SE4	Business and industry	A Local Procurement Strategy will be prepared for the Project, in consultation with relevant stakeholders, aimed at maximising procurement opportunities for regional businesses. Among other things, this will outline: ▪ Communication and engagement strategies with local businesses, and other stakeholders in accordance with the SCEP about potential business opportunities and minimum requirements for workers and businesses (e.g., certifications, procurement standards, etc) ▪ Strategies for maximising the participation of regional businesses in the construction phase, including establishment of a local business register and preferences for regional businesses (subject to meeting relevant minimum standards) ▪ Measures for reviewing business requirements and monitoring the level of participation of regional businesses ▪ Implement training to increase local skills and availability of labour.	Prior to construction, construction
SE5	Local business and industry	▪ Consult with owners of surrounding businesses in accordance with the SCEP about the timing, duration, impacts and management of construction activities, including (but not limited to): - Wildwood Kangaroo Valley, at Lower Bendeela Road - Wirramina, at Lower Bendeela Road - Jack's Corner Retreat, at Jack's Corner Road - Tullawalla, at Jack's Corner Road - Cedarvale Health and Lifestyle Retreat, at Moss Vale Road - Accommodation provides at Bendeela Road and Old Bendeela Road - Kangaroo Valley Safaris - Kangaroo Valley Kayaks - Kangaroo Valley Adventure Company - Valley Outdoors ▪ Development and implement processes and procedures, in accordance with the SCEP, for the review and monitoring of potential impacts and the effectiveness of mitigation measures for local businesses near to construction activities, including identifying any additional mitigation measures as required. Development and implement processes and procedures, in accordance with the SCEP, for the review and monitoring of potential impacts and the effectiveness of mitigation measures for local businesses near to construction activities, including identifying any additional mitigation measures as required. ▪ Where possible, consider opportunities to minimise potential impacts on adjoining businesses in the layout of Laydown Area 7 (e.g., through siting of noisy activities and equipment, maintaining vegetation buffers along boundaries).	Prior to construction, construction

Ref	Impact	Mitigation measure	Timing
SE6	Social infrastructure	Engage with users and managers of community facilities near to construction activities in accordance with the SCEP about the timing and duration of construction activities and any potential impacts for users. This will include, but not be limited to, the following facilities: ▪ Bendeela Recreation Area ▪ Morton National Park ▪ Scots College Glengarry Campus ▪ Southern Highlands Sailing Club ▪ Communicate to wider communities through the CSEP about any disruptions to social infrastructure from construction and decommissioning activities for the Project. ▪ Monitor community complaints received through the CSEP processes relating to social infrastructure near the Project and review relevant mitigation and management measures as required.	Prior to construction, construction
SE7	Scots College Glengarry Campus	Engage with managers of Scots College in accordance with the SCEP about: ▪ The timing of major college activities that use local roads (e.g., bicycle rides, 24 hour rogaining) and proposed management measure ▪ Any construction activities that may impact on the college's use of Lower Bendeela Road for emergency access ▪ Timing and duration of construction activities that have potential to impact on activities within the college campus (e.g., noise intensive works).	Construction
SE8	Bendeela Recreation Reserve	▪ Engage with WaterNSW in accordance with the SCEP about any construction activities that may impact on public use or access to the Bendeela Recreation Reserve	Operation
SE9	Promised Land Trail	▪ Minimise the duration of any closure of the Promised Land Trail ▪ Communicate with local communities and users of the Promised Land Trail about the closure of trail ▪ Reinstate the Promised Land Trail as soon as practicable following construction.	Construction
SE10	Southern Highlands Sailing Club use of Fitzroy Falls Reservoir	Development and implement processes and procedures, in accordance with the SCEP, for the review and monitoring of potential impacts on activities of the Southern Highlands Sailing Club from the drawdown or release of water in Fitzroy Falls Reservoir.	Operation
SE11	Community values	▪ Minimise the extent of native vegetation clearing on WaterNSW land and within Morton National Park, as far as practicable ▪ Early and ongoing communication and consultation in accordance with the SCEP with local residents closest to construction activities about the timing, duration and potential impacts on construction and haulage activities ▪ Communication with communities in Kangaroo Valley, Fitzroy Falls, Wildes Meadow, and Barrengarry about the timing and duration of major haulage activities ▪ Where practicable, restrict haulage activities during night-time hours ▪ Develop and implement protocols relating to worker code of conduct to minimise potential disruptions on community cohesion.	Construction
SE12	Cumulative impacts	Consultation and communication with communities and stakeholders through the planning, construction, and operation phases will also be important in avoiding, minimising, or managing identified socio-economic impacts of the Project.	Prior to construction and construction.

6.14 Visual impacts

This section provides an assessment of the potential visual impacts of the Project and measures to mitigate them. Whilst there is no SEARs requirement to undertake a visual impact assessment, one has been carried out to understand amenity impacts on local residents and to inform the detailed design of Project infrastructure.

6.14.1 Legislative and policy context

State and local authority planning documents provide guidance for the management of landscape character and visual amenity of the Project area. The landscape character and visual impact assessment was carried out with reference to the following legislation, policies and planning strategies:

- *Shoalhaven Local Environmental Plan 2014*
- *Wingecarribee Local Environmental Plan 2010*
- *Morton and Budawang National Parks Plan of Management* (NSW NPWS, 2001).
- *Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment* (Transport for NSW, 2018)
- *Guideline for landscape character and visual impact assessment* (Transport for NSW, 2020).

6.14.2 Methodology

The methodology for the visual impact assessment included:

- A description of the Project area and surrounds
- Identification of potential viewpoints using digital elevation model and aerial photography
- An assessment of the visual impact of the Project from publicly accessible locations
- Identification of appropriate mitigation measures.

When considering the predicted effect of changes upon views/ visual receptors, the sensitivity of the view to change is combined with the magnitude of the change to give an overall judgement of significance of impact supported by analysis of evidence and professional judgement. The Guideline for landscape character and visual impact assessment (Transport for NSW, 2020) is regarded as best practice for visual impact assessments within NSW and provides the following definitions:

- Sensitivity refers to the qualities of an area, the number and type of receivers and how sensitive the existing character of the setting is to the proposed nature of change
- Magnitude refers to the physical scale of the Project, how distant it is and the contrast it presents to the existing condition.

Table 6-54 is adopted from the TfNSW guidelines and has been used to rank the criteria above and provide an overall impact assessment as a conclusion to this assessment.

Table 6-54. Visual impact assessment rating matrix

		Magnitude			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High	Moderate/High	Moderate	Negligible
	Moderate	Moderate/High	Moderate	Moderate/Low	Negligible
	Low	Moderate	Moderate/Low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

The viewshed comprises the area from within which the Project area would likely be visible. The extent of the viewshed is influenced by a combination of factors including elevation, landform and vegetation.

This viewshed has been generated using the following method:

- Establishment of elevation models for ground, buildings and vegetation from Lidar data
- Establishment of infrastructure envelope for major operational components of the Project
- Applying points along all sides and tops of these components to represent the most visible parts of the Project (top of infrastructure envelope)

- Using Geographic Information System to identify locations from which these points have unobstructed views of the assessed Project components.

The different components of the Project have been considered separately as well as a holistic Project, in order to better describe what elements can be seen from each location. The components of the Project that have been considered are the surge tank, pipeline, operational admin buildings and spoil emplacement mound. No viewshed has been prepared for the intake/outlet at Lake Yarrunga given that it is below ground level.

As the Project design is concept level, there is no design available for the operational buildings, and as such a 2 m envelope has been applied to the parcel of land in which they would be located. This is to provide a conservative basis for the viewshed analysis

6.14.3 Existing environment

As described in **Section 2.4**, the Project is located in an environmental sensitivity area, including the Morton National Park.

The Morton National Park is managed in accordance with the Morton and Budawang National Parks Plan of Management (NSW NPWS, 2001) (Plan of Management). This document recognises the important landscape, geology, biodiversity, heritage and wilderness values of the Morton National Park. The document also recognises existing uses associated with water and electricity infrastructure, including the Existing Scheme, which has been a key feature of the Project surrounds since the 1970s, as described in **Section 2.4.1**.

The B73 Moss Vale Road is identified on the NPWS website as part of the 'Coast to the Highlands scenic drive – Kangaroo Valley' (NSW NPWS, 2022) noted for its lookouts and 'breathtaking scenic views' across Morton National Park.

The area is sparsely populated with rural landholdings and associated private dwellings. Potential visual receptors are identified in **Table 6-55**. The nearest township is Kangaroo Valley, approximately 2 km to the east. The Kangaroo Valley is known for its scenic beauty and tranquil surroundings and is a popular destination for visitors who are attracted to the area for its rural lifestyle and amenity.

Table 6-55. Potential visual receptors

Distance	Potential for views
Within 250 m	▪ Users of Bendeela Road/Jacks Corner Road in the vicinity of the existing Kangaroo Valley Power Station ▪ Users of the Coast to the Highlands scenic drive in the vicinity of the Promised Land Trail ▪ Recreational users of Lake Yarrunga and the Promised Land Trail ▪ Users of, and two properties along, Lower Bendeela Road and Jim Edwards Place, though existing vegetation would provide screening of the spoil emplacement area.
250 m – 500 m	▪ Bendeela Road/Jacks Corner Road in the vicinity of the existing Kangaroo Valley Power Station ▪ Recreational users of Lake Yarrunga ▪ The northern extent of the Bendeela Recreation Area ▪ Users of the Coast to the Highlands scenic drive ▪ One property is located at Moss Vale Road, to the north of the access along the Promised Land Trail. Two properties are located within this distance of the Lower Scheme, one on Jim Edwards Place and one off Jacks Corner Road. All are screened by existing vegetation.
500 m – 1 km	▪ Rural residential properties on Bendeela Road/Jacks Corner Road ▪ Bendeela Recreation Area ▪ Users of the Coast to the Highlands scenic drive ▪ Properties along Bendeela Road, Old Bendeela Road and
1 km – 2 km	▪ Rural residential properties on Bendeela Road/Jacks Corner Road ▪ The Scots College – Glengarry Campus ▪ Rural landholdings and associated properties ▪ Users of the Coast to the Highlands scenic drive

Distance	Potential for views
2 km – 5 km	▪ Various trails exist throughout Morton National Park, though views are limited given the high level of vegetation and topography. ▪ Users of the Coast to the Highlands scenic drive ▪ Views from Kangaroo Valley township to the southeast of the Project ▪ Rural properties south of Lake Yarrunga.

6.14.4 Construction impacts

Visual impacts during construction could include a reduction in the visual amenity associated with the presence of construction activities.

The majority of works associated with construction of the pipeline, surge tank, underground power station and tail race take place away from publicly accessible areas or underground, and therefore would not impact visual amenity for members of the public. The Promised Land Trail would be used for construction and if unclosed would provide potential visual amenity impacts for trail users noting that views into the works areas are limited. Construction works, plant and equipment at laydown/works areas would be visible to the public as follows:

- Laydown / works area 5 (located next to the existing Kangaroo Valley Power Station) would be visible from vehicles travelling along Bendeela Road/Jacks Corner Road.
- Laydown / works area 6 associated with the intake outlet would be visible to recreational users of Lake Yarrunga
- Laydown / works area 7 would be partially visible from vehicles travelling along Lower Bendeela Road, though these views would be brief and mostly screened by existing vegetation.

The Project would result in an increase in construction vehicles on the local road network as described in **Section 6.7.4** (specifically along Bendeela Road, Lower Bendeela Road, Jacks Corner Road and Moss Vale Road). Users of these roads would experience temporary change in the visual and landscape amenity. Whilst views of these roads from private properties are generally screened by existing vegetation, there may be some glimpsed views resulting in reduction of visual amenity.

Some construction activities of the Project would be carried out up to 24 hours a day and would require task lighting and low level security lighting at night time. Given the low levels of lighting in the existing environment, this would result in a reduction in amenity of local views at night.

Visual impacts during construction would be temporary (medium term) over the five year construction period.

6.14.5 Operational impacts

The Project has the potential to impact the visual amenity of receptors within the surrounding landscape through the installation of infrastructure within an area dominated by native vegetation. Generally, the new infrastructure would be adjacent or near to the Existing Scheme and in-keeping with the existing infrastructure. The underground location of the power station also reduces visual impacts during operation.

The viewshed analysis is presented in **Figure 6-21** to **Figure 6-25**. The coloration represents locations that have unobstructed views of component(s) of the Project. Where the viewshed is limited to specks/dots, this represents the top of existing vegetation, meaning the view of the Project at this location would only be unobstructed from the top of the trees; the Project would likely not be visible from ground level. The viewshed includes locations which are inaccessible to the public.

To the north, views of Project components would be generally determined by the viewshed of the surge tank, (as shown on **Figure 6-23** and **Figure 6-25**), given its height of 45 m. Views would be limited due to existing dense vegetation and topography. Where some open areas may have clear lines of sight to the surge tank, for example in Myra Vale, these locations are over 5 km from the surge tank, resulting in distant views. Any impact resulting from reduction in visual amenity from these locations would be low or negligible.

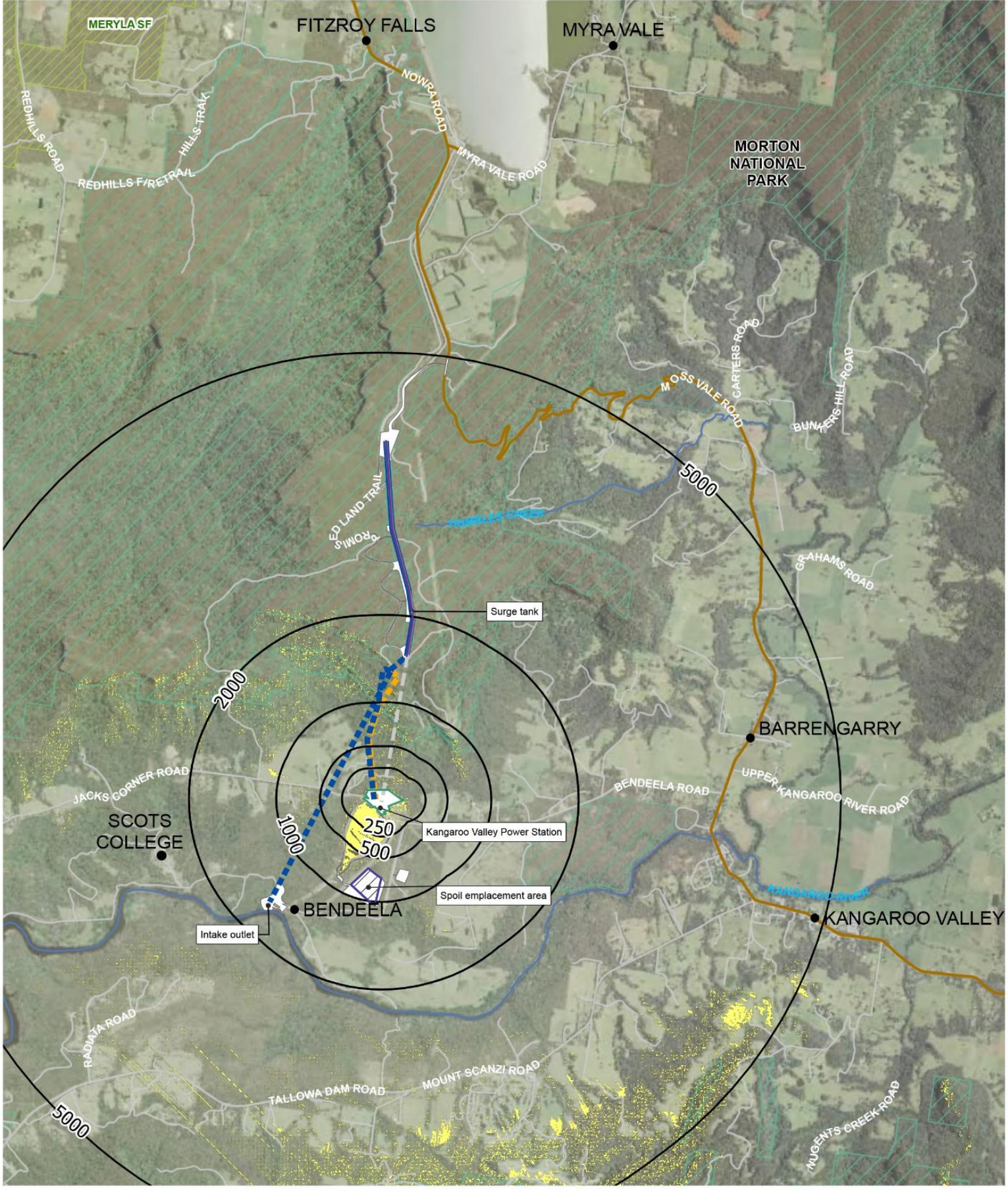
The surge tank would be visible from areas of open space over 5 km away to the southeast in Kangaroo Valley (as shown on **Figure 6-23**). At this distance perceived changes in views would be low or negligible, resulting in low visual impact.

Given its location in an existing cutting and away from publicly accessible areas, the penstock would likely only be visible from vegetation immediately to the east and west. The viewshed (**Figure 6-24**) also includes vegetated areas over 5 km away to the east and south. Views from ground level would be obstructed and distant. The visual impact of the penstock is therefore negligible.

Operational buildings would be visible from vehicles passing on Bendeela Road/Jacks Corner Road (**Figure 6-21**). The presence of these buildings would be close range, however given the presence of the existing Kangaroo Valley Power Station buildings and infrastructure and the low sensitivity of view by travellers along this road, the visual impact is expected to be moderate/low. Viewshed at more distant locations would be limited to the tops of vegetation, and impacts are likely to be negligible. Detailed design would include consideration of forms and colours for structures and buildings that would integrate them into the surrounding visual context.

The spoil emplacement facility has been conceptually designed such that its highest point would be below the height of the existing vegetation that would screen it from Lower Bendeela Road. As such, there may be glimpsed short range views from users of the road but visual impacts are expected to be low. Unobstructed views of the spoil emplacement facility may be visible from over 5 km to the east. However, the rehabilitated mound would not be prominent in such distant views (**Figure 6-22**).

The viewshed presented in **Figure 6-25** indicates that there are limited locations from which all assessed components of the Project would be visible. These locations are over 2 km to the south of the Project, where the Project would not be prominent in views.



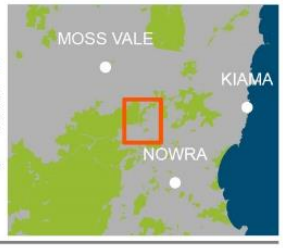
Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- Coast to the Highlands scenic drive
- State Forest
- NPWS Reserve
- Viewshed
- Buffer

0 1 2 km

1:60,000 at A4

GDA2020 MGA Zone 56

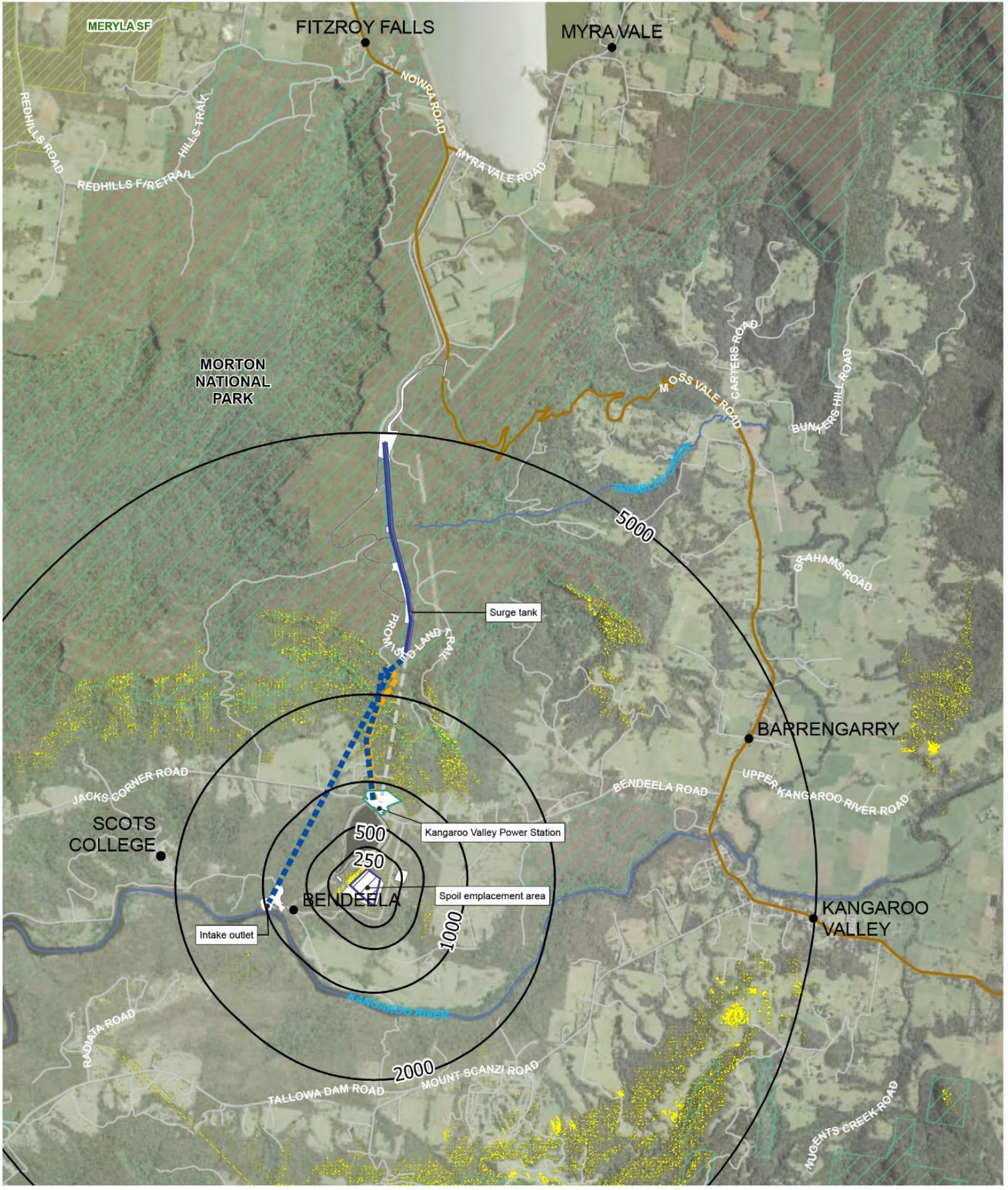


Data sources1

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-21 Viewshed analysis - operational buildings

Date: 9/26/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_VisualImpactAssessment.aprx
Created by: CC | QA by: HK



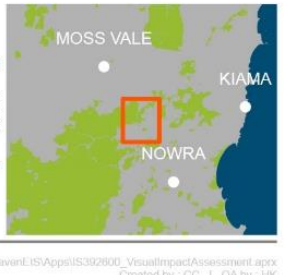
Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- Coast to the Highlands scenic drive
- State Forest
- NPWS Reserve
- Viewshed
- Buffer

0 1 2 km

1:60,000 at A4

GDA2020 MGA Zone 56

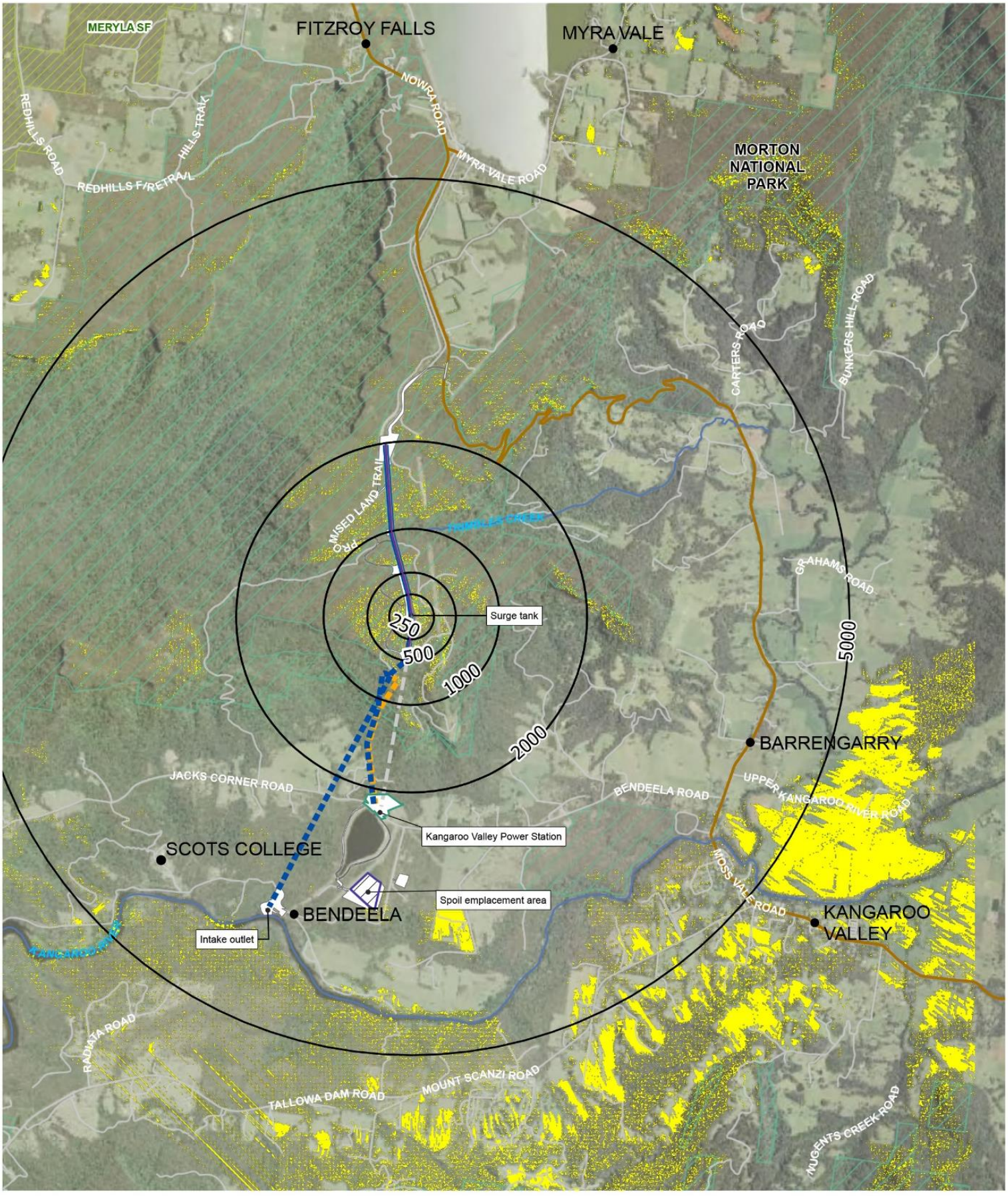


Data sources2

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-22 Viewshed analysis - spoil site

Date: 9/28/2022 Path: \\ausyd0vs01\GISProj\NSW_IS\302600_ShoalhavenLIS\Apps\IS302600_VisualImpactAssessment.aprx
Created by : CC | QA by : HK



Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- Coast to the Highlands scenic drive
- State Forest
- NPWS Reserve
- Viewshed
- Buffer

0 1 2 km

1:60,000 at A4

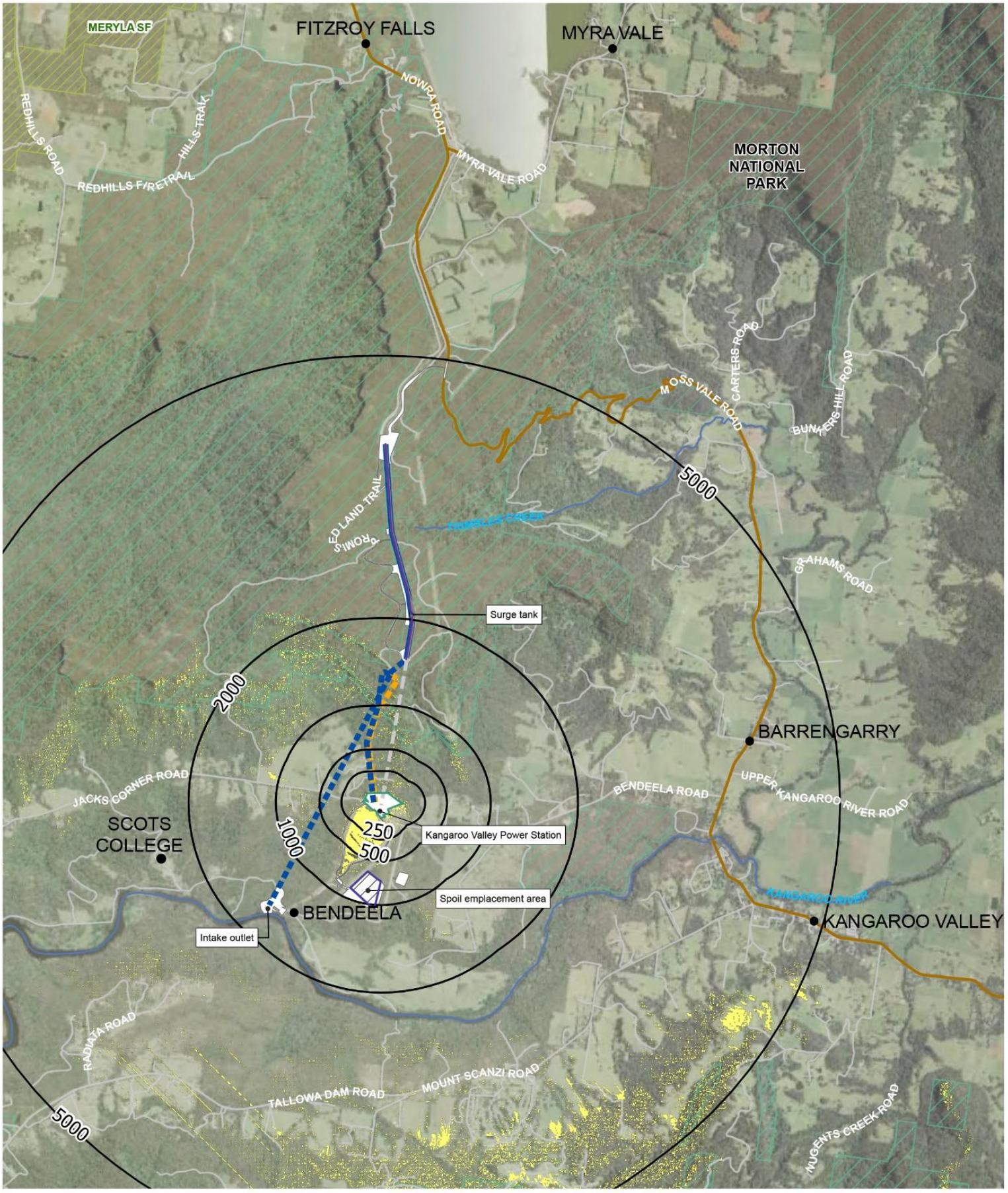
GDA2020 MGA Zone 56

Data sources3

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-23 Viewshed analysis - surge tank

Date: 9/28/2022 Path: \\ausyd1vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_VisualImpactAssessment.aprx
Created by : CC | QA by : HK



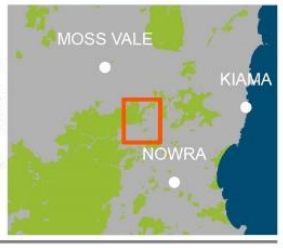
Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Project area
- Spoil site
- Waterway
- Road
- Coast to the Highlands scenic drive
- State Forest
- NPWS Reserve
- Viewshed
- Buffer

0 1 2 km

1:60,000 at A4

GDA2020 MGA Zone 56

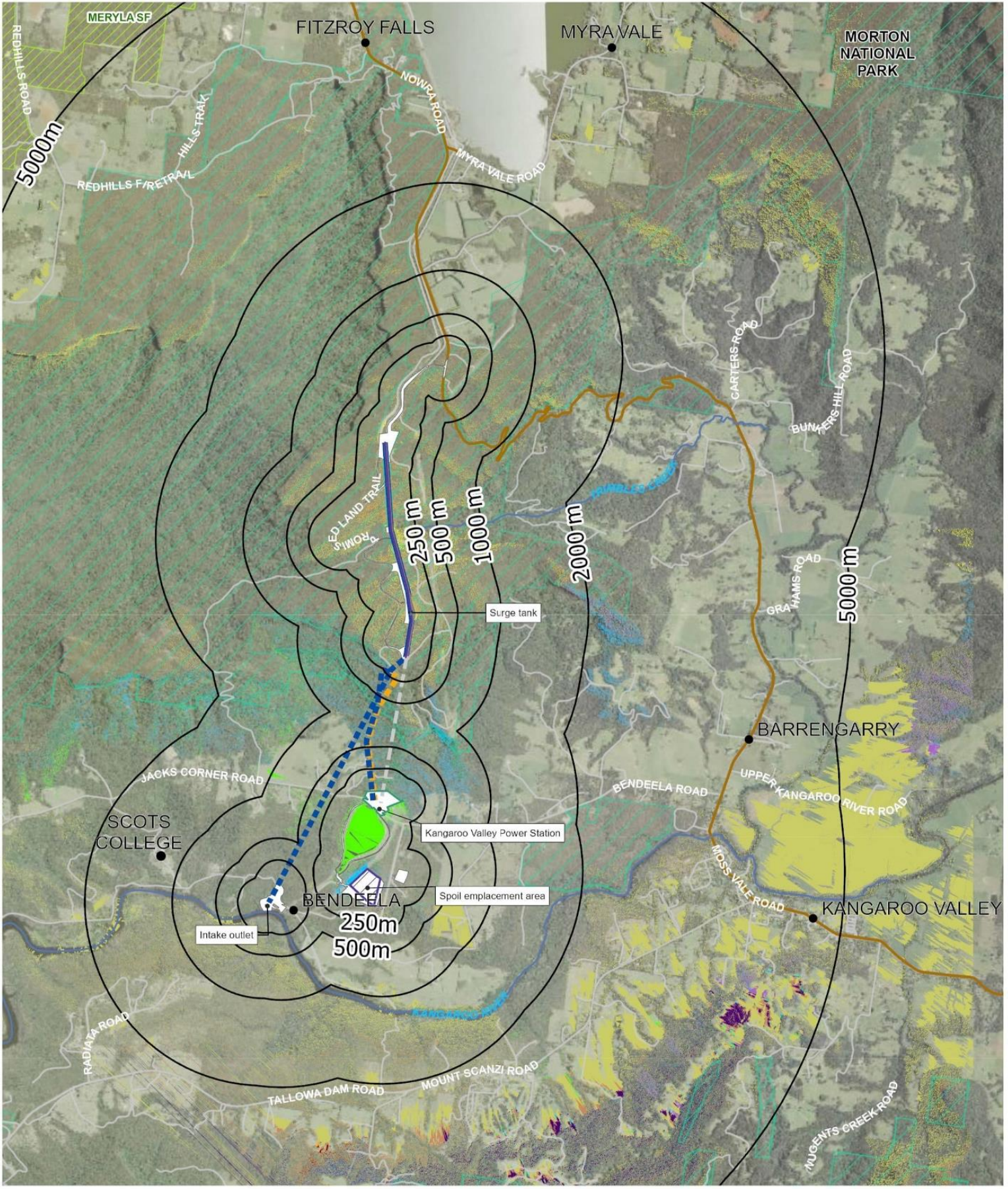


Data sources1

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-21 Viewshed analysis - operational buildings

Date: 9/28/2022 Path: \\ausyd0vs01\GISProj\NSW_IS392600_ShoalhavenEIS\Apps\IS392600_VisualImpactAssessment.aprx
Created by: CC | QA by: HK



Legend

- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Disturbance area
- Spoil site
- State Forest
- NPWS Reserve
- Coast to the Highlands scenic drive

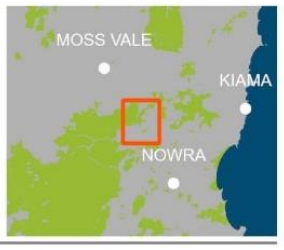
Viewshed visibility

- Spoil site
- Operational Buildings Area
- Penstock
- Surge Tank
- Operational Buildings Area & Spoil site
- Penstock & Spoil site
- Penstock & Operational Buildings Area
- Surge Tank & Spoil site
- Surge Tank & Operational Buildings Area
- Surge Tank & Penstock
- Penstock, Operational Buildings Area & Spoil site
- Surge Tank, Operational Buildings Area & Spoil site
- Surge Tank, Penstock & Spoil site
- Surge Tank, Penstock & Operational Buildings Area
- All visible

0 1 2 km

1:60,000 at A4

GDA2020 MGA Zone 56



Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-25 Viewshed analysis – Project

Date: 10/25/2022 Path: \\ausyd0vs01\GISProj\NSW_IS\392600_Shoalhaven\FIS\Apps\IS392600_VisualImpactAssessment.aprx Created by: CC Ch by: MC

6.14.6 Mitigation measures

Mitigation measures to address the potential visual impacts of the Project are listed in **Table 6-56**.

Table 6-56. Visual impact mitigation measures

Ref	Impact	Mitigation Measure	Timing
V1	Vegetation clearance	Origin will seek to minimise disturbance associated with the Project, for example by minimising areas of vegetation clearance where practicable in order to limit the visual impact of the Project.	Prior to construction and Construction
V2	Presence of construction activities	Where feasible and reasonable, the elements within the construction site will be located to minimise visual impacts (for example storing materials and machinery behind fencing or existing vegetation, maintaining clean and tidy construction sites).	Construction
V3	Lighting impacts	Where required, lighting of the construction sites will be orientated to minimise glare and light spill impacts on receivers	Construction
V4	Presence of Project components in the landscape	A visual impact management plan will be developed and implemented that includes consideration of colour of proposed structures and built form in a suitable muted palette to visually integrate the Project within the landscape and Existing Scheme infrastructure.	Detailed design, operation

6.15 Cumulative impacts

This section provides an assessment of the potential cumulative impacts of the Project when considered with other projects in the locality.

The assessment addresses the following SEARS:

- an assessment of the likely impacts of the project on the biophysical and socio-economic environment - including:
  - an assessment of the potential impacts of the project, including any cumulative impacts, and taking into consideration relevant guidelines, policies, plans and industry codes of practice.

Cumulative impacts are compounding environmental and community impacts caused by past, present or reasonably foreseeable future activities. Cumulative impacts may arise from the interaction of construction and operation activities of the Project and other approved or proposed projects in the area. When considered in isolation, specific Project impacts may be considered minor. However, these minor impacts may be more substantial when the impact of multiple projects on the same receivers is considered.

6.15.1 Legislative and policy context

Under the EP&A Regulation, the EIS for an SSI project must be prepared having regard to the SSI Guidelines prepared by the Planning Secretary. These guidelines reference a requirement to assess cumulative impacts considering Cumulative Impact Assessment Guidelines for State Significant Projects.

6.15.2 Assessment methodology

The assessment of cumulative impacts focused on the Project's interaction with other projects in area where construction and/or operational timeframes are likely to be concurrent and impacts could reasonably expect to accumulate. Other projects in the locality were identified based on a search of the following data sources in August 2022:

- DPIE's online major projects database
- Local council websites/ DA tracking databases
- Proponent websites
- Discussion with Origin.

Nearby projects identified were screened in relation to their potential for cumulative impacts with the Project, based on their nature, size, and proximity to the Project area and identified timeframes for development.

The assessment of cumulative impacts has been limited to desktop review of the predicted impacts of external projects and consideration of where these impacts would overlap with the Project. These potential cumulative impacts have been described in general terms to identify the implications over and above those that would result if the Project were to be constructed in isolation. The assessment draws on the findings of **Section 6.1** to **Section 6.14** and EIAs of other projects.

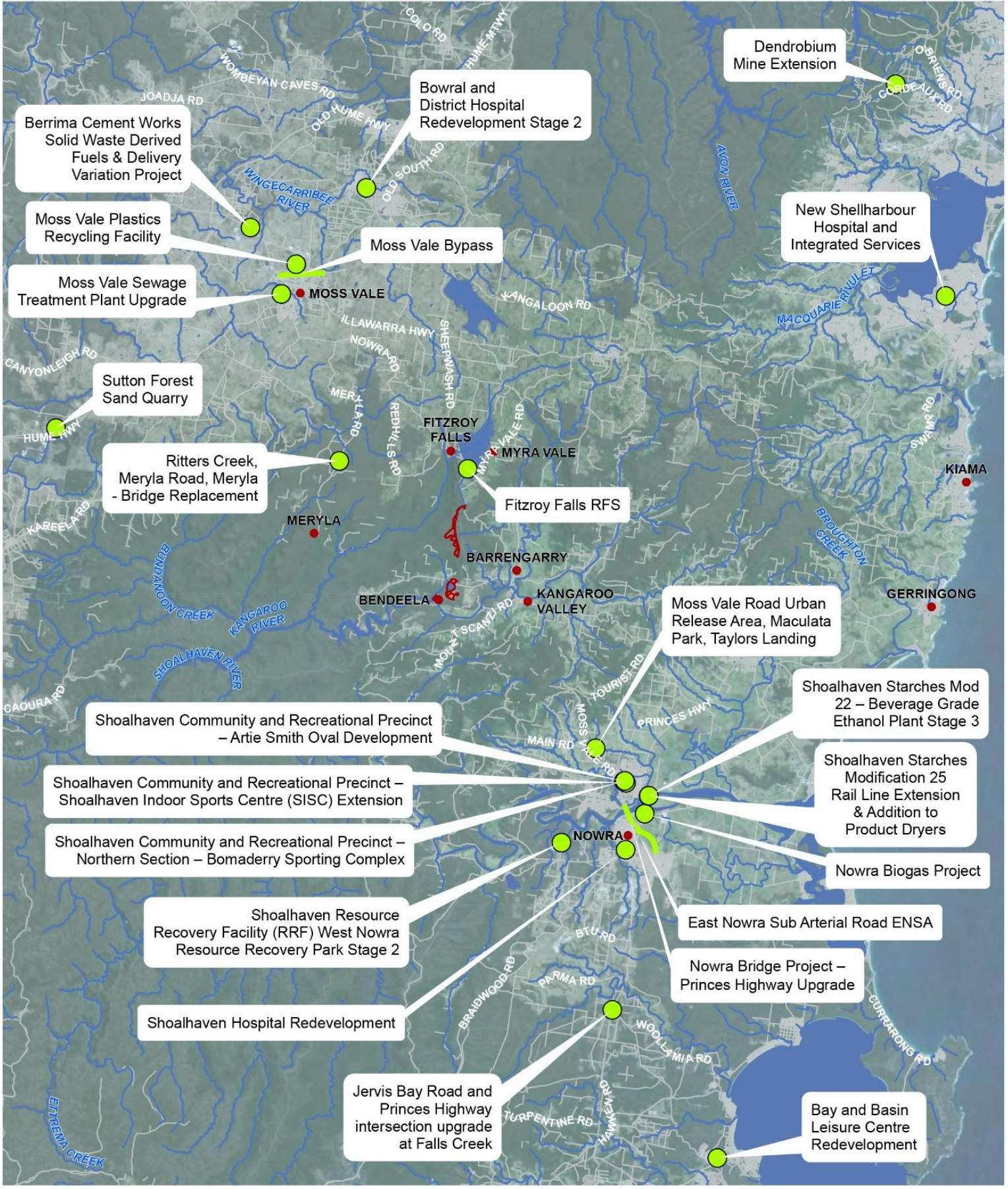
6.15.3 Other projects in the locality

Other projects in the locality that were considered in relation to identifying potential for cumulative impacts with the Project are listed in **Table 6-57** and illustrated in **Figure 6-26**.

Table 6-57. Projects considered in the cumulative impact assessment

Project	Brief project description
Shoalhaven Hospital Redevelopment SSD-35999468	Proposed construction of a new hospital building and ancillary works, including demolition of existing structures within the footprint of the new building, located about 17 km south east of the Project area
Nowra Biogas Project SSD-26264096	Construction and operation a large-scale renewable energy biogas power plant to process up to 170,000 t per year of food waste, cow manure and yeast processing waste using anaerobic digestion to produce electricity, and would be located about 17 km south east of the Project area.
Shoalhaven Starches Mod 22 – Beverage Grade Ethanol Plant Stage 3 MP06_0228-Mod-22	Proposed expansion to the Beverage Grade Ethanol Plant including proposed increased production capacity to 450 ML of Ethanol, new distillery columns and associated plant infrastructure. The expansion will lead to double the current flour being transported to site, up to 8,600 t per week, located about 17 km south east
Shoalhaven Starches Modification 25 Rail Line Extension & Addition to Product Dryers	Extension of existing rail line by 1280 m including a 850 m train reverse loop and 180 m rail maintenance spur; and the addition of a roof baghouse to Product Dryer 3 & 4.
Rowany Medieval Festival DA 21/0797.01	An annual week-long festival located at Camp Wombaroo, about 33 km north west of the Project area. The festival is the largest event for the Society for Creative Anachronism, and typically would attract more than 1,000 attendees.
Wildfest	Community event within the township of Berrima, including a 10-day 'feast' event annually located about 24 km north west of the Project area
Dendrobium Mine Extension SSI-33143123	Proposed extension of mining within Area 5 and extension of the life of Dendrobium Mine until 2041 Area 5 is located in the Wingecarribee LGA, about 40 km north of the Project area. The mine extension would involve extraction of coal from the Bulli Seam un the proposed Area 5, with an increase in workforce anticipated during construction and operation.
Moss Vale Plastics Recycling Facility SSD-9409987	Proposed facility to sort and recycle plastic waste in Moss Vale. The facility would be located about 17 km north west of the Project area
New Shellharbour Hospital and Integrated Services	Proposed construction and operation of the New Shellharbour Hospital and Integrated Services project, to meet the demand for healthcare services for the growing Illawarra population, located about 33 km north east of the Project area. Work would begin before March 2023.
Berrima Cement Works Solid Waste Derived Fuels & Delivery Variation Project DA 401-11-2002-I	Proposed modification to increase waste consumption in the kiln, expanding storage and handling facilities, and increase truck deliveries and hours at the existing Berrima Cement Works, located about 22 km north west of the Project area.
Sutton Forest Sand Quarry	Proposed sand quarry which seeks to extract up to 1 million t of friable sandstone per year for up to 30 years.
Moss Vale Road Urban Release Area Maculata Park / Taylors Landing	Establishment of the urban release area includes rezoning of land and other works such as water and wastewater infrastructure. Planning is underway to deliver a future residential area in the Nowra-Bomaderry area – Moss Vale Road North Urban Release Area and is currently under exhibition. The project is located about 13 km south east of the Project area and would be expecting about 3,400 additional dwellings when complete

Project	Brief project description
Shoalhaven Community and Recreational Precinct – Artie Smith Oval Development	Upgrade of the oval, located about 15 km south east of the Project area.
Shoalhaven Community and Recreational Precinct – Shoalhaven Indoor Sports Centre Extension	Extension of the sports centre including the refurbishment of the Bomaderry Basketball Stadium, located about 15 km south east of the Project area
Shoalhaven Community and Recreational Precinct – Northern Section – Bomaderry Sporting Complex	Redevelopment of the area to the north of Cambewarra Road Bomaderry Sporting Complex, and provide new facilities including a new Community Hub, new pools, development of an athletics track and two senior rugby league fields with associated change rooms and amenities. The project is located about 15 km south east of the Project area.
Moss Vale Sewage Treatment Plant Upgrade	Proposed upgrade to provide treatment capacity to meet current and future population needs within the catchment, located about 18 km north west of the Project area. Design would be completed in 2022 with tendering and construction to follow.
Moss Vale Bypass	The 3-stage project would assist motorists travelling through Moss Vale by providing an alternative to Argyle Street. The Bypass includes an additional crossing of the Main Southern railway and critically, one which is not subject to flooding or height restrictions. The bypass would be located about 17 km north west of the Project area.
Ritters Creek, Meryla Road, Meryla - Bridge Replacement	Replacement of the single span timber bridge on Meryla Road with a new crossing, widening and other works such as bank stabilisation, located about 7 km west of the Project area
Fitzroy Falls RFS	A new RFS Shed will be built at Fitzroy Falls at the corner of Myra Vale Road and Nowra Road. The shed will replace the RFS Shed currently situated at Avoca. The detailed design has been completed and the Development Application is currently being reviewed. Located 2 km north of the Project area
Bowral and District Hospital Redevelopment Stage 2	Proposed redevelopment of the Bowral & District Hospital to expand clinical services, located about 21 km north west of the Project area
Bay and Basin Leisure Centre Redevelopment	Redevelop the existing Bay and Basin Leisure Centre and Vincentia Oval to enhance the current facilities, including upgrading and extending the existing centre, sporting precinct. The redevelopment would add new pool, gym extension, sportsground precinct upgrades, carparks, and is located about 40 km south east of the Project area
East Nowra Sub Arterial Road (ENSA)	Proposed to connect Greenwell Point Road (in the vicinity of Old Southern Road) to the Princes Highway, at North Street and Junction Street. ENSA will provide a much needed alternative connection to the highway from the East Nowra, Worrigee and coastal village areas. The road would be located about 18 km south east of the Project area
Shoalhaven Resource Recovery Facility West Nowra Resource Recovery Park Stage 2 SSD-9887	Proposal for constructing and operating a resource recovery facility with pre-treatment for mixed municipal waste of up to 130,000 t per year, located about 16 km south east of the Project area
Nowra Bridge Project – Princes Highway Upgrade	The project will provide a new four lane bridge over the Shoalhaven River, upgraded intersections and additional lanes on the Princes Highway.
Jervis Bay Road and Princes Highway intersection upgrade at Falls Creek	The project will provide a grade separated interchange, or flyover, with roundabouts on either side.



Legend

- Project location
- Project location indicative
- The Project area
- Location
- Road
- Waterway
- Waterbody

0 7 14 km

1:350,000 at A4

GDA2020 MGA Zone 56

Data sources

Jacobs 2022
Department of Planning and Environment 2022
© Department of Customer Service 2020

Figure 6-26 Location of the projects considered in the cumulative impact assessment

Date: 9/21/2022 Path: \\aursyd0vsD1\GIS\Proj\NSW_IS\392600_Shoalhaven\mxd:IS\Apps\IS392600_GENERAL.aprx
Created by : NT | QA by : CC

6.15.4 Cumulative impacts with other projects

Construction specific cumulative effects would most likely occur where construction works overlap in terms of timing and / or location with other local projects. Cumulative effects from construction activities usually relate to biodiversity, water, amenity (visual, air quality, noise and vibration), traffic and access. The scale of the impacts largely depends on the type of work, its duration, and the sensitivity of surrounding land uses.

The majority of the proposed and existing projects listed in **Table 6-57** would not interact with the Project in a manner likely to lead to any cumulative impacts due to the distance away from the Project.

6.15.4.1 Biodiversity

Site selection had deliberately targeted areas of prior disturbance and the implementation of the BAM including avoidance and offsetting requirements is aimed at achieving a maintained or improved outcome for biodiversity.

6.15.4.2 Aboriginal heritage

Prior impact to large areas of land in the immediate surrounding region, have increased the rarity of surviving Aboriginal sites in the region. Site selection had deliberately targeted areas of prior disturbance. The Partial loss of value of the identified Bendeela Hydro AS01 (AHIMS ID 52-4-0729) contributes to the cumulative impacts on Aboriginal heritage. Mitigation measures for the salvage of the site have been developed in consultation with RAPs to minimise Aboriginal heritage impacts.

6.15.4.3 Historical heritage

There are no other projects occurring within the vicinity of the Project, or nearby the State listed Hampden Bridge heritage items that are expected to impact non-Aboriginal historical heritage. Therefore, it is expected there will be no cumulative impacts to historical heritage during the construction and operation of the Project.

6.15.4.4 Land

Impacts to land as a result of the Project of the Project would be contained to the Project area. As a result, it is expected there will be no cumulative impacts to land during the construction and operation of the Project.

6.15.4.5 Surface water

Surface Water Assessment in **Appendix I** considered the cumulative impacts of the Project**.** That assessment identified two projects known as Fitzroy Falls RFS and Ritters Creek, Meryla Road Bridge Replacement located within the vicinity of the Project with common downstream receivers.

As the constructions of Fitzroy Falls RFS Service building and the Project are likely to occur at the same time, there is a risk that water quality at Fitzroy Falls Upper Canal may be impacted by increased sedimentation from dust produced during concurrent constructions activities. Given that the Fitzroy Falls RFS is located upstream of the Project and the appropriate mitigation measures would be implemented by both projects, there is unlikely to be cumulative impacts to the downstream water quality of Fitzroy Canal.

The Ritters Creek, Meryla Road Bridge Replacement will not be constructed at the same time as the Project and is located upstream. As a result, it is expected there will be no cumulative impacts to water quality during the construction and operation of the projects.

6.15.4.6 Groundwater

Cumulative groundwater impacts are further considered in **Appendix J**.

Potential groundwater related impacts for the Project during construction and operation are not considered to be significant and are restricted to the vicinity of the Project. The potential for cumulative impacts with other aquifer interference activities within the area is therefore unlikely.

6.15.4.7 Traffic and transport

Traffic and transport cumulative impacts are further considered in **Appendix L**.

Traffic modelling has included traffic growth that would accommodate the Moss Vale Road Urban Release Area. As such, traffic generated by this development that would potentially result in cumulative impacts has been adequately captured in the conservative background annual traffic growth adopted in the transport and traffic assessment for the Project.

A number of projects, including the Shoalhaven Community and Recreational Precinct, the Moss Vale Sewerage Treatment Plant Upgrade and the Moss Vale Bypass, would result in cumulative traffic volumes. The cumulative traffic impact of these projects is considered to be minor, given the limited cumulative traffic volumes, distance from the Project and use of major roads. All other projects listed described in All other projects listed described in **Table 6-57** are considered to have negligible cumulative traffic and transport impacts.

6.15.4.8 Noise and vibration

Noise and vibration impacts are further considered in Appendix M.

The highest risk of noise and vibration impacts from the Project is at receivers located in close proximity to the Project. Owing to the distance of the projects described in **Table 6-57** from the Project, cumulative noise and vibration impacts are not expected.

6.15.4.9 Air quality

Air quality cumulative impacts are further considered in **Appendix N.**

The air quality assessment considered the cumulative impacts of the projects described in **Table 6-57**. That assessment determined that the highest risk of air quality impacts from the Project would be near the emplacement area during construction. Given that the listed projects are located a sufficient distance from the Project, there would be no cumulative air quality impacts.

6.15.4.10 Waste

Spoil would be appropriately managed and disposed of within the on-site spoil emplacement area where it cannot be beneficially re-used such that cumulative impacts associated with consumption of limited land fill space are avoided.

Significant quantities of other wastes are not anticipated to be generated by the Project. Local options for waste disposal are limited and will require transfer to larger regional centres where a broad range of disposal options are available. As a result of the small volumes of waste and requirement for use of larger regional waste management facilities, it is expected there will be no cumulative waste impacts during the construction and operation of the Project.

6.15.4.11 Public safety

The Project and other projects in the locality may increase the risk of on-site ignitions which may result in a fire escaping into the surrounding vegetation. Other fire risks would be associated with hot works, potential for fuel spills providing a fuel source, and uncontrolled discarding of cigarettes and domestic rubbish by construction workers.

A bushfire would provide a direct threat to the safety of Project construction workers, visitors to Morton National Park, Bendeela Recreation Area and other recreational areas, or others working in the area (e.g. Water NSW and NPWS personnel). A fire would also have the potential to impact public and private property and infrastructure.

The Project would implement public safety mitigation measures including the preparation and implementation of a Bush Fire Emergency Management Plan.

No other cumulative hazards have been identified, as during construction, the Project area would be unavailable to the public. No cumulative impacts are expected during operation.

6.15.4.12 Social and economic impacts

The potential cumulative socio-economic impacts with other projects are anticipated to mainly occur during the construction phase and would mainly be associated with:

- Demand for local construction workers from communities in the primary and secondary study area, resulting in:
  - Reduced availability of local workers for the Project, increasing the need for construction workers to be sourced from areas outside of the primary and secondary study areas. This would result in increased demand for visitor accommodation and rental housing to accommodate construction workers (refer below for discussion of possible cumulative impacts of increased demand for housing and accommodation)
  - Increased potential for workers from existing industries to be attracted to work on the Project, resulting in possible worker shortages for local businesses and industries, possibly leading to increased costs and availability of some construction-related services, and increased wage costs for businesses to retain workers
- Demand for accommodation by construction workforces of multiple projects, including as a result of the need to increase the number of non-local residents due to reduced availability of local workers. This has potential to result in:
  - Additional positive impacts for accommodation providers such as increased business income by providing reliable and consistent business throughout the construction phase
  - Potential to further reduce the availability of some visitor accommodation types (e.g., hotels, motels, and caravan park cabins) for tourists and visitors, making it more difficult for visitors to secure accommodation and increasing the possibility that some people may be discouraged from visiting the primary and secondary study area during the construction phase. This may exacerbate potential flow on effects for other businesses that reply on accommodation providers to support their business such as reduced trade
  - Potential to further increase demand for rental housing and increasing upward pressure on rental prices in towns in the primary and secondary study areas, exacerbating potential impacts on rental housing affordability and possible housing stress for vulnerable households
- An increase in the number of non-local workers temporarily moving to towns and centres in the primary and secondary study area, exacerbating potential impacts on community cohesion (i.e., due to incidents of poor worker behaviour) and demand for social infrastructure, and further increasing the possibility that some community members will feel resentment to non-local workers and the Project.

Consultation and communication with communities and stakeholders through the planning, construction, and operation phases will be important in avoiding, minimising, or managing identified socio-economic impacts of the Project.

6.15.4.13 Visual impacts

Cumulative visual impacts would be unlikely given the locations of the other projects identified. Although the construction of Fitzroy Falls RFS Service building would also introduce new infrastructure into the local landscape, it is not likely to be visible from the same locations as the Project and therefore no cumulative visual impacts are anticipated.

7. Justification of the Project

This chapter presents a justification and merits for the project and a conclusion for the EIS.

7.1 Justification

Origin has undertaken a review of how the intermittency of VRE may be managed, and believes that the additional, rapidly dispatchable long duration energy storage provided by the Project would contribute significantly to supporting greater VRE penetration in NSW. The Project is wholly consistent with all State and National strategies and policies related to climate change and energy security and has been recognised through the Minister for Planning's critical State significant infrastructure declaration as essential for the economic, environmental and/or social needs of the State.

The essential nature of the Project is considered to outweigh the identified adverse impacts. While some environmental impacts cannot be avoided, in all cases they would be minimised to the extent reasonable and feasible through the design process and implementation of mitigation measures. The Project as described in Chapter 3 is considered to best meet the Project objectives when compared to all other alternatives and options (refer to **Section 2.5**).

Section 192(f) of the EP&A Regulation requires that an EIS provide 'the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in Section 193'. The principles of Ecologically Sustainable Development (ESD) are discussed in **Section 7.1.1** and the biophysical, economic and social considerations are as following:

- Biophysical costs and benefits: The Project would result in the direct removal of about 29.5 ha of native vegetation which includes about 0.23 ha of the TEC listed under both the BC Act and EPBC Act. The removal of this vegetation would also have direct impacts on 10 threatened species. Where impacts on biodiversity cannot be avoided or minimised, appropriate offsets would be provided
- Economic and social considerations: Most social impacts are localised and would be temporary during construction. Economic benefits are anticipated for local businesses during construction due to increased demand for goods and services and direct employment opportunities for up to 250 FTE workers during construction. During operation, the Project would export 235 MW of electricity into the energy grid for up to 13 hours. The Project is anticipated to represent a significant saving in GHG emissions compared to the existing energy market. With the long-term reduction in fossil fuel based generated electricity, this saving is anticipated to become more efficient over time, which will support Origin's commitment to be net zero emissions by 2050
- The Project is considered to be in the public interest. The Project represents a significant and cost-efficient private investment in electricity infrastructure. Overall, it would results in strong net public benefits by delivering essential energy storage and firming capacity as part of the energy transition
- In addition, the Project is consistent with all State and Commonwealth government policy related to energy security and climate change.

7.1.1 Ecologically sustainable development

ESD is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD were an integral consideration throughout the development of the Project.

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD and how the Project responds to these principles are discussed below.

7.1.1.1 The precautionary principle

The principle states that:

"if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by-

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

(ii) an assessment of the risk-weighted consequences of various options".

The precautionary principle deals with reconciling scientific uncertainty about environmental impacts with certainty in decision-making.

This principle was considered during development of the Project. The precautionary principle has guided the assessment of environmental impacts for this EIS and the development of management measures.

This EIS assesses the environmental impacts associated with the Project. The EIS was prepared adopting a conservative approach, which included assessing reasonable worst case impact scenarios. Management measures are proposed to address identified impacts. These management measures would be implemented during the Project. No management measures have been postponed as a result of lack of scientific certainty regarding impacts. No threat of serious or irreversible damage is considered likely as a result of the Project.

Origin's approach to site selection and tender evaluation has considered various options including consideration of environmental consequences. Commitments to detailed design as specified in each section of **Chapter 6** specify ongoing efforts to minimise environmental and social impacts.

7.1.1.2 Intergenerational equity

The principle states:

"that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations".

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Intergenerational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

The Project may have very minor impacts on intergenerational equity through the consumption of resources during construction and operation, including fuel and raw materials. Nevertheless, the Project would provide a significant and cost-efficient private investment in electricity infrastructure necessary to attain global climate change objectives. Overall it would result in strong net public benefits by delivering essential energy storage and firming capacity as part of the energy transition.

7.1.1.3 Conservation of biological diversity and ecological integrity

The Principle states:

"That conservation of biological diversity and ecological integrity should be a fundamental consideration"

Biodiversity values were considered in the development of the concept design of the Project. The assessment and ongoing design of the Project has been carried out with the aim of identifying, avoiding, minimising and mitigating impacts.

The direct biodiversity impact of the Project would be the clearing of up to 29.5 ha of native vegetation which includes about 0.23 ha of the TEC listed under both the BC Act and EPBC Act. The removal of this vegetation would also have direct impacts on threatened species.

Mitigation measures were identified to reduce the severity of direct and indirect impacts of the Project on biodiversity. Where there are likely to be residual impacts associated with vegetation clearance, such impacts would be offset. Offsets would be delivered in accordance with the Biodiversity Offset Scheme under the BC Act such that long-term improvements and conservation outcomes would be achieved.

7.1.1.4 Improved valuation, pricing, and incentive mechanisms

The Principle states:

"That environmental factors should be included in the valuation of assets and services, such as—

(i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems".

The principle of internalising environmental costs into decision making requires consideration of all environmental resources which may be affected by the carrying out of a project, including air, water, land and living things. Environmental factors were considered throughout the development of the design and in planning for construction and operation of the Project. As a consequence, environmental impacts were avoided or minimised where practical during the concept design development for the Project. Mitigation measures outlined in this EIS will be implemented during construction and operation of the Project. The cost of these management measures is incorporated into the Project cost, as well as the extent of environmental investigations carried out to inform this EIS.

7.2 Consideration of the objects of the EP&A Act

The objects of the EP&A Act provide a framework within which the justification of the Project can be considered. summary of this assessment is provided in **Table 7-1.**

Table 7-1. Consideration of objects of the EP&A Act

Object	Comment
To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources	The Project may result in amenity impacts, including construction noise and the generation of additional construction traffic. During construction, economic benefits are anticipated for local businesses and accommodation owners due to increased demand for accommodation, goods and services. Benefits would also be associated with direct and indirect employment opportunities. During operation, the Project would provide a significant and cost-efficient private investment in electricity infrastructure. Overall it would result in strong net public benefits by delivering essential energy storage and firming capacity as part of the energy transition.
To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	As described in **Section 7.1.1**, the Project is consistent with the principles of ESD.
To promote the orderly and economic use and development of land.	The Project is considered to constitute the orderly and economic use and development of land as it would maximise the energy generation benefits planned as part of the development of the Existing Scheme that have not be realised. The Project provides long duration storage essential to the energy transition with limited ongoing environmental impacts above those of the Existing Scheme.
To promote the delivery and maintenance of affordable housing.	The Project would not affect the delivery and maintenance of affordable housing.
To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	Biodiversity was considered in the development and selection of the preferred option, as discussed in **Section 2.5.** Biodiversity impacts are assessed in **Section 6.1.** The Project would result in the direct removal of about 29.5 ha of native vegetation. This would about 0.23 ha of the TEC listed under both the BC Act and EPBC Act. The removal of this vegetation would also have direct impacts on 10 threatened species due to the loss of habitat. Where impacts on biodiversity cannot be avoided or minimised, appropriate offsets would be provided.

Object	Comment
To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	Ground disturbing works are planned to take place within the extent of Bendeela Hydro AS01 (AHIMS ID 52-4-0729) that will result in partial harm and a partial loss of value to Aboriginal heritage. Impacts to non-Aboriginal heritage are considered unlikely
To promote good design and amenity of the built environment.	The Project has limited potential to impact visual amenity as most infrastructure is screened by native vegetation or underground. A rehabilitation strategy would provide for landscaping consistent with the surrounding environment. No significant built features are proposed.
To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants	The design, construction and maintenance of the Project would be undertaken in accordance with applicable standards and Origin's existing management systems. An assessment of public safety impacts has been undertaken in **Section 6.12**.
To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Origin is seeking approval for the Project Part 5 of the EP&A Act. Consultation was carried out with relevant local Councils and government agencies throughout the development of the Project and preparation of this EIS as described in **Chapter 5**.
To provide increased opportunity for community participation in environmental planning and assessment	Development of the Project has included consultation with relevant stakeholders as described in **Chapter 5**. The EIS would be placed on public exhibition, in which stakeholders and the community will be able to review the EIS and provide submissions on the Project. Any submissions received would be responded to by Origin. This process provides further opportunity for community participation in the environmental planning and assessment process.

7.3 Conclusion

This EIS addresses the key issues identified in the Secretary's environmental assessment requirements issued under Part 5, Division 5.2 of the EP&A Act and the relevant provisions of Part 8, Division 5 of the EP&A Regulation.

The proposed Shoalhaven Hydro Expansion Project and associated infrastructure represents a significant investment by Origin to assist in securing reliable, dispatchable electricity supplies for the national electricity market over the long term.

Site selection, options consideration and concept design for the Project was based on best meeting the Project objectives and maximising the benefits through the use of areas of existing disturbance, existing infrastructure, operating within the limitations of the Existing Scheme to achieve good environmental and social outcomes.

Key environmental issues were considered and potential impacts on those issues assessed. With the implementation of appropriate mitigation measures the residual impacts of the project would be minimised, with limited ongoing operational impacts beyond those of the Existing Scheme.

Based on the findings of the EIS, the Project is considered suitable for approval by the Minister for Planning. The overall Project benefits including dispatchable electricity and other network services are considered to outweigh the environmental and social impacts.

8. References

AEMO, 2022. 2022 ISP. *For the National Electricity Market*. https://aemo.com.au/-/media/files/major-publications/isp/2022/2022-documents/2022-integrated-system-plan-isp.pdf?la=en

Ahern, C R, Stone, Y, and Blunden B, 1998. Acid Sulfate Soils Assessment Guideline, Acid Sulfate Soils Management Advisory Committee. https://www.environment.nsw.gov.au/resources/soils/ASS-Manual-2-Assessment-Guidelines.pdf

ANZEC, 1990. Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration. http://www.nepc.gov.au/system/files/resources/378b7018-8f2a-8174-3928-2056b44bf9b0/files/anzec-gl-technical-basis-guidelines-minimise-annoyance-due-blasting-overpressure-and-ground.pdf

ANZECC and ARMCANZ, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, Chapter 1-7. https://www.waterquality.gov.au/sites/default/files/documents/anzecc-armcanz-2000-guidelines-vol1.pdf

ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments. www.waterquality.gov.au/anz-guidelines

Australia ICOMOS, 2013. The Burra Charter: The Australia ICOMOAS Charter for Places of Cultural Significance. Burwood, Victoria: Australia ICOMOS Incorporated. https://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf

Australian Government, 2018, Charter: National Water Quality Management Strategy, Department of Agriculture and Water Resources. https://www.waterquality.gov.au/sites/default/files/documents/nwqms-charter.pdf

Austroads, 2020. Guide to Traffic Management Part 12: Integrated Transport Assessments for Developments.

Austroads, 2017. Guide to Traffic Management Part 3: Traffic Studies and Analysis.

Bureau of Meteorology, 2020. Atlas of Groundwater Dependant Ecosystems.

DEC, 2006a. Assessing Vibration: A Technical Guideline. https://www.environment.nsw.gov.au/resources/noise/vibrationguide0643.pdf

DEC, 2006b. Morton National Park (North of Shoalhaven River) Fire Management Strategy. https://www.environment.nsw.gov.au/research-and-publications/publications-search/morton-national-park-north-of-shoalhaven-river-fire-management-strategy.

DECC, 2009. Interim Construction Noise Guideline. https://www.environment.nsw.gov.au/resources/noise/09265cng.pdf

DECC, 2007. Guidelines for the Assessment and Management of Groundwater Contamination. https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/clm/groundwaterguidelines07144.ashx

DECCW, 2011. NSW Road Noise Policy. https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/noise/2011236nswroadnoisepolicy.ashx

DECCW, 2010a. Aboriginal cultural heritage consultation requirements for proponents 2010. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Aboriginal-cultural-heritage/aboriginal-cultural-heritage-consultation-requirements-for-proponents-2010-090781.pdf

DECCW, 2010b. Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Aboriginal-cultural-heritage/due-diligence-code-of-practice-aboriginal-objects-protection-100798.pdf

DECCW, 2010c. Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Aboriginal-cultural-heritage/code-of-practice-for-archaeological-investigation-of-aboriginal-objects-100783.pdf

DECCW, 2006, NSW Water Quality Objectives. https://www.environment.nsw.gov.au/ieo/whatsnot.htm

Department of Industry, 2019. Sydney Basin South Groundwater Source of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011.

Department of Urban Affairs and Planning, 1996. EIS Guidelines – Roads and Related Facilities. https://www.planning.nsw.gov.au/-/media/Files/DPE/Guidelines/roads-and-related-facilities-eis-guideline-1996-10.pdf?la=en

DLWC, 1998. NSW Groundwater Quality Protection Policy.

DLWC. 2002. NSW State Groundwater Dependent Ecosystems Policy.

DPI, 2022. Fisheries Spatial Data Portal. Accessed in March 2022. https://www.dpi.nsw.gov.au/about-us/research-development/spatial-data-portal

DPI, 2018, Guidelines for controlled activities on waterfront land. Riparian corridors. https://water.nsw.gov.au/__data/assets/pdf_file/0003/367392/NRAR-Guidelines-for-controlled-activities-on-waterfront-land-Riparian-corridors.pdf

DPI, 2017. Agricultural Land Use Mapping Resources in NSW. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/711493/Agricultural-Land-Use-Mapping-Resources-in-NSW-User-s-Guide.pdf

DPI, 2013. Policy and guidelines for fish habitat conservation and management. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf

DPI, 2011. Land use Conflict Risk Assessment Guide. Resource Planning and Development Unit. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/412551/Land-use-conflict-risk-assessment-LUCRA-guide.pdf

DPIE, 2021a. Social Impact Assessment Guideline. For State Significant Projects. https://www.planning.nsw.gov.au/-/media/Files/DPE/Guidelines/Policy-and-legislation/Social-Impact-Assessment/SIA-Guideline.pdf

DPIE, 2021b. Illawarra-Shoalhaven Regional Plan 2041. https://www.planning.nsw.gov.au/-/media/Files/DPE/Plans-and-policies/Plans-for-your-area/Regional-plans/Illawarra-Shoalhaven-Regional-Plan-05-21.pdf

DPIE, 2020. BAM.

DPIE, 2020. Guideline for applying the Biodiversity Assessment Method at severely burnt sites.

International Standardisation Organisation, 2018. ISO14064-1:2018 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.

Serov, P, Kuginis, L and Williams, J.P, 2012. Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 – the conceptual framework. NSW Department of Primary Industries, Office of Water.

Landcom, 2004. Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition. https://www.landcom.com.au/assets/Uploads/managing-urban-stormwater-soils-construction-volume-1-fourth-edition-compressed.pdf

NHMRC and NRMMC 2011. Australian Drinking Water Guidelines.

NHMRC, 2008. Guidelines for Managing Risks in Recreational Water.

NPWS, 2001. Morton and Budawang Parks Plan of Management. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/morton-budawang-national-parks-plan-of-management-010131.pdf

NSW EPA, 2020. Consultants Reporting on Contaminated Land. Contaminated Land Guidelines. https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/contaminated-land/20p2233-consultants-reporting-on-contaminated-land-guidelines.pdf?la=en&hash=EBB6758A2DE448534B6FDD5057D280523E423CC7

NSW EPA, 2022. Approved methods for the sampling and analysis of air pollutants in NSW. https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/22p3487-approved-methods-for-air-in-nsw.pdf?la=en&hash=3267864B804C7CDE9C7730395A6BABE51D11CBDC

NSW EPA, 2014a. NSW Waste Avoidance and Resource Recovery Strategy 2014-21. https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wastestrategy/140876-warr-strategy-14-21.pdf?la=en&hash=EC6685E6624995242B0538B18C2E80C0CA2E51B3

NSW EPA, 2014b. Waste Classification Guidelines. Part 1 Classifying Waste. https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/wasteregulation/140796-classify-waste.ashx

NSW Government, 2021a. Net Zero Plan. Stage 1: 2020-2030. https://www.energy.nsw.gov.au/sites/default/files/2022-08/net-zero-plan-2020-2030-200057.pdf

NSW Government, 2021b. Net Zero Plan: Stage 1 Implementation Update. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/net-zero-plan-stage-1-2020-30-implementation-update-210460.pdf

NSW RFS, 2019, Planning for bushfire protection. A guide for councils, planners, fire authorities and developers. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0005/130667/Planning-for-Bush-Fire-Protection-2019.pdf

NSW Health, 2007, Health Impact Assessment: A Practical Guide. https://hiaconnect.edu.au/wp-content/uploads/2012/05/Health_Impact_Assessment_A_Practical_Guide.pdf

NSW Heritage Office, 1996a. Archaeological Assessments: Archaeological Assessment Guidelines.

NSW Heritage Office, 1996b. NSW Heritage Manual.

NSW National Parks and Wildlife Service, 2001, *Morton and Budawang National Parks Plan of Management*.

NSW Office of Water, 2012. NSW Aquifer Interference Policy. NSW Government policy for the licensing and assessment of aquifer interference activities. https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0005/151772/NSW-Aquifer-Interference-Policy.pdf

NTC, 2020. Australian Code for the Transport of Dangerous Goods by Road and Rail, National Transport Commission. Edition 7.7, 2020, Volume 1. https://www.ntc.gov.au/sites/default/files/assets/files/ADG-Code-7.7.pdf

OEH, 2011. Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Aboriginal-cultural-heritage/guide-to-investigating-assessing-reporting-aboriginal-cultural-heritage-nsw-110263.pdf

OEH, 2012. Land And Soil Capability Assessment Scheme.

OEH, 2022. Biodiversity Assessment Method – Calculator.

Roads and Traffic Authority, 2002. Guide to Traffic Generating Developments, version 2.2. https://roads-waterways.transport.nsw.gov.au/business-industry/partners-suppliers/documents/guides-manuals/guide-to-generating-traffic-developments.pdf

Roads and Maritime Services, 2016. Construction Noise and Vibration Guideline. https://roads-waterways.transport.nsw.gov.au/business-industry/partners-suppliers/documents/guides-manuals/construction-noise-and-vibration-guideline.pdf

Roads and Maritime Service, 2013. Supplements to Austroads Guides

Safework NSW, 2014. *Managing asbestos in or on soil*. https://www.safework.nsw.gov.au/resource-library/asbestos-publications/managing-asbestos-in-or-on-soil

Shoalhaven Bushfire Management Committee, 2018. Shoalhaven Bushfire Risk Management Plan. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0016/2527/Shoalhaven-BFRMP.pdf

Shoalhaven City Council , 2022. Shoalhaven 2032 Community Strategic Plan. https://doc.shoalhaven.nsw.gov.au/Displaydoc.aspx?Record=D22/390974

Shoalhaven City Council, 2014. Shoalhaven Development Control Plan 2014: Chapter G9 - Guidelines for Development on Flood Prone Land. https://dcp2014.shoalhaven.nsw.gov.au/sites/default/files/Chapter%20G9.2%20-%20Supporting%20Document%201%20see%20D19.177473.pdf

TfNSW, 2021. 2026 Road Safety Action Plan. https://towardszero.nsw.gov.au/sites/default/files/2022-05/TNSW9659%20Road-Safety-Action-Plan-2026-ACC_1_0.pdf

Transport for NSW, 2018. *Guidance note EIA-N04 Guidelines for Landscape Character and Visual Impact Assessment*.

TfNSW, 2020. Future Transport Strategy 2056.

TfNSW Centre for Road Safety, 2022. Database.

WaterNSW, 2015. Neutral or Beneficial Effect on Water Quality Assessment Guideline.

Workcover, 2005, Storage and Handling of Dangerous Goods Code of Practice, NSW Government. https://www.safework.nsw.gov.au/__data/assets/pdf_file/0005/50729/storage-handling-dangerous-goods-1354.pdf

Wingecarribee Shire Council, 2017. Wingecarribee Shire Community Strategic Plan.

Appendix A. SEARs compliance table

Appendix B. Indicative concept design

Appendix C. Statutory compliance table

Appendix D. Community engagement table

Appendix E. Mitigation measures

Appendix F. Biodiversity development assessment report

Appendix G. Aboriginal cultural heritage assessment report

Appendix H. Historical heritage impact assessment

Appendix I. Surface water quality, hydrology and geomorphology impact assessment

Appendix J. Groundwater impact assessment

Appendix K. Spoil management strategy

Appendix L. Traffic and transport impact assessment

Appendix M. Noise and vibration impact assessment

Appendix N. Air quality impact assessment

Appendix O. Bushfire assessment

Appendix P. Preliminary risk assessment

Appendix Q. Socio-economic impact assessment